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JURASSIC AND LOWER CRETACEOUS PALEOGEOGRAPHY AND DEPOSITIONAL TECTONICS OF PORCUPINE PLATEAU, ADJACENT AREAS OF NORTHERN YUKON AND THOSE OF MACKENZIE DISTRICT

J. A. JELETZKY

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ABSTRACT

Jurassic and Lower Cretaceous paleogeography was characterized by the presence of a major northeast-trending marine intracratonic trough (aulacogene) opening southward into the Mesozoic orogenic belt of the Canadian Cordillera. This Porcupine Plain - Richardson Mountain Trough extended across the present Porcupine Plateau from the Yukon Coastal Plain to Selwyn Mountains, and covered most or all of the sites of the present Ogilvie and Wernecke Mountains. It separated an extensive, eastern, Peel Landmass from a western, Keele-Old Crow Landmass.

The ancient Peel Landmass extended at least from Tuktoyaktuk to Wernecke Mountains, and was flanked on the west by a belt of arenaceous to argillaceous, marine to nonmarine Jurassic and Lower Cretaceous sediments derived from it. It became submerged in the earliest Albian stage of the Cretaceous. Keele-Old Crow Landmass was flanked on its east side by Jurassic and Lower Cretaceous sediments derived from it and similar to those flanking Peel Landmass. The two belts of arenaceous and argillaceous rocks were separated by a belt of Jurassic and Lower Cretaceous deep-water, predominantly argillaceous sediments, 40 to 120 miles wide, occupying the central part of the Porcupine Plain-Richardson Mountain Trough. This central argillaceous facies is unknown and probably absent in Ogilvie Mountains and in wells of Eagle Plain because of subsequent erosion; however, it occurs beneath the Aptian unconformity in the Molar YT P-34 well.

The prevalent quartzose to orthoquartzitic lithology of Jurassic to mid-Lower Cretaceous arenites of Keele Range and Nahoni Range suggests their derivation from early Carboniferous to Permotriassic quartzose clastics and mid-Paleozoic granitoids of Keele-Old Crow Range and British-Barn Mountain areas in Yukon and adjacent areas of northeastern Alaska. The smallish present day plutons occurring in these areas apparently are the roots of much more extensive laccolith- to sheet-like plutons destroyed by Jurassic to mid-Early Cretaceous erosion. An abrupt regional replacement of quartzose to orthoquartzitic arenites by chert-rich greywackes in the late Aptian supports this idea.

The above-described facies and paleogeographical pattern of the trough was controlled by predominantly vertical, oscillatory, localized to interregional tectonic movements of the principal tectonic elements of the report-area. The influence of eustatic fluctuations of sea level is discounted because of their insignificant amplitude (less than 500 feet) in comparison with that (2,000 to 4,000 feet) of the minimum short-term oscillatory vertical tectonic movements characteristic of tectonically active belts. Within such belts, the effects of eustatic movements can be expected to be completely overprinted by those of the areally localized, contemporary, oscillatory tectonic movements

RÉSUMÉ

La présence d'une grande fosse intracratonique (aulacogène) occupée par la mer, orientée vers le nord-est, et s'ouvrant vers le sud, sur la zone orogénique mésozoique de la Cordillère canadienne caractérise la paléogéographie du Jurassique et du Crétacé inférieur. Cette fosse, la fosse de Porcupine Plain - Richardson Mountain, s'étendait sur le plateau de Porcupine actuel à partir de la plaine côtière du Yukon jusqu'à la chaîne de Selwyn, et couvrait la totalité, ou du moins la majeure partie de l'emplacement actuel des monts Oglivie et Wernecke. Elle séparait la grande masse continental de Peel, à l'est de la masse de Keele-Old Crow, à l'ouest.

L'ancienne masse continentale de Peel s'étendait au moins de Tuktoyaktuk jusqu'aux monts Wernecke et était flanquée à l'ouest par une bande de sédiments du Jurassique et du Crétacé inférieur, arénacés ou argileux, marins ou non marins dont les éléments provenaient de la masse continentale de Peel. Elle a été submergée au tout début de l'étage Albien, du Crétacé. La masse continentale de Keele-Old Crow était flanquée éa l'est par une bande de sédiments du Jurassique et du Crétacé inférieur dont les éléments provenaient de cette dernière et sont semblables aux sédiments qui flanquaient la masse de Peel. Les deux bandes de sédiments arénacés et argileux étaient séparées par une zone de 40 à 120 miles de largeur de sédiments en majeure partie argileux, déposés en eau profonde datant du Jurassique et du Crétacé inférieur et occupant la partie centrale de la fosse de Porcupine Plain - Richardson Mountains. Ce faciès argileux de la zone centrale est inconnu et n'existe probablement pas dans les monts Oglivie et dans les puits de la Plaine d'Eagle par suite d'érosion subséquente; ce faciès apparaît cependant sous la discordance aptienne dans le puits Molar YT P-34.

Les arénites des chaînons Keele et Nahoni, du Jurassique au milieu du Crétacé inférieur sont surtout quartzeuses et orthoquartzitiques. Cette lithologie nous amène à penser que leurs éléments provenaient des roches clastiques quartzeuses du début du Carbonifère au Permo-Trias et des roches granitiques du milieu du Paléozoique des régions du Yukon occupées par les Chaînons Keele, Old Crow et Barn et les Monts Britanniques et des régions limitrophes du nord-est de l'Alaska. Les masses plutoniques, plutôt petites, qu'on rencontre aujourd'hui dans ces régions, ne sont, semble-t-il, que les rastes de masses plutoniques beaucoup plus larges - des laccolites ou feuillets - réduites par l'érosion au cours du Jurassique au milieu du Crétacé inférieur. Cette hypothèse semble être supportée par arénites quartzeuses et orthoquartzitiques qui sont remplacées soudainement à la fin de l'Aptien par des grauwackes riches en cherts.

Les facies décrits plus haut et la configuration paléogéographique de la fosse ont été déterminées par les mouvements principalement verticaux, oscillatories, locaux ou inter-régionaux, des principaux éléments tectoniques de la région étudiée. Nous ne tenons pas compte des variations eustatiques du niveau de la mer en raison de leur faible amplitude

Among the principal tectonic elements of the report-area, the east-northeast-trending Aklavik Arch was uplifted and flexed in late Early to early Middle Jurassic and again in Valanginian to mid-Hauterivian time. The north-trending Cache Creek Uplift (probably a northward offshoot of Aklavik Arch) and Canoe Depression apparently were active only in Valanginian to mid-Hauterivian time. The oscillatory movements of these tectonic elements resulted in the emergence of short-lived and localized source areas and shallow-water areas within the Porcupine Plain-Richardson Mountain Trough. However, all these depositional-tectonic events were merely second and third order complicating features happening on the longlasting background of a prevalent and strong subsidence and a rapid deposition of deep sea sediments within the well-defined, relatively narrow but deep, mid-basin zone of the trough.

The partly decoupled vertical tectonic movements on the flanks of the trough exhibit a Jurassic to early Valanginian phase of hinge-like movements around a centrally situated north-south-trending axis. In Early to Middle Jurassic time the eastern flank was moving up (relatively speaking) while the western flank was moving down. The direction of this hinge-like movement was reversed in the Late Jurassic. One more reversal occurred in the early Early Cretaceous (Valanginian) when the eastern flank was again (as in Early to Middle Jurassic time) moving up while the western flank was moving down.

The ensuing phase of regional oscillatory movements started with the early to mid-Hauterivian uplift of both flanks coupled with the uplift of Aklavik Arch and Cache Creek Uplift inside the trough. This regional uplift was followed by a late Hauterivian to late Barremian subsidence which was followed, in turn, by a regional Aptian uplift. This uplift culminated in the latest Aptian interregional orogeny which strongly uplifted the southern part of the trough and the south-western part of Peel Landmass. This orogeny apparently caused an inversion and folding of most or ?all of the mid-basin zone of the trough south of Aklavik Arch and severed permanently its longlasting depositional-tectonic connection with the Mesozoic orogenic belt of the Canadian Cordillera. The focal point of the latest Aptian tectonic pulse was situated south of the report-area. There was a gradual northward weakening of its effects resulting in the preservation of a residual deep-water "furrow" in the westernmost part of the trough north of Aklavik Arch. This "furrow" continued to subside strongly while the adjacent part of the Keele-Old Crow Landmass continued to rise strongly. The resulting new type of hinge-like movement around a strongly asymmetrically situated north-south-directed axis transformed this part of the trough into a foredeep of the latest Aptian Keele-Old Crow Landmass. This hinge-like movement dominated the entire studied length of the Porcupine Plain-Richardson Mountain Trough in the Early Albian. A mid- to Late Albian regional uplift of the Porcupine Plateau concludes the Jurassic to Early Cretaceous tectonic history of the report-area.

(moins de 500 pieds) en comparaison avec les mouvements rapides, verticaux et oscillatories (de 2,000 à 4,000 pieds) caractéristiques des régions tectoniquement actives. A l'intérieur de ces régions, on peut s'attendre à ce que les effets des mouvements eustatiques soient complètement masqués par ceux des mouvements tectoniques locaux, contemporains et oscillatories.

Parmi les principaux éléments teconiques de la région étudiée, l'arche d'Aklavik de direction est-nord-est a été soulevé et plisse de la fin du Jurassique inférieur au début du Jurassique moyen et à nouveau du Valanginien au milieu de l'Hauterivien. Le soulèvement de Cache Creek de direction nord, (Probablement une extension vers le nord de l'arche d'Aklavik), et la dépression de Canoe n'ont été en apparence actifs que du Valanginien à l'Hauterivien moyen. Les mouvements oscillatoires de ces éléments tectoniques donnèrent lieu à l'émersion temporaire de régions sources locales et éa des régions recouvertes d'eau mais de faible profondeur dans la fosse de Porcupine Plain-Richardson Mountains. Cependant, tous ces événements tectoniques et de sédimentation étaient simplement des événements de second et de troisième ordre, superposées à des événements beaucoup plus importants i.e. un affaissement prononcé et long et une sédimentation rapide en eau profonde dans la partie médiane, bien délimitée, relativement étroite mais profonde, de la fosse.

Les movements verticales reconnus sur les flancs de la fosse sont du type de bascule typique d'une phase tectonique du Jurassique à la fin du Valanginien. La charnière de ces mouvements était orientée nord-sud, et située au centre de la fosse. Du Jurassique inférieur au Jurassique moyen, le flanc est s'est élevé (en termes relatifs) alors que la flanc ouest s'abaissé. La direction du mouvement de bascule était inversé a la fin du Jurassique. Il y a eu, au début du Crétacé inférieur (Valanginien) une nouvelle inversion, le flanc est s'est élevé de nouveau tandis que le flanc ouest s'est abbaissé (comme au cours du Jurassique inférieur au Jurassique moyen).

La phase suivante des mouvements oscillatories régionaux dans la fosse a débuté avec le soulèvement, de l'Hauterivien inférieur à moyen, des deux de la fosse, accompagné du soulèvement de l'arche d'Aklavik et du soulèvement de Cache Creek. Ce soulèvement régional a été suivi, de l'Hauterivien supérieur au Barrémien supérieur, d'un mouvement de subsidence, qui a été suivi par le soulèvement régional de l'Aptien. Le point culminant du dernier soulèvement est représenté par l'orogénie inter-régionale de l'extrême fin de l'Aptien qui souleva fortement la partie méridionale de la fosse et la partie sud-ouest de la masse continentale de Peel. Cette orogénie causa apparamment une inversion et le plissement de la plus grande partie, sinon de la totalité (?), de la zone centrale de la fosse au sud de l'arche d'Aklavik, et rompit définitivement les vieilles relations (de tectonique et de) (sédimentation), de la fosse avec la zone orogénique mésozoique de la Cordillère canadienne. Le centre de cette poussée tectonique de la fin de l'Aptien était situé au sud de la région étudiée. Ses effets ont diminué en intensité progressivement vers le nord, ce qui permit la préservation d'un "sillon" résiduel formé en eau profonde dans la partie la plus à l'ouest de la fosse, au nord de l'arche d'Aklavik. Ce "sillon" continua de s'affaisser rapidement pendant que la partie adjacente de la masse continentale de Keele-

The Aklavik Arch has remained linear, contiguous and in its present-day geographical position at least since the early Paleozoic. The present claim of an *en échelon* arrangement of its component uplifts is incorrect. Other major tectonic elements and source areas of northern Yukon retained their relative geographic positions at least since the earliest Jurassic. These data refute the alleged occurrence of post-Precambrian continental drift within northern Yukon, adjacent parts of Northwest Territories, and northeastern and east-central Alaska. All of these regions formed part of an ancient North American craton which had been growing by accretion of adjacent orogenic belts at least since the early Paleozoic.

Old Crow continua de s'élever fortement. Un nouveau type de mouvement de bascule en résulta, dont l'axe de rotation était orienté nord-sud et de localisation fortement asymmétrique par rapport au centre de la fosse; ce mouvement transforma cette partie de la fosse en une avant-fosse de la masse continentale de Keele-Old Crow, de l'extrème fin de l'Aptien. Ce mouvement de bascule domina, au début de l'Albien, toute la longeur de la fosse de Porcupine Plain-Richardson Mountains à l'intérieur de la région étudiée. Un soulèvement rétional du plateau de Porcupine, de l'Albien moyen a l'Albien supérieur, mit fin a l'histoire tectonique du Jurassique au Crétacé inférieur de la région étudiée.

L'arche d'Aklavik est demeuré linéaire, continu et dans sa position géographique actuelle, au moins depuis le Paléozoique inférieur. L'hypothèse actuelle selon laquelle ses différents soulèvements seraient disposés en échelon est incorrect. Les autres éléments tectoniques importants et les régions sources du nord du Yukon ont conservé leur position géographique relative au moins depuis le tout début du Jurassique. Ces données écartent la possibilité que le nord du Yukon, les régions adjacentes des Territoires du Nord-ouest et le nord-est et centre est de l'Alaska ont été l'objet d'une dérive continentale postérieure au Précambrien. L'ensemble de ces régions formait un ancien craton nord-américain que s'est agrandi par l'annexion des zones orogéniques adjacentes, depuis des temps au moins aussi reculés que le début du Paléozoique.

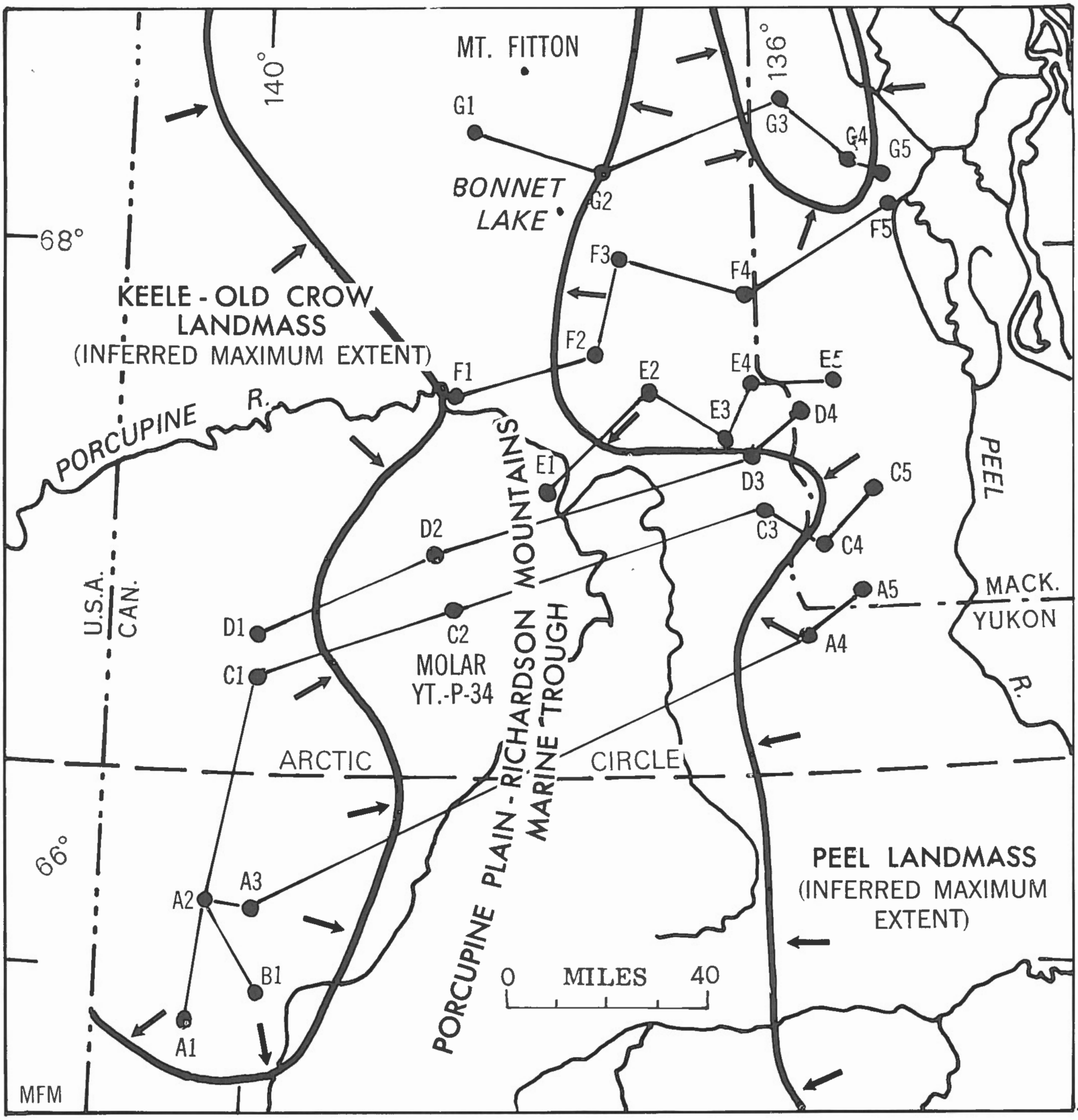


Figure 1. Index map of report area showing approximate directions and geographical positions of geological profiles across Porcupine Plain-Richardson Mountains Trough and adjacent landmasses. (palaeogeography simplified from Fig. 13).

JURASSIC AND LOWER CRETACEOUS PALEOGEOGRAPHY AND DEPOSITIONAL TECTONICS OF PORCUPINE PLATEAU, ADJACENT AREAS OF NORTHERN YUKON AND THOSE OF MACKENZIE DISTRICT, NORTHWEST TERRITORIES

INTRODUCTION AND ACKNOWLEDGMENTS

The purpose of this report is to provide the numerous geologists now engaged in the study of Mesozoic rocks of northern Yukon with a summary of the Jurassic and Lower Cretaceous paleogeography and depositional tectonics of this extremely complex but most intriguing and economically prospective region.

In order to achieve the maximum possible elucidation of the rather complex subject, the writer decided to present as many data as possible in geological cross-sections, paleogeographical maps, and structural diagrams. For the same reason, the text was organized as a series of separate summaries of the most critical biochronological, stratigraphical, lithological, sedimentological, and tectonic data keyed to the individual figures. These summaries should be used accordingly in conjunction with the corresponding figures. A considerable number of cross-references to other sections and figures and even a few repetitions resulting from this approach are accepted as a "necessary evil". The above-mentioned summaries also provide references to previously published reports of the writer and other sources where the topics concerned have been discussed more extensively. No attempt is made to replace the well-known informal nomenclature of rock units introduced by the writer by formal formational and member nomenclature in this preliminary report.

All of the relatively little known geographical names used in the text and figures of this report can be found in figures 9 to 16 of this report, in the provisional physiographic map of Canada published by Bostock (1964), in a more detailed physiographical map (Map 1254A) appended to the 5th Edition of the Geology and Economic Minerals of Canada (R.J.W. Douglas, 1970), and in an even more detailed physiographical map of the northern part of the report-area published by Miall (1973, p. 84, Fig. 1). This makes it unnecessary to include a physiographical map in this report.

The results as set forth in this report are based entirely on the study of directly or indirectly (Jeletzky, 1967, p. 9, 10) biochronologically controlled patterns of Jurassic and Lower Cretaceous bio- and lithofacies. A comprehensive review of principles and methods involved in the environmental interpretation of marine biofacies is contained in the Treatise on Marine Ecology and Paleoecology published by the Geological Society of America (GSA Mem. 67, 1957). Furthermore, these methods and principles were summarized ably by Ager (1963). Therefore, they will not be discussed in this report, except for some supplementary remarks dealing with specific topics inadequately treated or omitted in the above-mentioned publications.

As pointed out repeatedly by the writer (Jeletzky, 1963, p. 57, 58; 1967, p. 9, 10), attempts to interpret reliably the geological history of most lithostratigraphically and structurally complex Phanerozoic geological regions depend ultimately on the quality and precision of the accompanying or preceding biochronological research. This is particularly true of the tectonically active belt of northern Yukon and adjacent parts of the Mackenzie District. The still common neglect of the biochronology and the reliance on lithostratigraphical and/or sedimentological methods alone are deprecated by the writer. It is felt strongly, by the writer, that all now available lithostratigraphical and sedimentological methods can produce reliable results only in geologically simple, excellently exposed or closely drilled areas. Elsewhere they must be used under the conditions of a rigorous biochronological control which alone is able to reveal the relative merits of numerous possible, in themselves equally plausible, lithostratigraphic correlations and related hypotheses (e.g. those dealing with paleogeography and source areas).

On the basis of personal experience in the Mesozoic rocks of northern Yukon and other areas, the writer is especially sceptical about the practical value of currently fashionable attempts to restore the paleogeography of ancient marine basins and the source areas of their sediments by means of paleocurrent studies alone. Regardless of equitable spatial distribution and quantity (i.e. statistical approach) of paleocurrent measurements used, the uncertainties involved in their paleogeographical evaluation are judged to be even greater than it is admitted by some of the most outstanding practitioners of the method (e.g. Dżulynski and Walton, 1965, p. 240-254 and particularly p. 241-242, 248, 250, Fig. 165). The writer feels that a more or less reliable paleogeographical interpretation of paleocurrent measurements is possible only in the relatively simple to very simple types of ancient basins where the same, or at least similar paleocurrent and depositional patterns were maintained over long segments of geological time. As it will be shown below, these conditions are not met in the complexly shaped and tectonically strongly active basins, similar to the Porcupine Plain-Richardson Mountain Trough. In such basins, the paleocurrent and depositional patterns are apt to be extremely confused and obscure. Furthermore, they tend to change drastically and very fast in the course of geological time (i.e. within the time of a stage or even a single fossil zone). Under these circumstances a sedimentologist attempting to use paleocurrent evidence for the purpose of a broadly areal or regional analysis is bound to obtain extremely complex patterns of paleocurrent directions incapable of a definitive interpretation without recourse to other admittedly "more coarse grained" but much more reliable (within their own limits of precision) and much less time consuming methods, such as the analysis of lithofacies and biofacies patterns, paleobiogeographical data etc. If this is not done, the sedimentologist will not be able "to see the forest because of the trees". Worst of all, a sedimentologist working in the above-discussed situation is apt to amalgamate several successive and, most likely, radically different paleocurrent patterns within a single map of paleocurrent directions. This most critical source of error can be avoided only by using paleocurrent measurements confined to a single paleontological zone or subzone. In the writer's opinion, it is inadmissible to utilize paleocurrent patterns obtained from measurements made indiscriminately in any part of a broadly areally or regionally occurring unit that is not known to be continuous and essentially contemporary throughout and does not represent a short to very short segment of geological time (i.e. a single paleontological zone).

Because of the above considerations, it is extremely dangerous to attempt to work out the paleogeography and source areas of any complexly shaped and tectonically active ancient marine basin by any sedimentological or lithostratigraphical methods before its paleogeographical framework has been outlined by a broad areal or regional analysis of lithofacies, biofacies, and paleobiogeography. Those lithostratigraphers and structural geologists (e.g. Miall, 1973, p. 110) who treat the evidence of paleocurrent studies in such areas as the British and Barn Mountains as more reliable than that of the lithofacies patterns literally "place the cart before the horse" in the writer's opinion.

The above-mentioned criticisms may seem to be unduly severe. However, they are believed to be appropriate and constructive in the actually existing situation. It would appear that, in our age of ever increasing specialization and quantification, some sedimentologists and lithostratigraphers have lost sight of the relative merits and demerits of various available methods of paleogeographical reconstruction and have come to rely only on the most recent, fasionable but comparatively inferior methods which happened to be favoured in their geological schools.

In the writer's opinion, a number of recent conflicting interpretations of the Jurassic and Lower Cretaceous paleogeography and depositional tectonics of the report-area and adjacent areas of northern Yukon reflect the above-discussed over-reliance on sedimentological and lithostratigraphical methods and/or the neglect of biochronological control by some geologists working in this fascinating but extremely complex geological region.

This report is based largely on the already mentioned published and unpublished results of the writer's own field work in northern Yukon and adjacent parts of the Mackenzie District, N.W.T. in 1955, 1958, 1959, 1970, 1971, and 1973. However, it also utilizes considerable published and unpublished information obtained by other officers of the Geological Survey of Canada and other persons representing various Canadian and American organizations. The field and office work of the writer was greatly facilitated thereby but the limitations of space in this preliminary report make it impossible to thank individually most of these persons and organizations in Canada and the United States of America. However, much of this assistance was acknowledged individually in the previous reports (e.g. Jeletzky, 1958, 1960, 1961a, 1961b, 1963, 1967, 1971a, 1972a, 1972b and 1973) dealing with the stratigraphy, paleogeography and tectonics of the report-area. The writer expresses his sincere thanks to all colleagues and organizations who supported his research but accepts the full responsibility for any statements and conclusions resulting therefrom, except where stated otherwise in this report.

All Early Cretaceous and latest Jurassic (late Tithonian) fossils listed in text and figures of this report were identified and dated by the writer who also has identified and dated the older Jurassic belemnites and pelecypods that are listed. All listed pre-late Tithonian ammonites were identified and dated by H. Frebold (Geol. Surv. Can., retired).

The paleogeographical and structural interpretations offered appear to be reasonable and satisfactory to the writer in the light of presently available but often unevenly distributed and scarce information. However, many details may well be subject to considerable adjustment and reappraisal in the future because of rapid accumulation of new data about all aspects of the geology of northern Yukon. This paper, therefore, should be regarded as a progress report only.

GENERAL AND HISTORICAL REMARKS

The Porcupine Plateau and adjacent areas of northern Yukon are interpreted here as the site of a major north-northeast-trending, fault-controlled, marine intracratonic trough fragmenting the western shelf of the Canadian Shield (Fig. 1). This trough appears to be an aulacogene under the original definition of the term (Shatsky, 1964, p. 551, 552) as it appears to merge into the northern part of the Mesozoic orogenic belt of the Canadian Cordillera to the south and southwest. Contrary to the earlier opinion of the writer (Jeletzky, 1963, p. 77, 78, Fig. 5), the Porcupine Plain-Richardson Mountain aulacogene appears to end abruptly or gradually in the north beneath the Beaufort Sea. In this area, the Jurassic to Lower Cretaceous depositional trough seems either to abut against or to peter out within the structurally positive Arctic (= Hyperborean) Platform of older Soviet and North American authors (*see in* Jeletzky, 1963, p. 76, 77, Fig. 1 and Sirrine, 1973, p. 20, Fig. 1). This platform appears to be a relatively young, early Hercynian (= Ellesmerian), rather than a Precambrian structure in the light of subsequent work by Churkin (1969, p. 549-551, Figs. 1-3; 1973, p. 43-45, Fig. 19) and other American workers. The well-established marine connections (Jeletzky, 1971c) of the Jurassic to Lower Cretaceous Porcupine Plain-Richardson Mountain Trough with the contemporary Colville Foredeep of northern Alaska and the contemporary Sverdrup successor basin of the Canadian Arctic Archipelago appear to be paleogeographical (i.e. widespread transgressions across temporarily depressed but fundamentally unrelated tectonic elements) rather than depositional-tectonical in nature. The aulacogene of the report-area was named the Richardson Mountain Trough by the writer (Jeletzky, 1963) but was subsequently renamed the Porcupine Plain-Richardson Mountain Trough (Jeletzky, 1971b, p. 1; 1972a, p. 212, Fig. 1). This trough extended across the present Porcupine Plateau at least from the Yukon Coastal Plain to the present Selwyn Mountains, included most or all of the present Ogilvie Ranges, and connected on a wide front with the Jurassic-Cretaceous basin of east-central Alaska (figure 1). In the south, the Porcupine Plain-Richardson Mountain Trough must have been directly connected with the geosynclinal troughs of the Canadian Western Cordillera across the present Klondyke Plateau throughout Jurassic time (unpublished personal data) and in Berriasian to late Barremian time (Jeletzky, 1971c, p. 36-40, Fig. 5-7). Throughout the Jurassic and Early Cretaceous, this locally narrow but deep, subsiding marine trough separated the eastern Peel Landmass forming part of the Canadian Shield proper from a western land forming the eastern end of the ancestral Brooks Range Welt (figure 1). The latter land was named the Keele-Old Crow Landmass by the writer (Jeletzky, 1972a, p. 212, Fig. 1).

The above paleogeographical and tectonic interpretation of the Porcupine Plateau and adjacent areas of northern Yukon is disputed by some workers [e.g. Frebold, 1961, p. 37-40, Fig. 1; Frebold, Mountjoy and Tempelman-Kluit, 1967, p. 24; Tempelman-Kluit, 1970; Young, 1973 (pers. com.)] who believe that the southern part of the report-area comprising the Eagle Plain and the Nahoni Range was, generally speaking, not flooded by the Jurassic and Early Cretaceous seas until Albian time. These workers believe that only the northern part of the report-area, extending from the Yukon Coastal Plain to the Bell Basin and including most or all of the latter area, was covered by shallow epicontinental seas in pre-Albian time. According to this hypothesis (*see* Tempelman-Kluit, 1970, p. 31, Fig. 10), the Keele-Old Crow Landmass, as shown in figure 1 of this report, was but a frontal part of a large westward and northward prograding deltaic to alluvial complex which fringed the Jurassic to Lower Cretaceous cratonic landmass of Canada prior to the emergence of an Early Albian foredeep trough across the Porcupine Plateau. According to Frebold et al. (1967, p. 24), this landmass: "extended from Southern Richardson Mountains across the Eagle Plains to Monster Syncline in northwest Ogilvie Mountains (Fig. 1) as indicated by the present distribution of Mesozoic formations in this area (Mountjoy, in press, a, b; Norris, Price and Mountjoy, 1963)." However, it must be mentioned that Frebold et al. (1967, p. 24, 25) admitted the possibility of a different interpretation of the evidence then available; they state: "The region (i.e. Eagle Plain; writer's remark), however, may also have been thinly covered by Jurassic sediments which were later eroded in the late Lower Cretaceous time". So far as the writer knows, this alternative hypothesis harking back to the writer's (Jeletzky, 1963) earlier ideas was never mentioned again by the subsequent adherents of the hypothesis of the Eagle Plain Landmass.

The huge deltaic-alluvial lobe postulated by the above-mentioned workers apparently was believed to separate the northern embayment of the Jurassic to mid-Lower Cretaceous shelf sea from its southern embayment which occupied the Kandik Basin and central Yukon south of the report-area. According to its authors and adherents, this hypothesis is supported by a virtual lithological identity of mature quartz sands deposited throughout the Jurassic to mid-Early Cretaceous (until the late Aptian) time in the Richardson Mountains and in the Keele-Old Crow area. Another argument advanced in favour of the hypothesis was (and still is) the apparent lack of sediments of Jurassic to mid-Early Cretaceous age in subcrop under and outcrop around central and southern Eagle Plain. However, none of the authors or adherents of the hypothesis presented any information about the facies trends observed within the then known outcrop-areas of the Jurassic to mid-Lower Cretaceous rocks in the proximity of Eagle Plain (i.e. eastern headwaters of Rock River, Nahoni Range, Fishing Branch of Porcupine River, etc.; *see* GSC Map 10-1963).

In the writer's opinion, the hypothesis of the Eagle Plain Landmass was neither explained in detail nor sufficiently supported by factual data including facies analysis, paleobiogeographical data, and paleogeographical maps. However, the above comments and citations are believed to be a correct rendition of its principal tenets.

EXTENT, FACIES AND TECTONIC PATTERN OF THE PORCUPINE PLAIN-RICHARDSON MOUNTAIN TROUGH

The validity of above-discussed, conflicting paleogeographical-structural interpretations of the report-area now will be tested using a series of geological profiles (Figs. 2-8) based almost exclusively on personally measured, areally representative, biochronologically controlled individual sections or a combination of several such closely spaced incomplete sections. The approximate locations of these profiles and those of individual sections utilized in their compilation are indicated in Fig. 1. Except for the profile B1-A2-C1 (Fig. 3), these profiles are oriented as nearly as possible in the west-east direction, across the structural grain of the report-area.

Because of technical considerations, many rock-units had to be shown much thinner than their true scale. The true thicknesses of all such unusually thick units are, however, indicated by numerical values placed alongside their cut out middle parts (*see* Figs. 2-8).

Only the most critical biochronological data, consisting of the single best available index fossil for each selected control point, are included in profiles

2-8. All of the GSC locality numbers had to be omitted due to lack of space. The stratigraphic positioning of the fossils is approximate in all cases. Readers interested in more extensive biochronological background data are referred to previous reports of the writer. This is facilitated by the inclusion of references to these reports and to the previously published individual sections in the appropriate sections of the report.

SOUTHERN EAGLE PLAIN-NAHONI RANGE SEGMENT

The stratigraphy, biochronology and facies pattern of the Jurassic and Lower Cretaceous rocks of the southern Eagle Plain-Nahoni Range segment of the trough as well as those of the adjacent parts of the Richardson Mountains, the Canadian part of Kandik Basin and the southeastern part of Keele Range have been discussed previously (Jeletzky, 1960, 1971a, 1972a, 1972b) and will not be recapitulated in this report. However, some new data, either pertaining directly to the geological profiles A_1 to A_5 and C_1-A_2-B_1 or necessary for their paleogeographical-structural interpretation, have been included.

The facies pattern of the Jurassic to mid-Lower Cretaceous rocks in Sections A_1 to A_3 (Fig. 2) is obviously incompatible with the assumption of a landmass beneath the southern Eagle Plain and Nahoni Range (Frebold, Mountjoy and Tempelman-Kluit, 1967, p. 24).

The Lower to Middle Jurassic rocks, more recently discovered in the Kandik River-Nahoni Range area (Jeletzky, 1971a, p. 213, 214, 218, Fig. 3), are represented everywhere by the outer neritic to upper bathyal Kingak shale (restricted) which is almost entirely devoid of littoral to inner neritic mollusks. The almost total absence of belemnites is particularly significant as these animals apparently inhabited only the littoral and inner neritic zones of the open sea (i.e. stenohaline waters) not exceeding 150 to 200 feet in depth. These paleoecological data and the absence of any shoreward facies changes, except in close proximity of southeastern Keele Range (Fig. 3, Sec. C1), indicate the absence of land either within the area or in its immediate vicinity in Early and Middle Jurassic (i.e. Kingak) time.

The Upper Jurassic to mid-Lower Cretaceous rocks of Sections A1 to A3 inclusive exhibit a pronounced northeastward shaling out and thinning out of all nonmarine to littoral arenaceous and coarser clastic units beginning with the Unnamed Upper Jurassic sandstone and ending with the mid-Lower Cretaceous equivalents of the White and Coaly quartzite divisions (Fig. 2). The less complete record of the Upper sandstone division indicates a similar situation. Most of these facies relationships have been described in considerable detail by Jeletzky (1971a, p. 214-219, Fig. 3; 1972a, p. 213, Fig. 2; 1972b) and will not be repeated here. However, the following, especially striking (mentioned briefly in Jeletzky, 1971a, p. 217, 219) basinward facies changes of the Upper shale-siltstone division and its equivalents from southwest to northeast deserve to be described in greater detail.

As indicated by the discovery of diagnostic Barremian fossils (Jeletzky, 1971a, p. 217, 219; this report Fig. 2, Sec. A1), the time interval of the Upper shale-siltstone division of the more easterly areas is represented in the headwaters of the Kandik River by predominantly nonmarine, carbonaceous to coaly sandstones and silstones of the mid-Lower Cretaceous coaly clastic division. This part of the apparently deltaic unit includes some layers and thin beds of coal and a few interbeds of upper littoral (including beach) deposits but is completely devoid of the argillaceous open sea deposits. Only about 20 miles to the northeast (Jeletzky, 1971a, p. 217; this report Fig. 2, Secs. A2 and A3), these nonmarine clastics are replaced laterally by the reliably dated, mostly outer neritic to upper bathyal shale and siltstone of the Upper shale-siltstone division. The division is represented largely or ?entirely (none of the studied sections is complete) by non-turbiditic, presumably outer to inner (as indicated by the local presence of belemnites) neritic argillaceous rocks in the southwesternmost known sections (Fig. 2, Sec. A2). However, farther northeastward (Fig. 2, Sec. A3), the division is largely represented by extremely thick (at least 5000 feet; Jeletzky, 1971a, p. 215), almost unfossiliferous, presumably upper bathyal shale and siltstone. These argillaceous rocks include a large proportion of rhythmically and thinly bedded to laminated, distinctly graded flyschoid shale and siltstone. These rocks are lithologically and presumably sedimentologically similar to the apparently equivalent argillaceous rocks of the Biedermann Formation in east-central Alaska (Brabb, 1969, p. 116-121, Figs. 7, 8) and the flyschoid phase of the upper member of the similarly thick western facies of the Upper shale-siltstone division of the northern part of the trough (Jeletzky, 1973; and this report, in the discussion of the appropriate parts of the northern Bell Basin and Bonnet Lake-Lower Donna River segments). As indicated in Figure 14 and in the appropriate section of the paleogeographical chapter, all these deep water rocks are believed to form part of a contiguous mid-basin belt of the late Hauterivian to late Barremian Porcupine Plain-Richardson Mountain Trough.

A completely isolated erosional remnant of the eastern facies of the Upper shale-silstone division occurs on upper Peel River (Jeletzky, 1927b). The exposed section consists of the intertidal sandstones with diagnostic mid- to late Hauterivian fossils overlapping unconformably the deeply eroded surface of Permian rocks. The sandstones are overlain gradationally first by sandy and glauconitic siltstones and then by pure, presumably outer neritic siltstones representing the basal part of the Upper shale-siltstone division. The earlier Cretaceous and Jurassic rocks appear to be absent by nondeposition, so that this erosional remnant is a vestige of an extensive flooding of an elevated source area of the Peel Landmass by an eastward or southeastward late Hauterivian transgression.

The above-discussed facies relationships indicate that the predominantly arenaceous, partly coaly, and predominantly nonmarine Upper Jurassic to mid-Lower Cretaceous rocks of western Nahoni Range (exemplified by Sec. B1 of Fig. 3) and Kandik River area (exemplified by Sec. A1 of Fig. 2) were separated from the equivalent littoral to nonmarine arenites and rudites of the adjacent parts of Richardson Mountains (exemplified by Secs. A5 and A4 of Fig. 2) by a broad belt of open marine, predominantly or entirely argillaceous Upper Jurassic to mid-Lower Cretaceous rocks. The apparent absence of these rocks in the southern Eagle Plain wells may be due to widespread to total erosion during or after the interregional latest Aptian orogeny (e.g. Jeletzky, 1961a, p. 539-540, 543; 1971a, p. 209) or there may be misinterpretation of evidence on the part of lithostratigraphers. Besides, most wells in this area were drilled on the crests of buried Paleozoic anticlinal structures where the pre-Albian Mesozoic rocks are most likely to be eroded away in the aftermath of the latest Aptian orogeny.

In perfect agreement with the above interpretation of the subcrop area of southern Eagle Plain, the Jurassic to mid-Lower Cretaceous rocks of Sections A4 and A5 (Fig. 2), situated in the headwaters of Vittrekwa and Rock River, exhibit distinct basinward facies changes from east to west. For example, the North Branch area of eastern Richardson Mountains is characterized by nondeposition of the Lower to Middle Jurassic Bug Creek Formation (Jeletzky, 1967, p. 26, 130, 131; this report, Sec. A5 of Fig. 2). The North Branch Formation of this area overlaps directly unfossiliferous shales apparently representing either some part of the Upper Devonian Imperial Formation or a still unnamed Lower Mississippian turbidite unit which is widespread both in the area and to the west of it (Jeletzky, 1961a, p. 569, Figs. 2, 12; 1973).

The piedmont to alluvial facies of the Bug Creek Formation, which appears stratigraphically below either the North Branch Formation or the equivalent arenaceous facies of Husky Formation a few miles to the west and northwest of the North Branch valley and is widespread in the adjacent parts of central and western Richardson Mountains (Jeletzky, 1967, p. 26, 141, 146; 1972b; this report, Sec. A4 of Fig. 2), evidently was derived from the North Branch area to the east which, as already mentioned, represented an elevated source area throughout the Early and Middle Jurassic. Still farther west in the proximity of Rock River (Jeletzky, 1973), this entirely nonmarine facies of the Bug Creek Formation is replaced laterally by predominantly fine-grained, non-carbonaceous, intensively crossbedded and ripple-marked sandstones locally containing rare, poorly preserved marine pelecypods. These quartzose to orthoquartzitic sandstones appear to be of an alluvial, lagoonal, beach and upper littoral origin. They were deposited seaward of the abovementioned piedmont to alluvial facies of the Bug Creek Formation along the western shoreline of the Lower to Middle Jurassic Peel Landmass.

The Upper Jurassic to basal Cretaceous North Branch Formation of the North Branch area and other parts of the Vittrekwa River Basin is predominantly a beach to piedmont deposit equivalent to the predominantly littoral to neritic facies of the Husky Formation deposited farther west in the eastern headwaters of Rock River (Jeletzky, 1972a, p. 213, Fig. 2; 1972b, 1973; this report, Secs. A5 and A4 of Fig. 2).

The lower Lower Cretaceous Lower sandstone and Coal-bearing divisions exhibit a facies pattern entirely similar to that of the Bug Creek sandstone. These two divisions appear to be represented only by a hiatus between the North Branch Formation and the Upper shale-siltstone division (Jeletzky, 1967, p. 132; 1973; this report, Sec. A5 of Fig. 2) in the headwaters of Vittrekwa River. However, they are represented by almost exclusively nonmarine (deltaic to alluvial), coaly arenites and rudites to the west in the headwaters of Rock River (Jeletzky, 1972a, p. 213, Fig. 2; 1972b; this report, Sec. A4 of Fig. 2). Like the nonmarine facies of the Bug Creek Formation, these rock units were derived evidently from the North Branch area to the east.

The mid-Lower Cretaceous Upper shale-siltstone and Upper sandstone divisions also exhibit the same facies pattern as the Husky and North Branch Formations. These two divisions are fining and partly shale out markedly westward across the Richardson Mountains (*see* Secs. A5 and A4 of Fig. 2).

The east to west facies changes across the Richardson Mountains confirm the present or ?former existence of a belt of deep-water Jurassic to mid-Lower Cretaceous rocks in the subcrop of southern Eagle Plain as indicated by the previously discussed west to east facies relationships across the Nahoni Range-Kandik River area.

It must be stressed emphatically that the above-described facies pattern in the Vittrekwa-Rock River area is incompatible with an assumption of a westward prograding Jurassic deltaic lobe there. It indicates instead the occurrence of a strong eastward transgression lasting right through the Jurassic. This is indicated clearly by the eastward overstep of the Bug Creek hiatus by the predominantly beach to piedmont North Branch Formation and by an eastward overstep of predominantly nonmarine Bug Creek rocks by the littoral to neritic Husky Formation (Fig. 2). This eastward trangression culminated in the flooding of the headwaters of Vittrekwa River in latest Jurassic and earliest Cretaceous time resulting in the replacement of nonmarine to littoral clastics of the older part of the Sandstone-conglomerate member of the North Branch Formation by open marine shales of its topmost unit 37 containing *Buchia okensis* sensu stricto fauna (Jeletzky, 1960, p. 133; 1973) thus indicating a deep submergence of the elevated Lower to Middle Jurassic source area on the eastern flank of the Porcupine Plain-Richardson Mountain Trough. As already noted by Jeletzky (1963, p. 80, 81), these eastward transgressive relationships of the Jurassic rocks are characteristic of the entire length of the northern Richardson Mountains and are in themselves sufficient to discredit the hypothesis of an eastern or southeastern source for the Unnamed Upper Jurassic sandstone of western Porcupine Plateau.

The generally north-south oriented geological profile C1-A2-B1 (Fig. 3) across the southern Keele Range and western Nahoni Range clearly demonstrates a gradual but pronounced southward shaling out and thinning out of Jurassic to mid-Lower Cretaceous arenaceous units. As already mentioned, the Lower to Middle Jurassic Kingak Shale (restricted) is represented everywhere by outer neritic to upper bathyal rocks. This shale is extremely thick and contains considerable interbeds of littoral to inner neritic sandstones in southern Keele Range as exemplified by Section C1 (*see* also *in* Jeletzky, 1971a, p. 212, 213, Fig. 3). However, these sandstones shale out farther south in northwestern Nahoni Range as evidenced by Section A2 (Fig. 3). In this area and still farther south in the southwestern Nahoni Range (*see* Sec. B1, Fig. 3) and Kandik River area (*see* Sec. A1, Fig. 2), the now pure to silty Kingak shale thins out rapidly.

The Unnamed Upper Jurassic sandstone pronouncedly thins out and at the same time shales out toward the south. The predominantly nonmarine facies of Section C1 (*see* Fig. 3; and *in* Jeletzky, 1971a, p. 212, 213, Fig. 3) is laterally replaced by a lower littoral to inner neritic facies in the northwestern Nahoni Range exemplified by Section A2 (Fig. 3; and in Jeletzky 1971a, p. 212, 213, Fig. 3). Only a 90- to 150-foot tongue of this unit, including 50 per cent or more of the strongly arenaceous siltstone, extends into southwestern Nahoni Range (*see* Sec. B1 of Fig. 3) and Kandik River area (*see* Sec. A1 of Fig. 2) where it is reduced to an interbed in the deep marine Husky shale (Jeletzky, 1971a, p. 214, 215, Fig. 3). This mostly pure shale is believed to be an outer neritic to upper bathyal (i.e. deposited in the depths of approximately 400 to 800 feet) deposit in this area because of a total absence of belemnites and shallow-water pelecypods in its depauperated faunas. These consist almost exclusively of rare to very rare nectonic ammonites and depth-tolerant *Buchia* forms.

The same southward shaling out and thinning out characterizes the mid-Lower Cretaceous equivalents of the White quartzite and Coaly quartzite divisions which become largely replaced laterally by the outer neritic shale and siltstone of the uppermost part of Husky Formation and similar rocks of the lowermost part of the Upper shale-siltstone division in the southwestern Nahoni Range (*see* Sec. B1 of Fig. 3; and *in* Jeletzky, 1971a, p. 216, 217, Fig. 3). The record of the Upper shale-siltstone and Upper sandstone divisions is poor in this profile and throughout the area but the scanty data available point in the same direction as the above-discussed data for older units.

The above-discussed facies pattern exemplified by the profile C1-A2-B1 (Fig. 3) indicates that the previously discussed belt of open marine, predominantly or entirely argillaceous Jurassic to mid-Lower Cretaceous rocks inferred to exist in the subcrop of southern Eagle Plain extended at least into the Ogilvie Range. This deep sea apparently covered all of the Nahoni and Ogilvie Ranges and extended southward into the Selwyn Mountains. In the west, this deep sea connected on a wide front with the equally deep Jurassic to mid-Early Cretaceous sea of the Alaskan part of the Kandik Basin. The Jurassic to lower Lower Cretaceous parts of the Glenn shale and the Biedermann argillite of the Kandik Basin (Brabb, 1969) appear to represent a direct continuation of the Jurassic to mid-Lower Cretaceous mid-basin facies of adjacent parts of the Porcupine Plain-Richardson Mountain Trough as discussed in this report.

The apparently complete absence of Jurassic to mid-Lower Cretaceous marine rocks between the Kandik River-Nahoni Range area on the one hand and the Tombstone-Mayo area on the other is evidently the result of pre-Albian erosion. The Jurassic to ?mid-Lower Cretaceous rocks of the latter area (*see* Tempelman-Kluit, 1966, 1970, p. 26, 27, and *in* Frebold et al., 1967, p. 3, 4, 6, 7, 9) represent the same mid-basin facies as those of the Kandik River-Nahoni Range area. The southeastern flank of this basin therefore must have been situated still farther south within the present Klondyke Plateau. It may well have been displaced subsequently by the right-hand lateral faulting along Tintina Trench and may be represented now by the Tofty segment of central Alaska (Tempelman-Kluit, 1970, p. 82-84, Fig. 25).

The extremely thin development of all Jurassic to mid-Lower Cretaceous units of western Nahoni Range-Kandik River area (Jeletzky, 1971a; 1972b; and Figs. 2 and 3 of this report) indicates the sediment-starved nature of the mid-basin part of the Porcupine Plain-Richardson Mountain Trough at least from the southern Eagle Plain to the present Ogilvie Range. The inferred thinness of these rocks may help to explain why they were either eroded or not recognized in the Eagle Plain wells.

The combined evidence of profiles A1 to A5 (Fig. 2) and C1-A2-B1 (Fig. 3) and other evidence presented in this section amply demonstrates that, contrary to the ideas of Frebold (1961), Frebold, Mountjoy and Tempelman-Kluit (1967) and Tempelman-Kluit (1970), none of the Jurassic to mid-Lower Cretaceous wedges of the littoral to nonmarine arenites developed in the Keele-Nahoni Range area was derived from an eastern or southern source area. A deep, sediment-starved central zone of the Porcupine Plain-Richardson Mountain Trough was situated in these directions as indicated in figures 1 and 9 to 14 inclusive. The above-mentioned arenaceous wedges must have been derived exclusively from a northwestern to northern source area as originally suggested by Jeletzky (1963, p. 80, 81).

NORTHERN EAGLE PLAIN SEGMENT

The rebuttal of the alleged presence of a Jurassic to mid-Lower Cretaceous landmass in the southern Eagle Plain-Nahoni Range area does not demonstrate necessarily the absence of this hypothetical landmass farther north in the northern Eagle Plain area. The profile C1-C5 (Fig. 4) was compiled to resolve this problem. Like Sections A5 and A4 of Figure 2, Sections C5, C4, and C3 (Fig. 4) exhibit a regular and marked fining, shaling out and thinning out of all nonmarine to littoral, arenaceous to conglomeratic Jurassic to mid-

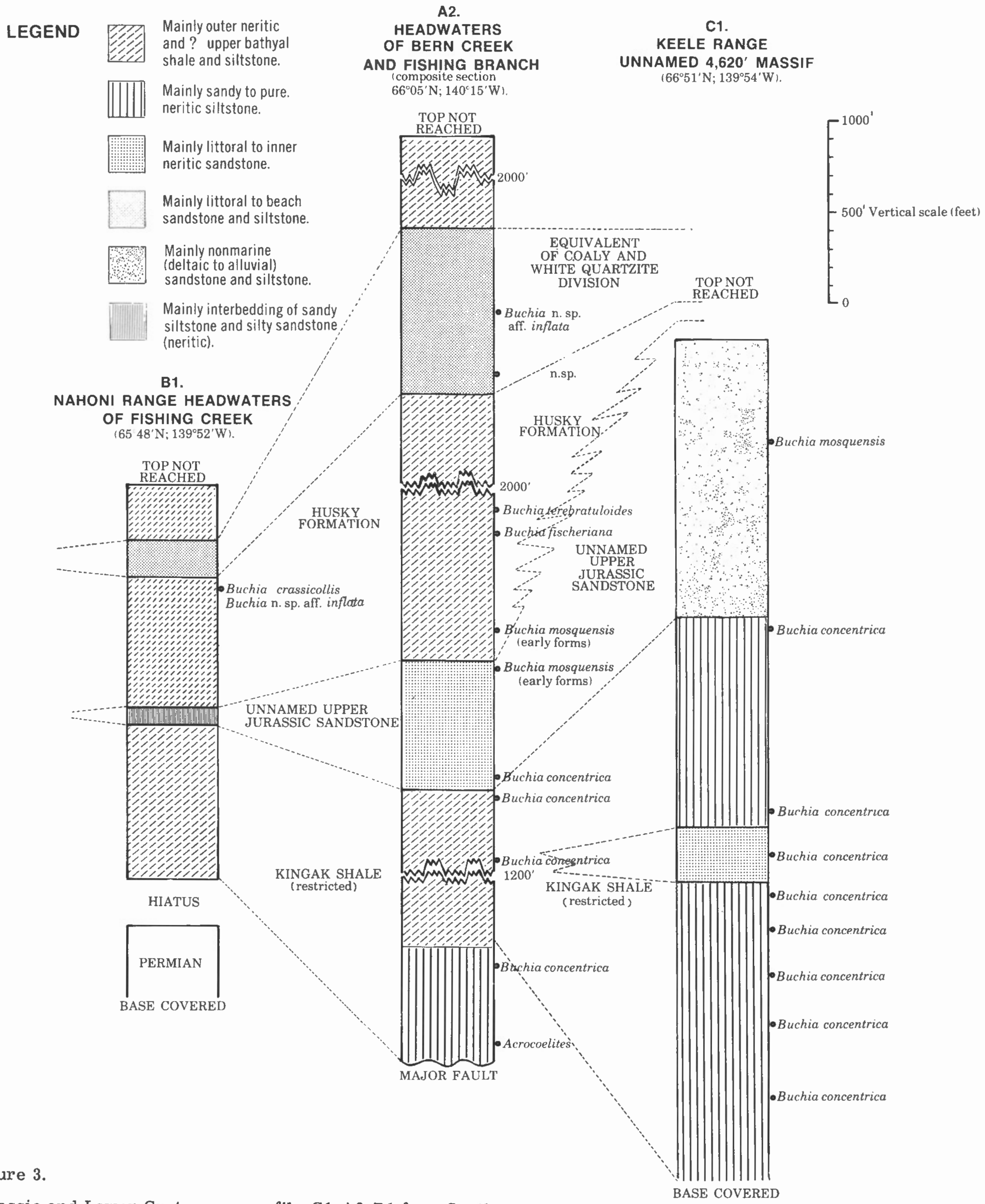


Figure 3.

Jurassic and Lower Cretaceous profile C1-A2-B1 from Southern Keele Range to Southwestern Nahoni Range, Southwestern Yukon. Approximate direction and geographical position of the profile is indicated in Figure 1.

Lower Cretaceous units from east to west across the central Richardson Mountains characteristic of the area. These lateral facies changes, beginning with the Upper Jurassic Husky Formation and ending with the Aptian Upper sandstone division, have been discussed previously by Jeletzky (1972b) and only a few additional comments will be made in this report.

The westward replacement of the nonmarine to littoral facies of the Bug Creek sandstone by the predominantly littoral to inner neritic arenites is ill-defined in the profile because of the faulting out of the larger upper part of the unit in Section C3 (Fig. 4). It is much better displayed in some other isolated, short sections of Bug Creek Formation on the northern side of the Pacific Rat River.

The prolonged lower to mid-Lower Cretaceous (late Berriasian to mid-Hauterivian) hiatus punctuating the Lower Cretaceous column on the eastern slope of Richardson Mountains and exemplified by Section C5 (Fig. 4) gradually diminishes westward and then disappears in the mostly neritic sequence of Section C3. The same is true of the hiatus between the Upper sandstone division and the Albian shale-siltstone division which appears to be restricted to the eastern slope of the Richardson Mountains (*see* Sec. C5 of Fig. 4). The westward pinching out of this hiatus is accompanied by a marked shaling out of the Upper sandstone and Albian shale-siltstone divisions in the same direction.

Like Sections A4 and A5 of Figure 2, Sections C3 to C5 (Fig. 4) indicate the occurrence of a continuous and strong eastward transgression during the Late Jurassic and earliest Cretaceous. This attests to the absence of any westward prograding Upper Jurassic deltaic lobe in the Barrier Ridge-Brat Creek area of the Richardson Mountains.

Section C1 in the Keele Range, described by Jeletzky (1971a, p. 213, Figs. 2, 3), and the Molar-YTP-34 well, interpreted in Section C2 (Fig. 4) from the lithostratigraphic log of Canadian Stratigraphic Services Ltd. and the micropaleontological data of Chamney (*in* Norford et al., 1971, p. 10-13), are rather incomplete. However, these sections indicate an eastward shaling out and thinning out of the Jurassic to lowest Cretaceous rocks on the western side of northern Eagle Plain. The upper Husky Formation of Section C2 is represented by the presumably inner neritic siltstones containing a marine fauna of foraminifers and belemnite fragments which indicate a normal salinity (Chamney *in* Norford et al., 1971, p. 13). It must have been deposited within the Porcupine Plain-Richardson Mountain Trough.

The almost entirely nonmarine, carbonaceous to coaly facies and the great thickness of the Unnamed Upper Jurassic sandstone in Section C1 are in contrast with its littoral facies (as indicated by foraminifers and belemnite fragments; *see* Chamney *in* Norford et al., 1971, p. 13) and apparently thin development in Section C2 (Fig. 4). There is thus every reason to assume that the Unnamed Upper Jurassic sandstone pinches out completely east of the Molar-YTP-34 well as indicated in Figure 4 and is replaced laterally by the shales of the lower Husky Formation in the subcrop of northern Eagle Plain.

The Kingak shale of the Molar-YTP-34 well (Sec. C2 of Fig. 4) is an offshore (?outer neritic) deposit as indicated by its shaly lithology and open marine foraminiferal fauna (Chamney *in* Norford et al., 1971, p. 13; and pers. com., Jan., 1973).

The combined evidence of facies relationships of Jurassic to mid-Lower Cretaceous rocks observed in Sections C1, C2 and C3 to C5 contradicts the hypothesis of the presence of a Jurassic to mid-Lower Cretaceous land in the subcrop of northern Eagle Plain. It indicates at least the former (i.e. pre-late Aptian) presence of open marine, predominantly or ?entirely argillaceous Jurassic to mid-Lower Cretaceous rocks throughout this area as shown in Figures 1 and 4. The Porcupine Plain-Richardson Mountain Trough evidently extended at least that far north and the eastern belt of littoral to nonmarine arenites of the Peel Landmass remained separated from the western belt of the same rocks surrounding the Keele-Old Crow Landmass by the above-mentioned mid-basin belt of outer neritic to upper bathyal argillaceous rocks throughout the Jurassic and early to mid-Early Cretaceous time.

The noticeable to marked basinward (i.e. westward) thinning out of the Husky Formation, combined Lower sandstone and Coal-bearing divisions, and the Upper shale-siltstone division between Sections C4 and C3 on the eastern flank of the trough suggest that the Jurassic to mid-Lower Cretaceous column of the mid-basin belt of the trough was attenuated in comparison with those of its flanks. However, it is uncertain just how pronounced this attenuation was and whether or not it was comparable to that actually observed in (*see* Fig. 3) or inferred for (*see* Fig. 2) the more southerly segments of the Porcupine Plain-Richardson Mountain Trough.

The absence of most of the lower to mid-Lower Cretaceous units in the Molar-YTP-34 well is attributable to their pre-Albian erosion during or immediately after the interregional latest Aptian orogeny (Jeletzky, 1961a, p. 539, 540, 543; 1971a, p. 209). These structural relationships are most important in providing a direct confirmation of a strong uplift (probably accompanied by folding) of the central belt in the southern part of the Porcupine Plain-Richardson Mountain Trough as suggested by the writer (*see* the preceding sections) to explain the absence of the Jurassic to mid-Lower Cretaceous rocks in all other deep wells drilled within the Eagle Plain. It seems likely that the central, sediment-starved belt of the trough was inverted completely during the latest Aptian orogeny within its southern part extending from the Ogilvie Range into the northern Eagle Plain (Jeletzky, 1973). The flanks of the trough apparently were considerably less uplifted and so retained a considerable part of their cover of Jurassic to mid-Lower Cretaceous rocks. The preservation of these rocks on the trough's flanks probably was facilitated by their considerably greater thickness as compared with the equivalent rocks in the central belt of the trough.

SOUTHERN BELL BASIN SEGMENT

Profile D1 to D4 (Fig. 5) illustrates characteristic facies trends across the southern part of Bell Basin (*see* Fig. 1). The eastern half of the profile (e.g. Secs. D3 and D4) is based on unpublished sections measured by the writer in Barrier Ridge. However, some stratigraphical and lithological features of these sections were discussed briefly by Jeletzky (1960, p. 6, 8, 11, 12, 14; 1967, p. 23, 24, 37, Fig. 2). Section D2 on the flank of Sharp Mountain and Section D1 on the divide between Bluefish and Lord creeks are based on groups of sections described in considerable detail in recent preliminary reports of the writer (Jeletzky, 1972b; 1973).

The westward shaling out of all littoral to nonmarine arenaceous wedges so characteristic of the corresponding parts of all preceding areas is equally characteristic of the eastern part of southern Bell Basin. It is exemplified by Sections D4 and D3 measured on the eastern and western flanks of Barrier Ridge (Fig. 5). The westward disappearance of the carbonaceous to coaly, predominantly beach to piedmont facies of the Bug Creek Formation and its lateral replacement by fine-grained, littoral to inner neritic sandstone is particularly striking (Fig. 5). However, the westward shaling out of Husky Formation and Upper shale-siltstone division is almost equally impressive.

Sections D4 and D3 also exhibit the continuous and strong Late Jurassic to earliest Cretaceous (Husky time) transgression characteristic of the already discussed parts of the eastern flank of the trough. Thus, there was no westward prograding Upper Jurassic deltaic lobe in the Stony Creek-Rat River area of the eastern Richardson Mountains.

A thin Upper Jurassic quartzose sandstone occurs in the Husky shale of Section D3. This sandstone appears to be correlative with the deeply eroded and therefore, presumably thicker Unnamed Upper Jurassic sandstone of Section D2 and with the thicker, equivalent sandstone of Section D1, and to represent their eastern pinchout zone. If so, the gradually attenuating Unnamed Upper Jurassic sandstone extended across the most part of southern Bell Basin as indicated in Figure 5.

The Jurassic and basal Cretaceous (Berriasian) parts of Section D1 are based on the writer's field work in 1973 (Jeletzky, 1973) which has invalidated his previously expressed (Jeletzky, 1972b) doubts about the correctness of Mountjoy's (in Frebold, Mountjoy and Tempelman-Kluit, 1967, p. 7) interpretation of this part of the section and particularly his suggestion concerning the provenance of the Upper Jurassic *Buchia* faunas collected there by Mountjoy (ibid.).

The presence of the open marine Kingak and Husky Formations and the attenuated marine facies of the Unnamed Upper Jurassic sandstone in the eastern Keele Range (Sec. D1 of Fig. 5) necessitates a re-interpretation of the Jurassic paleogeography of the area. The earlier idea (Jeletzky, 1972a, p. 212, Fig. 1; 1972b, Fig. 1) that the Valanginian to mid-Lower Cretaceous marine rocks outcropping in the headwaters of Bluefish River and Lord Creek apparently resulted from an eastward onlap of a shallow sea which originated in the adjacent part (Coleen Quadrangle) of the marine basin of east-central Alaska appears to be improbable as no Upper Jurassic to lower Valanginian marine rocks are known to be present in the latter area (*see* Brosgé et al., 1969). It is suggested instead that the Jurassic to mid-Lower Cretaceous rocks outcropping in the headwaters of Bluefish River and Lord Creek were deposited in a narrow but deep embayment of the Porcupine Plain-Richardson Mountain Trough which separated two eastward protruding peninsulas (apparently eastward prograding deltaic lobes) of the Keele-Old Crow Landmass. This embayment apparently ended within the western part of Keele Range somewhere east of the Yukon-Alaska boundary as shown in Figure 10. It was situated within the western arenaceous belt of the Porcupine Plain-Richardson Mountain Trough and received mature clastic detritus from the surrounding southwesterly, westerly and northwesterly areas of the Keele-Old Crow Landmass. In the writer's opinion, the Keele Trough of Norris (1972, p. 91, 93, Fig. 1) did not exist either in Jurassic or in Cretaceous time.

The apparently direct superposition (contact is covered) of thick Lower Albian pebble conglomerates on the ?lower part of the Unnamed Upper Jurassic sandstone containing poorly preserved ?*Buchia* (*Anaucella*) sp. (unpublished intradepartmental fossil report) and the apparent absence of the intervening Kimmeridgian to Aptian rocks in the studied sections of the Sharp Mountain area (*see* Sec. D2 of Fig. 5) suggest pre-Albian erosion either during or after the interregional latest Aptian orogeny. The structural and paleogeographical implications of these relationships were discussed in the preceding section in connection with the discussion of the Molar-YTP-34 Cretaceous succession.

Though largely limited to the eastern part of southern Bell Basin, the evidence available indicates the extension of the Porcupine Plain-Richardson Mountain Trough into the area and the absence of a Jurassic to mid-Lower Cretaceous land in the subcrop of its central part. The subcrop column of Figure 5 indicates the inferred facies relationships there.

NORTHERN BELL BASIN SEGMENT

The profile E1 to E5 (Fig. 6) illustrates the facies and tectonic pattern characteristic of the northern part of Bell Basin area.

Jurassic and basal Cretaceous facies and tectonic pattern on the eastern flank

The characteristic Jurassic to basal Cretaceous facies and tectonic pattern of the eastern part of the area is illustrated by Sections E5, E4, and E3. Sections E5 and E4 are based on previously published (Jeletzky, 1967, p. 147-156, 159, 160, 164, 165) Sections 153, 154 154a, 155, 155b and H-W-90 as well as on data derived from other still unpublished sections. Section E3 is based on an already published (Jeletzky, 1973) group of sections measured in the area situated between Summit Lake and the confluence of Bell and Little Bell rivers. This background information will be summarized only briefly in this section.

The Jurassic to basal Cretaceous parts (i. e. Bug and Husky Formations) of Sections E5, E4 and E3 exhibit the same westward fining and shaling out of the littoral to nonmarine arenaceous wedges as those of the corresponding parts of previous geological profiles (*see* Figs. 2, 4, and 5) representing more southerly parts of the eastern flank of the trough.

The inner littoral to ?nonmarine (?deltaic to lagoonal) sandstones, only 300 to 400 feet thick, of the easternmost facies of Bug Creek Formation as exemplified by Section E5 are replaced laterally westward by much thicker, commonly moderately to richly fossiliferous (including belemnites and thick-shelled, shallow-water pelecypods), lower littoral to inner neritic sandstones and sandy siltstones as exemplified by Section E4. Still farther west, the greater middle part of the formation consists of sandy to pure siltstone lithologically similar to the Kingak shale. Only the relatively thin basal and topmost beds of the formation are still represented by the sandstone in the Summit Lake-Little Bell River area. This predominantly outer neritic (absence of belemnites) mid-basin facies of Bug Creek Formation is exemplified by Section E3. It is strongly transitional to the Kingak shale of the more westerly parts of the area [compare with the equivalent upper (post-Toarcian) part of the Kingak in Section E2] and apparently passes into it laterally (Jeletzky, 1973; this report, Fig. 6) in the easternmost part of Waters River basin.

The characteristic absence of the lower Bug Creek Formation throughout the eastern part of the area is exemplified by Sections E3, E4, and E5. As pointed out by Jeletzky (1967, p. 18, Figs. 2, 3; 1973), this hiatus appears to reflect a subsequent erosion rather than nondeposition of this part of the formation.

The Early to early Middle Jurassic hiatus extends much farther westward (i. e. basinward) in the northern Bell Basin area than it does in the adjacent areas (*see* Figs. 5, 7, 8, and 9). This is attributable to the northern Bell Basin area being situated astride the crestal zone of the east-northeast-trending Aklavik Arch which was flexed and briefly but strongly uplifted in late Early and early Middle Jurassic time. This orogenic phase, as well as its paleogeographical and depositional-tectonic consequences, have been described previously (Jeletzky, 1963, p. 79, 80, Figs. 5, 6; 1967, p. 18, Figs. 2, 3; 1973).

The predominantly sandy, commonly fairly fossiliferous, mostly inner neritic to lower littoral siltstones dominating the Husky Formation in the easternmost part of the area (i. e. in Rat River Gorge and Brat Creek areas) are exemplified by Section E5 of Figure 6. Toward the west, these siltstones are replaced laterally by mostly pure, extremely poorly fossiliferous to nonfossiliferous, outer neritic to ?upper bathyal siltstones and shales which become prevalent in the Summit Lake-Bell River area (*see* Sections E3 and E4 of Figure 6). These basinward facies changes parallel those occurring in the Bug Creek Formation.

The pronounced eastward overlap of the littoral to ?nonmarine arenites of the Bug Creek Formation by the predominantly neritic siltstones of the Husky Formation (*see* Sec. E5 of Fig. 6; and Jeletzky, 1967, p. 158) in the Rat River Gorge-Brat Creek area demonstrates the occurrence of the previously mentioned eastward Late Jurassic transgression on the eastern flank of the northern Bell Basin segment.

A strong westward thickening of the Bug Creek and Husky Formations characteristic of the eastern part of the area is exemplified by Sections E5, E4 and E3 (*see* Fig. 6). This basinward thickening of Jurassic rocks in the northern Bell Basin contrasts with the characteristic basinward thinning out of the Jurassic rocks in the previously discussed southern segments of the Porcupine Plain-Richardson Mountain Trough.

Jurassic and basal Cretaceous facies and tectonic pattern on the western flank

The characteristic facies pattern of Jurassic and basal Cretaceous (early Berriasian)rocks observed on the western side of the northern Bell Basin and in adjacent parts of Keele Range is exemplified by Sections E1 and E2 (Fig. 6). Section E1 is based mainly on the already published data (Jeletzky, 1963, p. 78-81, Fig. 6) with the addition of some more recent, unpublished information. Section E2 is based exclusively on recent field work already published in a preliminary form (Jeletzky, 1973).

Sections E1, E2, and E3 illustrate the characteristic eastward shaling out of the littoral to nonmarine Jurassic arenaceous units widespread on the western side of the area. In principle (*see* Jeletzky, 1973), these facies changes consist of an almost complete lateral replacement of the western arenaceous wedges by the argillaceous rocks of the Kingak (restricted) and Husky Formations in the mid-basin zone of the northern Bell Basin segment (*see* Sec. E3 of Fig. 6).

The attenuated sandstone interbeds occurring in the Kingak Formation of Section E2 (*see* Fig. 6) and other neighbouring sections of Waters River basin occupy different stratigraphic levels as compared with the attenuated sandstone members of the mid-basin facies of the Bug Creek Formation occurring in Section E3 and elsewhere in the Little Bell River-Summit Lake area. This suggests that the distal parts of the western and eastern sandstone wedges do not merge with one another but pinch out within the interval, about 20 miles wide, separating the eastern headwaters of Waters River from the Little Bell River-Summit Lake area as shown in Figure 6.

Like the previously discussed basinward facies changes of the Jurassic rocks on the eastern flank of the northern Bell River segment, those occurring on its western flank are accompanied by a moderate to pronounced basinward thickening of the Jurassic column (compare Sections E1, E2 and E3). The apparently complete absence in the Waters River basin (*see* Sec. E2 of Fig. 6) of the Early to early Middle Jurassic hiatus corresponding to that of the eastern part of the area indicates that only the eastern part of Aklavik Arch was flexed and uplifted at that time.

Section E1 (Fig. 6) and other unpublished adjacent sections provide positive evidence of the approximate position of the eastern shoreline of the Early to mid-Jurassic Keele-Old Crow Landmass in northern Bell Basin area. The prevalence of abundantly fossiliferous littoral sandstones and the nondeposition of the Hettangian and Sinemurian [except for the uppermost Sinemurian *Arctoasteroceras jeletzkyi* and *Echioceras* (sensu lato) sp. zones; *see* Jeletzky, 1963, p. 79, 80, Fig. 6, and unpublished interdepartmental fossil reports] rocks in the Porcupine River canyon area exemplified by this section indicate its close proximity to the eastern shoreline of this land.

The Unnamed Upper Jurassic sandstone division is more than 2,000 feet thick in the Porcupine River canyon area and the adjacent western part of Dave Lord Ridge represented by Section E1 (*see* Jeletzky, 1963, p. 80, 81, Fig. 6; 1971a, p. 211-213, Fig. 2; 1972b; 1973). In this area the lower part of the division, which is at least 1,200 feet thick, appears to be entirely or at least predominantly nonmarine (presumably deltaic and/or supratidal) as it consists largely of extremely carbonaceous to coaly sandstone and siltstone locally containing abundant but poorly preserved plant remains, accumulations of carbonized or silicified branches, twigs and sizable tree trunks and is almost to entirely devoid of marine fossils. The overlying upper part of the division, more than 800 feet thick, appears to be predominantly or entirely shallow marine as it includes few or no carbonaceous to coaly interbeds and contains a number of beds rich in marine fossils. Farther east in the basin of Waters River, as exemplified by Section E2 (*see* Jeletzky, 1973 for further details), the sandstone becomes appreciably thinner, represents a shorter time span in terms of biochronological units, and is represented mainly by littoral deposits. This richly fossiliferous, shallow marine facies of the Unnamed Upper Jurassic sandstone division was deposited in a basin of a normal to near normal salinity as indicated by the presence of ammonites, belemnites, and starfish in its predominantly pelecypod faunas. Hence it cannot be interpreted as a lagoonal or estuarine facies. Still farther east in the Little Bell River-Summit Lake area, as exemplified by Section E3 of Figure 6 (*see* Jeletzky, 1973 for further details), this littoral sandstone is replaced almost completely laterally by the deep water argillaceous rocks of the Husky Formation. The outermost neritic to upper bathyal nature of these sparsely fossiliferous to almost unfossiliferous rocks is indicated by a complete absence of littoral to inner neritic mollusks, including belemnites, and by the rarity of such depth-tolerant forms as *Buchia, Inoceramus* and ammonites.

No traces of the Unnamed Upper Jurassic sandstone are recognizable in the more shallow water (inner neritic) facies of the Husky Formation in the eastern part of the northern Bell River segment, as exemplified by Sections E4 and E5 of Figure 6. Minor sandstone interbeds and bodies locally present in this facies (e.g. that occurring in Sec. E4 of Fig. 6) occupy a much higher stratigraphic position than the easternmost known tongues of the Unnamed Upper Jurassic sandstone in the Little Bell River-Summit Lake area (e.g. Sec. E3 of Fig. 6) and so cannot be connected with the latter. The apparently limited extent and random distribution of these eastern sands suggest their resulting from a winnowing out and/or transporting action of bottom currents on and around underwater banks situated within the eastern part of the northern Bell Basin segment.

The above-discussed facies changes as well as the eastward overstep (i.e. offlap) of the shallow water facies of the Kingak Formation by the deltaic to ?alluvial facies of the Unnamed Upper Jurassic sandstone and a similar overstep of the open marine facies of the Kingak by the predominantly littoral facies of the Unnamed Upper Jurassic sandstone (*see* Secs. E1 and E2 of Fig. 6) indicate a pronounced uplift of the northern Bell Basin segment of the Keele-Old Crow Landmass in the Late Jurassic. This uplift was accompanied by the formation of a large eastward prograding Upper Jurassic delta on the western side of the segment (Jeletzky, 1963, p. 80, 81, Fig. 6; 1971a, p. 211-213; Fig. 2; 1972b; 1973). These data, and especially the presence of an attenuated, entirely marine facies of the Unnamed Upper Jurassic sandstone southeastward of Porcupine River canyon area (Sec. D1 of Fig. 5; Fig. 10), wholly confirm the northwestern to western source area of the mature, quartzose to orthoquartzitic arenites of the Unnamed Upper Jurassic sandstone of the northern Bell Basin area long advocated by Jeletzky (1963, p. 80, 81, Fig. 6).

The early Late Jurassic uplift of the Keele-Old Crow Landmass within the segment and the ensuing deposition of a thick apron of the eastward, northeastward and ?southeastward prograding deltaic and littoral arenites of the Unnamed Upper Jurassic sandstone unit are reflected in a remarkable eastward shift of the mid-basin zone (i.e. axial part) of the trough (*see* Secs. E1 to E3 of Fig. 6). This zone was situated within the western part of Waters River-Berry Creek area throughout Kingak time but shifted into the Bell River-Summit Lake area in the early Late Jurassic and remained there until the end of Husky time (i.e. till the end of the early Berriasian).

Late Berriasian to mid-Hauterivian facies and tectonic pattern

Like the underlying Bug Creek and Husky Formations, the Lower sandstone division of the eastern and central parts of the area exhibits marked basinward changes from east to west (*see* Secs. E2 to E5 of Fig. 6). However, the rocks of the division are unknown on the western flank. The details of these facies changes and their tectonic causes (i.e. uplift and flexing of the crestal part of Aklavik Arch) have been discussed elsewhere (Jeletzky, 1973). However, it must be pointed out that, like its previously discussed late Early to early Middle Jurassic predecessor, the early Early Cretaceous (Valanginian to mid-Hauterivian) orogenic phase is in evidence much farther westward (i. e. basinward) in the northern Bell Basin area than in the adjacent areas to the south and north (*see* Jeletzky, 1973; and this report, Figs. 5, 7, 8 and 12). This is again attributable to the northern Bell Basin area being situated astride the crestal zone of the east-northeast-trending, tectonically active Aklavik Arch.

The Valanginian to mid-Hauterivian flexing and uplift of the arch were considerably stronger than the Jurassic pulse judging by the paleogeographical and depositional-tectonic effects (Jeletzky, 1973). By late Berriasian time, the lower littoral to inner neritic mid-basin zone (i. e. basin's axis) shifted westward at least into Waters River basin (from its early Berriasian position in the Little Bell River-Summit Lake area; *see* Sec. E2 and E3 of Fig. 6) while all of the more easterly parts of the northern Bell Basin segment were uplifted above sea level (Jeletzky, 1973; and this report, Secs. E3 to E5 of Fig. 6). In Valanginian time (i. e. time of deposition of the White sandstone member), all of the Waters River basin was uplifted above sea level and the same may have been true of the eastern Keele Range area farther west (*see* Jeletzky, 1973, Fig. 2). In early to mid-Hauterivian time (i. e. time of deposition of the Coal-bearing, White quartzite and Coaly quartzite divisions), most of the segment was an elevated land (a source area) which supplied nonmarine sediments to the adjacent areas (i. e. southern Bell Basin and White Mountain segments; *see* Figs. 5, 7, 13; and in Jeletzky, 1973). The early to mid-Hauterivian sea (i. e. the axial zone of the trough) apparently was restricted to a narrow strait situated in the extreme western part of the area. This strait apparently was centred around the lower course of Driftwood River and adjacent parts of Porcupine River (Fig. 13). The acme of the westward migration of the mid-basin zone of the trough apparently occurred in early to mid-Hauterivian time.

The evidence now available about the existence of a narrow, marine, early to mid-Hauterivian strait in the Driftwood-Porcupine area is indirect and inconclusive (Jeletzky, 1973; and this report, Secs. G1 and G2, Fig. 8). Therefore, it is possible that, contrary to the writer's belief, the crestal zone of the early to mid-Hauterivian Aklavik Arch was briefly elevated above sea level right across this structurally depressed (presumably cross-faulted) interval. Should this alternative hypothesis be found to be correct, one would expect only the nonmarine clastics of the White and Coaly quartzite divisions to be deposited on the crest of the arch in the area around the confluence of Driftwood and Porcupine rivers at the acme of this orogenic phase.

Late Hauterivian to Albian facies and tectonic pattern

The rapid and widespread late Hauterivian transgression re-flooded all of the crestal part of the Aklavik Arch uplifted above sea level by the Valanginian to mid-Hauterivian tectonic pulse. The ensuing late Hauterivian to late Barremian facies and tecontic pattern in the northern Bell Basin area is illustrated by Sections E2 to E5 inclusive. The corresponding parts of Sections E5 and E4 are based on still unpublished sections measured by the writer between the Big Bend of Rat River in the east and Summit Lake in the west. Some of the characteristic stratigraphical and lithological features of these sections were summarized in preliminary reports (Jeletzky, 1958, p. 10; 1960, p. 11-13). However, the characteristic reduction of the thickness of the Upper shale-siltstone division to between 800 and 1,000 feet was not recorded previously.

Sections E3 and E2 (*see* Fig. 6) are representative of a number of good sections recently measured in the area between the north-south-trending stretch of Bell River and Waters River and described in considerable detail in a preliminary report (Jeletzky, 1973).

The basinward facies changes from east to west were more pronounced in the time of the deposition of the Upper shale-siltstone division than ever before. The division is represented by relatively thin (800-1,000 feet), sandy to pure siltstone and concretionary shale with a neritic fauna (commonly including inner neritic belemnites and pelecypods) throughout the eastern part of the northern Bell River segment, as exemplified by Sections E3 to E5 inclusive (*see* in Jeletzky, 1973; and this report, Fig. 6). It is only in the interval between the north-south flowing stretch of Bell River (i. e. above the mouth of Little Bell River) and the eastern confluents of Waters River that this eastern facies becomes replaced laterally by the deep water, mid-basin facies. This western facies is at least four times thicker (3,500 to 4,200 feet) than the eastern facies and is represented by almost unfossiliferous (no belemnites), outer neritic to upper bathyal, partly flyschoid shale and siltstone (Jeletzky, 1973; this report, Sec. E2 of Fig. 6). The westward extent of the mid-basin, western facies within the area is unknown. However, it apparently becomes more sandy and non-flyschoid to the northwest of the northern Bell Basin segment (i. e. the Dark grey siltstone division of Jeletzky, 1961b, p. 19, 33; 1973, p. 29) and so presumably was derived largely from a not too distant western source area. Unfortunately, this suggestion cannot be confirmed within the northern Bell Basin segment because of an apparently complete absence of the outcrops of the Upper shale-siltstone division west of Waters River (Jeletzky, 1973; and this report, Fig. 6). For the same reason, it is impossible to reach any definitive conclusion as to the approximate position of the eastern shoreline of the late Hauterivian to late Barremian Keele-Old Crow Landmass within the segment.

In spite of a great eastward spread of the late Hauterivian to late Barremian transgression, the axis of the mid-Lower Cretaceous northern Bell River segment of the basin was situated far to the west of its Late Jurassic to early Berriasian position. Its position paralleled closely that of the late Berriasian (i. e. time of deposition of the Lower sandstone division) axis.

This fact and the prevalence of the relatively thin, outer to inner neritic eastern facies as far west as the Summit Lake-Little Bell River area appear to be aftereffects of the Valanginian to mid-Hauterivian orogenic phase. Judging by the above-described contrast in the thickness and depth of deposition of the eastern and western facies of the Upper shale-siltstone division only the western part of the Aklavik Arch resumed the rapid subsidence following the conclusion of this orogenic phase. The rather more extensive eastern part of the arch became only feebly to moderately negative in the late Hauterivian to late Barremian time. It was transformed consequently into a wide zone of an inner to outer neritic, shelf-like sea flanking the northern Bell Basin segment of the trough proper from the east. As will be pointed out in the following two sections, this zone of the shelf-like, late Hauterivian to late Barremian sea extended into the middle parts of the White Mountain and Bonnet Lake-Lower Donna River segments of the trough where it was restricted to the apparently entirely submerged but nevertheless structurally discernible northward continuation of the Cache Creek Uplift (*see* Figs. 1 and 13).

As pointed out by Jeletzky (1973), the facies pattern of the Upper sandstone division in the northern Bell Basin segment is basically similar to the above-described pattern of the Upper shale-siltstone division. However, the Upper sandstone (i. e. latest Barremian to Aptian) sea was considerably shallower than its late Hauterivian to late Barremian predecessor throughout those parts of the segment where its deposits are preserved.

In the greater, eastern part of the northern Bell Basin segment (*see* Jeletzky, 1973; this report, Secs. E3 to E5 of Fig. 6), the division appears to be fining gradually westward much as it does in the southern Bell Basin segment (*see* Secs. D3 and D4 of Fig. 5). This eastern facies of the Upper sandstone division remains comparably thin throughout this interval. It delimits the same relatively stable, eastern shelf-like zone of the trough as the previously mentioned eastern facies of the Upper shale-siltstone division. The eastern facies of the Upper sandstone division rapidly thickens and partly shales out in the interval between the north-south trending stretch of Bell River and the easternmost confluents of Waters River. The resulting thick, predominantly silty, western facies of the Upper sandstone division (*see* Jeletzky, 1973; this report, Sec. E2 of Fig. 6) occupies the same part of the area as the above-described western facies of the Upper shale-siltstone division. This western facies appears to delimit the same deep, rapidly subsiding and filling up mid-basin zone of the northern Bell Basin segment of the trough as does the preceding western facies of the Upper shale-siltstone division. However, the preserved part of the mid-basin zone of the trough was considerably shallower (inner to outer neritic; *see* Jeletzky, 1973) during the time of deposition of the Upper sandstone division than it was during that of the Upper shale-siltstone division. No outcrops of the Upper sandstone division were found west of Waters River. Therefore, the westward extent of the western facies of the division as well as the position and the character of the axis and the western flank of the Aptian trough must remain conjectural.

The easternmost littoral facies of the Upper sandstone division is disconformably and apparently discordantly overlain by the Upper Cretaceous shale division everywhere between Treeless Creek and the headwaters of Stony Creek (Jeletzky, 1958, p. 18, 21, geol. map; this report, Sec. E5 of Fig. 6). In contrast, to the north and the south of the area, the Upper sandstone division is overlain by open marine rocks of the Albian shale-siltstone division (*see* Sec. D4 of Fig. 5; Jeletzky, 1961a, p. 540, 541; Young, 1972) which does not exhibit any shoreward facies changes toward the eastern part of the northern Bell River segment. Therefore, the above-mentioned absence of Albian rocks in the eastern part of the northern Bell River segment is attributable to the effects of Late Albian or ?early Cenomanian erosion during or after yet another phase of uplift and flexing of the crestal part of the Aklavik Arch (Jeletzky, 1961a, p. 540, 541, Fig. 1). Like the previously discussed older hiatuses, the Albian hiatus decreases westward (i. e. basinward). This is indicated by the appearance of the Albian shale-siltstone division in that part of the area situated a few miles south of the confluence of Bell and Little Bell Rivers (Jeletzky, 1973; this report, Sec. E3 of Fig. 6) and its extremely thick development in the Waters River basin (*see* Jeletzky, 1973; this report, Sec. E2 of Fig. 6). Because of an apparently complete absence of Upper Cretaceous rocks between the eastern slope of the Richardson Mountains and the western flank of Bell Basin proper, it is impossible to either estimate the westward extent of the crestal zone of Aklavik Arch affected by the Late Albian or ?early Cenomanian orogenic phase or to compare its intensity with that of the preceding phases. However, the complete absence of Middle and Late Albian fossils in the Albian rocks of the northern Bell Basin segment and elsewhere in the Porcupine Plateau region suggests that the orogenic phase was widespread and of considerable strength.

General remarks

The preceding analysis of the profile E1 to E5 and related stratigraphic-tectonic data indicate the extension of the Jurassic to mid-Lower Cretaceous Porcupine Plain-Richardson Mountain Trough into the northern Bell Basin segment. The previously known and once more confirmed (Jeletzky, 1973) presence of some shallow water to nonmarine Jurassic to mid-Lower Cretaceous rocks within the segment is not a valid reason to assume the presence of a long-lasting landmass in its middle. These rocks reflect instead the extremely active tectonic regime of the northern Bell Basin segment. As already mentioned, this regime consisted of recurrent uplifts and flexings of the underlying crestal part of Aklavik Arch and a complex interaction of these east-northeast and west-southwest oriented tectonic movements with other partly decoupled north-south oriented tectonic movements largely but not entirely (i. e. Cache Creek Uplift) restricted to the trough's margins. These areally restricted tectonic movements caused hiatuses, pronounced lateral displacements of the mid-basin zone of the trough, temporary and localized shallowing of the sea with far-reaching facies changes, and even shorlived uplifts of parts or most of the segment well above sea level. However, as pointed out above, all these depositional-tectonic events were merely second and third order complicating features happening on the longlasting background of a prevalent and strong subsidence of a well-defined, relatively narrow but deep, mid-basin part of the trough and a rapid deposition of deep sea sediments within it.

As already pointed out in connection with the description of individual lithological units and illustrated by Figure 6, the northern Bell Basin segment is characterized by a pronounced basinward thickening of most Jurassic to mid-Lower Cretaceous units. The deep water, mid-basin facies of the Porcupine Plain-Richardson Mountain Trough obviously was not sediment-starved within this segment in contrast to most (?or all) of the previously discussed southern segments of the trough. This appears to be due to a relative narrowing of the northern Bell Basin segment in comparison with the southern segments and a relatively much higher elevation of the adjacent parts of Peel River and Keele-Old Crow Landmasses which were underlain by the Rat and Dave Lord Uplifts of Aklavik Arch.

WHITE MOUNTAIN SEGMENT

The profile F1 to F5 (Fig. 7) extending from the mouth of Driftwood River across the White Mountains to the southern part of Aklavik Range (Fig. 1) was compiled to illustrate the previously insufficiently understood Jurassic to mid-Lower Cretaceous stratigraphy, facies pattern and depositional tectonics characteristic of the area immeditely north of the northern Bell Basin segment. The western part of the profile (i. e. Secs. F1 and F2) is based on the recent, only partly published work of the writer (Jeletzky, 1972a, p. 212, 214, Figs. 1, 3; 1972b). Section F3 is based on Jeletzky's (1961b, p. 23-36, corr. chart) older work in the headwaters of Bell and Driftwood Rivers supplemented by more recent, only partly published (Jeletzky, 1972b; 1973), field work in the area. Section F4 on the eastern flank of White Mountains is based on published sections 165 and Goat and Eagle Section 65-G. E. S. -1-56 (Jeletzky, 1967, p. 161-163, 166-171) and on the more recent, only partly published, field work of the writer (Jeletzky, 1972b; 1973) in the area. Section F5 is based on a compilation of data published in several reports of Jeletzky (1958; 1960; 1961a; 1967). Only a brief summary of these background data will be attempted in this section.

Jurassic and basal Cretaceous facies and tectonic pattern

The predominantly argillaceous, neritic to ?upper bathyal mid-basin facies of Early to mid-Jurassic time (i. e. time of deposition of the Kingak Formation, restricted) is well illustrated by the extremely thick Sections F2 and F3 (Fig. 7). This part of the basin is characterized by an apparently complete absence of the late Early to early Middle Jurassic hiatus characteristically present on the eastern flank of the trough (*see* Sec. F5 of Fig. 7; and Jeletzky, 1963, p. 80, Fig. 6). Minor interbeds of inner neritic (belemnite-bearing) to ?lower littoral sandstone occurring in Section F2 are believed to be pinch-out zones of the so far almost unknown (*see* Sec. F1 of Fig. 7; and Jeletzky, 1972b) western arenaceous wedges.

The short Section F1 (Fig. 7), consisting of fossiliferous beach equivalents of the Kingak shale (Jeletzky, 1972b) represents the only known remnant of the western marginal facies of that time in the White Mountain segment. Because of its occurrence halfway between the Porcupine River canyon (*see* the previous section) and Old Crow River (Jeletzky, 1972b) outcrop-areas of the littoral arenaceous equivalents of the Kingak shale, Section F1 is paleogeographically significant. Its beach deposits pinpoint the position of the northeastern shoreline of the Lower to Middle Jurassic nucleus of the Keele-Old Crow Landmass (Fig. 9).

The Jurassic parts of Sections F3 to F5 representing the eastern flank exhibit a well-defined westward fining and shaling out of the predominantly arenaceous eastern marginal facies of the trough. These basinward facies changes are accompanied by a pronounced westward thickening of all Jurassic units. The essentially mid-basin facies of Section F3 includes a considerable number of thin sandstone interbeds which appear to be pinch-out zones of the predominantly arenaceous eastern marginal facies, as exemplified by Section F4. The stratigraphic link-ups of the two remain obscure. It is uncertain also whether or not the sandstone interbeds, as exemplified by Section F3, persist across the mid-basin zone of the trough to merge with the distal parts of the western sandstone wedges.

The late Early to early Middle Jurassic hiatus is less prominent than in the northern Bell Basin segment because of the characteristic presence of Upper Sinemurian rocks underlying it. The hiatus appears to be restricted to the easternmost zone of the eastern flank (Sec. F5 of Fig. 7) as the Bug Creek sandstone outcropping on the eastern slope of White Mountains (*see* Jeletzky, 1967, p. 18; this report, Sec. F4 of Fig. 7) is considerably thicker and includes Toarcian to mid-Bajocian rocks. The appearance of lower Sinemurian rocks, characteristically present in the central parts of the basin but not yet found (presumably because of nondeposition) in the easternmost marginal zone (*see* Sec. F5) is another notable feature of this area. These depositional-tectonic conditions contrast with those observed in the equivalent parts of the adjacent northern Bell Basin segment (*see* previous section) and indicate that the eastern flank of the White Mountain segment was situated north of, and largely beyond, the sphere of influence of the tectonically most active crestal part of the upper Lower to lower Middle Jurassic Aklavik Arch. However, the influence of this southern source is still felt in the abnormally great thickness and almost exclusively arenaceous lithology of the Bug Creek Formation on the eastern flank of White Mountains (*see* Jeletzky, 1967, p. 18; this report, Sec. F4 of Fig. 7). No influence of the Cache Creek Uplift (*see* following sections for a detailed description) is apparent during Bug Creek time and the uplift apparently was not tectonically active at that time.

The facies and thickness changes of the Husky Formation and its lateral replacement by the Unnamed Upper Jurassic sandstone in the west parallel closely those occurring in the northern Bell Basin segment (compare Figs. 6 and 7), except that the westernmost largely nonmarine facies of the Unnamed Upper Jurassic sandstone, corresponding to that of the Porcupine River canyon area (*see* Sec. E1 of Fig. 6), is unknown in the White Mountain segment, apparently because of its complete destruction by subsequent erosion in the interval between Sections F2 and F1.

Sections F2 and F3 indicate that the mid-basin belt was situated west of the present White Mountains throughout Kingak time. As indicated by the almost entirely argillaceous, apparently mostly upper bathyal facies of the Kingak Formation in the headwaters of Berry Creek (*see* Sec. F2 of Fig. 7), the axis of the Early to Middle Jurassic Porcupine Plain-Richardson Mountain Trough was situated in that area in the proximity of the Keele-Old Crow Landmass. However, the mid-basin belt and the axis of the trough shifted abruptly far to the east to the eastern side of White Mountains at the onset of the Late Jurassic (at the beginning of Husky time; *see* Sec. F4 of Fig. 7) and remained there until the end of the early Berriasian (end of Husky time). This remarkable eastward shift of the trough's axis parallels that observed in the northern Bell Basin segment and happened evidently for the same reason (*see* the preceding section). The Unnamed Upper Jurassic sandstone appears to pinch-out completely somewhere between the eastern flank of the present White Mountains and the predominantly argillaceous, inner to outer neritic facies of the Husky Formation exposed in the southern part of the Aklavik Range (Jeletzky 1958; 1960; 1967, p. 28-33; and Secs. F4 and F5 of Fig. 7)

As everywhere else on the eastern flank of the trough (*see* previous sections of this report) the Upper Jurassic to lowest Cretaceous Husky Formation is transgressive (i. e. it onlaps the more shallow water Bug Creek Formation) throughout the east flank of the White Mountain segment. No westward prograding Upper Jurassic delta could have existed anywhere in the area.

Late Berriasian to mid-Hauterivian facies and tectonic pattern

Though commonly missing or eroded away in part as a result of the Valanginian to mid-Hauterivian orogenic phase (*see* the preceding section and on this page to Buff sandstone member of the Lower sandstone division of the eastern flank of the segment exhibits quite obvious basinward facies changes from east to west. The partly to predominantly argillaceous mid-basin facies of the member is widespread in the western headwaters of Bell River (Jeletzky, 1961b, p. 9-11, 28, 29, Fig. 1; this report, Sec. F3 of Fig. 7). This predominantly outer to inner neritic facies of the member is lithologically and sedimentologically identical to its mid-basin facies in the northern Bell Basin segment (Jeletzky, 1973; and in the preceding section) and is apparently contiguous with the latter. The mid-basin facies contrasts lithologically and sedimentologically with the almost exclusively littoral eastern marginal facies of the member described by Jeletzky (1958, p. 6, 7; 1960, p. 5, 6; this report, Sec. F5 of Fig. 7) in the Aklavik Range.

Sections F2 and F3 (Fig. 7) illustrate the characteristic eastward fining and partial shaling out of the Lower sandstone division (restricted) on the western flank of the segment. As pointed out by Jeletzky (1972b), the restricted Lower sandstone division (= Buff sandstone member of the eastern slope; *see* Jeletzky, 1961b, p. 12, Fig. 1) of the eastern headwaters of Berry Creek (Sec. F2 of Fig. 7) is represented by the upper littoral to supratidal sandstones derived from a nearby western source. This indicates that the adjacent part of the eastern shoreline of the late Berriasian (i. e. time of deposition of the Buff sandstone member) Keele-Old Crow Landmass was situated somewhere between the eastern headwaters of Berry Creek and the confluence of Driftwood and Porcupine Rivers (*see* Fig. 11)

The Valanginian to mid-Hauterivian hiatus is restricted to the eastern flank of the segment as illustrated by Sections F5 and F4 of Figure 7. However, it is more strongly expressed on the eastern flank of White Mountains where it cuts into the upper part of the Husky Formation (Jeletzky, 1973; this report, Sec. F4 of Fig. 7) than in the adjacent part of Aklavik Range. In the latter structurally more negative area, the lower part of the Coal-bearing division is still present beneath the hiatus in the northern part of the Mount Goodenough massif and the lower part of the Buff sandstone member is developed in the normal shallow marine facies to the canyon of Sheep Creek (Jeletzky, 1960, p. 6-8; 1961a, p. 537, 538, Fig. 1). This relatively more positive behaviour of the western part of the eastern flank of the segment during the Valanginian to mid-Hauterivian orogenic phase is attributable to the present day White Mountains forming the southeastern part of the north-trending Cache Creek Uplift (*see* Norris, 1972, p. 91, 93, Fig. 1; this report, Figs. 12, 13) which apparently was then tectonically active for the first time since the emergence of the Mesozoic Porcupine Plain-Richardson Mountain Trough in the earliest Jurassic (Jeletzky, 1963, p. 77). The tectonic nature of the Cache Creek Uplift as well as its areal extent and tectonic relationship with the Aklavik Arch will be discussed in the following sections of this report (*see* p. 35-36).

The Lower sandstone and Coal-bearing divisions are unknown on the eastern flank of White Mountains while the uppermost beds of Husky shale beneath the erosional disconformity are represented by outer neritic siltstone (Jeletzky, 1973). The age limits of the Valanginian to mid-Hauterivian uplift in the area accordingly can be appraised more exactly only by comparison with the adjacent areas to the south (e.g. the Summit Lake-Little Bell River agea; *see* the preceding section). It is suggested that the White Mountain area was uplifted above sea level and transformed into an elevated source area in the early Valanginian (time of deposition of the White sandstone member) and remained so until the onset of the late Hauterivian transgression. Neither the White quartzite nor the Coaly quartzite division ever were deposited in the White Mountain area according to this hypothesis.

The Coaly quartzite division appears on the southwestern flank of White Mountains in the north bank of an unnamed western tributary of Bell River (approx. Lat. 67°55'N; Long. 136°57'W) 1.5 miles above its mouth. In these complexly folded and strongly faulted sections, the Coaly quartzite division is entirely nonmarine, partly coarse grained and gritty to pebbly, and coal-bearing. The overlying basal beds of the Upper shale-siltstone division are represented by the inner neritic, mostly sandy, concretionary siltstone with diagnostic mid-to late Hauterivian *Acroteuthis (Acroteuthis)* aff. *conoides* Swinnerton. This suggests that the western bank of upper Bell River west of White Mountains formed the easternmost part of the mid-basin zone of the segment, and that the previously mentioned highly elevated southeastern part of the Cache Creek Uplift did not extend westward much beyond the presently exposed Paleozoic core of White Mountains. However, this briefly emergent (i.e. early Valanginian to mid-Hauterivian) source area apparently contributed sediment to the above-described outcrop area of the Coal-bearing and Blue-grey shale divisions on the southwestern flank of White Mountains.

The western part of the mid-basin zone of the White Mountain segment, situated in the western headwaters of Bell River (*see* Jeletzky, 1961b; this report, Sec. F3 of Fig. 7) was not affected at all by the early to late Valanginian tectonic movements. This area became more strongly negative instead as indicated by the deposition of outer neritic to upper bathyal mid-basin facies of the Blue-grey shale division on top of the predominantly inner to outer neritic mid-basin facies of the Lower sandstone division. The same is true furthermore of the western flank of the trough situated in the headwaters of Berry Creek and Driftwood River (*see* Jeletzky, 1972b; this report, Sec. F2 of Fig. 7), where the inner to outer neritic, marginal facies of the Blue-grey shale division was deposited on top of the upper littoral to supratidal shoreline facies of the Lower sandstone division. Judging by the above-mentioned presence of the Coal-bearing division on the southwestern flank of White Mountains, this structurally negative mid-basin zone of the White Mountain segment may have extended eastward into the proximity of that north-south trending stretch of the Bell River adjoining White Mountains from the west (Fig. 12). However this is a tentative suggestion only as there is no information about the presence or absence of the Lower sandstone and Blue-grey shale divisions in this area and about the presence or absence of the Valanginian to mid-Hauterivian hiatus on the western flank of White Mountains.

In the late Berriasian and Valanginian, the above-mentioned mid-basin zone and possibly the western flank of the White Mountain segment were undergoing increasingly strong subsidence while an increasingly strong uplift was occurring on the eastern flank. Only in the early to mid-Hauterivian time did the uplift spread into the mid-basin zone and onto the western flank of the segment. This resulted in the transformation of these areas into an alluvial lowland receiving nonmarine sediments from the more greatly uplifted crestal zone of the Aklavik Arch situated to the south and southeast (*see* Jeletzky, 1973; and the preceding section) and the adjacent White Mountains area of the Cache Creek Uplift to the east. The above-described Valanginian to mid-Hauterivian depositional-structural conditions of the White Mountain segment contrast strongly with those characteristic of the equivalent parts of the adjacent northern Bell Basin segment (*see* the preceding section) and indicate that the segment was situated north of the tectonically most active crestal part of the Valanginian to mid-Hauterivian Aklavik Arch. However, the influence of this adjacent southern to southeastern source area and that of the source area in the southern part of Cache Creek Uplift (i.e. White Mountains area) was felt strongly within the segment. These influences are reflected in:

1. A great thickness and nonmarine, almost exclusively arenaceous (including considerable medium- to coarse-grained sandstone and some pebble conglomerate) facies of the White and Coaly quartzite divisions in the mid-basin zone and on the western flank of the segment (Jeletzky, 1961b, p. 14-18; 1972b; this report, on this page and Figs. 7, 13); and

2. The above-mentioned depositional area of lower to mid-Hauterivian nonmarine rocks being confined between the area characterized by the presence of the Valanginian to mid-Hauterivian hiatus situated on the eastern flank of the segment and another such area situated to the south and southeast within the northern Bell Basin segment (*see* p. 11-12; Figs. 6, 12, 13).

Late Hauterivian to Aptian facies and tectonic pattern

Complete sections of the Upper shale-siltstone division are known only on the eastern flank of the segment (e.g. Secs. F4 and F5 of Fig. 7). Generally speaking, these sections of the division appear to agree closely with its eastern facies as developed in the northern Bell Basin segment to the south. Therefore, the eastern flank represents the northward extension of the only feebly to moderately negative eastern zone of the last-mentioned segment. However, the facies pattern of the Upper shale-siltstone division within the eastern flank of White Mountain segment appears to be more complex and somewhat peculiar in detail. The division locally includes arenaceous, shallow water interbeds in the area (Jeletzky, 1973; this report, Sec.

F4 of Fig. 7) and its partly arenaceous, presumably more shallow water (inner neritic to lower littoral) facies occurs to the west (i. e. on the eastern flank of White Mountains) of the almost exclusively outer neritic facies characteristic of Aklavik Range (e. g. Sec. F5 of Fig. 7). These anomalous facies changes appear to be related to the continuing existence of a major shoal, or even a residual source area (an island?), within the area of the present White Mountains. Although it was largely submerged by the late Hauterivian transgression, the White Mountain area of the Cache Creek Uplift evidently remained relatively positive in late Hauterivian to late Barremian time.

The facies pattern to the north of the White Mountain segment (*see* Sec. G2 of Fig. 8) and the scant evidence available in the western headwaters of Bell River (Jeletzky, 1961b, p. 19, 20, 23, 33; 1973; this report, Sec. F3 of Fig. 7) suggest that the eastern facies of the Upper shale-siltstone division grades laterally into a deep water, very thick western facies much as it does in the northern Bell Basin segment (*see* the preceding section).

The rather scant record of the Upper sandstone division is restricted to the eastern flank of the White Mountain segment. It is exemplified by Sections F5 and F4 (Fig. 7). Unlike the Upper shale-siltstone division, the thickness of the Upper sandstone division increases greatly (probably about four times)westward At the same time, the sandstone becomes finer and finer and interfingers with a progressively more argillaceous rocks. The division is predominantly littoral in the Aklavik Range but becomes predominantly outer neritic on the eastern slope of White Mountains (Jeletzky, 1973). These pronounced basinward facies changes, however, are complicated by the presence of several shallow water arenaceous members in the very thick, predominantly argillaceous White Mountain facies of the division. The presence of these apparently upper littoral, outer bar and ? lagoonal interbeds in the predominantly outer neritic environment seems best explained by the tectonically caused, intense and rapid fluctuations of the depth of this part of the basin (Jeletzky, 1973) related to the tectonic regime of the now deeply submerged but nevertheless tectonically active White Mountain area of the Cache Creek Uplift. The fact that the Upper sandstone division of the eastern slope of the White Mountains is represented largely by the western facies suggests that the mid-basin zone of that time occurred closely to the west (i. e. on the western side of the present White Mountains). As pointed out by Jeletzky (1973), this so-far unexplored mid-basin facies of the Upper sandstone division was probably as thick as, and lithologically similar to the mid-basin facies of the adjacent northern Bell Basin and Bonnet Lake-lower Donna River segments and connected these two outcrop areas of the western facies.

General Remarks

The above data indicate that the Jurassic to mid-Lower Cretaceous Porcupine Plain-Richardson Mountain Trough extended across the White Mountain segment of the Porcupine Plateau. This segment of the trough was characterized by a depositional-tectonic regime which differs from that of the adjacent northern Bell Basin segment in a temporary existence of the north-trending Cache Creek Uplift in the White Mountain area. Beginning with its emergence in the ?early Valanginian, the more elevated eastern part of the uplift delimited a moderately negative, probably synclinal tectonic structure (i. e. Canoe Depression of Norris, 1972, p. 71, 73, Fig. 1) situated to the east of White Mountains from the pronouncedly negative principal part of the trough situated to the west. As pointed out in the following section, the Cache Creek Uplift and the Canoe Depression extend northward into the adjacent Bonnet Lake-lower Donna River segment of the trough. In the south, the Cache Creek Uplift appears to branch directly from the Rat River Uplift of Aklavik Arch while the Canoe Depression appears to abut the eastern part of the same uplift (*see* Figs. 12, 13 and p. 35-36, for further details). In spite of the complicating tectonic influences of the Cache Creek Uplift and Canoe Depression, the tectonic regime of the White Mountain segment apparently was considerably less active than that of the adjacent northern Bell Basin segment. This is attributable to its being situated well to the north of the tectonically most active crestal part of the Aklavik Arch.

As with the northern Bell Basin segment, the temporary presence of some shallow water to non-marine, Jurassic to mid-Lower Cretaceous rocks and local hiatuses within the White Mountain segment reflects only its acitve tectonic regime. These rocks and hiatuses reflect short-lived, localized uplifts and are merely second and third order complicating features happening on the long-lasting background of a prevalent and strong subsidence of, and a rapid deposition of deep sea sediments within, a well-defined relatively narrow but deep mid-basin zone of the segment.

BONNET LAKE-LOWER DONNA RIVER SEGMENT

The northernmost profile G1 to G5 (Fig. 8) illustrates the facies and tectonic pattern characteristic of the area extending from Barn Mountains to the western side of Mackenzie Delta near Aklavik (Fig. 1).

Sections G5 and G4 are based mainly on the published results of Jeletzky's (1958, 1960, 1961a, 1967) older field work supplemented by his only partly published more recent work in the area (Jeletzky, 1972b, p. 21-26). Section G3 is based on the only partly published work of Jeletzky (1961a; 1967, p. 27, 28; 1971a, p. 203-205, Fig. 2) in the headwaters of Fish River and Cache Creek and that of Young (1973a) in adjacent sections on Fish River. Sections G1 and G2 are based predominantly on the writer's published research in the Blow Pass-Bonnet Lake area (Jeletzky 1961a; 1971a, p. 205-211, Fig. 2; 1972a, p. 212-214, Figs. 1-3; 1972b; 1973). The field work in 1970 (Jeletzky, 1971a, p. 205, 210) necessitated a reassessment of the age of coal-bearing clastics and chert conglomerates occurring in the area and previously tentatively assigned an earliest Jurassic to latest Triassic and mid-Jurassic age respectively (Jeletzky, 1963, p. 80, 81, Fig. 6).

Jurassic and basal Cretaceous facies and tectonic pattern of the eastern flank

The Bug Creek parts of Sections G5 and G4 duplicate lithologically and tectonically the corresponding part of Section F5 (*see* Fig. 7). These two sections characterize the easternmost predominantly littoral facies of the Bug Creek Formation within the here-discussed segment. No counterpart of the thick but predominantly arenaceous transitional Bug Creek facies, as exemplified by Section F4 (Fig. 7), is known in the Bonnet Lake-lower Donna River segment. This appears to be due to the corresponding part of the segment being situated rather far away from the previously discussed tectonically active crestal part of upper Lower to lower Middle Jurassic Aklavik Arch. So far as is known (Jeletzky, 1967, p. 18, 19, Fig. 2; 1971a, p. 203, 205), the easternmost arenaceous facies of the Bug Creek Formation gradually thins out and shales out westward and northwestward in the interval between the Canoe Lake area and the western headwaters of Cache Creek until it becomes reduced to a tongue, 100 to 150 feet thick, in the uppermost part of the Kingak shale (*see* Secs. G4 and G3 of Fig. 8). These basinward facies changes appear to culminate in a complete disappearance of the eastern arenaceous wedge of the Bug Creek Formation in the thick, almost to ?entirely argillaceous (mostly pure shale), predominantly outer neritic to ?upper bathyal (because of an almost complete absence of belemnites and inner neritic pelecypods and a rarity of ammonites) mid-basin facies of the Kingak shale (*see* Sec. G2 of Fig. 8).

The Husky Formation of Sections G5 to G3 (Fig. 8) exhibits exactly the same basinward facies and thickness changes from east to west as in the corresponding eastern parts of the previously discussed northern Bell Basin and White Mountain segments (*see* Secs. E3 to E5 of Fig. 6; Secs. F5 and F4 of Fig. 7). Sections G3 to G5 also illustrate the occurrence of a strong eastward Late Jurassic transgression characteristic of more southerly segments of the trough in the easternmost zone of the Bonnet Lake-lower Donna River segment.

Older Jurassic (pre-Husky) facies and tectonic pattern of the western flank

Though conforming in general to the facies and tectonic pattern observed on the western flanks of more southerly segments, the pattern of the pre-Husky Jurassic rocks outcropping on the western flank of the Bonnet Lake-lower Donna River segment is somewhat peculiar in detail. All shallow water to ?deltaic or ?lagoonal arenaceous units of the Kingak Formation and Unnamed Upper Jurassic sandstone appear to be concentrated around the eastern and southeastern flanks of Barn Mountains. These units are fining and shaling out more or less simultaneously and equally fast toward the east and south. The Hettangian to early Sinemurian hiatus occurring on the eastern and southeastern flanks of Barn Mountains becomes replaced by argillaceous open marine rocks in these two directions.

On the southern and southeastern flanks of Barn Mountains, as exemplified by Section G1 (Fig. 8), the Kingak shale (restricted) is represented predominantly by moderately to abundantly fossiliferous (including belemnites and shallow water pelecypods), inner neritic, pure to sandy siltstone with some interbeds of fine- to very fine grained, ?lower littoral sandstone (Jeletzky, 1972b, p. 26, 27; 1973). This western marginal facies begins with the arenaceous upper upper Sinemurian beds (Jeletzky, 1963, p. 79, Fig. 6) overlying paraconformably the Lower Mississippian coal-bearing clastics (Jeletzky, 1971a, p. 205, Fig. 2). As elsewhere in the marginal zones of the trough (Jeletzky 1967, p. 18), it lacks completely older Lower Jurassic rocks. Eastward and southward (i. e. on the eastern side of Blow Pass and south of Bonnet Lake; *see* Sec. G2 of Fig. 8), this Kingak facies is replaced laterally by an almost unfossiliferous, predominantly outer neritic to ?upper bathyal, mostly pure shale and siltstone. In contrast to the previously discussed marginal facies occurring on the flanks of Barn Mountains, this mid-basin facies begins with the apparently Hettangian siltstone locally containing ?*Psiloceras* (sensu lato) sp. indet. (Jeletzky, 1971a, p. 205, Fig. 2).

The Unnamed Upper Jurassic sandstone is relatively thick (up to 1, 250± feet) and predominantly represented by nonfossiliferous, carbonaceous to coaly, presumably deltaic, lagoonal or outer bar deposits (Jeletzky, 1972b, p. 28, 1973) near the eastern and southeastern slopes of Barn Mountains. This facies, which is exemplified by Section G1, locally includes minor interbeds and pods of grit and fine pebble conglomerate with poorly rounded to angular, evidently locally derived clasts (Jeletzky, 1972b, p. 28). The Unnamed Upper Jurassic sandstone rapidly thins out eastward and southward. It represents a shorter time span in terms of biochronological units, and consists predominantly of noncarbonaceous, shallow marine (mostly littoral) very fine grained arenites on the eastern side of Blow Pass (Jeletzky, 1971a, p. 207, Fig. 2; this report, Sec. G2 of Fig. 8) and in the banks of Johnson Creek (Jeletzky, 1972b, p. 28). Still farther eastward, the Unnamed Upper Jurassic sandstone appears to extend as a gradually thinning tongue right across the mid-basin zone of the segment (*see* Secs. G2 and G3 of Fig. 8). The unit is only 100 to 150 feet thick in the easternmost known exposures in the western headwaters of Cache Creek (Jeletzky, 1971a, p. 205, Fig. 2; and unpublished). In this eastern part of the mid-basin zone, the thin wedge of the Unnamed Upper Jurassic sandstone may overlap with the western pinchout zone of the Bug Creek sandstone (its Upper sandstone member), as illustrated by Section G3 (Fig. 8). No traces of the Unnamed Upper Jurassic sandstone were recognized on the eastern limb of the Canoe Lake anticline, as exemplified by Section G4 (Fig. 8), where the Husky Formation is still represented by its offshore (mainly outer neritic) facies.

No exposures of the Unnamed Upper Jurassic sandstone are known outside of the report-area to the northeast, north, and northwest of Barn Mountains (*see* Young, 1973a). This somewhat odd situation is attributed tentatively to a widespread destruction of Jurassic to mid-Lower Cretaceous rocks within this area during or after the Valanginian to mid-Hauterivian and late Aptian orogenic phases (Young, 1972; 1973a). The profound effects of the latter tectonic pulse in the area are evidenced by the presence of widespread and prolonged hiatuses underneath the thick Lower Albian conglomerates (Young, 1973a, p. 279, 280).

The above-described basinward facies changes of the Unnamed Upper Jurassic sandstone from west to east parallel closely those occurring on the west flanks of the northern Bell Basin and White Mountain segments (*see* Secs. E1 to E3 of Fig. 6; and Secs. F1 to F3 of Fig. 7). The less extensively studied (no profile compiled) basinward facies changes of this sandstone from north to south appear to parallel closely the basinward facies changes occurring in the same unit from north to south across northern Keele Range (i.e. between Sec. E1 of Fig. 6 and Sec. D1 of Fig. 5). As in the Keele Range area (*see* under the discussion of the western flank of the southern Bell Basin segment; Fig. 10), these facies changes suggest the existence of an Upper Jurassic embayment on the western side of the trough south of the present Barn Mountains. This embayment is believed to end north of the present Old Crow Mountains and east of the Yukon-Alaska boundary beneath the Old Crow Plain (Figs. 9, 10). However, it may have been opening northward or northwestward in the area west of Barn Mountains for reasons given below.

The above-discussed concentration of the shallow water to nonmarine facies of the Unnamed Upper Jurassic sandstone around the eastern and southeastern flanks of Barn Mountains appears to be attributable to the existence of a nearby northwestern or ?northern source area situated within the present Barn and/or Buckland Mountains. It was suggested by Jeletzky (1972b, p. 28; 1973; this report, Fig. 10) that this source area represented an eastward protruding peninsula of the Keele-Old Crow Landmass which was in the nature of an eastward, southeastward, and southward prograding deltaic lobe. However, this source area could have been an island within the northwestern part of the Porcupine Plain-Richardson Mountain Trough surrounded by a narrow belt of littoral to beach deposits if the apparent absence of thick, prevalently nonmarine facies of the Unnamed Upper Jurassic sandstone southwest and west of Barn Mountains (Young, 1973a, p. 279) was not caused by its subsequent erosion but by a lateral replacement by argillaceous sediments.

Late Late Jurassic and earliest Cretaceous facies and tectonic pattern in the western part of the segment

Unlike the older Jurassic formations, the Husky shale of the western flank of the Bonnet Lake-lower Donna River segment exhibits only minor east-west facies changes and no apparent north-south changes (Jeletzky, 1971a; 1972b; 1973; and unpublished data). Although its contact with the underlying Unnamed Upper Jurassic sandstone division is distinctly diachronic in the east-west direction (Jeletzky, 1973), Husky shale retains its great thickness (at least 1,700 feet and possibly up to 2,500 feet) and almost exclusively argillaceous facies throughout the area (compare Secs. G2 and G1 of Fig. 8). The predominantly outer neritic to upper bathyal nature of pure to silty shale and siltstone of the Husky Formation is indicated by a complete absence of belemnites and other shallow water mollusks and by a rarity to a complete absence of depth-tolerant ammonites, *Inoceramus* and *Buchia*. These facies relationships indicate a rapid and deep subsidence of at least the southern part of the above-discussed Barn Mountain source area early in the Late Jurassic (i.e. on the onset of Husky time). The investigated part of the Barn Mountain-Johnson Creek area must have formed the western part of the mid-basin zone (its eastern part being situated at the western headwaters of Cache Creek; *see* Sec. G3 of Fig. 8) of the trough during Husky time.

The western marginal zone of the Husky time trough was evidently situated somewhere to the west of the westernmost sections (exemplifield by Sec. G1 of Fig. 8) measured by the writer in the Bonnet Lake-lower Donna River segment. However, it is still impossible to infer the facies and tectonic pattern of Husky time in the areas southwest of Barn Mountains and in the headwaters of Canoe River from the scarce data provided by Frebold et al. (1967), Young (1973a) and Norris (1970; 1972).

Late Berriasian to mid-Hauterivian facies and tectonic pattern on the eastern flank

Sections G5 and G4 (Fig. 8) illustrate the characteristic east-west facies changes of the Lower sandstone and Coal-bearing divisions on the eastern flank of the segment between the western edge of the Mackenzie Delta and Canoe Lake. Generally speaking, these basinward facies changes consist of a pronounced fining and partial shaling out of all arenaceous beds and members of these two units coupled with a strong decrease followed by an almost complete disappearance of their nonmarine facies from east to west. The nonmarine sandstones and siltstones and the upper littoral sandstones become replaced largely by lower littoral to inner neritic siltstones, sandstones and shales (in that order of frequency) in the westernmost part of the area (i.e. in the extreme southwestern headwaters of Beaver House Creek, northeast and east of Canoe Lake).

More specifically, the facies of the Buff sandstone member changes from richly fossiliferous, fine- to coarse-grained, predominantly upper littoral to supratidal sandstones in the eastern Aklavik Range to less fossiliferous, predominantly lower littoral to inner neritic, very fine grained sandstones and sandy to pure siltstones (the two are about equally prominent in the westernmost sections) one to one and half mile east of

Canoe Lake (Jeletzky, 1958; 1960; 1972b, p. 21-23).

The westward facies changes of the White sandstone member are even more drastic. The fine- to coarse-grained, often gritty, pebbly and arkosic, predominantly alluvial sandstones of the Aklavik Range sections (Jeletzky, 1958, p. 7, 48-50; 1961a, p. 538) become rare in the lower Martin Creek sections. There they are largely replaced by an extremely complex interfingering of paludal to lagoonal, fine- to very fine grained, coaly sandstones and coaly to carbonaceous siltstones and shales (locally with coal seams and/or plant remains) with deltaic to upper littoral (locally with a rich fauna of shallow water marine pelecypods of the *Buchia* n. sp. aff. *inflata* Zone), feebly carbonaceous to non-carbonaceous, intensively crossbedded and ripple-marked, fine- to very fine grained sandstones (Jeletzky, 1972b, p. 22, 23). Still farther west between the lower course of Martin Creek and Canoe Lake, this lagoonal to shoreline facies of the White sandstone member is replaced laterally by a complex interfingering of littoral (prevalent), lagoonal or outer bar, fine- to very fine grained, non-carbonaceous to carbonaceous sandstones with littoral to inner neritic siltstone and shale. The sandstones of this predominantly open sea facies gradually thin out and mostly shale out in the proximity of Canoe Lake (Jeletzky, 1972b, p. 23).

The coal seams, coaly siltstones, and coaly shales characteristic of the paludal to alluvial Lower member of the Coal-bearing division on the eastern slope of Aklavik Range (primarily on lower Donna River; *see* Jeletzky, 1960, p. 8) rapidly disappear westward. On lower Martin Creek (Jeletzky, 1972b, p. 24; and unpublished data) the whole thickness of the division is represented by interbedding of fine- to very fine grained, commonly carbonaceous to coaly, mostly ferruginous, lagoonal to deltaic sandstones with dark grey to black, apparently non-carbonaceous, concretionary, ?marine siltstone and shale. These two rock types are lithologically and environmentally similar to the prevalent rock types of the Upper member of the eastern slope (Jeletzky, 1960, p. 8, 9). Farther westward, this mixed lagoonal to upper littoral facies of the Coal-bearing division rapidly is replaced laterally by a predominantly littoral, stenohaline facies between the lower course of Martin Creek and the eastern shore of Canoe Lake (Jeletzky, 1972b, p. 24; this report, Secs. G4 and G5 of Fig. 8). These predominantly shallow but open marine equivalents of the Coal-bearing division, only 90 to 100 feet thick, are represented mainly by sandstones. These sandstones are ferruginous, glauconitic, normally abundantly crossbedded and ripple-marked on a large scale, fine to very fine grained but poorly sorted. They are locally gritty to very fine pebbly, and commonly concretionary. The sandstones commonly contain a sparse but unmistakably stenohaline, littoral to inner neritic macroinvertebrate fauna including shallow water pelecypods and gastropods, belemnites and very rare mid- to late Hauterivian ammonites (Jeletzky, 1972b, p. 25)

No trace of an erosional disconformity, let alone an angular discordance, was observed between the Coal-bearing division and its marine equivalents on the one hand and the overlying Upper shale-siltstone division on the other (Jeletzky, 1960, p. 10, 12; 1961a, p. 537, 538). Nor are there any traces of a biochronologically measurable hiatus between these two units as the same diagnostic mid- to late Hauterivian belemnites and ammonites range from the upper part of the Coal-bearing division and that of its marine equivalents into the basal part of the Upper shale-siltstone division (Jeletzky, 1960, p. 9, 13; 1972b, p. 25, 26). This indicates that the rather abrupt lithological contact of the Upper shale-siltstone division with the other two underlying units reflects only a rapid regional subsidence of the eastern flank of the segment at the onset of late Hauterivian time.

The above-discussed depositional-tectonic conditions indicate that the eastern flank of the Bonnet Lake-lower Donna River segment of the trough was situated well to the north of and largely beyond the sphere of influence of the tectonically active crestal part of the Valanginian to mid-Hauterivian Aklavik Arch. The effects of this tectonic phase on the eastern flank apparently were limited to the shortlived and moderate uplift of its eastern marginal zone above sea level. This rather narrow, roughly north-south trending zone was transformed first into an alluvial plain (time of deposition of the White sandstone member) and then into a swampy lowland (time of deposition of the Lower member of the Coal-bearing division). The zone was uplifted above sea level early in the Valanginian and the acme of the uplift was reached in the mid- to late Valanginian (time of deposition of the White sandstone member, *see* Jeletzky, 1961a, p. 537, 538). Then the zone began to subside again in the early Hauterivian. A later beginning, an early climax, and a relatively short duration of the Valanginian to mid-Hauterivian tectonic phase on the eastern flank of the Bonnet Lake-lower Donna River segment contrast with the earlier beginning, the considerably later (early to mid-Hauterivian) climax, and the longer overall duration of the same phase in the crestal zone of Aklavik Arch (Jeletzky, 1973; and in this report under the discussion of the late Berriasian to mid-Hauterivian tectonic pattern of the northern Bell Basin segment).

The relatively minor scale of the Valanginian to mid-Hauterivian uplift on the eastern flank of the Bonnet Lake-lower Donna River segment is evidenced by the fact that it was accumulating the mostly non-marine sediments throughout the event. As pointed out by Jeletzky (1960, p. 9, 12; 1961a, p. 537, 538) these sediments were derived mostly from the erosion of much higher parts of the eastern flank situated farther to the south and thus closer to the Rat Uplift of the Aklavik Arch. The facies and tectonic pattern observed more recently in the eastern and central parts of the northern Bell Basin segment (Jeletzky, 1973; and in the preceding pages of this report) confirm this conclusion. Taken together with the presently known facies pattern of the Lower sandstone and Coal-bearing divisions (*see* its summary in the preceding pages), the above data strongly suggest that most or all of the Valanginian to mid-Hauterivian predominantly nonmarine sediments deposited on the eastern flank (i. e. in the northern Aklavik Range, etc.) of the Bonnet Lake-lower Donna River segment were derived from this southern to southwestern (possibly also southeastern) source area (*see* Figs. 12 and 13). That part of the Valanginian to mid-Hauterivian Peel Landmass, situated to the east of the lower Donna River-Jurassic Butte sector of Aklavik Range apparently was mostly or entirely a swampy lowland. Consequently it is inferred to be only a minor source of sediment even during the acme of the Valanginian to mid-Hauterivian tectonic pulse (i. e. in time of the White sandstone member).

The above-described coastal plain of the eastern flank was bordered in the west by the Valanginian to mid-Hauterivian sea (*see* Jeletzky, 1972b, p. 23-25; and in the following section of this report). The plain extended northward well beyond the limits of the report-area as already suggested by Jeletzky (1960, p. 12; 1961a, p. 538).

The relatively quiet (as compared with the northern Bell Basin and White Mountain segments) Valanginian to mid-Hauterivian tectonic regime of the eastern flank of the Bonnet Lake-lower Donna River segment of the trough appears to be responsible for the persistent and pronounced westward attenuation of the Lower sandstone and Coal-bearing divisions (including the marine equivalents of the latter) within the area pointed out by Jeletzky (1972b, p. 23-25) and illustrated by Sections G5 and G4.

Late Berriasian to mid-Hauterivian facies and tectonic pattern of the mid-basin zone

No exposures of the Lower Cretaceous rocks were seen within the 35- to 40-mile wide east-west anticlinal (Canoe Lake Anticline) interval separating the eastern shore of Canoe Lake from the western headwaters of Cache Creek. The sections of the upper Berriasian to mid-Hauterivian rocks studied in the latter area (Jeletzky, 1971a, p. 203, 205, Fig. 2; and unpublished data) are illustrated by Section G3 (Fig. 8). A section measured by Young (1972, p. 230) a couple of miles to the northwest on Fish River (Lat. 68°27'N; Long. 136° 32'W) appears to form part of the same outcrop belt.

In contrast to the eastern flank of the segment, the rocks of the Lower sandstone and Coal-bearing divisions are almost to completely absent in the headwaters of Cache Creek (Jeletzky, 1973, p. 38, 39, Fig. 2) and farther to the north and northwest in the basin of Fish River (Young, 1972, p. 230). Wherever present, these rocks are restricted to beds, 20 to 25 feet thick, of hard, quartzite-like sandstone overlying gradationally the 850- to 900-foot thick Upper Jurassic to basal Cretaceous shale-siltstone unit representing the upper tongue of the Husky Formation (*see* Sec. G3 of Fig. 8). This sandstone is correlative only with the basal part of the Buff sandstone member because of the presence of *Buchia* n. sp. aff. *volgensis* (Lahusen) and *B.* ex gr. *uncitoides* (Pavlov).

The 850- to 900-foot thick Upper shale-siltstone division is represented by almost unfossiliferous, mostly outer neritic to inner neritic (hardly any belemnites seen except in the basal 100 to 150 feet) concretionary shale and siltstone. It overlies either the above-mentioned sandstone or the uppermost part of the upper tongue of the Husky Formation with a sharp and uneven contact evidently representing an erosional disconformity. Similar contact relationships were observed by Young (1972, p. 230) who postulates an erosional truncation of the Lower sandstone and Coal-bearing divisions prior to the deposition of the Upper shale-siltstone division. These depositional-tectonic conditions duplicate those observed in the correlative beds on the eastern flank of White Mountains (compare Sec. F4 of Fig. 7; and in the discussion of the late Berriasian to mid-Hauterivian facies and tectonical pattern of the White Mountain segment), except that no arenaceous interbeds were observed in the overlying Upper shale-siltstone division either by the writer or by Young (1972, p. 230). The writer believes that, like the crestal zone of Rat Uplift of Aklavik Arch and the White Mountain area, the area embracing the headwaters of Cache Creek and Fish River was uplifted above sea level early in the Valanginian and acted as a local source area within the trough until the onset of the late Hauterivian transgression.

An entirely different facies of the late Berriasian to mid-Hauterivian rocks was observed westward of the headwaters of Cache Creek, in the headwaters of Rapid Creek and on the eastern side of Blow Pass (Jeletzky, 1961b, p. 14-18; 1971a, p. 207, 208). An apparently similar facies of these rocks was observed by Young (1972, p. 230, Fig. 1) about halfway between the headwaters of Rapid Creek and those of Cache Creek at the southern end of Mount Gilbert anticline.

In the Rapid Creek-Blow Pass area (Jeletzky, 1971a, p. 207, 208; this report, Sec. G2 of Fig. 8), the facies of upper Berriasian to mid-Hauterivian rocks is closely similar to that characteristic of the western headwaters of Bell River (Jeletzky, 1961b and in preceding sections of this report). The Rapid Creek-Blow Pass area facies differs from that of the western headwaters of Blow River only in:

1. An extreme attenuation of the Lower sandstone division which is restricted to discontinuous sandstone lenses (as much as 150 feet thick and 1½ miles long) in the middle part of a sequence of black shale and siltstone about 2, 600 feet thick. These sandstones contain only *Buchia* n. sp. aff. *volgensis* Lahusen and rare ammonites but no belemnites or other shallow water mollusks. They are interpreted accordingly as deep water sands representing either the product of a winnowing action of deep water currents on or around underwater banks existing on the sea bottom or that of downslope directed bottom currents from the western flank of the trough. The sands are overlain gradationally by the almost unfossiliferous (only very rare *Buchia* and ammonites were found) outer neritic to upper bathyal pure shales of the mid-basin facies of Blue-grey shale division containing a few diagnostic early, mid- and late Valanginian fossils.

2. Exceptionally thick (about 1,800 feet) but non-coal-bearing and only partly carbonaceous to coaly, predominantly deltaic to lagoonal and beach, or more rarely shallow marine (?upper littoral) facies of the White and Coaly quartzite divisions (Jeletzky, 1971a, p. 207, 208; this report, Sec. G2 of Fig. 8).

The rocks of the Coaly quartzite division apparently are conformably overlain by the western, deep water facies of the Upper shale-siltstone division, the basal beds of which have yielded a diagnostic late Hauterivian *Simbirskites* sp. indet. There is no reason whatsoever to assume the presence of a hiatus between the Coaly quartzite and Upper shale-siltstone division in the area.

The above-described strong uplift of the whole extent of the mid-basin zone of the segment in Valanginian to mid-Hauterivian time is attributable to this zone forming part of the north-south trending Cache Creek Uplift (Norris, 1972, p. 91, 93, Fig. 1; and this report p. 35-36, Figs. 12, 13). The Cache Creek-Blow Pass section of the uplift evidently represented an immediate northward extension of the White Mountain-western headwaters of Bell River section. As with the latter section, the Valanginian to mid-Hauterivian uplift of the Cache Creek-Blow Pass section appears to be the first tectonic activity since the emergence of the Porcupine Plain-Richardson Mountain Trough at the onset of the Jurassic. This is evidenced by the fact that the previously described Jurassic to basal Cretaceous rocks of the Cache Creek-Blow Pass section (*see* Secs. G2 and G3 of Fig. 8) are represented almost exclusively by argillaceous, deep water sediments deposited in the deep, rapidly subsiding mid-basin zone of the trough.

As with the White Mountains area of the White Mountain segment (*see* p. 15-16). the Cache Creek area of the Bonnet Lake-lower Donna River segment must have been transformed into a shortlived local source area situated in the middle of the northern part of the Porcupine Plain-Richardson Mountain Trough. This part of the uplift apparently was affected by the earlier tectonic movements and then elevated considerably more than the Blow Pass-Rapid Creek area adjoining it to the west. As with the area comprising the western headwaters of Bell River, the deposition of predominantly nonmarine clastics of the White and Coaly quartzite divisions in the Blow Pass-Rapid Creek area of the segment reflects its only moderate early to mid-Hauterivian uplift following a phase of deep subsidence in the late Berriasian to late Valanginian time. The resulting early to mid-Hauterivian coastal lowland (possibly a delta of a large northwest flowing river) apparently was contiguous with the alluvial plain occupying the western headwaters of Bell River. The Blow Pass-Rapid Creek part of the lowland apparently received sediment from both the strongly elevated crestal part of the Aklavik Arch to the south and the apparently strongly elevated, possibly cordillera-like eastern part of the uplift (i.e. in the present headwaters of the Cache Creek and the present White Mountains area) to the east and southeast (Figs. 12 and 13).

The nature of the junction of the above-discussed part of the Cache Creek Uplift with the previously discussed relatively depressed, tectonically quiet east flank of the Bonnet Lake-lower Donna River segment of the trough adjoining it to the east is obscured by the intervening 35- to 40-mile wide belt of Paleozoic rocks that apparently do not include any lower Lower Cretaceous outliers. It is suggested, however, that this interval was occupied mainly by the late Berriasian to mid-Hauterivian rocks forming the western flank of the previously mentioned, apparently synclinal Canoe Depression. These rocks are believed to have been of the same facies as the previously described late Berriasian to mid-Hauterivian rocks of the eastern flank of the depression. It is suggested, moreover, that these rocks exhibited basinward facies changes similar to those of the eastern flank but reversed in direction (i.e. fining and shaling out from west to east; *see* Figs. 12 and 13).

Late Berriasian to mid-Hauterivian facies and tectonic pattern of the western flank

The east-west facies and thickness changes of the late Berriasian to mid-Hauterivian rocks on the western flank of the Bonnet Lake-lower Donna River segment parallel closely those occurring on the western flank of the White Mountain segment (compare Secs. G1 and G2 of Fig. 8, with Secs. F2 and F3 of Fig. 7).

The restricted (Jeletzky, 1961b, p. 9, 10, Fig. 1) Lower sandstone division of the Barn Mountain-Blow Pass area thins out and then almost completely shales out eastward and northeastward (Jeletzky, 1961b, p. 9, 10; 1972a, p. 207; 1972b, p. 29; and this report Secs. G1 and G2 of Fig. 8). The westernmost sections studied are situated between the southeastern flank of Barn Mountains, headwaters of Johnson Creek and Sam Lake. In all these locations exemplified by Section G1, the Lower sandstone division is a laterally persistent, 400- to 450-foot thick body, consisting almost exclusively of ridge-forming, hard and dense, fine- to very-fine grained, feebly to fairly glauconitic, commonly crossbedded and ripple-marked sandstones. These often richly fossiliferous, predominantly shallow water (mostly lower to ?upper littoral) sandstones may include locally considerable interbeds of fine- to medium-grained carbonaceous to coaly (possibly supratidal) sandstone and rare (up to 1½ feet thick) beds of carbonaceous to coaly, fine to very fine pebble conglomerate and grit containing poorly rounded to angular, probably locally derived clasts. The division grades downward into the deep water argillaceous rocks of the Husky Formation through a unit, 100 to 150 feet thick, consisting of alternating thin-bedded (¼ to 4 inch) to laminated sandstones (as above) with dark grey, mostly sandy, hard siltstones. The division is considerably thinner and includes more siltstone interbeds farther east in the proximity of Bonnet Lake. Still farther northeast on the eastern side of Blow Pass the division is reduced to the series of lenses (described previously) of apparently deep water sands separating the outer neritic to bathyal shales and siltstones of the Husky Formation from those of the Blue-grey shale division (*see* Sec. G2 of Fig. 8). These rather regular basinward facies changes of Lower sandstone division, from west to east and northeast, as well as the presence of volumetrically significant interbeds of carbonaceous to coaly sandstone and rare beds of fine pebble conglomerate and grit with subangular to angular clasts, in some of the westernmost sections studied, indicate its derivation from a not too distant southwestern source. The present Keele and Old Crow ranges appear to be the most likely source areas (*see* Fig. 11). However, the apparent concentration of the above-mentioned coaly sandstones and fine to very fine pebble conglomerates with poorly rounded to angular clasts within a few miles south and southeast of Barn Mountains is somewhat suggestive of a second northwestern source area (?an island) situated within the present Barn and/or Buckland Mountains. The writer is unable to interpret the lithological and sedimentological characteristics of the Lower sandstone division in the headwaters of Babbage River from the scant data available (Young, 1973a, p. 279).

Eastward of the eastern side of Blow Pass (Sec. G2 of Fig. 8), the Lower sandstone division is believed to pinch-out completely within the western part of an area about 40 miles wide, separating it from the western headwaters of Cache Creek as shown in Figure 8. The axial zone of the late Berriasian Porcupine Plain-Richardson Mountain Trough presumably was situated somewhere in the present headwaters of Rapid Creek.

The restricted Lower sandstone division of the Barn Mountain-Blow Pass area grades upward into the Blue-grey shale division. This indicates that, like the western part of the White Mountain segment (*see* in preceding section), the western flank of the Bonnet Lake-lower Donna River segment was not affected by the early to late Valanginian tectonic movements. The onlap of the outer neritic to upper bathyal Blue-grey shale division onto the littoral Lower sandstone division (restricted) in the area confined between Barn Mountains, headwaters of Johnson Creek and Sam Lake (*see* Sec. G1 of Fig. 8) indicates that a brief and relatively weak late Berriasian uplift was replaced by a rapid and strong subsidence in the earliest Valanginian (*Buchia keyserlingi* zone). This episode of subsidence lasted through most or all of the Valanginian time as indicated by the presence of mid- to late Valanginian *Buchia* n. sp. aff. *inflata* fauna in the upper part of the Blue-grey shale division (Jeletzky, 1971a, p. 207; this report, Sec. G2 of Fig. 8) of the area. In the eastern part of the area, on the eastern side of Blow Pass, the late Berriasian uplift is barely perceptible as indicated by the appearance of the presumably bottom current deposited lenticular bodies of deep water sands (Jeletzky, 1971a, p. 207; this report, Sec. G2 of Fig. 8) between the outer neritic to upper bathyal argillaceous rocks of the upper Husky Formation and the Blue-grey shale division.

The Blue-grey shale division exhibits distinct basinward facies changes within the Barn Mountain-eastern side of Blow Pass area. It is only 450 to 500 feet thick and contains volumetrically significant interbeds of sandy siltstone and very fine grained, silty sandstone in the sections studied between Barn Mountains and Sam Lake (Jeletzky, 1972b, p. 29, 30). Eastward, however, it thickens to from 900 to ?1,100 feet and is represented almost exclusively by pure, almost unfossiliferous shale and siltstone. Like the underlying Jurassic and earliest Cretaceous units of the western flank, the Blue-grey shale was derived from a western source area. However, this source area must have been situated a considerable distance to the west (?or southwest) of the Barn Mountain-Sam Lake area, as even the westernmost sections studied are represented still by the open sea, predominantly outer neritic facies lacking belemnites and other shallow water mollusks. Hence the time of the Blue-grey shale division was characterized by a widespread westward transgression on the western flank of Bonnet Lake-lower Donna River segment.

As in the White Mountain segment, the strong Valanginian subsidence of the western flank of the Bonnet Lake-lower Donna River segment progressed while the central part of the segment (i.e. the headwaters of Cache Creek and those of Fish River) was increasingly strongly uplifted. Only in the early to mid-Hauterivian time did this uplift spread onto the western flank of the segment as evidenced by the transformation of the latter into a lowland (i.e. on the eastern side of Blow Pass; *see* Sec. G2 of Fig. 8) or a shallow sea (i.e. between Barn Mountains and Sam Lake; *see* Sec. G1 of Fig. 8).

In contrast to the previously discussed, predominantly nonmarine facies of the White and Coaly quartzite divisions on the eastern side of Blow Pass (Jeletzky, 1971a, p. 207, 208; this report, Sec. G2 of Fig. 8), the equivalent early to mid-Hauterivian rocks outcropping farther west in the area confined between Barn Mountains, headwaters of Johnson Creek and Sam Lake are almost exclusively shallow marine (lower littoral to inner neritic) sandstones and siltstones (Jeletzky, 1972b, p. 31, 33; this report Sec. G1 of Fig. 8). The same is true, furthermore, of the equivalents of the White and Coaly quartzite divisions outcropping in the headwaters of Canoe River (Young, 1973a, p. 279). The early to mid-Hauterivian sea of the main part of Porcupine Plain-Richardson Mountain Trough evidently migrated to the extreme western part of the Bonnet Lake-lower Donna River segment because of the previously mentioned westward spread of the Cache Creek Uplift at the end of the Valanginian (*see* Figs. 12 and 13). This residual, relatively shallow sea (as compared with the preceding sea of the Blue-grey shale time) apparently was restricted to a north-south trending strait situated in the Barn Mountain-headwaters of Johnson Creek area and immediately west in the upper Babbage River-Sam Lake area (Norris, 1972, p. 96; Young, 1973a, p. 279). The westward extent of this early to mid-Hauterivian seaway is unknown. Because of the generally similar overall facies and depositional-tectonic pattern of Valanginian to mid-Hauterivian rocks observed on the western flanks of the White Mountain and northern Bell Basin segments of the trough, this seaway is believed to have extended southward across the confluence area of Porcupine-Driftwood Rivers and the central Keele

Range as shown in Figure 13. The tentative nature of this conclusion was pointed out when discussing the facies and tectonic pattern of the northern Bell Basin segment.

As pointed out previously, the above-discussed acme of the westward migration and narrowing of the marine axial part of the main Porcupine Plain-Richardson Mountain Trough occurred simultaneously with the maximum "shrinking" of the marine part of the early to mid-Hauterivian Canoe Depression on the eastern flank of the segment.

Late Hauterivian to Aptian facies and tectonic pattern

As in the more southerly segments of the trough, the rapid and widespread late Hauterivian transgression re-flooded the whole extent of the Bonnet Lake-lower Donna River segment including all of the crestal part of the Cache Creek Uplift (Fig. 14). This transgression spread well beyond the limits of the report-area in the west (Young, 1973a, p. 279), north (Young, 1972, p. 230; 1973a, p. 279) and the east (Fig. 14).

The Upper shale-siltstone division exhibits pronounced basinward changes from east to west across the eastern and middle parts of the segment as it does in the Northern Bell Basin and White Mountain segments (Secs. G2 to G5 inclusive of Fig. 8). In the interval from eastern Aklavik Range to and including the headwaters of Cache Creek and Fish River the division is represented by a unit of pure to sandy siltstone and concretionary shale, only 800 to 1, 200 feet thick. The rare to common presence of inner to outer neritic mollusks (including inner neritic belemnites and some ornate shallow water pelecypods) suggests the absence or rarity (except possibly in the middle part of the division) of upper bathyal deposits throughout the area. This eastern facies of the Upper shale-siltstone division is replaced laterally by a considerably thicker, deeper water facies somewhere between the headwaters of Fish River and those of Rapid Creek. This western or mid-basin facies apparently extends westward into the eastern part of Blow Pass area. It is at least 2, 000 feet thick and may be considerably thicker there. However, the total thickness cannot be reliably estimated because of severe faulting of all measured sections. In the headwaters of Rapid Creek, the argillaceous rocks of the western facies replace laterally the lower part of the Upper sandstone division of more easterly areas. This is indicated by the presence of *Tropaeum* sp. in the basal beds of the former (Sec. G2 of Fig. 8). This ammonite is restricted to the upper part of the Upper sandstone division on the eastern flank of the trough. The western facies includes a volumetrically significant interbeds and members of thinly bedded to laminated, graded, crosslaminated on a small scale, sandy siltstone and very fine grained lithic sandstone lithologically similar to those of the Waters River area (Jeletzky, 1973, p. 30). Because of a distinctly flyschoid lithology and an apparently complete absence of macro-invertebrates, these siltstone-sandstone interbeds and members of the Upper shale-siltstone division of the Rapid Creek-eastern Blow Pass area are interpreted as bathyal turbidites deposited by feeble to ?moderate turbidity currents. The surrounding non-graded concretionary shale and pure to sandy siltstone are likewise interpreted as deep water (?upper bathyal) deposits because of an almost complete absence of macro-invertebrates, save for exceptionally rare ammonites and nuculid pelecypods found in the basal part of the division. This western facies of the Upper shale-siltstone division appears to represent the northward extension of the similar facies occurring in the western part of the northern Bell Basin segment and to be contiguous with the latter (Jeletzky, 1973).

Within the Bonnet Lake-lower Donna River segment the mid-basin zone of the late Hauterivian to late Barremian trough apparently was restricted to the area extending from the headwaters of Rapid Creek to the western headwaters of Blow River. Though the sections of the Upper shale-siltstone division observed between the southern flank of the Barn Mountains, headwaters of Johnson Creek, and Sam Lake are incomplete (*see* Sec. G1 of Fig. 8), their facies is unlike that of the mid-basin facies and similar to the previously described eastern facies of the segment. The section of the Upper shale-siltstone division measured by Young (1973a, p. 279) in the northwestern part of the same syncline as Section G1 (Fig. 8) in the headwaters of Canoe River is only 650 feet thick and appears to be lithologically similar to the eastern facies of the division. All these sections of the Upper shale-siltstone division are believed to be situated on the western flank of the Porcupine Plain-Richardson Mountain Trough in the proximity of its western shoreline (*see* Fig. 14) and to grade laterally eastward into its previously discussed mid-basin facies.

As in the northern Bell Basin and White Mountain segments, the deposition of the relatively thin and shallow water, non-turbiditic eastern facies of the Upper shale-siltstone division over a large eastern and central part of Bonnet Lake-lower Donna River segment is attributable to the aftereffects of the Valanginian to mid-Hauterivian orogenic phase. Like the corresponding parts of more southerly segments, this part of Bonnet Lake-lower Donna River segment became only feebly to moderately negative after the bevelling and submergence of the Cache Creek Uplift in mid- to late Hauterivian time.

In the Bonnet Lake-lower Donna River segment, the basinward east to west facies and thickness changes of the Upper sandstone division and its predominantly to ?entirely argillaceous mid-basin equivalents are similar to, but more pronounced than, those observed anywhere else in the report-area. These Aptian rocks range from a relatively thin (?400 to 1, 200 feet), predominantly upper to lower littoral, almost exclusively arenaceous eastern facies to a much thicker lowermost neritic to/or upper bathyal, predominantly or ?entirely argillaceous, and partly to ?entirely turbiditic mid-basin facies (i. e. Aptian-Albian flysch). The latter then reverts to a more shallow water, partly or ?predominantly arenaceous western facies in the westernmost part of the segment. Unlike the eastern facies of the Upper sandstone division of the southern

Bell Basin, northern Bell Basin, and White Mountain segments (*see* Jeletzky, 1973; and in the previous sections of this report), the eastern facies of the Bonnet Lake-lower Donna River segment does not seem to become finer grained, shale out, or thicken westward until the headwaters of Rapid Creek. The sections of the division studied on the divide between Cache Creek and Fish River in the interval 12 to 18 miles southeast of Mount Davies Gilbert (*see* Jeletzky, 1967, p. 27 where they were referred tentatively to the Lower sandstone division on the basis of a distant observation), are just as thick or thicker (as much as 1,000 feet thick with the top not reached; *see* Sec. G3 of Fig. 8) than those in Aklavik Range (*see* Jeletzky, 1958, p. 10, 13; 1960, p. 13, 14). Fine- to very-fine grained, upper to lower littoral, quartzose sandstones appear to predominate in most sections. Some of the sections in the headwaters of Cache Creek and Fish River include some interbeds of sandy to very sandy, non-carbonaceous siltstone which may be the eastern pinch-out zones of the siltstone units prevalent farther west in the headwaters of Rapid Creek. The same facies of the division was recorded a few miles northwest of the report-area (Young, 1972, p. 230, Fig. 1) at the southern end of Gilbert Anticline. This persistence to the west of the predominantly littoral eastern facies of the division appears to be caused by the aftereffects of the Valanginian to mid-Hauterivian orogenic pulse of the Cache Creek Uplift.

The eastern facies of the Upper sandstone division appears to grade laterally into the same western facies as in the northern Bell Basin and White Mountain segments somewhere within the eastern part of the headwaters of Rapid Creek as all investigated sections of the division in the western part of this area (Jeletzky, 1971a, p. 208, 209; 1972b, p. 33, 34; this report, Sec. G2 of Fig. 8) belong to the latter facies.

The 1,200- to 1,300-foot-thick, mostly inner to outer neritic, predominantly argillaceous but nevertheless lithologically recognizable western facies of the Upper sandstone division studied by Jeletzky (1971a, p. 208, 209; 1972b, p. 33, 34) in the western headwaters of Rapid Creek appears to correspond only to the Lower member of the division as developed farther south in the Waters River basin (Jeletzky, 1973; and in the previous sections of this report). However, the Lower sandstone member of the Rapid Creek area apparently was deposited in a tectonically more active part of the trough resembling the White Mountains area as the sandstone units occurring in its succession include intercalated beds of poorly sorted and rounded gritty and fine pebbly greywacke rich in commonly disarticulated and even fragmented shallow water pelecypods (Jeletzky, 1971a, p. 208, 209; 1972b, p. 33). These presumably upper littoral, stenohaline deposits appear to reflect brief episodes of uplift of the sea bottom within the area.

The Upper member of the Waters River succession of the Upper sandstone division (Jeletzky, 1973) appears to be represented in the headwaters of Rapid Creek by a unit, at least 800 feet thick, of dark grey, pure to silty shale (*see* Sec. G2 of Fig. 8) and an undetermined (because of faulting and contortion), but considerable thickness of similar shale interbedded with some laminated, apparently graded, ?flyschoid argillaceous rocks faulted against the uppermost (third) sandstone unit of the Lower member (Jeletzky, 1972b, p. 34). According to Young (1972, p. 231, 232, Fig. 1), the apparently correlative "lower mudstone member" is from 2,000 to 4,000 feet thick in the immediately adjacent, more northerly part of the Rapid Creek basin. The total thickness of the western facies of the Upper sandstone division in that part of the headwaters of Rapid Creek studied by the writer probably amounts to at least 3,000 feet. However, it cannot be estimated definitely because of the extremely faulted and contorted state of the Upper member in all sections studied.

No lithological equivalents of the Upper sandstone division were recognized west of the headwaters of Rapid Creek in the middle and western parts of Blow Pass, around Bonnet Lake, and near the eastern and southeastern slopes of the Barn Mountains. However, the Lower shale-siltstone unit of the Upper Aptian-Lower Albian flysch division, at least 3,100 feet thick (base faulted; *see* Jeletzky, 1971a, p. 209, 210; this report, Sec. G1 of Fig. 8), appears to be correlative (entirely or in part) with at least the Upper member of the Rapid Creek area. This considerably more arenaceous and, at the same time, pronouncedly flyschoid unit is believed to be an even deeper water (?predominantly bathyal) deposit than its Rapid Creek equivalent because of the lithological character and an almost total absence of macro-invertebrate fauna.

The proposed correlation of the Lower shale-siltstone unit of the Upper Aptian-Lower Albian flysch division is supported by the presence of fairly diagnostic Aptian fossils (*Inoceramus* cf. *neocomiensis* d'Orbigny) at one level near its top (Jeletzky, 1971a, p. 211) and by the presence of *Sonneratia* (sensu lato) n. sp. A, a diagnostic fossil of the oldest Albian zone known in Canada (Jeletzky, 1971a, p. 209-211), in the Upper shale-siltstone unit of the same division.

The predominantly argillaceous rocks of the Lower member of the Upper sandstone division of the Rapid Creek area also may be represented in the above-discussed deeper water (presumably upper bathyal) flyschoid rocks of the Lower shale-siltstone unit in the Blow Pass-southeastern slopes of Barn Mountain area. However, they may be faulted out as the base of the unit was not seen in any of the sections studied and appears to be a fault throughout the area.

The above-described very thick and predominantly to exclusively deep water, partly flyschoid facies of the Upper sandstone division appears to be restricted to the Upper Rapid Creek-Blow Pass area of the Bonnet Lake-lower Donna River segment of the trough. This is suggested because of the re-appearance of a shallow water, arenaceous facies of the lower part of the division correlative apparently with the Lower member of the Rapid Creek area (*see* in Young, 1973a, p. 279) west and northwest of the report-area on upper Canoe River and near the confluence of Babbage River and Phillip Creek. These sections are believed to be situated on the western flank of the trough in the proximity of the eastern shore of Keele-Old Crow Landmass. Under this interpretation the rapidly subsiding and equally rapidly filling up, Aptian (i. e. time of the Upper sandstone division) axial part of the here-discussed segment of the Porcupine Plain-Richardson Mountain Trough was narrow (almost furrow-like) and situated far westward of the geographical middle of the trough in the proximity of Keele-Old Crow Landmass.

Lower Albian rocks and the effects of the latest Aptian orogenic phase

The following account of the facies and tectonic pattern of lower Albian rocks in the Bonnet Lake-lower Donna River segment is strongly hampered by a limited distribution and an unsatisfactory state of knowledge of these rocks. A number of suggestions made in this section are based on the extrapolation of observations made by Young (1972; 1973a; 1973b) in the adjacent areas of the Yukon's north slope.

So far as is known, Albian rocks are completely eroded in the eastern and middle parts of the segment extending from the Mackenzie Delta to the western headwaters of Fish River (Jeletzky, 1961a, p. 540-542, Fig. 1; this report, p. 13, Secs. G3 to G5 of Fig. 8). This precludes any definitive conclusions about the strength, areal extent and tectonic expression of the latest Aptian orogenic phase in this part of the trough. However, the lower Lower Albian [*Sonneratia* (sensu lato) n. sp. A Zone] Bedded ironstone and shale member was observed by Young (1972, p. 232) to overlie unconformably the Upper sandstone division immediately north of the area at the point 5 miles east of Mount Davies Gilbert. This suggests that the latest Aptian orogenic phase also was felt throughout the eastern and middle parts of the segment and may have caused their uplift above sea level. This hypothesis is adopted as valid in this report. As previously mentioned (*see* p. 13), there are good reasons to assume that this uplift was followed by a re-submergence of the eastern and middle parts of the segment in early Early Albian time [i. e. time of *Sonneratia* (sensu lato) n. sp. A].

In the headwaters of Rapid Creek, west of the headwaters of Fish River, the contact relationships between the Upper member of the Upper sandstone division equivalent and the overlying, presumably Lower Albian flyschoid rocks are obscured by faulting and contortion in all sections studied. However, Young's (1972, p. 231, 232) field work in the adjacent, more northerly areas of Yukon's north slope suggests that the equivalents of the Upper member (i. e. Lower mudstone member) grade upward into the presumably early Early Albian Turbidite member. The latter member appears to be correlative with the Chert conglomerate unit of the Blow Pass-Barn Mountain area according to Young (1972, p. 232). These data suggest that, unlike its marginal, shallow water parts, the deep water, mid-basin part of the Bonnet Lake-lower Donna River segment of the trough was not appreciably affected by the latest Aptian tectonic pulse.

No data pertaining to the contact relationships between the predominantly argillaceous Aptian and Lower Albian rocks outcropping in the Lower Bell and Waters Rivers basins of the northern Bell Basin segment (*see* the previous sections of this report) are available at present. However, the general similarity of the facies of these rocks to that of their equivalents outcropping in the headwaters of Rapid Creek and farther north in the basins of Rapid and Purkis Creeks suggests that the poorly known mid-basin zones of the White Mountain and northern Bell Basin segments may not have been affected by the latest Aptian tectonic movements either. If so, the latest Aptian tectonic regime of the mid-basin zone of those segments of the Porcupine Plain-Richardson Mountain Trough situated astride and north of the Aklavik Arch was quite unlike that of its previously discussed more southern segments (*see* under the discussion of the southern Eagle Plain, northern Eagle Plain and southern Bell Basin segments).

West of the headwaters of Rapid Creek, in the middle and western parts of Blow Pass, around Bonnet Lake and in the headwaters of Johnson Creek, the Albian part of the Upper Aptian-Lower Albian flysch division includes (in ascending order) the Chert conglomerate unit, Upper shale-siltstone unit, and the overlying predominantly argillaceous shelf-like unit (Jeletzky, 1971a, p. 209, 210; 1972b, p. 34, 35; this report, Sec. G1 of Fig. 8) totaling at least 5, 000 feet. The original, tentative placement of the Chert conglomerate unit into the uppermost Aptian (Jeletzky, 1971a, p. 210) is withdrawn herewith because of subsequent discoveries of the *Sonneratia* (sensu lato) n. sp. A fauna in the correlative conglomerate units of Sharp Mountain (Jeletzky, 1972b, p. 55) and the Purkis Creek-Blow River (Young, 1973a, p. 280) areas. The upper part of the next younger Upper shale-siltstone unit contains the same fauna and, consequently, forms part of *Sonneratia* (sensu lato) n. sp. A Zone which is tremendously thick (at least 2, 000 feet) in the area. The youngest predominantly argillaceous shelf-like unit is correlated with the upper Lower Albian *Beudanticeras glabrum*-bearing shales of Bell River area (Jeletzky, 1972b, p. 34) because of similar lithology and stratigraphic position.

As pointed out by Jeletzky (1971a, p. 209), the deposition of the Upper Aptian to Lower Albian flysch in general, and of the Chert conglomerate unit in particular, was caused by strong uplifts of the adjacent part of the western flank of the Porcupine Plain-Richardson Mountain Trough resulting in the emergence of a fast-rising tectonic highland. The complete absence of paleontological or sedimentological indices of nonmarine or shallow water deposition (e. g. coal beds, interbeds of coaly to carbonaceous, plant-bearing siltstone or sandstone, large-scale ripple-marks and crossbedding, shallow water marine fossils, etc.), their occurrence within a thick deep water (?upper bathyal) flysch sequence, the abundance of argillaceous matrix and presence of pebbly mudstones, and their apparently completely unfossiliferous character suggest a deep water origin for the Cherty conglomerate unit on the western flank of Bonnet Lake-lower Donna River segment. However, the correlative chert pebble conglomerate outcropping in the Sharp

Mountain area appears to be an upper littoral (?beach) to piedmont deposit (Jeletzky, 1972b, p. 55, 56).

The Chert conglomerate unit of the area, including Blow Pass, Bonnet Lake, and eastern and southeastern flanks of Barn Mountains is indistinctly and irregularly bedded to massive, poorly sorted to unsorted, and not graded. Therefore, the unit may be interpreted as having been derived from shallow water gravel masses rapidly accumulating in a narrow shelf zone fringing the strongly uplifted and rapidly wasting early Early Albian Keele-Old Crow Landmass. The gravel masses apparently were transported rapidly by some kind of sediment flow eastward down the steep continental slope and re-deposited as a series of either disconnected or overlapping deep sea fans at its base. Neither the shallow water conglomerates nor the deposits of distributary channels (deep sea canyons) have been observed in the Blow Pass-Bonnet Lake area. All outcrop-areas of the Chert conglomerate unit discovered by Jeletzky (1971a, p. 210) in this area appear to represent the above-mentioned deep sea fan deposits because of the conformable and possibly gradational superposition on the uppermost Aptian Lower shale-siltstone unit However, the correlative chert conglomerate units reported by Young (1972, p. 230; 1973a, p. 280) northward of the report-area (i. e. northwest of Mount Fitton, in the highland between Blow River and Purkis Creek, on Anker Creek near the confluence with Annet Creek, and on Boulder Creek) are believed to be different. These units appear to represent either the deposits of distributory channels (deep sea canyons) and/or shallow water conglomerates because of their erosionally disconformable or unconformable relationships with the underlying, considerably older Cretaceous rocks. Like the previously mentioned Sharp Mountain conglomerate, these conglomerates were presumably deposited in the western marginal part of the trough which was strongly affected by the latest Aptian tectonic pulse. The geographical distribution of these conglomerates and the reappearance of deep water deposits of the Upper Aptian-Lower Albian flysch division still farther north on Babbage River (Young 1973a, p. 280) suggests the presence of an elevated, eastward-protruding peninsula of the early Early Albian Keele-Old Crow Landmass occupying the site of present Barn and Buckland Mountains (Fig. 16). The Upper Aptian-Lower Albian flysch division of Blow Pass-Bonnet Lake area apparently was deposited in a westward concave embayment of the early Early Albian Keele-Old Crow Landmass situated to the south of its Barn Mountain Peninsula.

Contrary to the opinion of Young (1973b, p. 31), the writer believes that neither the Bonnet Lake-lower Donna River segment of the Porcupine Plain-Richardson Mountain Trough nor the adjacent areas of the Yukon's north slope were restructured tectonically in Early Albian time. Unlike the apparently completely inverted southern segments of the trough (i. e. those segments situated south of Aklavik Arch; *see* in the previous sections of this report) and the completely submerged Peel Landmass east of the trough (*see* in the Early Albian section of paleogeographical chapter), the early Albian facies pattern, position of the axis, and general tectonic setting of the Bonnet Lake-lower Donna River segment remained basically the same as in the late Hauterivian to latest Aptian time (i. e. since the bevelling and submergence of the Cache Creek Uplift at the onset of the late Hauterivian). The Early Albian axis of the trough remained in approximately the same position as that of the preceding late Hauterivian to late Aptian trough. The characteristic contrast between the relatively thin and shelf-like eastern facies and the thick to very thick, predominantly deep water western facies of the late Hauterivian to Aptian rocks persisted through the Early Albian and was even more pronounced. Though difficult to observe within the Bonnet Lake-lower Donna River segment proper because of the effects of the latest Albian erosion, this contrast has been well documented by Young (1972, p. 230-232, Fig. 1; and this report, Figs. 8, 15) in adjacent areas of Yukon's north slope. There the extremely thick, evidently deep water Upper Aptian-Lower Albian flysch, corresponding to that of the Blow Pass-Bonnet Lake-headwaters of Rapid Creek area (Jeletzky, 1971a, p. 201, 210; 1972b; 1973), thins out very rapidly eastward and passes laterally into a relatively thin sequence of argillaceous shelf sediments. The Early Albian Keele-Old Crow Landmass remained, finally, in approximately the same position as its early to mid-Lower Cretaceous predecessor, albeit in a considerably enlarged and uplifted state.

General Remarks

The facies and tectonic pattern of the Bonnet Lake-lower Donna River segment is similar to that of the adjacent White Mountain segment in all essential features. As in the latter segment, the Jurassic to Lower Cretaceous facies and tectonic pattern of the Bonnet Lake-lower Donna River segment is considerably complicated by a shortlived (?early Valanginian to mid-Hauterivian) emergence of a narrow, ?cordillera-like, north-trending strip of land (Cache Creek Uplift) in its middle part (Figs. 12 and 13). This tectonic event and its long-lasting aftereffects caused the previously discussed pronounced westward displacement of the axial part of the main Porcupine Plain-Richardson Mountain Trough in the earliest Valanginian to Early Albian time. As in the White Mountain segment again, an apparently shortlived (late Berriasian to mid-Hauterivian) supplementary depositional basin (Canoe Depression) formed on the eastern flank of Bonnet Lake-lower Donna River segment. In the writer's opinion, the resulting, somewhat complex facies and tectonic pattern appears to be responsible for the interpretation (e. g. Young, 1973b, p. 31) of all Jurassic to mid-Lower Cretaceous (i. e. pre-Albian) sediments of Yukon's north slope as shallow water, epicontinental deposits. All these facies and structural features are, instead, but second and third rate details obscuring the longlasting existence of a well-defined, deep, rapidly subsiding and concurrently filling, Jurassic to mid-Lower Cretaceous trough crossing the western part of the segment and extending farther

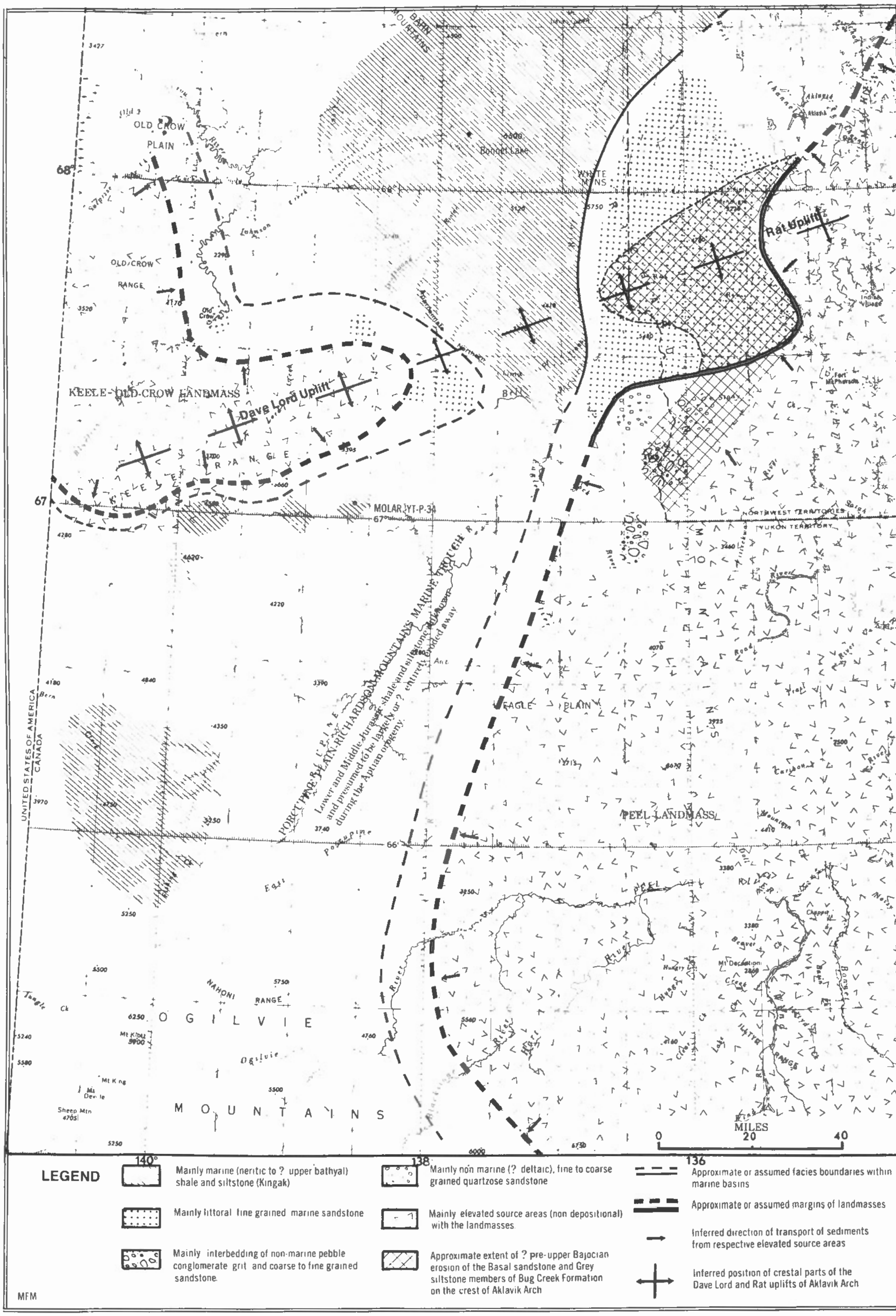


Figure 9. Early to Mid-Jurassic (i. e. Hettangian to Callovian time or the time of Bug Creek Formation and its argillaceous equivalents) palaeogeography and depositional tectonics.

northward onto the western part of Yukon's north slope (i.e. into the Babbage River-upper course of Rapid Creek area).

PALEOGEOGRAPHY AND DEPOSITIONAL TECTONICS OF PORCUPINE PLATEAU

The Jurassic and Lower Cretaceous paleogeography and depositional tectonics of Porcupine Plateau and adjacent areas of northern Yukon and Mackenzie District are summarized in eight paleogeographical maps (Figs. 9-16). To facilitate their interpretation, the general scheme of patterns depicting individual facies and features of depositional tectonics was almost completely standardized on all maps. Only the actually known outcrop- or subcrop-areas of the individual facies are covered with appropriate patterns to indicate the factual basis of each paleogeographical reconstruction. The inferred or assumed present or former extension of the individual facies away from their known outcrop-areas is indicated by dashed lines but is not covered by appropriate patterns. Sections devoted to the individual paleogeographical maps are essentially limited to subjects not treated in the preceding chapter and to cross-references facilitating the finding of the previously discussed paleogeographical, tectonic and biochronological background data. However, they also include brief summaries of some of the most important paleogeographical and tectonic topics discussed in the previous chapter.

EARLY TO MIDDLE JURASSIC (BUG-KINGAK) TIME

The Early to Middle Jurassic paleogeographic map (Fig. 9) exhibits a relatively narrow eastern belt of predominantly littoral to nonmarine sandstones of the Bug Creek Formation flanking the elevated eastern source area of Peel Landmass. The cross-hatched area in the upper right corner of the map outlines the known or inferred extent of a complete pre-?upper Bajocian (*Cranocephalites* beds) erosion of the lower Bug Creek Formation on the crest and flanks of the Rat Uplift of ancestral Aklavik Arch discussed in older reports of Jeletzky (1963, p. 79, 80, Fig. 5; 1967, p. 17, 18, Figs. 2, 3) and in the sections of this report dealing with the Jurassic rocks of the northern Bell Basin segment.

A much broader belt of the outer neritc to upper bathyal Kingak shale flanks that of the Bug Creek sandstone in the west. The information contained in Brabb's (1969, p. 112) paper and in an unpublished geological map of the Coleen quadrangle, east-central Alaska kindly provided by W.P. Brosgé (Brosgé and Reiser, 1969) indicates that this deep water facies of the Lower to Middle Jurassic extends into east-central Alaska, except in the area of the present Keele-Old Crow Ranges. As pointed out in the sections of this report dealing with the Jurassic rocks of the northern Bell Basin and White Mountain segments, the emerging nucleus of the Keele-Old Crow Landmass is outlined in the latter area by a few small outcrops of neritic to littoral (including beach) equivalents of the Kingak shale (Fig. 9). It is remarkable that the beak-like east-northeastward protruding peninsula of this nucleus occurs in the approximate position of the ancestral Dave Lord Creek Arch of Jeletzky (1963, p. 66). This Early to Middle Jurassic Dave Lord Creek Arch (more properly Dave Lord Uplift of ancestral Aklavik Arch; *see* in section dealing with early to mid-Hauterivian map and Figs. 12 and 13) appears to be exactly aligned with the contemporary Rat Uplift of the ancestral Aklavik Arch as indicated by the area of complete erosion of the lower Bug Creek sandstone discussed in previous chapter and indicated in Figure 9. This alignment of the Dave Lord and Rat Uplifts of the ancestral Aklavik Arch forms one of the lines of evidence supporting the writer's (Jeletzky, 1963, p. 63, Fig. 5) statement that: "Dave Lord Creek Arch is, so far, inseparable from the Aklavik Arch proper prior to Cretaceous time". These two uplifts apparently represented upwarped culminations of the same large east-northeast-trending cratonic arch in the Early and Middle Jurassic. The depressed segment between the two uplifts apparently represented a downfaulted and/or downwarped part of the same Lower to Middle Jurassic Aklavik Arch. As such it was a natural site of a long-lasting Jurassic to mid-Lower Cretaceous seaway connecting the much broader northern and southern parts of the Porcupine Plain-Richardson Mountain Trough (Figs. 9-16).

LATE JURASSIC AND EARLIEST CRETACEOUS (HUSKY-UNNAMED UPPER JURASSIC SANDSTONE) TIME

Because of frequent and complex vertical and lateral alternations of facies in the Late Jurassic and earliest Cretaceous time discussed previously, the paleogeographical map of Husky time (Fig. 10) is confined to the presentation of the mid-Late Jurassic (approximately Kimmeridgian to early Portlandian sensu stricto) facies and depositional-tectonic pattern when the Unnamed Upper Jurassic sandstone was most widespread and the North Branch Formation was represented by predominantly nonmarine rudites. This map exhibits a rather different paleogeographical and depositional-tectonic pattern as compared with that of the Early to Middle Jurassic time depicted in Figure 9. The Keele-Old Crow Landmass became strongly uplifted and expanded. This is indicated by the emergence of a fairly broad belt of nonmarine to littoral arenites of the Unnamed Upper Jurassic sandstone overlying (i.e. offlapping) the Kingak shale throughout the western part of the Porcupine Plateau. This western arenite belt included at least three eastward-directed protuberances apparently representing eastward prograding deltaic lobes. It is remarkable that the largest east-northeastward protruding lobe of the Keele-Old Crow Landmass is again situated in the position of the Dave Lord Uplift of ancestral Aklavik Arch and is aligned with the Rat Uplift as indicated in Figures 9 and 11. However, the Rat Uplift is not apparent in Figure 10 because of its bevelling prior to the Late Jurassic and

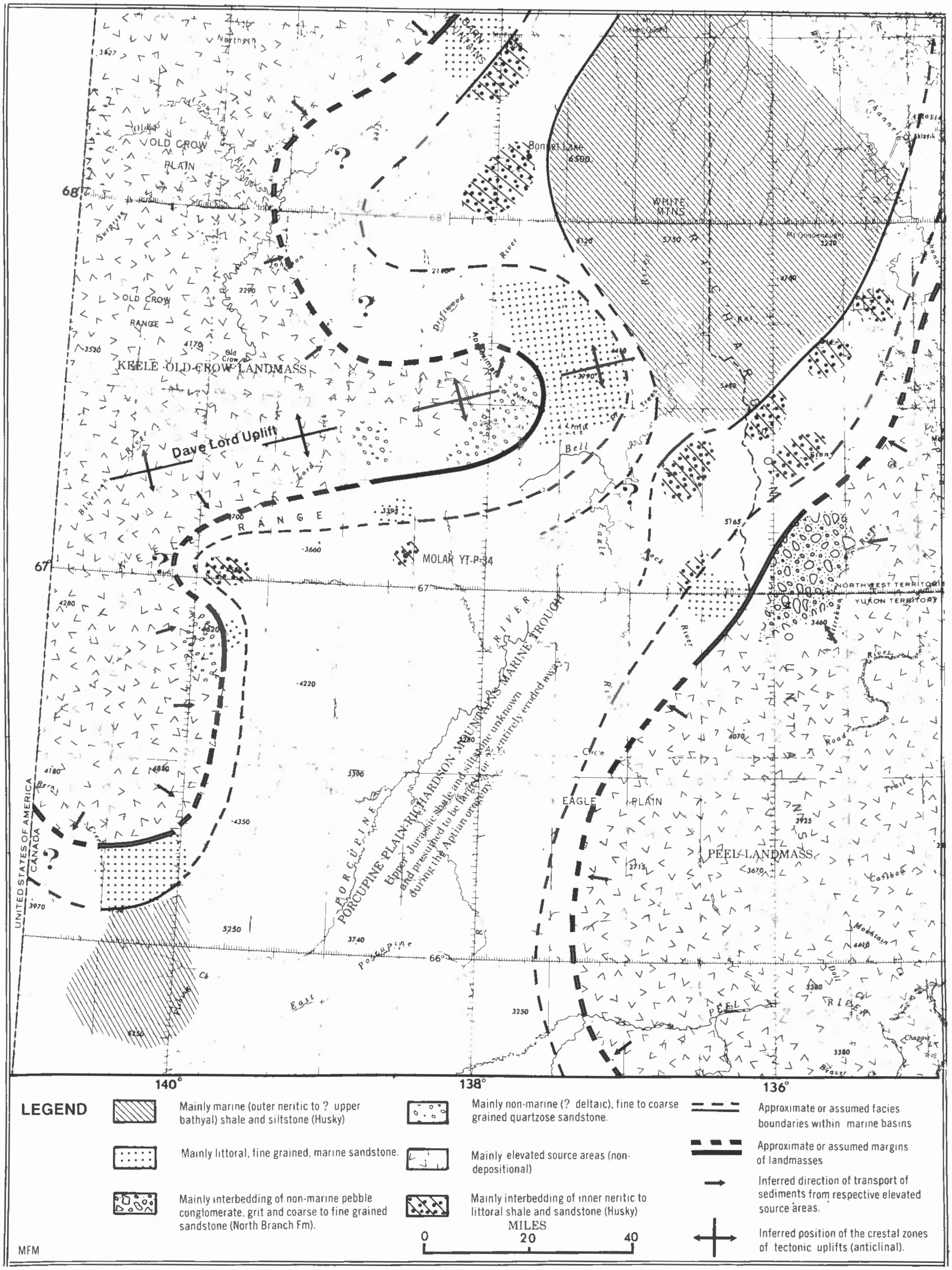


Figure 10. Mid Late Jurassic (i.e. Kimmeridgian to early Portlandian s. str. time or time of mid-Husky Formation and its arenaceous to rudaceous marine to nonmarine equivalents) palaeogeography and depositional tectonics.

subsequent deep subsidence and burial by Husky sediments during the continuous eastward Late Jurassic and earliest Cretaceous transgression which flooded the whole length of the eastern flank of the trough (*see* in previous sections for further details). This transgression caused a considerable eastward shift of the shoreline of the Upper Jurassic Peel Landmass and a considerable decrease in its size as compared with that of the Lower to Middle Jurassic predecessor (compare Figs. 9 and 10).

EARLY EARLY CRETACEOUS (LOWER SANDSTONE DIVISION AND ITS ARGILLACEOUS EQUIVALENTS) TIME

The lateral and vertical facies changes of early Early Cretaceous (i. e. late Berriasian to late Valanginian) time are far too extensive and complex to be represented adequately in a single paleogeographical map. It was decided accordingly to depict them on two maps the one representing facies and tectonic pattern of the late Berriasian "moment" (i. e. *Buchia* n. sp. aff. *volgensis* or Buff sandstone member time) and the other representing the pattern of Valanginian time (i. e. the time of the White sandstone member and the Blue-grey shale division) corresponding to *Buchia keyserlingi* and *Buchia* n. sp. aff. *inflata* zones of the Canadian standard (Jeletzky, 1964, Table 1).

Late Berriasian (Buff sandstone member and its unnamed argillaceous equivalents) time

The late Berriasian paleogeographical map (Fig. 11) features a considerable expansion of the Peel Landmass and an appreciable re-shaping, but no substantial shrinking, of the Keele-Old Crow Landmass as compared with mid-Late Jurassic time (*see* Fig. 10). The belt of littoral to nonmarine arenites flanking Peel Landmass formed several westward prograding deltas as evidenced by the offlap of the neritic to upper bathyal Husky shale by the littoral to nonmarine, fine-grained arenites of the Buff sandstone member and its entirely nonmarine, coarser grained equivalents throughout the eastern flank of the Porcupine Plain-Richardson Mountain Trough (*see* Figs. 3-8). For reasons presented in the preceding chapter, the late Berriasian eastern arenaceous belt remained separated from the narrower western arenite belt flanking the Keele-Old Crow Landmass by a narrow to broad belt of mid-basin lower littoral to outer neritic and locally upper bathyal, predominantly argillaceous rocks. The two belts did not merge even in the northern Bell Basin segment where a belt of mixed argillaceous-fine arenaceous, lower littoral to ?outer neritic rocks of *Buchia* n. sp. aff. *volgensis* Zone occupies the Waters River basin (Fig. 11). This area was the site of an apparently narrow but deep marine seaway separating the Rat and Dave Lord Uplifts of the Aklavik Arch and connecting mid-basin zones of the northern and southern parts of the Porcupine Plain-Richardson Mountain Trough in the late Berriasian.

So far as is possible to tell, the insufficiently documented largest east-northeastward protruding peninsula of Keele-Old Crow Landmass (Fig. 11) remained in the position of the Dave Lord Uplift of the ancestral Aklavik Arch and was aligned with the Rat Uplift of the same Arch. The extent of the latter uplift is well delimited by the deposition area of the nonmarine equivalents of the Buff sandstone member and/or a deep erosion of the Lower sandstone division extending from the Treeless Creek-Lower Barrier River area in the east to Summit Lake-Little Bell River area in the west (*see* Jeletzky, 1973; and in the corresponding sections of the previous chapter of this report).

Valanginian (White sandstone member and Blue-grey shale division) time

The Valanginian paleogeographical map (Fig. 12) is characterized by a continuing expansion of the Peel Landmass and by a considerable shrinking of the Keele-Old Crow Landmass. The Valanginian deltas of Peel Landmass continued to prograde westward over the marine rocks of the late Berriasian Buff sandstone member, and the narrow peninsula comprising the crest zone of the Rat Uplift of the Aklavik Arch expanded markedly west-southwestward into the western part of Waters River basin (*see* Jeletzky, 1973 and this report, in the section devoted to late Berriasian to mid-Hauterivian facies and tectonical pattern of the northern Bell Basin segment).

An apparently new paleogeographical and tectonic feature is the emergence of a narrow northward-directed strip of land in the White Mountain-Cache Creek area (Fig. 12). This possibly cordillera-like Valanginian nucleus of the Cache Creek Uplift separated the main Porcupine Plain-Richardson Mountain Trough situated farther to the west from a subsidiary depositional basin, the Canoe Depression, situated to the east of it. The tectonic nature of these features will be more extensively discussed in the following section dealing with the early to mid-Hauterivian paleogeography and depositional tectonics.

The strong Valanginian uplift of the Peel Landmass, Rat Uplift of the Aklavik Arch, and Cache Creek Uplift apparently was not felt either in the mid-basin belt of the Porcupine Plain-Richardson Mountain Trough or in the adjacent parts of the Keele-Old Crow Landmass. As indicated by the areal distribution of the predominantly outer neritic to upper bathyal Blue-grey shale division discussed extensively in the appropriate sections of the preceding chapter, these areas became pronouncedly negative at the onset of the Valanginian and continued to subside throughout most or all of Valanginian time. This subsidence is reflected in the flooding of the eastern part of Keele-Old Crow Landmass and a corresponding westward retreat of its eastern shoreline, including that of the Dave Lord Uplift of the Aklavik Arch (Fig. 12). Only the southernmost tip of Keele-Old Crow Landmass was exempt from this regional subsidence and transgression. An apparently narrow but long southward protruding peninsula emerged there in the headwaters of Kandik

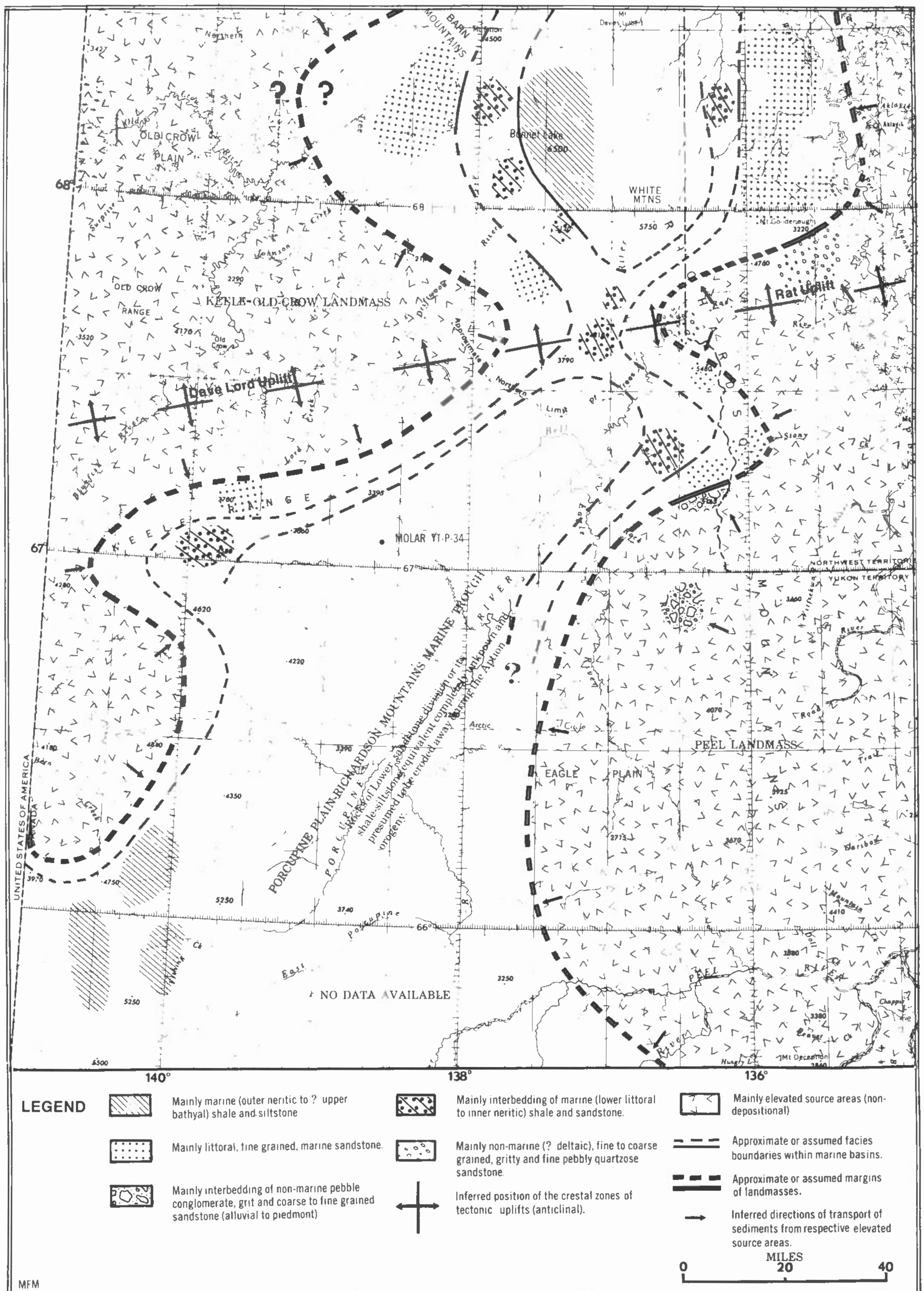


Figure 11. Late Berriasian (i. e. *Buchia* n. sp. aff. *volgensis* time or time of restricted Lower sandstone division, Buff sandstone member, and its argillaceous equivalents) palaeogeography and depositional tectonics.

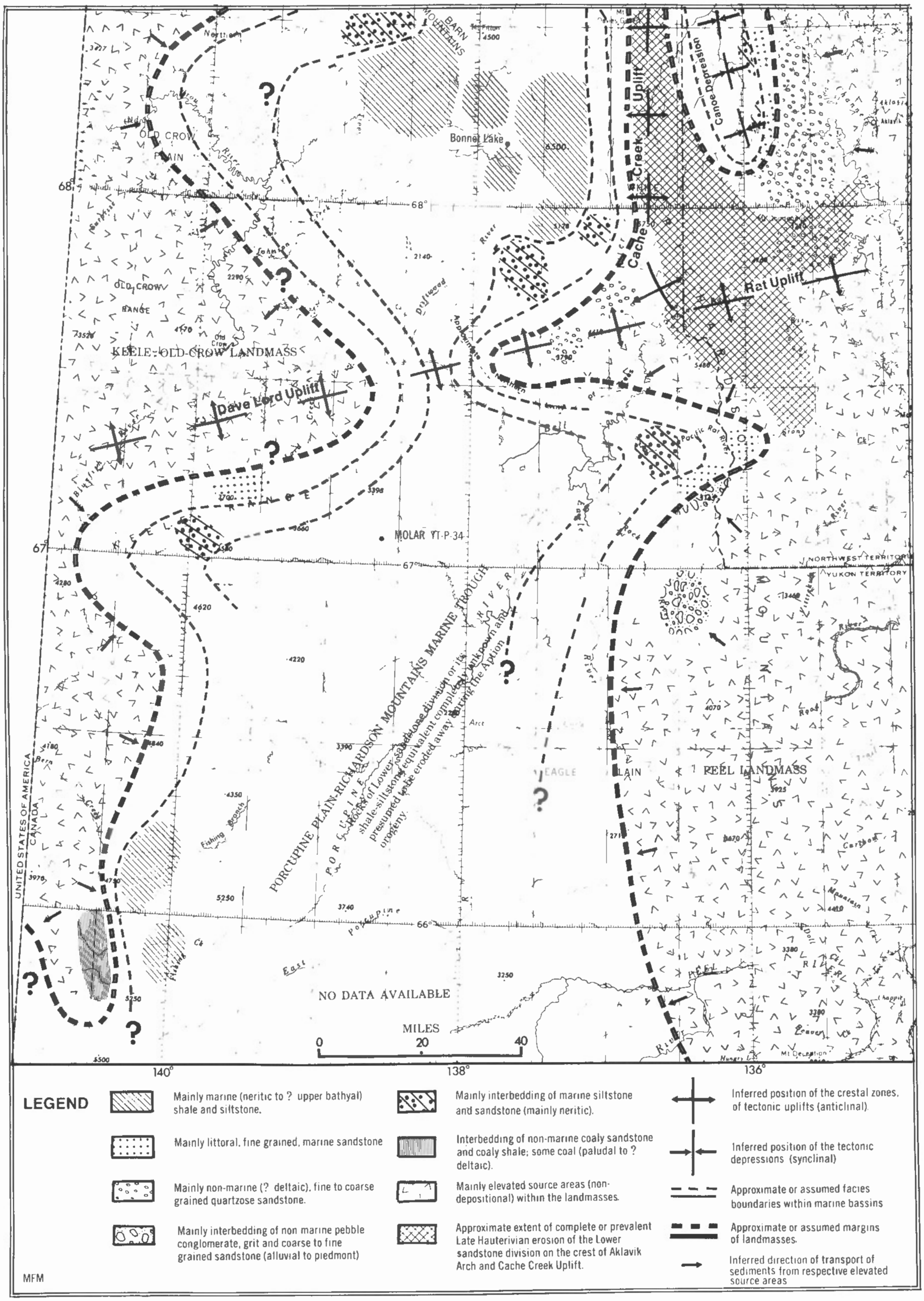


Figure 12. Valanginian (i.e. time of the White sandstone member, Lower sandstone division and Blue grey shale division) palaeogeography and depositional tectonics.

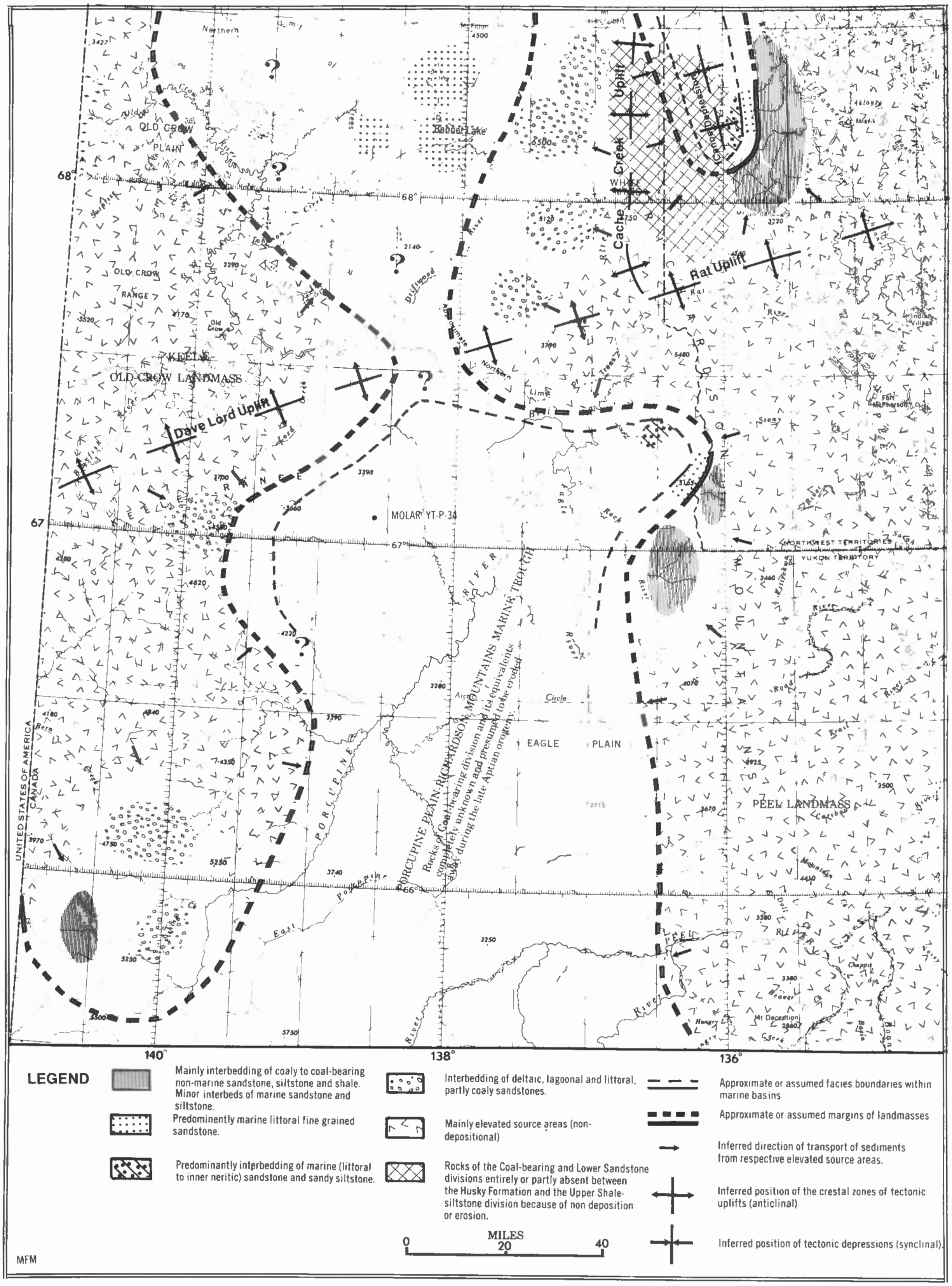


Figure 13. Early to mid-Hauterivian (i. e. time of the Coal-bearing division and its nonmarine to marine equivalents such as White quartzite and Coal-bearing quartzite divisions. "White sandstone member" of NW Ogilvie Mountains, unnamed marine sandstones and siltstones of Bonnet Lake to Keele Range area) palaeogeography and depositional tectonics.

River in the ?early or ?mid-Valanginian (compare Figs. 11 and 12). Judging by the character of its predominantly nonmarine Valanginian deposits and subsequent history, this peninsula was the starting point of a large southward and eastward prograding Valanginian to Aptian delta which began to offlap rapidly over the open marine, uppermost Husky shale (equivalent to the lower part of the Blue-grey shale division of other areas) in ?early or ?mid-Valanginian time (*see* Jeletzky, 1971a, p. 218, 219 for further details).

Because of this subsidence of the mid-basin zone of the trough and the adjacent parts of the Keele-Old Crow Landmass, the axial part of the trough separating the eastern and western arenaceous wedges became considerably wider and deeper in the Valanginian as compared with late Berriasian time (compare Figs. 11 and 12). In spite of the apparently complete destruction of the Valanginian rocks within the Keele Range and in adjacent parts of the crestal zone of the Aklavik Arch, the overall Valanginian facies pattern reproduced in Figure 12 indicates that a fairly wide belt of deep water argillaceous sediments of the Blue-grey shale division separated the western and eastern belts of shallow water arenites even in this most constricted part of the Valanginian trough.

As far as it is possible to tell, the greatly expanded Valanginian Rat Uplift of the Aklavik Arch remained as closely aligned with the contemporary Dave Lord Uplift as did its Jurassic to Berriasian predecessors. However, the position of the crestal zone of the Dave Lord Uplift is highly conjectural because of the absence of Valanginian rocks within the Dave Lord Ridge and the adjacent parts of the northern Bell Basin segment.

EARLY TO MID-HAUTERIVIAN (COAL-BEARING DIVISION AND ITS EQUIVALENTS) TIME

The early to mid-Hauterivian paleogeographical map of Figure 13 depicts the facies and depositional tectonics of the time of the Coal-bearing division and its nonmarine to marine equivalents in the mid-basin belt and on the western flank of the trough. The latter include the White and Coaly quartzites of the headwaters of Bell river and the Bonnet Lake-Blow Pass area (*see* Jeletzky, 1961b; 1971a; 1972b; and in the preceding part of this report) and the equivalent "White quartzite" unit of the Nahoni Range (Jeletzky, 1971a).

Early to mid-Hauterivian paleogeography

The early to mid-Hauterivian phase of the evolution of the trough immediately following that of the Valanginian phase depicted in Figure 12 was the peak time of the early Early Cretaceous (late Berriasian to mid-Hauterivian) uplift of the report-area. The early to mid-Hauterivian time witnessed the reversal of the previously negative tectonic behaviour of the Valanginian mid-basin belt of the trough and the adjacent eastern part of Keele-Old Crow Landmass. The details of this reversal and the resulting facies changes have been described in the preceding sections of the report. The ensuing simultaneous early to mid-Hauterivian uplifts of the Peel and Keele-Old Crow Landmasses resulted in a strong narrowing and shallowing of the whole length of the Porcupine Plain-Richardson Mountain Trough as compared with any segment of the Jurassic and early Early Cretaceous time.

As pointed out in the sections of the report dealing with the late Berriasian to mid-Hauterivian facies and tectonic patterns of the northern Bell Basin, White Mountain, and Bonnet Lake-lower Donna River segments, the suggested presence of a narrow early to mid-Hauterivian seaway separating the eastward and westward protruding peninsulas of Dave Lord and Rat Uplifts of the Aklavik Arch (Fig. 13) is somewhat conjectural. It is quite possible that the Keele-Old Crow Landmass and Peel Landmass briefly merged in this area representing the crestal zone of the Aklavik Arch. If so, the much broader southern and northern parts of the Porcupine Plain-Richardson Mountain Trough were separated from each other by an isthmus in the early to mid-Hauterivian.

The previously mentioned ?mid- to late Valanginian deltaic nucleus in the Kandik River part of the Keele-Old Crow Landmass (Fig. 12) expanded greatly in the early to mid-Hauterivian as evidenced by the areally extensive offlap of the marine "Coaly quartzite" unit (equivalent to the upper part of the Blue-grey shale division of more northerly parts of the report-area) by the nonmarine, presumably alluvial to deltaic, early to mid-Hauterivian "White quartzite" unit in Fishing Creek, Bern Creek and Fishing Branch of Porcupine River areas of Nahoni Range (Jeletzky, 1971a, p. 216- 218; Figs. 3 and 13 of this report).

Tectonic nature of the Valanginian to mid-Hauterivian Cache Creek Uplift and Canoe Depression and their relationships with contemporary Aklavik Arch

As pointed out in the previous sections of this report, the Valanginian to mid-Hauterivian Cache Creek Uplift extends southward into the area of the present White Mountains and is even more prominent there than in the Cache Creek-Blow Pass area of the Bonnet Lake-lower Donna River segment. The Mesozoic to upper Paleozoic rocks outcropping between the exposed older Paleozoic core of White Mountains and the axial zone of the Aklavik Arch in the Summit Lake area were even more strongly uplifted in the Valanginian to mid-Hauterivian time than those of the more northerly parts of Cache Creek Uplift. It is inferred therefrom that the uplift merges structurally into the adjacent part of the Rat Uplift of Aklavik Arch and forms a northward directed offshoot of the latter. The writer can see no valid structural (as distinct from physiographical) reason to follow Norris (1972, p. 91, 93, Fig. 1) in regarding the Cache Creek Uplift as an "*en echelon*" structure in relation to the Aklavik Arch.

The previously discussed shoreward, north-south directed facies changes of the upper Berriasian to mid-Hauterivian rocks on the eastern flank of the Porcupine Plain-Richardson Mountain Trough, and the

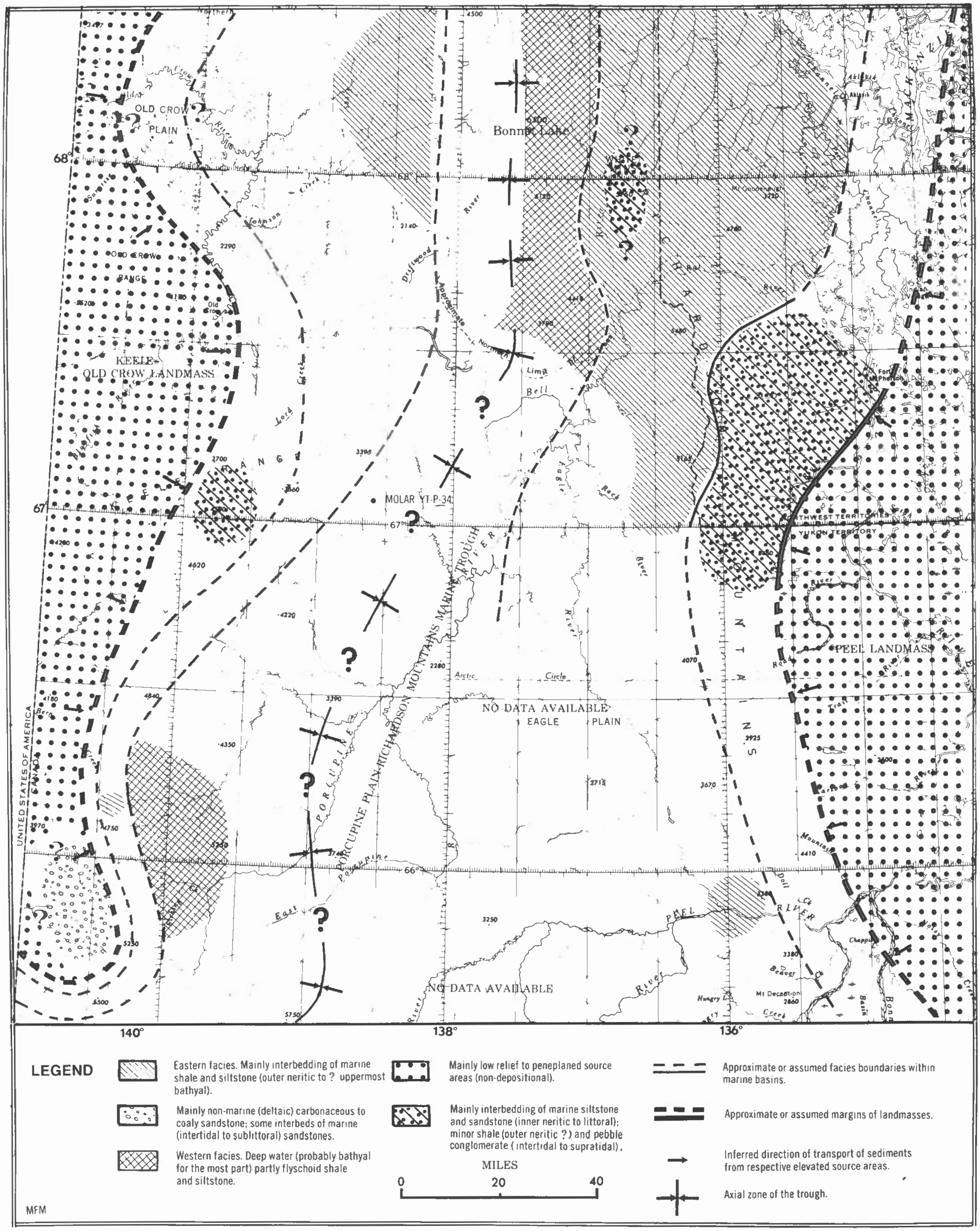


Figure 14. Late Hauterivian to Barremian (i.e. time of the Upper shale-siltstone division and its littoral to non-marine equivalent) palaeogeography.

persistence of the strongly uplifted Valanginian to mid-Hauterivian axial zone of Aklavik Arch from the western flank of the Mackenzie Delta to the western side of Bell Basin (*see* Figs. 5, 12), indicates to the writer that the presumably synclinal structure of the Canoe Depression ended in the south by abuting against the strongly positive northern flank of the Aklavik Arch (*see* Fig. 12) instead of being connected structurally with the Eagle Basin as claimed by Norris (1972, p. 91, 93, Fig. 1). Therefore there is no valid structural reason to assume an "*en echelon*" arrangement of the Dave Lord Uplift, Rat Uplift and White Uplift as Norris (ibid.) does. The former two uplifts are merely structurally more positive culminations of the continuous Valanginian to mid-Hauterivian Aklavik Arch (Fig. 12) while the White Uplift is but a structurally more positive culmination of the subsiduary Cache Creek Uplift (possibly itself a north-trending cratonic arch). Generally speaking, the "*en echelon*" tectonic pattern of the northern Yukon suggested by Norris (1972, p. 91, 93, Fig. 1) appears to be a physiographical rather than a truly tectonic feature, though it may have been influenced in part by the distribution of post mid-Upper Cretaceous faulting.

Depositional-structural data provided by Young (1972, p. 230) indicate that the Valanginian to mid-Hauterivian Cache Creek Uplift extended northward onto the north slope of Yukon as shown in Figures 1 and 12. However, it is beyond the scope of this report to trace its continuation there.

So far as it is possible to tell, the Cache Creek Uplift was either nonexistent or relatively inactive throughout the Jurassic to early Berriasian phase of existence of the Porcupine Plain-Richardson Mountain Trough. However, it became active during the Valanginian to mid-Hauterivian orogenic phase when its whole extent within the report-area was briefly raised above sea level. This resulted in the emergence of a narrow but long, possibly cordillera-like strip of land separating the main or western part of the Valanginian to mid-Hauterivian Porcupine Plain-Richardson Mountain Trough from a supplementary depositional trough of the Canoe Depression (probably a broadly synclinal structure) which formed east of the uplift (Fig. 12). As already pointed out, the Canoe Depression ended abruptly in the south. It probably joined the main Porcupine Plain-Richardson Mountain Trough in the north somewhere on the Yukon's north slope and so was presumably but an embayment of this latter.

The exact tectonic nature of the Valanginian to mid-Hauterivian Cache Creek Uplift is uncertain because of the scarcity of data about facies and the depositional-tectonic pattern of the Lower to mid-Lower Cretaceous rocks outcropping within its confines. It seems most likely that the uplift is a subsidiary north-trending cratonic arch branching off the principal east-northeast trending cratonic Aklavik Arch. However, the markedly asymmetrical cross-section of the uplift with the most strongly uplifted eastern side and considerably less uplifted western side (as indicated by the above-discussed areal restriction of the Valanginian to mid-Hauterivian hiatus, etc.) is somewhat suggestive of its being a relatively uplifted north-south trending, westward tilted fault block activated by the Valanginian to mid-Hauterivian orogenic phase but bevelled again prior to the onset of the late Hauterivian transgression. For this reason the writer continues to use the noncommital term, Cache Creek Uplift, introduced by Norris (1972, p. 91, 93, Fig. 1).

LATE HAUTERIVIAN AND BARREMIAN (UPPER SHALE-SILTSTONE DIVISION) TIME

The late Hauterivian to late Barremian paleogeography depicted in Figure 14 contrasts strongly with that of the immediately preceding early to mid-Hauterivian time. A rapid, apparently instantaneous geologically speaking, transgression of the sea of the Upper shale-siltstone division flooded most of the Peel and Keele-Old Crow Landmass within the report-area and apparently transformed their remnants into lowlands which provided but little arenaceous to conglomerate detritus.

The known outcrop-areas of the littoral to nonmarine equivalents of the Upper shale-siltstone division are limited to the headwaters of Kandik River, the Stony Creek-Vittrekwa River area and the Upper Peel River (Fig. 14). They suffice, however, to outline the approximate positions of the largely peneplaned remnants of the Peel and Keele-Old Crow Landmasses.

The extraordinary speed and regional extent of the late Hauterivian transgression in the northern Bell Basin segment suggests that the Dave Lord and Rat River Uplifts of the Aklavik Arch were completely bevelled prior to its onset. The apparently complete absence of the north-south oriented facies changes within the explored parts of the crestal zone of the Aklavik Arch (as defined by areal extent of its Jurassic to mid-Hauterivian generations; *see* Figs. 9-13) suggests that the whole length of this bevelled and deeply buried tectonic structure remained inactive in the late Hauterivian to late Barremian time. The same is not true of the Cache Creek Uplift. As pointed out in the sections of the preceding chapter dealing with the late Hauterivian to late Barremian facies and tectonic pattern of the northern Bell Basin, White Mountain, and Bonnet Lake-lower Donna River segments, only those parts of these segments of the trough situated to the west of the Cache Creek Uplift became pronouncedly negative in the late Hauterivian. This is reflected in the restriction of the deep water, partly flyschoid facies (i.e. the western facies) of the Upper shale-siltstone division to these western parts of the segments (Fig. 14). A wider zone situated to the east and above the Cache Creek Uplift became only moderately to slightly negative in the late Hauterivian to late Barremian time as indicated by deposition of a much thinner, outer to inner neritic facies of the Upper shale-siltstone division over most of this zone. The occurrence of partly arenaceous, presumably inner neritic to lower littoral, facies of the division on the northeastern flank of White Mountains (*see* p. 16-17) suggests the presence of shoal or even an unsubmerged

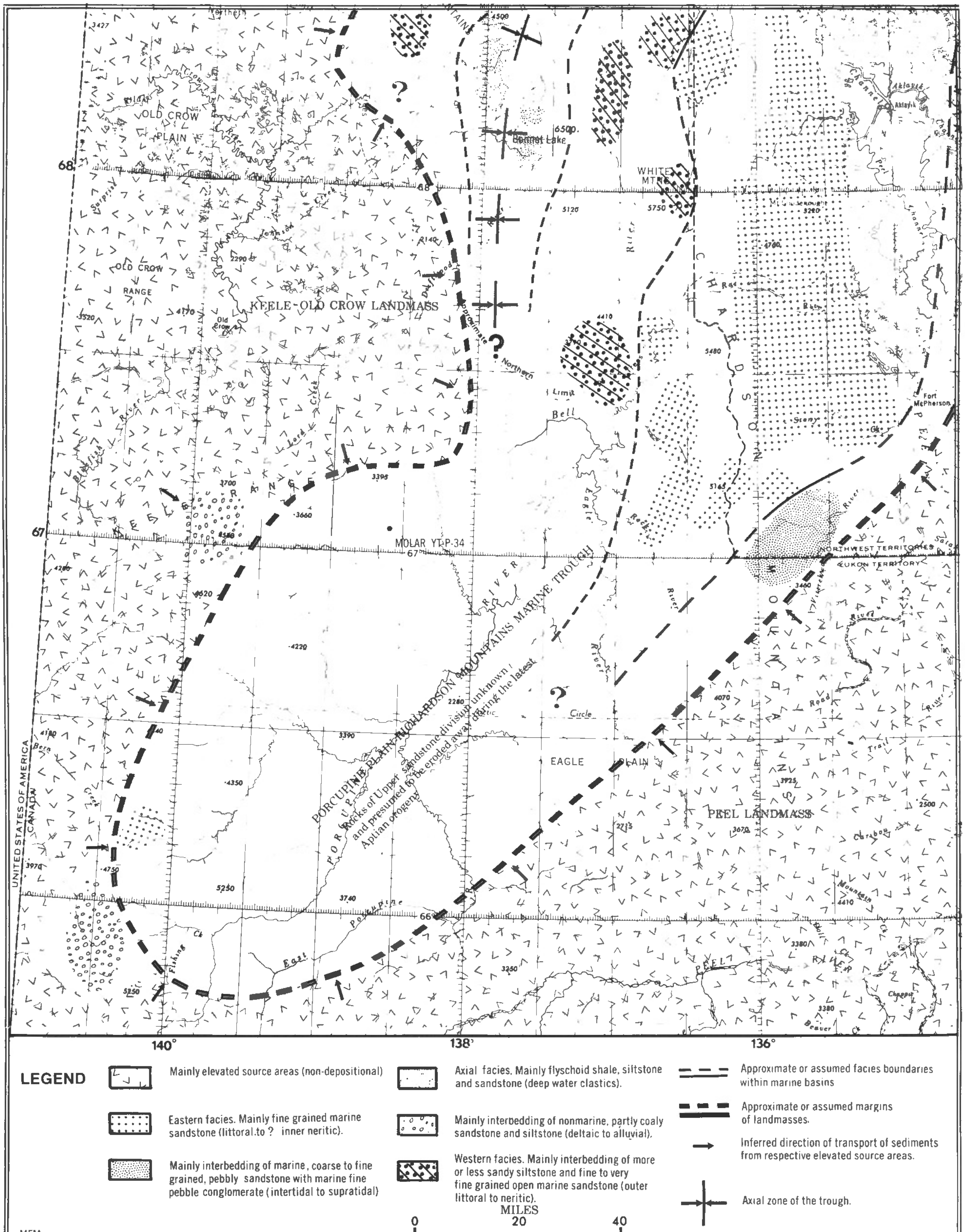


Figure 15. Early to early Upper Aptian (i.e. time of the Upper sandstone division and its argillaceous, non-marine and flysch equivalents) palaeogeography.

remnant of the Cache Creek Uplift within the present White Mountains as indicated in Figure 14.

The previously discussed mid-Valanginian to mid-Hauterivian southward prograding delta of the Kandik River area decreased in size but continued to exist, right through the time of the Upper shale-siltstone transgression (Jeletzky, 1971a, p. 219; as well as p. 4 and Fig. 14 of this report). This area of deltaic facies of the Upper shale-siltstone division is flanked from the east by an outcrop-belt of extremely thick, deep water (partly flyschoid) facies of the division. This facies is lithologically and sedimentologically identical to that of the western facies of the northern Bell Basin and Bonnet Lake-lower Donna River segments and it seems likely that the two outcrop-areas formed part of a continuous deep water mid-basin belt of the late Hauterivian to late Barremian Porcupine Plain-Richardson Mountain Trough as suggested in Figure 14.

The previously described (*see* p. 4) isolated erosional remnant of the shallow water facies of the Upper shale-siltstone division occurring on the upper Peel River opposite the Kandik River-Fishing Branch outcrop-area of the division is extremely important in indicating the width of the late Hauterivian to late Barremian trough across the southern Eagle Plain.

APTIAN (UPPER SANDSTONE DIVISION AND ITS EQUIVALENTS) TIME

The Aptian paleogeography, depicted in Figure 15 features an extensive early to early late Aptian regression followed by an interregional latest Aptian orogeny which profoundly restructured the southern part of the Porcupine Plain-Richardson Mountain Trough and the adjacent southwestern part of the Peel Landmass. The Aptian regression restored the northern and middle parts of the Keele-Old Crow Landmass to approximately its late Berriasian (i. e. time of the Buff sandstone member; *see* Fig. 11) size. However, the size of the northeastern and middle parts of the Peel Landmass either did not increase or increased only slightly in comparison with the late Hauterivian to late Barremian time (*see* Fig. 14), in spite of a strong shallowing of the sea within an extensive eastern zone of the trough in front of it (Fig. 15).

The greatest paleogeographical changes occurred in the southwestern part of Peel Landmass and the adjacent southeastern part of Keele-Old Crow Landmass which were uplifted and expanded considerably. The strong uplift (and probably flexing) of the southernmost parts of the report-area was caused apparently by even more extensive and stronger tectonic movements (i. e. interregional latest Aptian orogenic phase) in the southern parts of Ogilvie and Wernecke Ranges (Jeletzky, 1971c, p. 40-42, Fig. 8). This tectonic pulse apparently caused a complete closure of the southern outlet of the Porcupine Plain-Richardson Mountain Trough ?early in the Aptian and so severed its long-lasting depositional-tectonic connection with the Mesozoic orogenic belt of the Canadian Cordillera. The strongest evidence for this ?early Aptian closure of the trough is paleobiotic in nature (Jeletzky, 1971c, p. 40-42) as no rocks of the Upper sandstone division or its nonmarine equivalents are known to occur anywhere east or southeast of the headwaters of the Kandik River and those of the Fishing Branch of Porcupine River (Fig. 15). However, the paleobiotic evidence is supported by the previously discussed (*see* in the sections devoted to the Eagle Plain and southern Bell Basin segments of the trough) strong pre-Albian erosion of the Jurassic to mid-Lower Cretaceous rocks in the mid-basin zone of the southern part of the trough. This pre-Albian erosion appears to be a result of a complete inversion and ?folding of this part of the trough by the latest Aptian tectonic movements coeval with the above-mentioned interregional latest Aptian orogenic phase. Further indirect evidence favoring the Aptian closure of the southern outlet of the trough is the clearly discernible northward weakening of the effects of the latest Aptian orogenic phase noted by Jeletzky (1961a, p. 539, 540; 1973). As already pointed out (*see* under the discussion of the Aptian facies and tectonic pattern of the Bonnet Lake-lower Donna River segment of the trough), that part of the Porcupine Plain-Richardson Mountain Trough situated north of the Aklavik Arch "escaped" the above-discussed profound tectonic restructuring. This northern part of the trough retained the basic late Hauterivian to late Barremian facies and tectonic pattern throughout the Aptian and into the Early Albian (*see* p. 27 of previous chapter and Figs. 14-16). This northward weakening of the latest Aptian tectonic movements (especially lessening of the uplift) within the intracratonic Porcupine Plain-Richardson Mountain Trough also is interesting in confirming the above-proposed localization of their focal point to the south of the report-area within the Mesozoic orogenic belt of the Canadian Cordillera.

In an apparent contradiction to the above data, the presently known facies pattern of Aptian rocks (*see* its detailed discussion in the previous chapter and a reproduction in Fig. 15) suggests that the whole length of the Aklavik Arch remained just as tectonically inactive in the Aptian time as it was in the late Hauterivian to late Barremian time. However, the record of the eastern and western facies of the Upper sandstone division in the northern Bell Basin and White Mountain segments is rather incomplete. Therefore, it is possible that future work in these critical areas will change this impression.

The apparently completely submerged Cache Creek Uplift continued to influence the areal distribution of the littoral eastern and the deeper water western facies of the Upper sandstone division much as it did in late Hauterivian to late Barremian time (*see* in the preceding section and compare Figs. 14 and 15). However, the Aptian facies pattern was complicated by an apparently new depositional feature - the emergence of a well-defined but narrow, almost furrow-like zone of deep water flyschoid sediments to the west of the western facies of the Upper sandstone division. It is still uncertain whether these Aptian flyschoid rocks, which

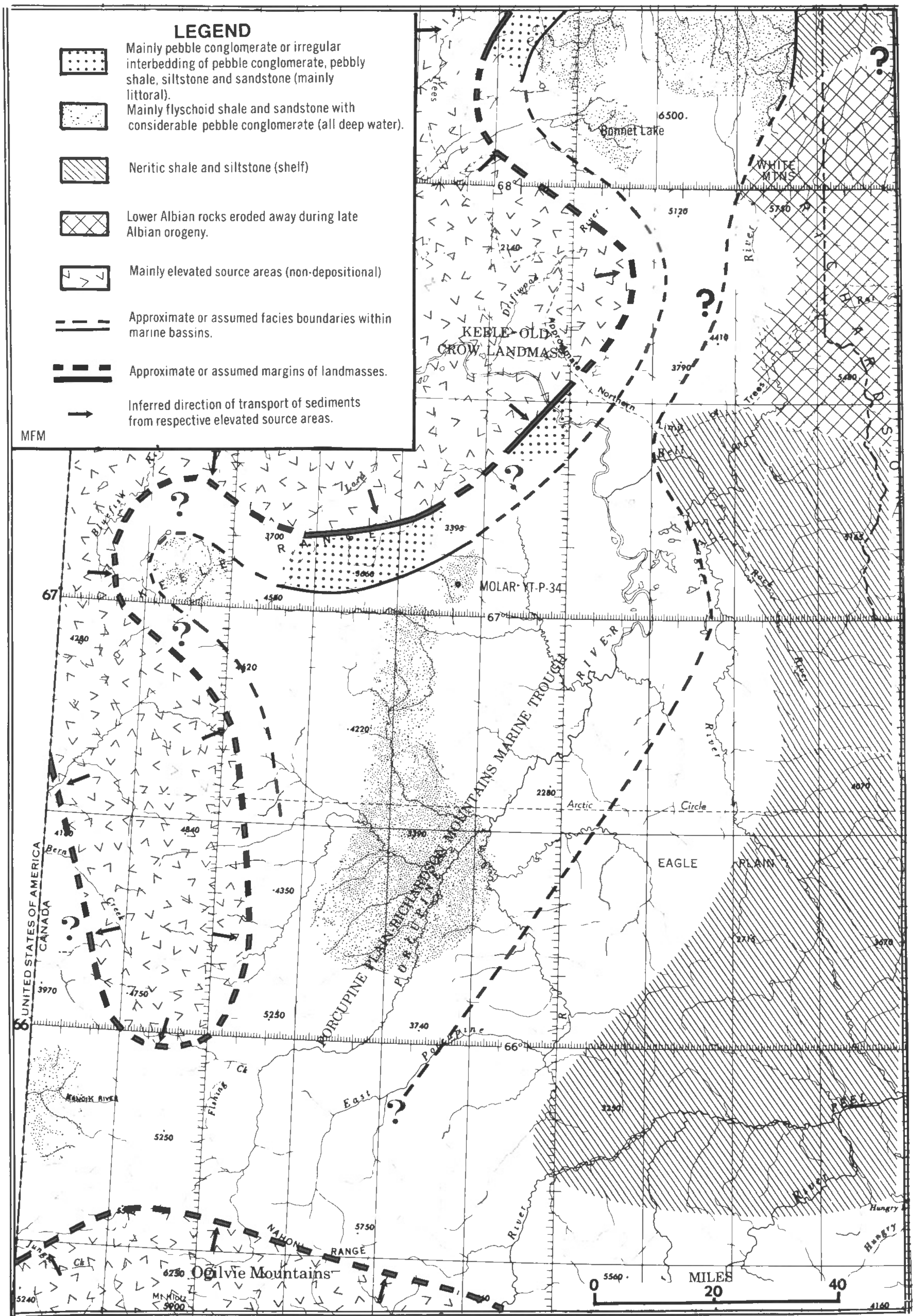


Figure 16. Early Albian (i. e. *Sonneratia* n. sp. A Zone in shelf and flyschoid facies) palaegeography.

seem to be restricted to that western part of the Bonnet Lake-lower Donna River segment adjoining the Keele-Old Crow Landmass from the east (Jeletzky, 1971a, p. 209; Fig. 15 of this report), are correlative with the whole of the Upper sandstone division of more easterly areas (e.g. of its western facies in the headwaters of Rapid Creek) or correspond only to its Upper member. In either case they are important in being the emerging nucleus of the much more widespread, mid-basin belt of the Lower Albian flyschoid rocks (*see* in the next section).

The axis of the Aptian (?only late Aptian) Porcupine Plain-Richardson Mountain Trough apparently was situated within the above-discussed deep water belt of flyschoid rocks, at least in the Bonnet Lake-lower Donna River segment. This is suggested, in particular, by the previously mentioned apparent presence of a non-flyschoid, more shallow water facies of the Upper sandstone division (apparently lithologically and sedimentologically similar to the western facies of the eastern flank; *see* Fig. 15) to the west of the belt of the Aptian flyschoid rocks. Though this cannot be demonstrated as yet because of an apparently complete destruction of Aptian rocks on the western flanks of the White Mountain and the northern Bell Basin segments, it seems likely that the mid-basin belt of the upper and ?lower Aptian flyschoid rocks extended originally into the western parts of these segments of the trough as indicated in Figure 15.

EARLY ALBIAN TIME

The early Early Albian paleogeography depicted in Figure 16 features the results of the widespread early Early Albian transgression which had largely annihilated the effects of the previously discussed latest Aptian interregional orogeny. The complete paleogeographical restructuring of the eastern part of the report-area as compared with the Jurassic to mid-Lower Cretaceous conditions (*see* Figs. 9-15) is the most important change. The Peel Landmass became completely submerged and the eastern shore of the resulting broad, but only moderately deep (mostly inner to outer neritic), shelf basin was situated east of the Mackenzie River (*see* Jeletzky, 1971c, p. 42-44, Fig. 9). As already mentioned in the section of the previous chapter dealing with the upper Hauterivian to Albian rocks of the northern Bell Basin segment, the apparently complete absence of the Albian rocks on the crestal part of the Aklavik Arch reflects their subsequent erosion during or after the latest Albian or early Cenomanian orogenic phase. There is no evidence suggestive of either the Rat or the Dave Lord Uplifts of the Aklavik Arch having been tectonically active in early Albian time and the same appears to be true of the Cache Creek Uplift. So far as the available, rather meager data goes, all three uplifts were submerged completely and buried by the argillaceous sediments of the Early Albian shelf sea.

The shape and size of the Keele-Old Crow Landmass changed only marginally as compared with those of its early to early late Aptian predecessor (Figs. 15, 16). However, the deep and wide late Hauterivian to late Barremian strait connecting the Porcupine Plain-Richardson Mountain Trough with the Kandik Basin of east-central Alaska (Fig. 14) apparently re-opened as shown in Figure 16. This ?earliest Albian transgression flooded most or all of the previously discussed southward prograding mid-Valanginian to Aptian delta that occupied the headwaters of Kandik River.

Most or all of the Keele-Old Crow Landmass, strongly uplifted by the latest Aptian orogeny, remained so uplifted in the early Early Albian as indicated by the formation of a deep, mostly bathyal marine trough all along its eastern and southern margins (Fig. 16). This narrow trough received as much as 15,000 feet of predominantly argillaceous to arenaceous turbidites and lesser amounts of shallow to deep water (deep sea fans) pebble conglomerates in the early Albian (Jeletzky, 1971a, p. 209-211, 219, 220; 1972a, p. 213, 214, Figs. 2, 3; 1972b, and in the preceding chapter of this report). As previously mentioned, this thick flyschoid wedge thins rapidly eastward and grades laterally into the suspension settled neritic shales and siltstones occupying the eastern part of the present Porcupine Plateau and Richardson Mountains (Fig. 16).

The largest east-northeast trending peninsula of the lower Lower Albian Keele-Old Crow Landmass occupies the area around the confluence of Driftwood and Porcupine Rivers (Fig. 16). The inferred position of the eastern tip of this peninsula appears to be displaced from 20 to 25 miles north in relation to the inferred positions of the eastern tips of the earlier Jurassic and Cretaceous generations of Dave Lord Uplift of the Aklavik Arch as shown in Figures 10, 11, 12 and 13. The tip of this lower Lower Albian peninsula also appears to be displaced 20 to 25 miles northward in relation to the inferred positions of the western tips of earlier Cretaceous and Jurassic generations of the Rat Uplift of the Aklavik Arch indicated in Figures 9, 11, 12 and 13. This lower Lower Albian peninsula appears accordingly to be a new paleogeographical and possibly tectonic feature unrelated to either of the above mentioned uplifts of the Aklavik Arch.

No attempt was made to reconstruct the mid- and late Albian paleogeographies of the report-area as the writer cannot add anything to the information provided in an older report (Jeletzky, 1971c, p. 44-46, Fig. 10). The apparently complete absence of biochronologically dated mid- to late Albian rocks on Porcupine Plateau appears to be due to the whole of the report-area having been raised above sea level and undergoing erosion at that time.

SOURCE AREAS OF MATURE QUARTZOSE SANDSTONES

The regional facies and tectonic pattern of Porcupine Plateau and adjacent areas of northern Yukon and Mackenzie District, N.W.T. outlined in the preceding sections of this report and illustrated by Figures 1-16 necessitates a rejection by the writer of the ideas of

Frebold (1961), Frebold et al. (1967, p. 24), Tempelman-Kluit (1970) and Young (1973b) about paleogeography and depositional tectonics of this area. In the writer's opinion, it is impossible to extend either the western or the eastern arenaceous wedge of any part of the Jurassic to mid-Lower Cretaceous Porcupine Plain-Richardson Mountain Trough across its continuous, generally argillaceous, deep water mid-basin belt, except possibly for the early to mid-Hauterivian stage of its history. Hence, it is wrong to interpret any part of this mid-basin belt of the trough within the report-area as a shallow epicontinental sea with numerous deltaic lobes and sand bar complexes. Except for the White and Coaly quartzite divisions and their predominantly arenaceous, marine equivalents, all relatively thin, sheet-like, wedge-like, or lenticular sandstones of the Jurassic to mid-Lower Cretaceous mid-basin belt shown on the geological profiles (Figs. 2-8), and other similar sandstones occurring in unfigured sections studied by the writer, do not appear to be either shallow water marine or nonmarine deposits. For previously presented reasons, most of these sands appear to be either deep water pinch-out zones of the marginal arenaceous wedges or are related to several brief but strong, more or less localized tectonic uplifts of the trough's bottom which caused a variably deep but brief penetration of the littoral to inner neritic arenaceous facies into the mid-basin belt. Some other Jurassic to mid-Lower Cretaceous sandstones occurring in the mid-basin belt appear to be either deep water products of downslope or ?longitudinal bottom currents, or deep water turbidites. As perceived by Jeletzky (1963, p. 80, 81, Fig. 6), these considerations alone are more than enough to rule out any eastern, southeastern or southern source area for the bulk of mature, quartzose sandstones and orthoquartzites of Jurassic to mid-Lower Cretaceous (pre-Albian) age that are widespread all along the western and southwestern flank of the Porcupine Plain-Richardson Mountain Trough. However, it seems important to point out that there is no real need to look for an eastern cratonic source area for these sandstones because suitable northwestern sources of mature quartz detritus are available. Dr. R.L. Detterman (U.S.G.S., Menlo Park; personal communication of March 5, 1971) suggested the Permo-Triassic Sadlerochit Formation of Eastern Brooks Range as a likely source for the Jurassic and Lower Cretaceous (pre-Albian) quartzose sandstones of Keele Range and northwestern Nahoni Range. Generalizing on this valuable idea, the writer considers the late Paleozoic arenites and rudites of the Eastern Brooks Range, those of the Barn-British Mountains, and those of the Old Crow-northern Keele Range as the most likely source of the above mentioned quartz detritus. All these areas were repeatedly and strongly uplifted in Late Jurassic and Early Cretaceous (pre-Albian) time and consequently were largely or entirely stripped of a thick cover (at least 2,000 feet) of quartzose clastics of the Kekiktuk, Kyak, Sadlerochit Jungle Creek and Step Formations. After a recycling by the southward, southeastward, and eastward flowing streams of the Keele-Old Crow Landmass these clastics easily could provide the amounts of mature quartz detritus necessary for the deposition of quartzose to orthoquartzitic sands of the Unnamed Upper Jurassic sandstone and other pre-Albian arenaceous wedges of the western flank of the Porcupine Plain-Richardson Mountain Trough and Kandik Basin of mid-eastern Alaska.

The mid-Paleozoic granitoid intrusions of the Old Crow Range (Baadsgaard et al. 1961) and adjacent areas in Alaska are another suitable source of quartz detritus for the pre-Albian arenaceous wedges of the western flank of the trough. The smallish present day plutons are probably but the roots of shallow-seated, originally much larger and spacially more extensive, sheet- or laccolith-like intrusions largely destroyed by the late Paleozoic, Jurassic and early to mid-Lower Cretaceous erosion. It is becoming more and more obvious that a great many allegedly batholithic granitoid intrusions in North America (e.g. Hamilton and Myers, 1967; Carson,, 1973) and elsewhere (e.g. Petrov, 1964) are actually relatively thin sheet-like intrusions (or metamorphic melts) which rise through the crust as stocks or huge dykes and then spread out laterally at shallow depths. Many such "batholiths" appear almost to reach the surface before spreading and crystallize either beneath the cover of their own volcanic ejecta or beneath a thin cover of upwarped sedimentary rocks. The quartz detritus of the late Paleozoic clastic units may have been derived partly also from these mid-Paleozoic intrusions even if more of it undoubtedly was derived from more distant northerly source areas.

The drastic latest Aptian to earliest Albian change in the sedimentological regime of northern Yukon originally recognized by Jeletzky (1971a, p. 209) for the whole extent of Porcupine Plateau and subsequently confirmed by Young (1973a, p. 280; 1973b, p. 31) in adjacent areas of Yukon's north slope probably registers the "moment" of geological time when the cover of late Paleozoic quartzose clastics and mid-Paleozoic sheet- or laccolith-like plutons were sufficiently eroded in all strongly positive areas of the region to expose large outcrop-areas of the underlying, predominantly cherty early Paleozoic to late Precambrian rocks (mainly Neruokpuk "formation").

THE EVOLUTION OF STYLE OF SOME VERTICAL TECTONIC MOVEMENTS

This section is an attempt to describe and depict diagrammatically (Figs. 17-22) some of the vertical tectonic movements which caused the previously discussed Jurassic and Lower Cretaceous facies patterns of the Porcupine Plain-Richardson Mountain Trough and adjacent landmasses. The discussion is limited to the previously poorly known marginal movements oriented along north-south trending axes which are important in the Jurassic and Lower Cretaceous history of the report-area and exhibit an extremely interesting sequence of styles. The Jurassic and Cretaceous vertical movements oriented along east-northeast trending axes (i.e. those of the Rat and Dave Lord Uplifts of the Aklavik Arch) and the north-south oriented Valanginian to mid-Hauterivian movements of Cache Creek Uplift have already been discussed by Jeletzky (1961a, p. 537-543, 576-579, Figs. 1, 22; 1963, p. 77-81, Figs. 5, 6) and in the preceding sections of this report in connection with the description of the facies trends, tectonic patterns and paleogeography of the report-area. Therefore, they will be arbitrarily disregarded in the following discussion, except for a few fleeting comments.

ROLE OF EUSTATIC FLUCTUATIONS OF SEA LEVEL

For reasons explained elsewhere (Jeletzky, 1971c, p. 75, 76), the writer believes that the Cretaceous transgressions and regressions in Western and Arctic Canada have been (Jeletzky, 1971c, p. 75): "caused largely or ?entirely by the periodic oscillatory (i.e. alternatively positive and negative) movements of major tectonic elements of the region". As already pointed out in the previous chapters of this report, (e.g. p. 13-14) the observed general pattern of the Jurassic and Lower Cretaceous transgressions and regressions within the investigated part of the Porcupine Plain-Richardson Mountain Trough agrees perfectly with this conclusion. As will be shown below, the same is true of transgressions and regressions caused by the marginal north-south oriented vertical tectonic movements described in this chapter.

The above conclusions seem to contradict the presently fashionable (e.g. Brookfield, 1970; Grasty, 1967; Hallam, 1969; Jacoby, 1972; Naidin, 1971; Pessagno, 1972; Russell, 1968) idea of geologically simultaneous world-wide transgressions and regressions being caused by eustatic oscillations of sea level in the sense of Suess (1906, p. 538-544). In the writer's opinion, this contradiction may prove to be more apparent than real. Namely, the apparent absence of any traces of continental or worldwide transgressions and regressions in Western and Arctic Canada could have been caused easily by a high level of tectonic activity characteristic of the region concerned. It is easy to demonstrate that the minimum amplitudes of short term vertical tectonic movements (i.e. those occurring within the time of a single paleontological zone or a stage) occurring in the ancient folded or faulted intracratonic troughs or orogenic belts (= geosynclines) fluctuated between 2,000 to 4,000 feet. This is indeed the range of amplitudes required to transform shelf to bathyal (i.e. 50 to 2,000 feet deep) depositional areas into elevated tectonic highlands capable of providing large quantities of fine- to coarse-grained clastics (i.e. areas standing at least 1,500 to 2,000 feet above sea level). There is hardly any need to stress that more or less strongly localized vertical tectonic movements of that amplitude were a common occurrence in any of the tectonically active belts of the past. A good example is provided by the previously discussed late lower to early Middle Jurassic, Valanginian to mid-Hauterivian, latest Aptian, and latest Albian to early Cenomanian tectonic pulses of the investigated part of the Porcupine Plain-Richardson Mountain Trough.

The earliest estimated value of the amplitude of the eustatic movements of sea level derived from the average ratio of the continental surface flooded by ancient transgressions (Kuenen, 1939, p. 195) is, in contrast: "less than 100 meters but more than 25 meters". Consequently Kuenen (ibid) assumes: "that the mechanism we are investigating must be able to account as a minimum for eustatic movements of more than 40 meters". Kuenen's (1939) estimates were accepted as valid by a number of workers and their validity was confirmed recently by investigations of Wise (1972, p. 91-93). As far as the writer knows, none of the recent adherents of the hypothesis of eustatic movements claimed their having had amplitudes in excess of 500 feet. The above data suffice to demonstrate that any eustatic fluctuations of sea level that may have occurred in the past can be expected to be almost one order of magnitude less than the minimum, not to mention the largest, short term vertical movements of major tectonic elements of tectonically active belts of the Earth. Hence one should expect a continuous overprinting of the effects of the eustatic movements by those of the contemporary tectonic movements within all tectonically active belts. Except for some infrequent quiescent periods in the geological history of tectonically active belts, the record of eustatic movements can only be expected to be preserved within the most stable tectonic elements of the continental crust such as the cratons or stable shelves (or stable platforms). This circumstance amply justifies the author's decision to disregard any possible effects of eustatic movements either in the preceding analysis of the north-northeast trending vertical movements or in the following analysis of the north-south directed vertical movements within the Porcupine Plain-Richardson Mountain Trough. It is beyond the scope of this report to try to answer the long-debated and most difficult question as to whether world-wide transgressions and regressions of sea level are a reality as claimed by the above cited recent adherents of the concept or merely a figment of their imagination as claimed by the recent opponents of the concept (e.g. Yanshin, 1973).

EARLY JURASSIC TO LATE VALANGINIAN HINGE MOVEMENTS

Early to Middle Jurassic phase

The tectonic regime of the Lower to Middle Jurassic (Bug-Kingak) time depicted diagrammatically in Figure 17 was (relatively speaking) positive on the eastern flank of the trough. Throughout the time of deposition of the Bug Creek Formation this flank continued to be uplifted in short-lived pulses. This is best illustrated by the repetitive alternation of facies and by the fact that the youngest sheet of the Bug Creek sandstone (i.e. the Upper sandstone member; Jeletzky, 1967, p. 14, 15; this report, Figs. 5-8) has the greatest basinward extent (Fig. 17). Some of the

Figure 17.

Depositional tectonics of Bug Creek-Kingak (Lower-Middle Jurassic) time.

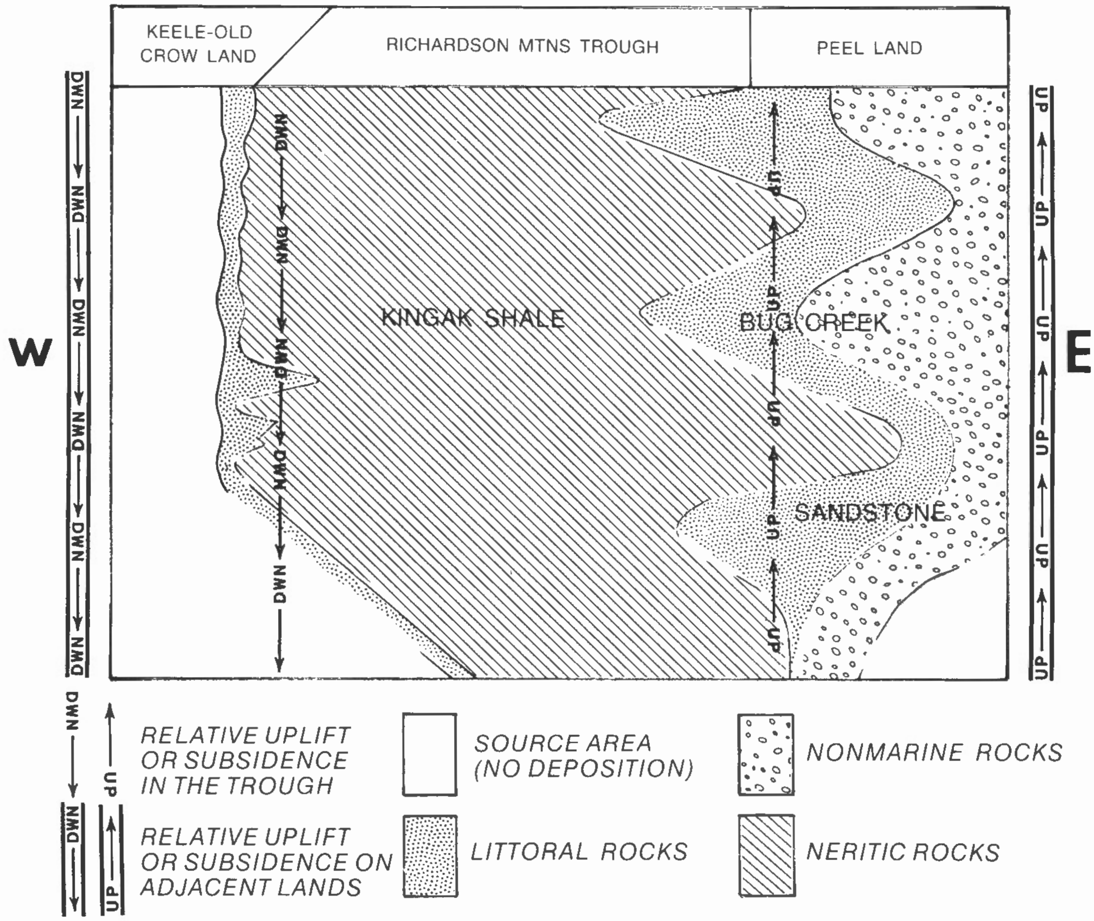
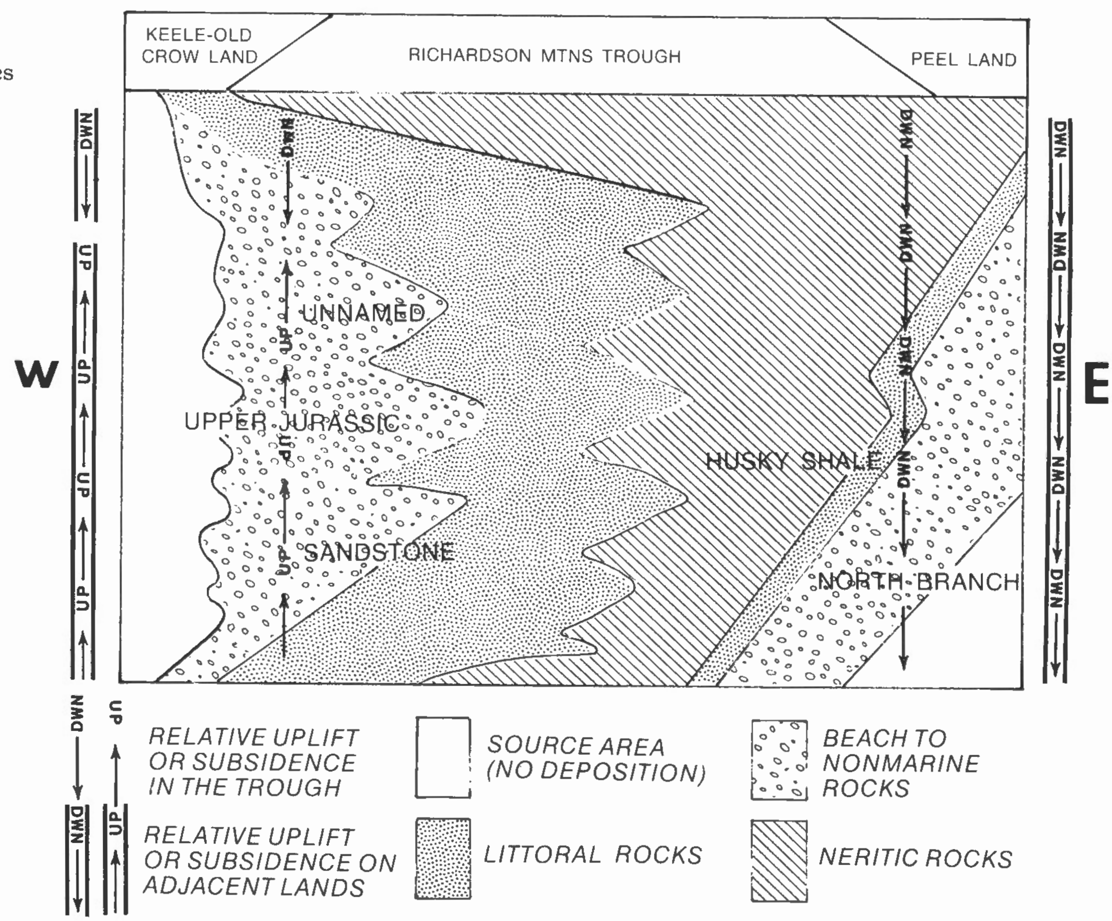


Figure 18.

Depositional tectonics of Husky (Late Jurassic-Earliest Cretaceous) time.



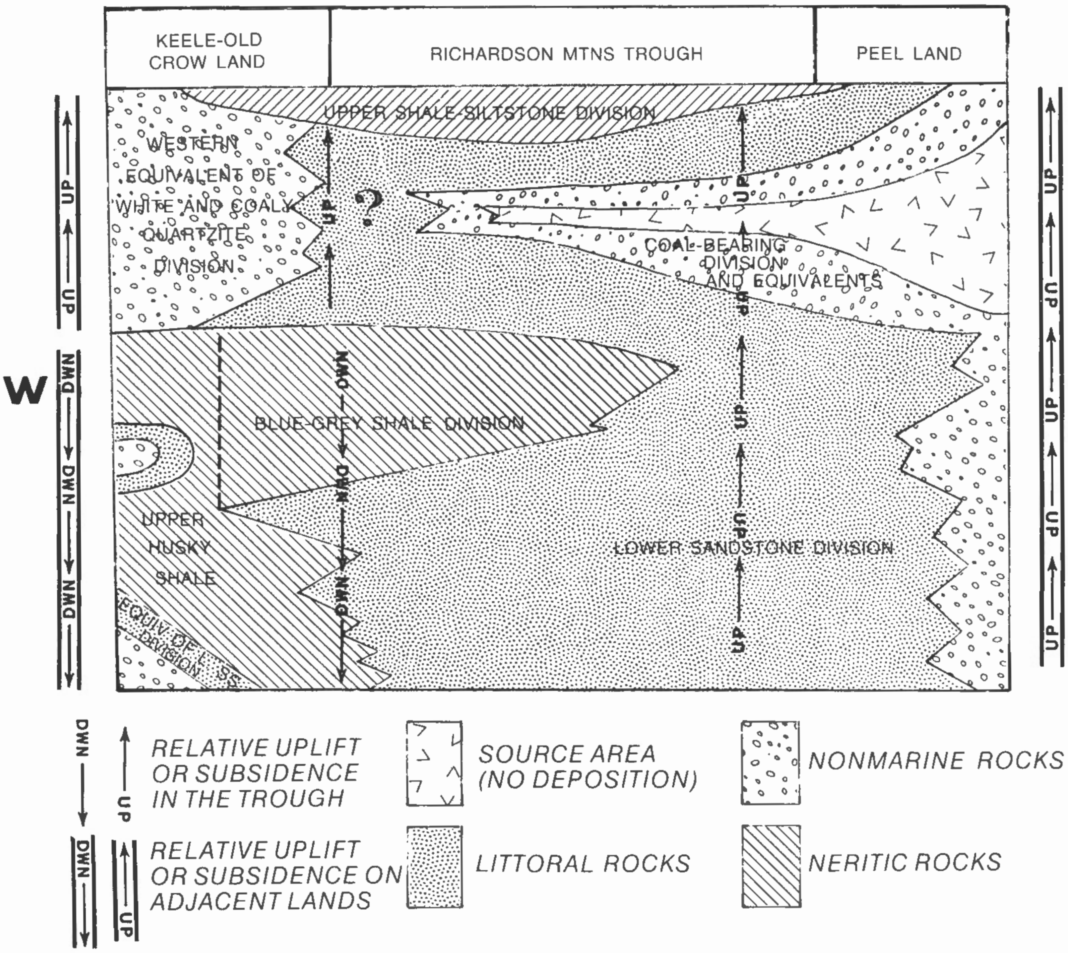


Figure 19.

Depositional tectonics of the time of Lower sandstone and Coal-bearing divisions and their argillaceous equivalents (Valanginian to mid-Hauterivian).

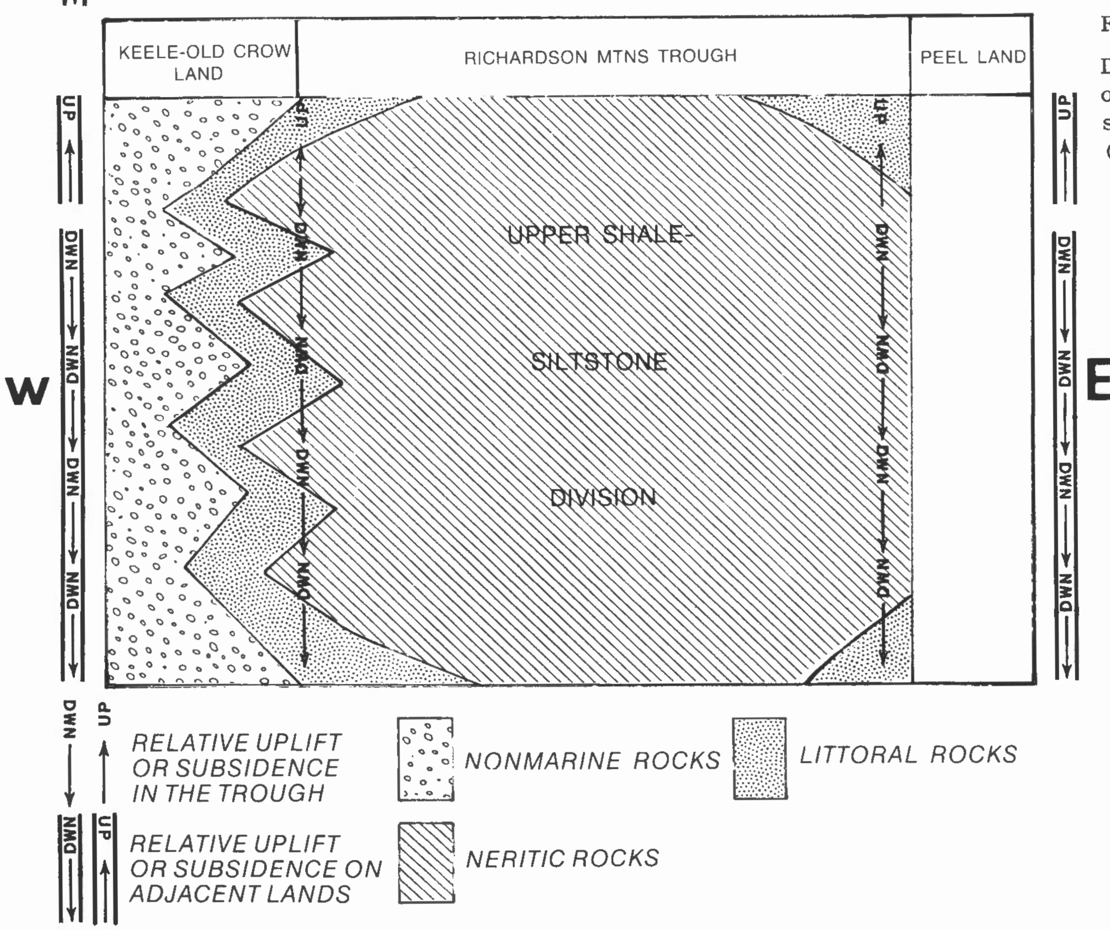


Figure 20

Depositional tectonics of the time of Upper shale-siltstone division (mid-Lower Cretaceous).

pulses may have been caused by the uplifts of the Aklavik Arch rather than by the north-south trending uplifts of the flank proper, but this possible interference is disregarded herein.

The western flank of the trough was structurally negative and subsided more or less steadily (again disregarding the possible but still unproven shortlived uplifts of the ancestral Aklavik Arch) throughout the Lower and Middle Jurassic (Fig. 17). This is evidenced by the gradual westward spreading of the Kingak transgression on this flank and by an equally gradual westward spreading of the shale-siltstone facies best illustrated by section E1 of Figure 6 but inadequately shown in Figure 17.

The Lower to Middle Jurassic tectonic regime of the Porcupine Plain-Richardson Mountain Trough must have been dominated by hinge-like tectonic movement with the eastern flank moving up and the western flank moving down (relatively) around a north-south trending, centrally situated, axis (Fig. 17).

Late Jurassic and earliest Cretaceous phase

The onset of Late Jurassic time brought a reversal of the tectonic regime of the trough illustrated diagrammatically in Figure 18. The eastern flank began to subside, relatively and the subsidence continued through the Late Jurassic into the earliest Cretaceous. This steady subsidence apparently was not disturbed by the east-northeast oriented tectonic movements of the ancestral Aklavik Arch. The western flank of the trough became, in contrast, strongly positive. The apparently steady uplift (again relatively speaking) of the western flank continued until the late Upper Jurassic (*Buchia mosquensis* f. typ. time) when it began to subside again. This latest Jurassic to basal Cretaceous subsidence of the west flank resulted in a brief phase of a simultaneous subsidence of both flanks of the trough (Fig. 18). Except for this brief phase, the Late Jurassic to earliest Cretaceous tectonic regime of the Porcupine Plain-Richardson Mountain Trough was dominated by hinge-like vertical movements but with the direction reversed (i. e. eastern flank was going down while the western flank went up) in comparison with that of the Early to Middle Jurassic phase. This north-south oriented hinge movement is, of course, responsible for the previously discussed Late Jurassic facies pattern in the trough characterized by the strong development of eastward prograding deltas on the west flank and the complete absence of the westward prograding deltas on the east flank.

Early Early Cretaceous (late Berriasian to late Valanginian) phase

The brief latest Jurassic to earliest Cretaceous phase of a simultaneous subsidence of both flanks of the trough was followed by the early Early Cretaceous phase again dominated by the hinge-like vertical tectonic movements (Fig. 19). The steady Late Jurassic to earliest Cretaceous subsidence of the east flank was replaced by a relative uplift in mid-Berriasian time. This is reflected in the regional deposition of the Lower sandstone and Coal-bearing divisions above the Husky shale (Figs. 2, 4-8), the development of westward prograding deltaic lobes, and the presence of a widespread Valanginian to mid-Hauterivian hiatus (*see* Figs. 2, 4, 5, 7) on this flank. On the west flank, in contrast, the latest Jurassic subsidence continued almost uninterruptedly approximately until the end of the Valanginian as evidenced by a considerably younger age of the Upper Husky shale and the Blue-grey shale (Jeletzky, 1961b, p. 12-14, Fig. 1; 1971a, p. 215, 216, Fig. 3; 1972b; and in preceding chapters of this report) of this flank in comparison with that of the uppermost Husky shale of the east flank (Jeletzky, 1967, p. 33-36). This lower Lower Cretaceous tectonic phase is, thus, again dominated by the hinge-like vertical movements around the north-south oriented, centrally situated axis (Fig. 19). However, it features one more reversal of the direction of these movements which brings the tectonic regime back to that characteristic of Early to Middle Jurassic time (Fig. 17). This hinge-like tectonic regime is, of course, complicated considerably by the previously discussed strong Valanginian to mid-Hauterivian upheaval of the Aklavik Arch and Cache Creek Uplift.

The early Early Cretaceous tectonic phase concludes the period of prevalent hinge-like vertical movements around the north-south oriented, centrally situated axis in the Jurassic and Lower Cretaceous history of the Porcupine Plain-Richardson Mountain Trough.

REGIONAL UPLIFTS AND SUBSIDENCES

Early to mid-Hauterivian uplift

The above-discussed subsidence of the west flank of the trough was replaced by its strong uplift (relatively) at the end of the Valanginian. Thereafter both flanks moved up simultaneously until the beginning of the late Hauterivian (Fig. 20) ushering in the period of regional uplifts and subsidences of the Jurassic to Lower Cretaceous history of Porcupine Plain-Richardson Mountain Trough. As already mentioned in the paleogeographical chapter, the latest-Valanginian to mid-Hauterivian regional uplift resulted in the greatest regression in the Jurassic and Lower Cretaceous history of the trough with the westward and eastward prograding deltaic fronts almost merging in the northern Bell Basin segment (Fig. 13). This strong regional uplift was followed by a rapid and strong regional subsidence of the report-area in the late Hauterivian.

Late Hauterivian to late Barremian subsidence

The late Hauterivian to late Barremian regional subsidence affected equally both flanks of the Porcupine Plateau-Richardson Mountain Trough as documented by strong oversteps of the littoral to nonmarine lower Lower Cretaceous and older rocks by the deep water argillites of the Upper shale-siltstone division

(Figs. 14, 20). This profound regional subsidence was, however, followed by another regional uplift at the end of the Barremian.

Aptian regional uplift

Like the early to mid-Hauterivian uplift but unlike the earlier uplifts, the Aptian regional uplift was characterized by simultaneous, apparently equally strong relative upward movements of both flanks of the trough (Fig. 21).

LATEST APTIAN INTERREGIONAL OROGENY AND HINGE MOVEMENTS AROUND ASYMMETRICALLY SITUATED AXIS

Latest Aptian phase

The Aptian uplift culminated in the interregional latest Aptian orogeny (Jeletzky, 1961a, p. 539, 540, 543; Jeletzky and Tipper, 1968, p. 88, 89) the effects of which have been described in the Aptian section of the paleogeographical chapter (*see* p. 39, 41). As indicated in Figure 21 the north-south trending latest Aptian vertical movements are peculiar in that the residual deep water "furrow" situated in the proximity of Keele-Old Crow Landmass continued to subside strongly whilst the adjacent part of the land itself continued to rise strongly. This is evidenced by the continuing deposition of very thick (3, 000 feet or ?more) latest Aptian and ?earliest Albian flyschoid turbidites within the "furrow". These presumably bathyal rocks were derived from the rapidly rising Keele-Old Crow Landmass as indicated by the presence of latest Aptian hiatuses and thick, shallow water, lower Lower Albian conglomerates closely to the west and northwest of the "furrow" and especially by the presence of redeposited deep water lower lower Albian conglomerates within the "furrow" (*see* p. 27). In contrast to the narrow western flank and the deep water "furrow" (which includes the axial zone of the trough), the much wider eastern flank of the trough continued to rise in unison with the adjacent part of the Peel Landmass (Fig. 21) until the end of the Aptian. The above-discussed interpretation of the latest Aptian tectonic regime in the Porcupine Plain-Richardson Mountain Trough is based largely on observations made by the author and Young (1972; 1973a) in the Bonnet Lake-Lower Donna River segment and the adjacent parts of Yukon's north slope. This interpretation was somewhat arbitrarily extended to include the White Mountain and northern Bell Basin segments because of the general considerations discussed in the Aptian section of the paleogeographical chapter (*see* p. 39, 41). This interpretation does not seem to be applicable entirely to the more southerly segments of the trough for the previously presented reasons.

The above-described latest Aptian type of hinge-like movements around a strongly asymmetrically situated, north-south oriented axis is a new type of the vertical tectonic movements in the Jurassic to Lower Cretaceous history of the Porcupine Plain-Richardson Mountain Trough as it involves only adjacent parts of the same flank of the trough (Fig. 21). It transformed the trough into a foredeep of the western tectonic land.

Early Albian phase

The Early Albian tectonic phase, represented diagrammatically in Figure 22, features a widespread but relatively mild subsidence of the eastern flank of the trough resulting in a complete submergence of the Peel Landmass (Fig. 16). The eastern flank of the Porcupine Plain-Richardson Mountain Trough became an ill-defined, extremely wide, only slightly westward sloping feature. It could have been called an epicontinental basin except for its westward intergradation with the deep, tectonically active flysch part of the same trough. In contrast to the extremely slow regional subsidence of the broad eastern flank of the trough evidenced by meagre thickness of the sediments (Fig. 22), its western flank continued to be dominated by the already discussed strongly asymmetrical type of hinge movement initiated in the latest Aptian. Namely, the Keele-Old Crow Landmass continued to rise strongly while the considerably expanded (as compared with the latest Aptian time) flysch basin flanking it from the east and south (Fig. 16) continued to subside strongly. This is evidenced by the deposition of more than 10, 000 feet of Lower Albian flyschoid turbidites and conglomerates in this western belt of the trough (Jeletzky, 1971a, p. 209-211, 219, 220; 1972b; Young, 1972, p. 232; 1973a, p. 280; 1973b, p. 31).

The late Early Albian time witnessed a strong narrowing of the flysch belt of the trough with the suspension-settled, concretionary, pure to glauconitic shales of the *Arcthoplites* sp. and *Beudanticeras glabrum* zone apparently overstepping the flyschoid turbidites of the earlier Lower Albian *Sonneratia* n. sp. A zone near the confluence of the Whitestone and Porcupine Rivers (Jeletzky, 1960, p. 19), on Bell River near its confluence with the Porcupine River (unpublished personal data) and in Bonnet Lake-Blow Pass area (Jeletzky, 1972b; this report, p. 26). The beginning of this relative uplift of the western flank of the trough (Fig. 22) possibly heralds the end of the subgeosynclinal, tectonically most active late Aptian-Early Albian phase of its Jurassic to Lower Cretaceous history. However, this suggestion is based on scarce and partly doubtful data and may be subject to a revision in the future.

No attempt was made to reconstruct the mid- to Late Albian tectonic regime of the report-area because of an extreme scarcity of available data.

DRIFT OR NO DRIFT?

In the writer's opinion, the preceding analysis of Jurassic and Lower Cretaceous facies and tectonic pattern of the report-area permits a definitive answer to the question "Drift or no Drift?" straight-forwardly asked recently but not answered by Miall (1973, p. 98).

Figure 21

Depositional tectonics of the time of Upper sandstone division and its argillaceous and flyschoid equivalents (Aptian). Largely based on facies and tectonic pattern observed in Bonnet Lake-Lower Donna River segment and adjacent parts of Yukon's north slope.

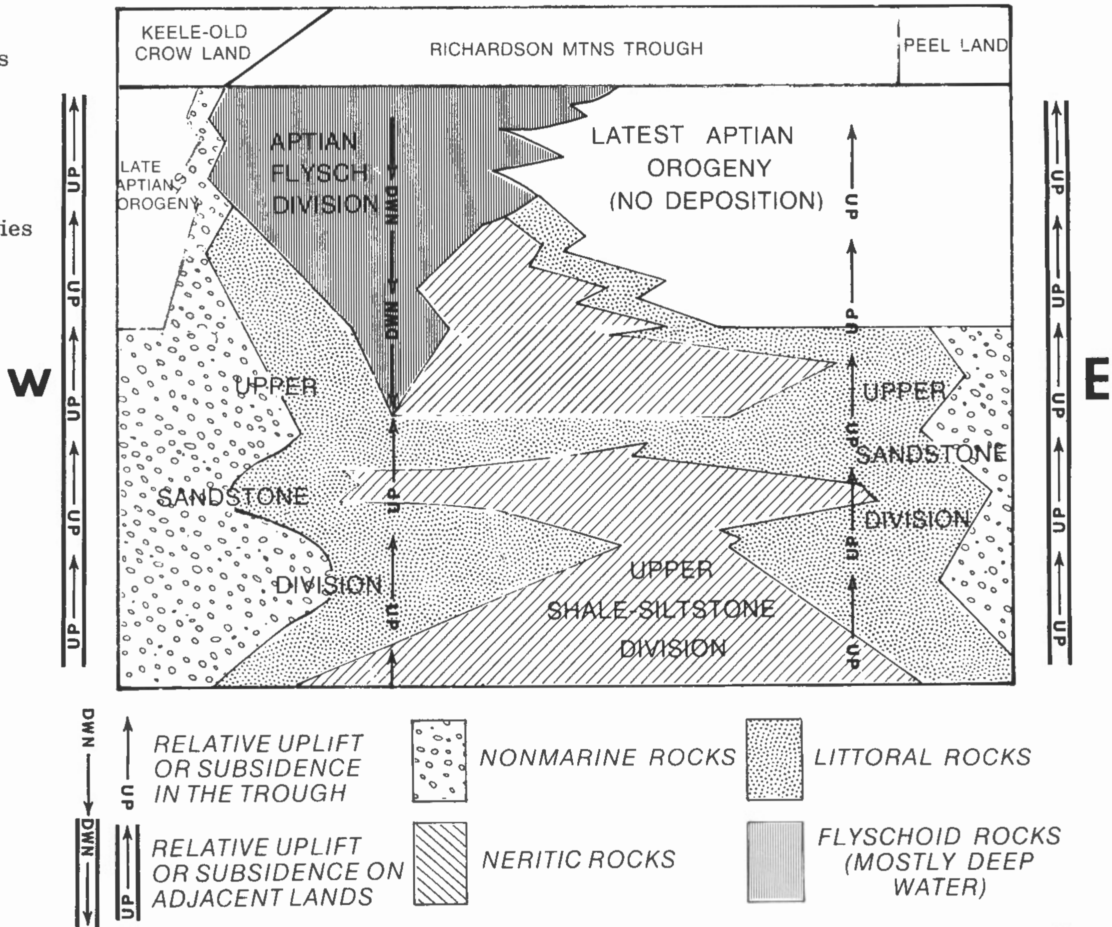
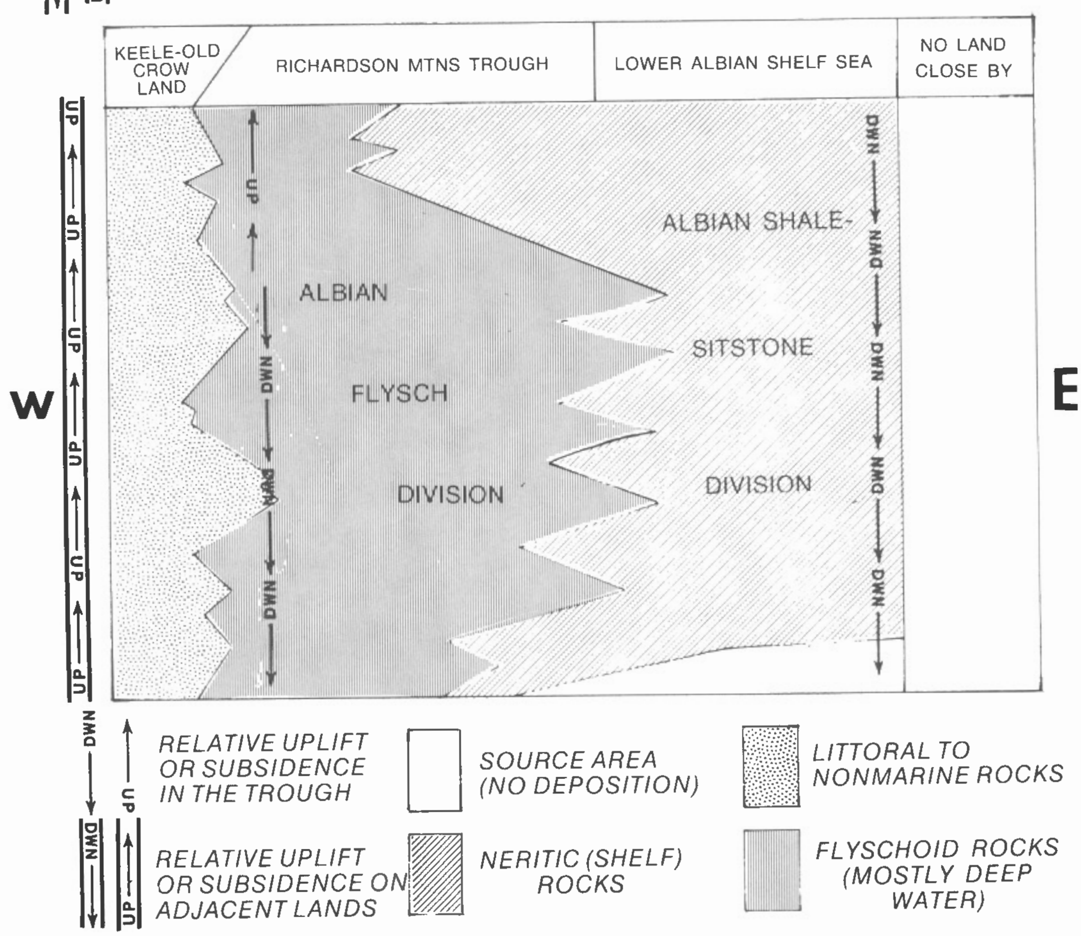


Figure 22.

Depositional tectonics of the Early Albian time.



This same question was, of course, asked before Miall (1973) by a number of other geologists cited in his paper.

Contrary to Miall's (1973, p. 111, 112) opinion, the Paleozoic linearity, extent, and geographical position of the Aklavik Arch as outlined by Jeletzky (1963) was maintained throughout the Jurassic and Lower Cretaceous. This is indicated by the repetition of basically similar Jurassic to mid-Lower Cretaceous facies and tectonic patterns discussed and illustrated in the preceding pages of this report (e.g. Figs. 9, 10, 11, 12, 13). Neither is there any evidence that this linearity, extent and geographical position of the arch changed materially between the Lower Cretaceous and the present.

The remarkably close alignment of Dave Lord and Rat Uplifts of the Aklavik Arch in the Jurassic and Lower Cretaceous necessitates the withdrawal of Jeletzky's (1963, p. 63, Fig. 5) suggestion that: "It could be that these two arches (24, Figs. 22, 24) only arose in Cretaceous time, perhaps because of the lateral offset of parts of the Aklavik Arch by north-trending strike-slip faults". Any major Cretaceous strike-slip faults would, of course, destroy the above-mentioned close alignment of the Jurassic (and older) facies and tectonic patterns of these two uplifts. This reasoning appears to rule out any post-Precambrian lateral separation of the Dave Lord and Rat Uplifts in excess of 25 to 30 miles as any greater displacement would affect appreciably even the admittedly rough facies and tectonic patterns outlined in the text and figures of this report.

The *en echelon* arrangement of the Dave Lord and Rat Uplifts, which was claimed by Norris (1972, p. 91, 93, Fig. 1) and gave Miall (1973, p. 111, 112) another reason to doubt the reality and ancient origin of the Aklavik Arch, appears to be a physiographic rather than truly tectonic feature (*see* p. 35-36, Figs. 12, 13). The apparent *en echelon* position of the Cache Creek Uplift and the Canoe Depression (Norris, 1972, p. 91, 93, Fig. 1) in relation to the Aklavik Arch is likewise irrelevant as these tectonic elements do not form part of the arch, even though the Cache Creek Uplift probably represents its northward offshoot.

The longlasting existence of the Jurassic to Aptian Porcupine Plain-Richardson Mountain Trough, Peel Landmass, and Keele-Old Crow Landmass evidenced by the previously discussed facies and tectonic pattern is yet additional evidence against Mesozoic or Cenozoic drift within northern Yukon and adjacent parts of northern and east-central Alaska postulated by Norris (1972, p. 98) and American workers whose papers are extensively discussed and cited by Miall (1973, p. 98, 99, Figs. 6-15). As pointed out by Jeletzky (1963, p. 80, 81) and confirmed once more by data contained in the present report, the Ancestral Brooks Range (of which the Keele-Old Crow Landmass appears to be but the easternmost part) persisted in approximately the same geographical position at least since the Late Jurassic until the present. As pointed out in the previous chapters of this report, the sediments derived from this major western to northwestern source area continued to pour eastward and southeastward into the western part of the Porcupine Plain-Richardson Mountain Trough throughout Jurassic and Early Cretaceous time. The same was true, furthermore, of the early to mid-Upper Cretaceous time (Jeletzky, 1972a, p. 214, Fig. 3; 1972b, p. 46-53, Fig. 3). This is inconsistent with Norris' (1972, p. 98) speculations concerning the placement of the boundary between North American and Eurasian continental plates within the northern part of the trough (i.e. in Porcupine River basin north of Aklavik Arch) and the occurrence of any major (i.e. in excess of 25-30 miles) right-lateral drift of these plates in relation to each other along the suggested northeastern continuation of the Alaskan Kaltag fault. As previously pointed out, any such major strike-slip movements would have been reflected in the above-discussed Jurassic and Lower Cretaceous facies and tectonic pattern of the Porcupine Plateau and adjacent areas of north Yukon and northwestern part of Mackenzie District. The apparently complete absence of such effects, attested by the persistence of major facies and tectonic elements across the above-mentioned boundary, suggests instead that the Kaltag fault dies out within the Yukon shelf (or Yukon stable block; Jeletzky, 1961a, p. 578-582; Fig. 24) of the Canadian Shield, where its 50 to 70 miles of right-lateral displacement is "dispersed" among numberless lesser strike-slip faults dominating the tectonical style of the whole region (Jeletzky, 1961a, p. 543-545, 547-576, 578-582).

The above evidence is deemed to be sufficient to refute all recent hypotheses (*see* Miall, 1973, p. 98-112, Figs. 6-15 for further details) proposing the occurrence of continental drift within northern Yukon, adjacent parts of Northwest Territories and those of northeastern and east-central Alaska. The evidence available indicates, instead, that these regions maintained essentially the present day geographical relationships to each other at least since early Paleozoic time. This conclusion agrees perfectly with the more general conclusions of Churkin (1969; 1973) and Lathram (1972) that neither Alaska nor northern Yukon were formed from segments rifted from other continental plates and drifted to their present position. These regions form instead part of an ancient continental mass which was enlarged in the course of Paleozoic, Mesozoic, and Cenozoic time by an accretion of two or ?more orogenic belts. Like some of the major tectonic elements of Alaska, central Yukon, and southern Yukon discussed by Churkin (1969; 1973) and Lathram (1972), the major tectonic elements of Porcupine Plateau and adjacent areas were dominated by vertical tectonic movements and suffered only relatively minor lateral movements (the largest being apparently the right-lateral displacement along Tintina fault; *see* Tempelman-Kluit, 1970, p. 82-84, Fig. 25) in relation to each other. These lateral movements appear to be but internal adjustments of these elements to ?continuing or ?episodical stresses from without the continental mass of North America.

The writer's decided opposition to the validity of the continental drift hypothesis for the report-area and adjacent parts of Northwest Territories and Alaska should not be interpreted in the sense that he is either for or against the fascinating hypothesis of plate tectonics on the global scale. This hypothesis must be tested by methods similar to those used in this report, in hundreds of continental areas spread all over the globe before a definitive conclusion about its global validity or invalidity will be possible.

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