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PRELIMINARY INTERPRETATIONS OF THE MACKENZIE-BEAUFORT BASIN DEEP CRUSTAL REFLECTION SURVEY

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General Introduction

This document presents the initial interpretations of crustal seismic reflection data recorded in the Mackenzie Delta region of the Northwest Territories. There are two parts to the report, one that outlines the interpretation of thrust structures beneath the Campbell Uplift, and a second that outlines evidence for reactivation of old structures during the formation of late extension faults. In addition to these two papers, the report also includes large scale interpretations of the seismic data from the main northwest-southeast Line 1. These are identified as Figures 7 and 8.

PART I

COMPRESSIONAL OROGEN BENEATH THE ARCTIC COASTAL PLAIN IN WESTERN CANADA

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ABSTRACT

A compressional orogen has been imaged on deep seismic reflection data from the Arctic Coastal Plain adjacent to the Mackenzie River delta in northwestern Canada. The compression is identified as offsets in reflections from Proterozoic strata underlying the Campbell Uplift near Inuvik, Northwest Territories. The age of the compression is not yet clearly established; it may be as old as late Proterozoic or as young as late Paleozoic. A late Proterozoic age would imply that an extensive, Precambrian compressional orogen underlies much of northwestern Canada. A late Paleozoic age would imply that the front of the Ellesmerian (Devonian - Carboniferous) orogen lies buried beneath the Arctic Coastal Plain from the Mackenzie River delta in the Northwest Territories to the Parry Islands fold belt some 1000 km to the northeast in the Arctic Archipelago.

INTRODUCTION

Application of the seismic reflection profiling technique in the northwestern Canadian Arctic has produced images of a pre-Mesozoic compressional orogen buried beneath the Arctic Coastal Plain. The compressional structures are situated south and east of the Mackenzie River delta in an area where the pre-Mesozoic tectonic history is not well understood but where the Mesozoic structures have been largely controlled by older features. In this paper, we describe the evidence for and implications of a pre-Mesozoic compressional orogen beneath the coastal plain. In a companion paper, Coflin et al. (1987) describe the relationship of the Mesozoic-Tertiary structures to the older structures.

The data were acquired east of the Mackenzie River delta where exposures of pre-Mesozoic rocks and well control are sparse. However, near Inuvik, Northwest Territories, Proterozoic and Paleozoic rocks are exposed in a small area known as the Campbell Uplift (Fig. 1). This uplift is part of a northeast-southwest trending complex of uplifts collectively known as the Aklavik Arch Complex (Norris and Yorath, 1981). The exposed portion of the complex extends from near the Alaska - Yukon border, some 500 km southwest of Inuvik, to the Campbell Uplift. From there the Aklavik Arch Complex plunges northeastward beneath the Arctic Coastal Plain and follows a trend of subsurface structural highs extending at least to Banks Island, the southwesternmost large island of the Arctic Archipelago. The Campbell Uplift is an integral part of the Aklavik Arch Complex, and information gained on the deep structure of this uplift may provide insight into the origin of the complex.

The Campbell Uplift has had a complex geological history since the middle Proterozoic. The oldest rocks exposed in the core of the uplift are probably about 1.1 Ga (Norris and Yorath, 1981), and may thus be younger than the compressional Racklan Orogeny (1.1-1.2 Ga) but older than the extensional Hayhook Orogeny (about 0.6-0.8 Ga; Young et al., 1979). Thicknesses of the Proterozoic are unknown but mapping indicates that at least 2 km of section are exposed in the uplift (Dyke, 1975). The Proterozoic strata are dominated by argillaceous rocks with some carbonates, indicating passive margin sedimentation (Dyke, 1975; Young et al., 1979). Early Paleozoic (Cambrian to Late Devonian) sediments overlie the Proterozoic rocks with angular unconformity and include thick carbonates that are also typical of passive margin sedimentation. The Upper Devonian is dominated by clastic flysch deposits of the Imperial Formation that dip southward on the south side of the Campbell Uplift and are structurally conformable with the older Paleozoic layers.

The formation of the Campbell Uplift occurred after the Devonian and prior to the Early Cretaceous; Albian clastics overstep progressively older strata toward the core of the uplift where they rest unconformably upon Proterozoic strata . Hence the arching of the uplift took place during the time interval that included the compressional Ellesmerian Orogeny (Late Devonian to Carboniferous) and the opening of the Canada Basin (about 115-155 Ma; Vogt et al., 1982).

DATA DESCRIPTION

The deep reflection data were acquired along two perpendicular lines east of the Mackenzie Delta (Fig. 1). The acquisition and processing parameters were similar to those used on reflection surveys conducted by LITHOPROBE (Clowes et al., 1987). The total length of the main northwest - southeast line, Line 1, is about 158 km and the total length of Line 2 is about 33 km (Figs. 1 and 2). A line drawing of the reflection geometry to 12.0 sec along Line 1 is shown in Figure 2 and an enlargement of the data from across the Campbell Uplift on the south end of this line is shown in Figure 3.

Geological identifications of the reflection horizons based upon the surface geology and well control are shown on the south side of

Figure 3. The Mesozoic (Cretaceous) at the top of the section unconformably overlies the south dipping Upper Devonian Imperial Formation at about 0.4 sec and the Paleozoic-Proterozoic unconformity is visible as a truncation at about 1.2 sec. Two strong, continuous reflections outline the sequence from the Paleozoic carbonate to the unconformity at the base of the Paleozoic from about 0.8 sec to 1.2 sec. The Paleozoic layers within this sequence are parallel to the unconformity and are in the form of an arch that outlines the shape of the Campbell Uplift between V. P. 251 and V. P. 1000. North of V. P. 400, however, the continuity of these Paleozoic reflections diminishes as the Mesozoic unconformity cuts into the arched layers.

The Proterozoic layers extend from about 1.2 sec (about 3 km) to perhaps 6.0 sec (about 18 km) at V. P. 251 (south end of Fig. 3). The zone of reflections at about 6.0 sec probably represents "basement" to the Proterozoic because Line 2 shows that this reflection zone has a significant component of southwest dip; the layers at shorter travel times do not. It is not clear, however, whether the 6.0 sec reflection is Hudsonian basement, or whether it is a feature within the younger Proterozoic. Nevertheless, the layers between 1.2 and 6.0 sec are Precambrian, and are most likely Proterozoic. The thickness of this sequence is about 4.8 sec, or about 15 km. Regional correlations of Proterozoic rocks throughout northwestern Canada have established that middle Proterozoic strata in the Wernecke Mountains some 500 km southeast of Inuvik are at least 14 km thick and the base is not exposed (Young et al., 1979). Hence, although we caution against efforts to correlate specific seismic reflections from the Mackenzie Delta to the Wernecke Mountains, geological studies indicate that thick middle Proterozoic sequences are present in this part of North America.

A key feature upon which the geological interpretation of the seismic profile is based is the distinctive, high amplitude, arcuate reflection at 3.0-3.2 sec between V. P. 300 and V. P. 550. Upon migration this feature is seen to have three segments (labeled A, B, and C on Fig. 3). We do not know what the lithology of these reflectors is, but the Proterozoic in northwestern Canada includes both carbonates and volcanics which, if sandwiched between argillaceous rocks, could easily produce reflections such as these. Segment B clearly overlaps segment A for about 5 km from south to north between V. P. 350 and V. P. 400. The distinctive high amplitudes of reflection B give way northward to a more subdued zone of south dipping reflections that extends from about 2.5 sec at V. P. 400 to about 1.0-1.5 sec at V. P. 475. This zone of reflections truncates the layered, continuous reflections of the upper part of the Proterozoic succession that are clearly visible between 1.0 and 2.0 sec between V. P. 251 and V. P. 475. North of V. P. 475, the distinctive upper Proterozoic reflections are not obvious.

The north side of the Campbell Uplift is characterized by complex reflections that extend to nearly 10.0 sec (about 30 km). Four features stand out (Fig. 2). First, near the surface, the arching of the Campbell Uplift is outlined by a nearly continuous, high amplitude reflection from 0.3 sec (V. P. 550) to 0.8 sec (V. P. 800). Well control aids in identifying this reflection as the Mesozoic unconformity, with the underlying rocks as either Paleozoic or Proterozoic. Second, between 1.0 and 2.0 sec in this same area there are several north dipping reflections that can be traced to shallow levels where extensional faulting is observed. A third feature occurs at longer travel times, where there is a nearly continuous reflection dipping northward from reflection A discussed above. This feature can be followed to nearly 8.0 sec (V. P. 900) where it merges with a subhorizontal zone of reflections (Fig. 2). Finally, between V. P. 800 and V. P. 1100 at 0.5 sec to 2.0 sec, the reflections illustrate significant offsets down-to-the-north associated with the Eskimo Lakes Fault Zone at the south margin of the Mackenzie Delta (Coflin et al., 1987).

INTERPRETATION

The interpretations of these data are constrained by the geology (from surface relationships and well control) and by the geometry of the seismic reflections (Fig. 4). Two key features of the reflections allow us to interpret a compressional orogen at depth beneath the Campbell Uplift. They are the northward overlap of reflection B on reflection A and the truncation of the upper Proterozoic layers near V. P. 450 - 475 at 1.0 - 2.0 sec. There are two fundamentally different interpretations of these structures shown in Figure 4. Figure 4a shows an interpretation in which a wedge of material has been driven from the north beneath reflector B such that B overlaps A and C overlaps B. This type of structure is known as a "passive-roof duplex" (Banks and Warburton, 1986), a "tectonic wedge" (Price, 1986), or a "triangle zone" (Gordy et al., 1977) and would represent the front of a thrust belt that had its core to the north. An alternative interpretation illustrated in Figure 4b shows that the overlap of reflection B upon reflection A may have been caused by thrusting from the south. In this case, the core of the thrust belt would have been to the south of the section with the implication that major compressional structures should be visible there.

Age of Compression

Although both interpretations require a compressional orogen to be present at depth, the orientation of the orogen (whether northwest verging or southeast verging) can only be established with additional subsurface information. When the orientation of the compression is more completely known, its tectonic significance can be more fully established. Nevertheless, as the truncation of the upper Proterozoic strata near V. P. 450-475 at 1.0-2.0 sec is apparently related to the thrusting, the thrusting must be younger than Middle Proterozoic. In addition, the parallel (undeformed) layering of the Cambrian to Upper Devonian sequence precludes an early Paleozoic age for the compression. Hence there are apparently two possible ages for the compression; it may have been middle to late Proterozoic or late Paleozoic to Jurassic.

Several constraints can be imposed by regional geological considerations. For example, if the compression were late Paleozoic (corresponding to the time of the Ellesmerian orogeny), it could not have emerged from the south, for the lower Paleozoic rocks of the Anderson Plain to the south are essentially undeformed. Hence, Figure 4b would not be an appropriate interpretation for late Paleozoic compression. On the other hand, if the compression were Proterozoic, it could have been from either the north (Fig. 4a) or the south (Fig.

4b). For either direction of thrusting, the spatial correspondence of Proterozoic compression with the late Paleozoic - Mesozoic arching of the Campbell Uplift would require two periods of deformation. The first would have been Proterozoic compression to form the thrust faults, and the second would have been vertical movement to form the Campbell Uplift. During the interval from the Cambrian to the upper Devonian, the area would have been essentially flat, thus allowing Paleozoic strata to be deposited horizontally. To the west in the Romanzoff Uplift of the northern Yukon and adjacent Alaska, sub-Mississippian and sub-Cambrian angular unconformities have been documented. There, the Proterozoic Neruokpuk Formation had been cleaved, folded and reverse-faulted prior to deposition of the Cambrian and younger rocks (Norris and Yorath, 1981).

A Proterozoic age for the compression could have the geometry of either Figure 4a or 4b and would imply that a large compressional orogen lies buried and essentially unexplored beneath the northwestern portion of Canada. A late Paleozoic age for the compression could have the geometry of Figure 4a and would imply that the south front of a thrust belt lies beneath the Arctic Coastal Plain east of the Mackenzie Delta and that the arching of the Campbell Uplift took place in response to shortening at depth. Such a thrust belt could be a structural link between the late Paleozoic (Ellesmerian) compression observed west of the Mackenzie Delta in the Yukon (Bell, 1973; Norris and Yorath, 1981), and the Ellesmerian thin-skinned thrusting of the Parry Islands Fold Belt in the Arctic archipelago some 1000 km northeast of the Mackenzie Delta (Kerr, 1981).

CONCLUSIONS

Deep seismic reflection profiling in the Canadian Arctic has provided images of compressional structures buried beneath the Arctic Coastal Plain east of the Mackenzie Delta. The age of the compression is not yet firmly established. It may be late Proterozoic, with the implication that a previously unknown Proterozoic thrust belt underlies this area of Canada, or it may be late Paleozoic, with the implication that it marks the southern front of the Ellesmerian orogen and that this orogen may be a more or less continuous, but hidden, feature from the northern Yukon to the Arctic archipelago.

PART II

INFLUENCE OF PROTEROZOIC STRUCTURE ON THE EVOLUTION OF THE SOUTH-EAST MARGIN, BEAUFORT-MACKENZIE BASIN, ARCTIC CANADA

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ABSTRACT

New crustal reflection profiles image the sediments of Beaufort-Mackenzie Basin under the Mackenzie Delta and adjacent areas in northwestern Canada. The thickness of the Mesozoic to Quaternary sediments is found to be as great as 12 km under Richards Island at the edge of the Beaufort Sea. The faults bounding the south edge of the Beaufort-Mackenzie Basin are listric normal faults that flatten into a decollement surface below the basin fill sediments. These faults parallel features that are Proterozoic in age suggesting that the older features controlled the younger. The base of the crust is imaged on the south end of the profile at approximately 39 km, whereas in the north it is inferred, from gravity modelling, to be at approximatively 28 km. The interpretation implies post-Mesozoic extension may have been more significant than strike-slip in the formation of the southern margin of the basin.

INTRODUCTION

New seismic reflection profiles provide new insights into the crustal structure of the Beaufort-Mackenzie Basin margin. Previous crustal cross sections have been based upon gravity modelling, constrained primarily by surface geology, shallow seismic data and exploration well control. The new data include 200 km of crustal reflection seismic data collected from southeast of Inuvik, Northwest Territories to the edge of the Beaufort Sea (Fig. 1). They provide information on the following: 1) the structure and thickness of the sediments under the Mackenzie Delta, 2) the geometry of the faults that bound the southern edge of the basin and 3) a possible image of the continental Moho. This paper presents a preliminary interpretation of the data relevant to the structure and evolution of the Beaufort-Mackenzie Basin. Interpretation of older features associated with the Proterozoic and Paleozoic succession of the Campbell Uplift may be found in Cook et al. (1987).

GEOLOGICAL BACKGROUND

The area of the Mackenzie Delta in northwest Canada (Fig. 1) includes three major tectonic features: the Beaufort-Mackenzie Basin, the Aklavik Arch Complex and the Eskimo Lakes Fault Zone (ELFZ). The Beaufort-Mackenzie Basin consists of a thick succession of Cretaceous and Tertiary sediments on the continental margin adjacent to the Canada Basin. The depth to the base of the sediment has not been clearly established even though a zero edge of the Mesozoic and Tertiary sediments is known to occur near the ELFZ and has been intensely studied because of its hydrocarbon potential.

The Aklavik Arch Complex is a northeast trending series of depressions and uplifts from the Yukon to Banks Island (Norris and Yorath, 1981). A local manifestation of the arch is the Campbell Uplift seen on Figure 1 as exposures of Proterozoic and Paleozoic rocks southeast of Inuvik. The formation of the Campbell Uplift has previously been interpreted to be a result of vertically faulted crustal blocks (Lerand, 1973; Norris and Yorath, 1981), the interpretation of the new reflection data indicates that the uplift may be underlain by thrust faults of uncertain age (Cook et al., 1987).

The ELFZ is an array of normal faults, each of which has a near vertical dip at the surface and down to basin displacement. The ELFZ is a part of the larger Richardson Fault Array that extends southward along the east flank of the Richardson Mountains. According to Norris and Yorath (1981) this fault array offsets part of the Aklavik Arch Complex during Cretaceous time and may have had significant left-lateral strike slip during the Paleozoic.

DATA DESCRIPTION

The seismic data were acquired using similar field parameters and processing as those described in Clowes et al. (1987). Figure 2 is a line diagram of the NW-SE line, Line 1, displayed to 12.0 sec (the profile was recorded to 16.0 sec two way travel time). Two obvious regional features of the profile are: 1) the large number of subhorizontal reflections in the north, that diminish southward toward the ELFZ, near the centre of the profile and 2) the Campbell Uplift on the south end of the line, which appears as a broad antiform in the first second of the data. Well control indicates that the shallow reflections of the antiform are generally from Paleozoic sediments. The geometry of the reflections between 2.0 and 5.0 sec has been interpreted as evidence for compressional deformation (Cook et al., 1987). We focus here on the data relevant to the structure of the Beaufort-Mackenzie Basin.

BEAUFORT-MACKENZIE BASIN

The Beaufort-Mackenzie Basin is located between V.P. 800 and V.P. 1833, and is visible as a southwardly tapering zone of sub-horizontal layered reflections. Drillholes identify the layers as Mesozoic and younger sediments. The base of the basin fill is assumed to be at the base of the coherent reflections although it may be deeper. Conversion of travel times to depths provides an estimate of 12 km to the base of the reflections under Richards Island (north end of Line 1). This is deeper than the 9 km thickness previously inferred from well and industry seismic data (Lerand, 1976; Young et al., 1976).

There is little primary reflected energy from travel times greater than 6.0 sec at the north end of the line. Coherent arrivals at longer travel times near V.P. 1680 and V.P. 1800 are probably multiple reflections. The highly layered sediments under the delta are excellent candidates for generation of multiples.

ESKIMO LAKES FAULT ZONE

The surface position of the ELFZ is between V.P. 800 and V.P. 1050 (Fig. 1) and the faults dip northward in the subsurface between V.P. 850 and V.P. 1100 to at least 4.0 sec. Figure 5a illustrates the data near the ELFZ. The sub-horizontal reflections, labelled D on Figure 5a , appear to be truncated against north dipping reflections, labelled E. This marks the location of a major fault in the ELFZ known as the Eskimo Lakes Fault. Other faults, such as the Treeless Creek Fault, are identified by diffractions and breaks in the Cretaceous and older reflections.

Near the surface the faults of the ELFZ are almost vertical. However, at depth they are listric and are subparallel to the north dipping E reflections, which appear to flatten with depth at about 6.0 sec (about 12 km).

The East Reindeer P-60 well is located near V.P. 845 and penetrated middle Proterozoic strata at a depth corresponding to 0.7 sec travel time. The dipping reflections labeled E can be traced below this time, and are therefore middle Proterozoic or older.

Figure 5b is a line diagram of the migrated version of the portion of Line 1 in Figure 5a. The north dipping events labelled C are truncated by a high amplitude horizontal event. Well information suggests that the high amplitude reflection is generated by Paleozoic strata; therefore the truncation marks a sub-Paleozoic unconformity. We further observe that the dip on reflections F is the same as that on the E reflections. The F and E reflections are separated by the projected trace of the Eskimo Lakes Fault that has displaced the C reflectors and the overlying Paleozoic strata, down toward the basin. Reconstructions of the faults by aligning the Paleozoic unconformity puts F and E adjacent to one other and strongly implies that these reflections are both middle Proterozoic or older. The cause of these reflections is unknown and could be related to stratigraphy or faults. Some of the Mesozoic faults of the ELFZ are thus parallel to Proterozoic layers E and F and were, to a large extent, controlled by the older zone of weakness.

CRUSTAL CROSS SECTION

Crustal models described by Sobczak (1975) and Wold et al. (1970) show the crust thinning from a continental thickness of approximately 40 km under the Campbell Uplift to approximately 25 km under Richards Island. The thinned crust is considered transitional because it is thicker than oceanic crust but thinner than normal continental crust. The new seismic data impose constraints on the interpretation of crustal thickness beneath the delta. The base of the crust under the Campbell Uplift is possibly represented by a zone of reflections between 11.0 and 12.0 sec (Fig. 2). A similar band of energy is found on a cross line (Line 2, not shown). Although there are no refraction data from this area, the character and depth (approximately 39 km) of these 11.0 to 12.0 sec reflections are consistent with reflections from the base of the crust elsewhere.

Sobczak (1975) and Wold et al. (1970) both show the crust thinning at the ELFZ and this is interpreted as a response to the thickening of the Mesozoic-Tertiary sediments. The Moho reflections on the south end of Line 1 terminate before reaching the ELFZ. Except for a short band of energy below V.P. 1081 at 10.5 sec, there is apparently no direct image of the base of the crust. Farther north there is no coherent energy below 9.0 sec, because the young sediments of the basin have absorbed the seismic energy.

By using the sediments thickness from the seismic profile, Bouguer gravity modelling can be effective in constraining the depth to the Moho. The regional gravity field is provided by

Sobczak <u>et al</u>. (1973). Densities for the Paleozoic and Cretaceous sediments at the south end of the profile are available from well logs, whereas densities of the deeper Proterozoic and lower crustal rocks are estimated from Sobczak <u>et al</u>. (1986). Densities for the sediments under the Mackenzie Delta are calculated from the stacking velocities for Line 1 following methods described by Gardener <u>et al</u>. (1974).

Figure 6 shows a cross section along Line 1 with the constraints of the Bouguer gravity and information provided in Cook <u>et al</u>. (1987). At the south end the Moho is located at 39 km to be consistent with the seismic, whereas a Moho depth of 28 to 31 km, somewhat deeper than that determined by Sobczak (1975) and Wold <u>et al</u>. (1970), is calculated for the area beneath the delta. The crust between the base of the basin fill and the Moho is considered to be thinned (about 16-19 km) continental crust. This thinning likely occurs to preserve isostatic equilibrium in response to the addition of the less dense Mesozoic-Tertiary delta sediment.

CONCLUSIONS

Deep crustal seismic reflection data from the Mackenzie Delta shows that the Mesozoic-Tertiary sediments are up to 12 km thick near the edge of the Beaufort Sea and that the Eskimo Lakes Fault Zone is characterized by faults that are listric with their geometry controlled by pre-existing structures. Gravity modelling constrained by the reflection profile shows the crust thins to about 30 km beneath the Delta. The thinning is coincident with the Eskimo Lake Fault Zone implying that the present crustal structure may be related to Proterozoic features.

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FIGURE CAPTIONS

Figure 1. Map illustrating the locations of the seismic lines and the local geology. The geology is taken from Norris and Yorath (1981) and Dyke (1975). Locations of wells are also noted. The Eskimo Lakes Fault Zone (ELFZ) trends northeast-southwest across the Mackenzie Delta and the Tuktoyaktuk Peninsula. The exposed portion of the Campbell Uplift is located near Inuvik where Proterozoic outcrops are shown. The unpatterned area represents Quaternary and Tertiary cover. Locations of selected wells are also noted. The line indicating the Eskimo Lake Fault Zone is near the center of an array of faults, with the two principal faults being the Eskimo Lakes and Treeless Creek Faults. The trend of the zone is northeast-southwest across the Mackenzie Delta and the Tuktoyaktuk Pensinsula.

Figure 2. Line drawing of the seismic reflection data along Line 1 frc the Campbell Uplift on the south to the Mackenzie Delta on the north. The data are unmigrated and are shown to 12.0 sec two way travel time. Note the obvious arch structure of the Campbell Uplift, the steep north-dipping reflections of the Eskimo Lakes Fault Zone (near V. P. 900-1000) and the Proterozoic reflections A, B, and C at about 3.0 sec on the south side. The Beaufort-Mackenzie Basin is seen as the thickening zone of sub-horizontal reflection north of the Eskimo Lakes Fault Zone. The outlined area on the south side is

enlarged in Figure 3, and the outlined area in the centre is enlarged in Figure 5.

Figure 3. Migrated reflection data to 7.0 sec travel time from the south end of Line 1. On the south side of the figure, the identification of the geological layers is noted. Note the parallel layering in the Paleozoic, the strongly layered Proterozoic, and the offsets in reflections A, B, and C. The arrow points to the north dipping zone of reflections that can be traced to about 8.0 sec (about 25 km) where it flattens. The pattern: used are the same as in Figure 1 with the addition of the following: vertical line pattern denotes the strongly layered reflection that shows thrust offsets in the Proterozoic, and the hachured pattern wit: a 'B' indicates basement.

Figure 4. Alternative interpretations for the generalized structure beneath the Campbell Uplift. a: Interpretation of the structure as a wedge of material (outlined between the south-verging thrust faults) driven beneath reflector A. This geometry is that of a 'passive-roof duplex'. b: Interpretation of the structure as thrusting from the south. In this interpretation, the age of the compression would have to be Proterozoic as the Paleozoic rocks south of the uplift are largely undeformed. ELFZ is the Eskimo Lakes Fault Zone and the patterns are the same as those used in Fig. 3.

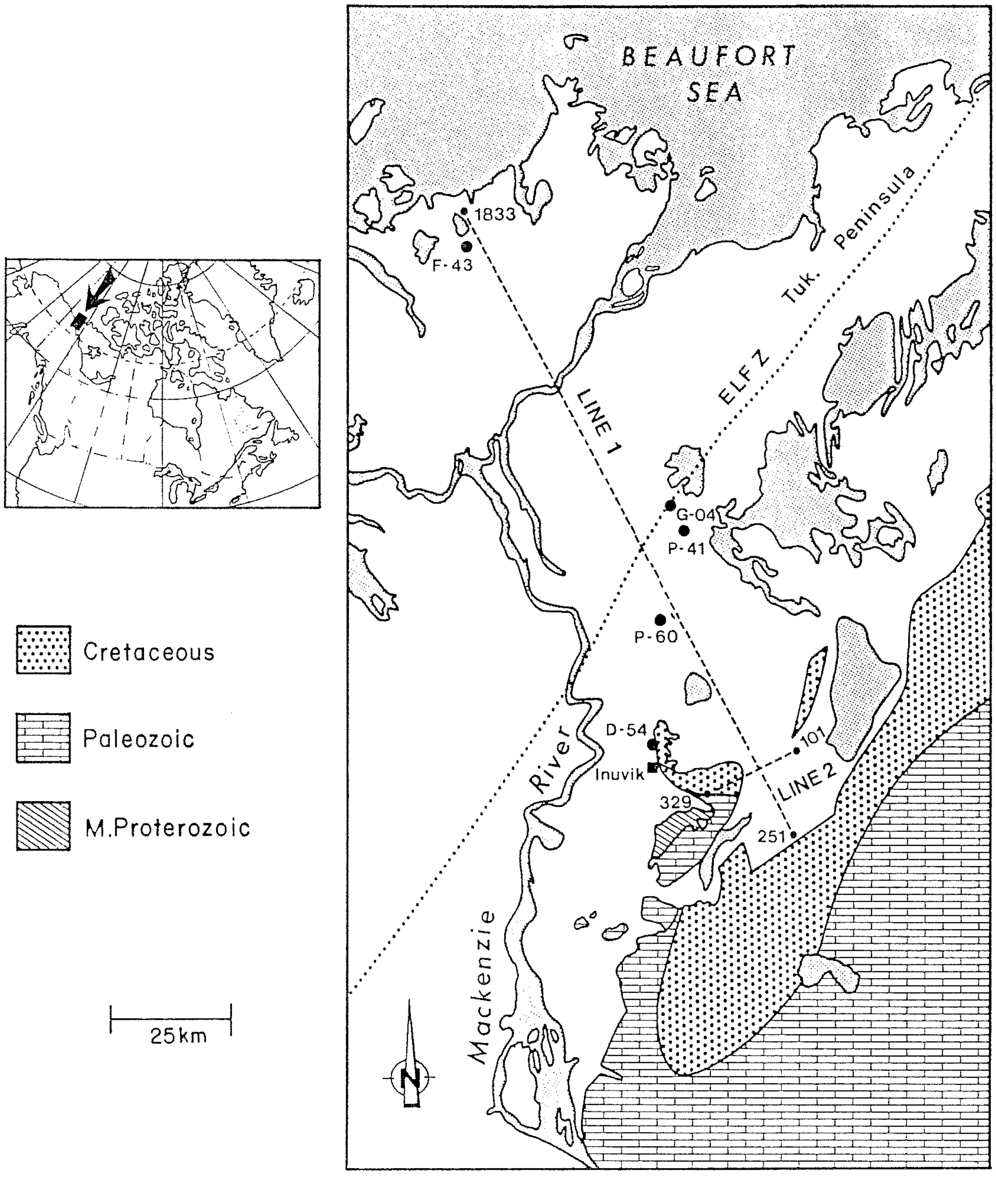
Figure 5. a) Unmigrated reflection data to 8.0 sec centered on the ELFZ. A major fault is located where the reflections labelled D abut the reflections labelled E. Other faults can be identified by breaks in the D reflections. b) Line diagram of migrated data for the portion of the line in Figure 5a. A Paleozoic unconformity is clearly identified by truncation of the reflections labelled F by the sub horizontal Cretaceous and Paleozoic layering (reflections D). Note that the E and F reflections are parallel indicating the position of the normal fault between them was controlled by the layering.

Figure 6. Interpretation of the profile using information presented here and from Cook et al. (1987). North of the ELFZ the Moho depth is inferred from Bouguer gravity, which gives a transitional thickness for the crust.

Figure 7. The processed seismic data from Line 1 are shown here at a large scale. The scale of this figure is the same as in Figure 8. These data are unmigrated.

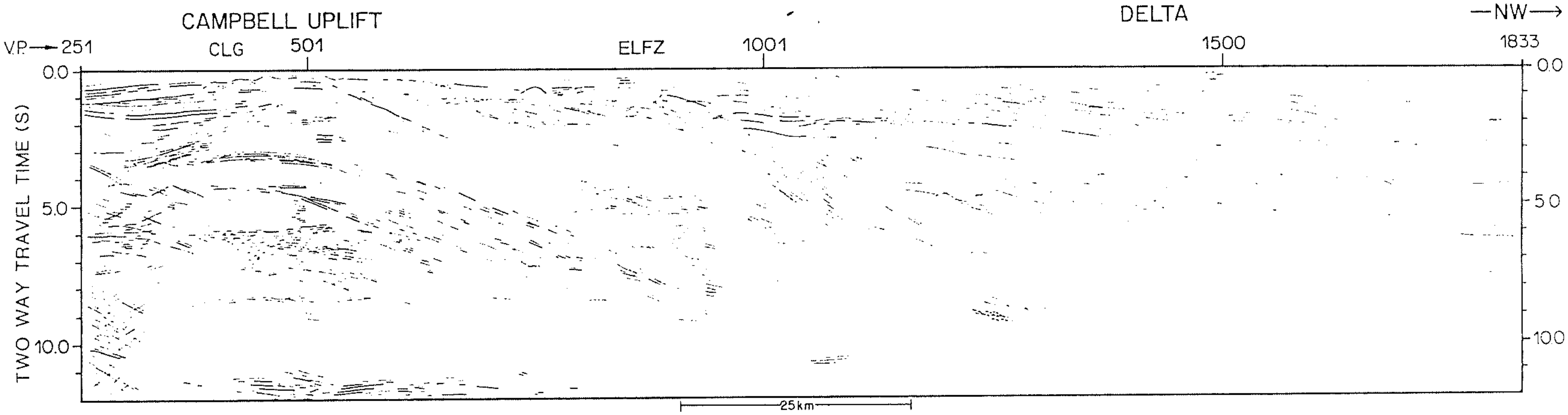
Figure 8. a). Line drawing interpretation of the complete seismic section showing the interpreted stratigraphy and faults. This version of the interpretation shows the north dipping reflections beneath the north side of the Campbell Uplift as compressional faults associated with wedging beneath the uplift. The layers labeled Proterozoic may be Neo-Helikian (Norris and Yorath, 1981), or they may be Hadrynian.

b). Same as a) except that the north dipping reflections in the middle crust on the north side of the Campbell Uplift are shown as extensional faults of unknown age.

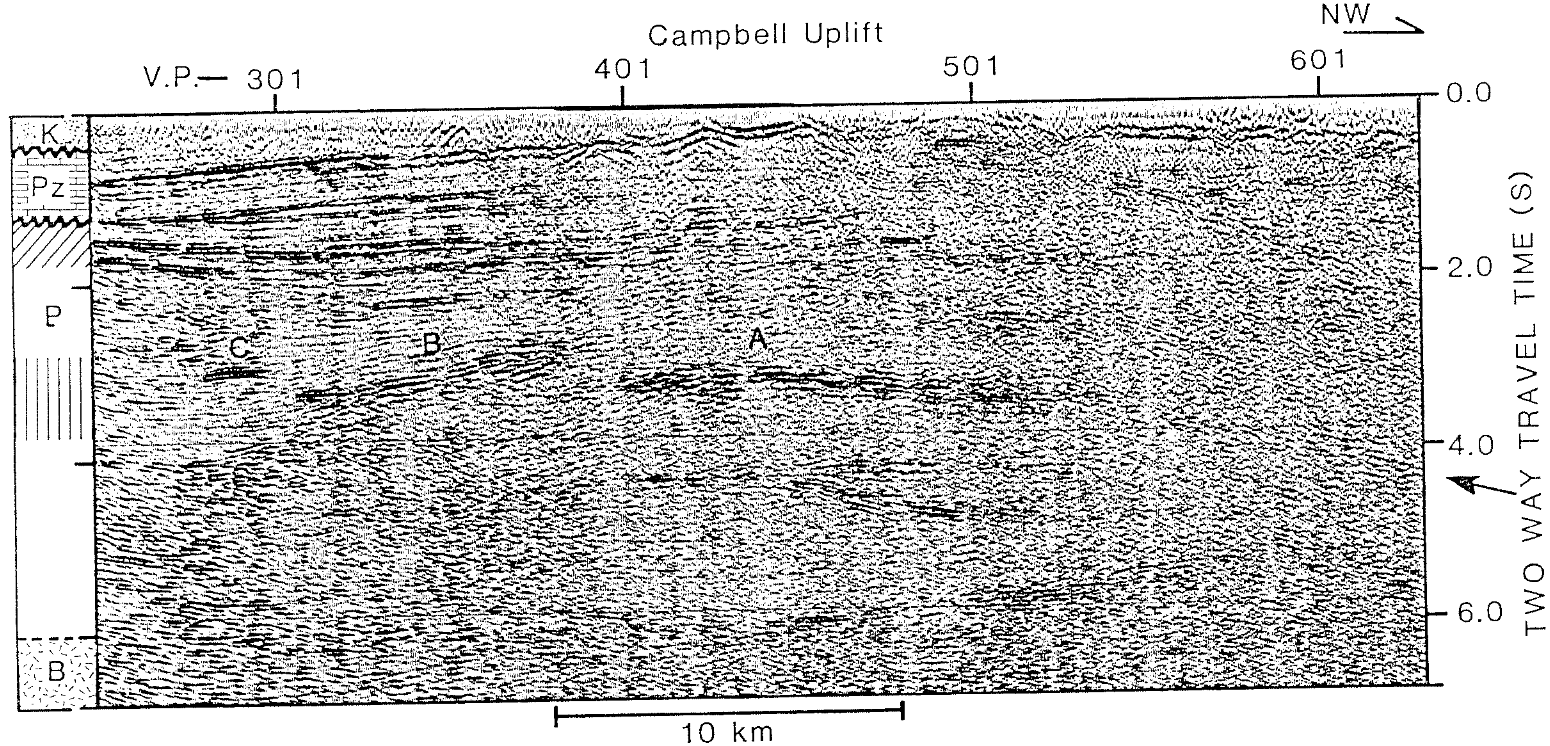

BEAUFORT SEA
1833
F-43
Tuk. Peninsula
ELFZ
LINE 1
G-04
P-41
P-60
D-54
Inuvik
329
101
LINE 2
251
Mackenzie River
Cretaceous
Paleozoic
M.Proterozoic
25km
N

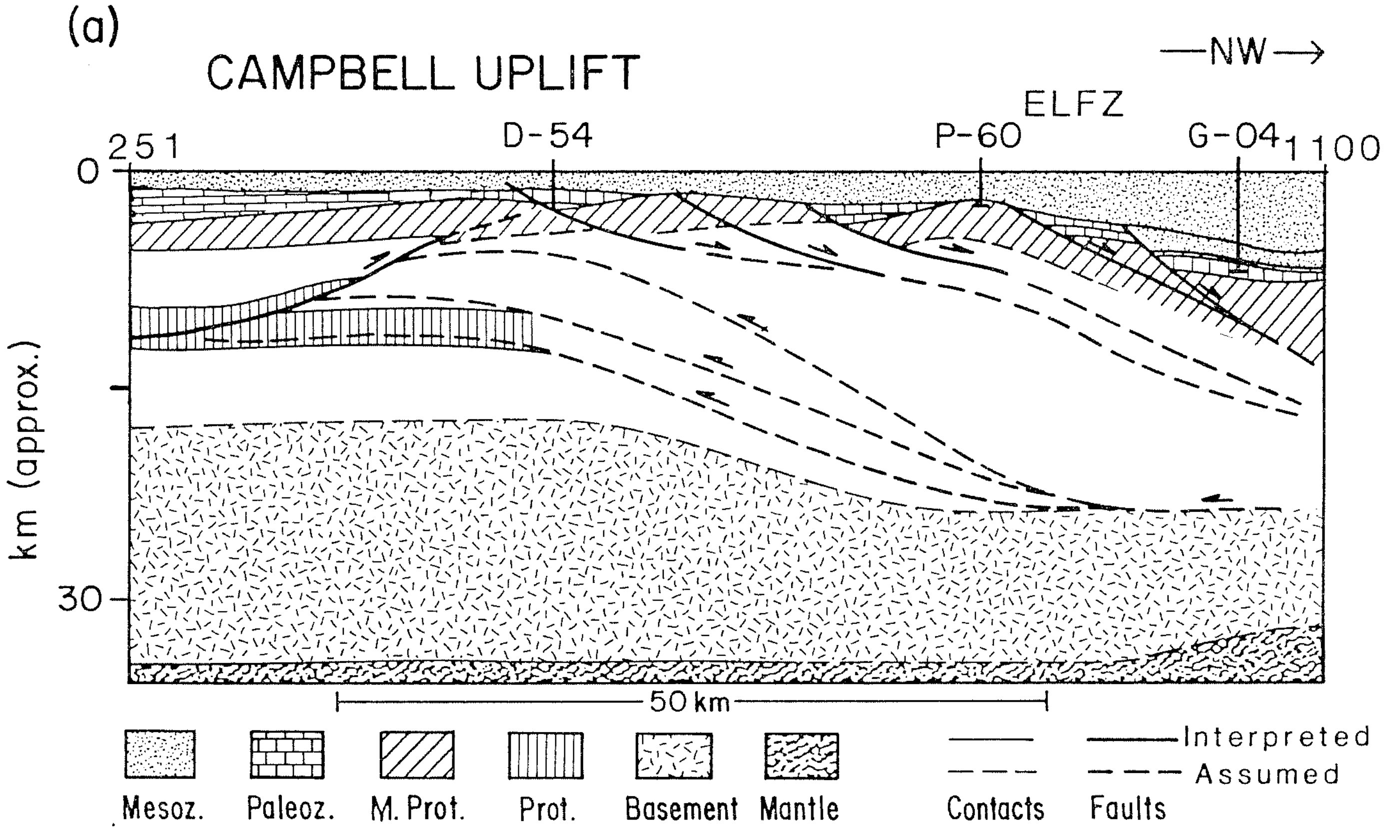
1.

LINE 1 – MACKENZIE DELTA

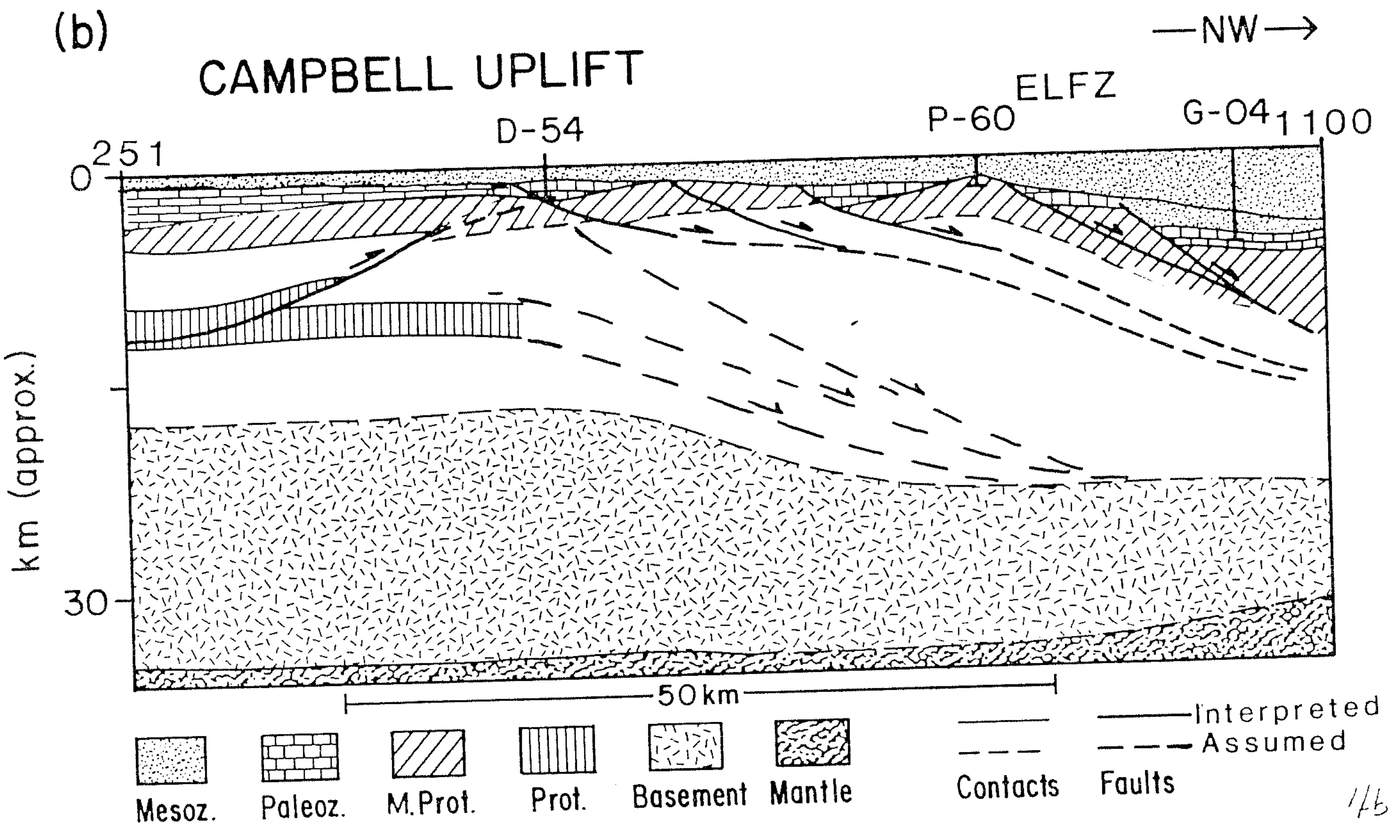


LINE 1 - MACKENZIE DELTA (SOUTH END)

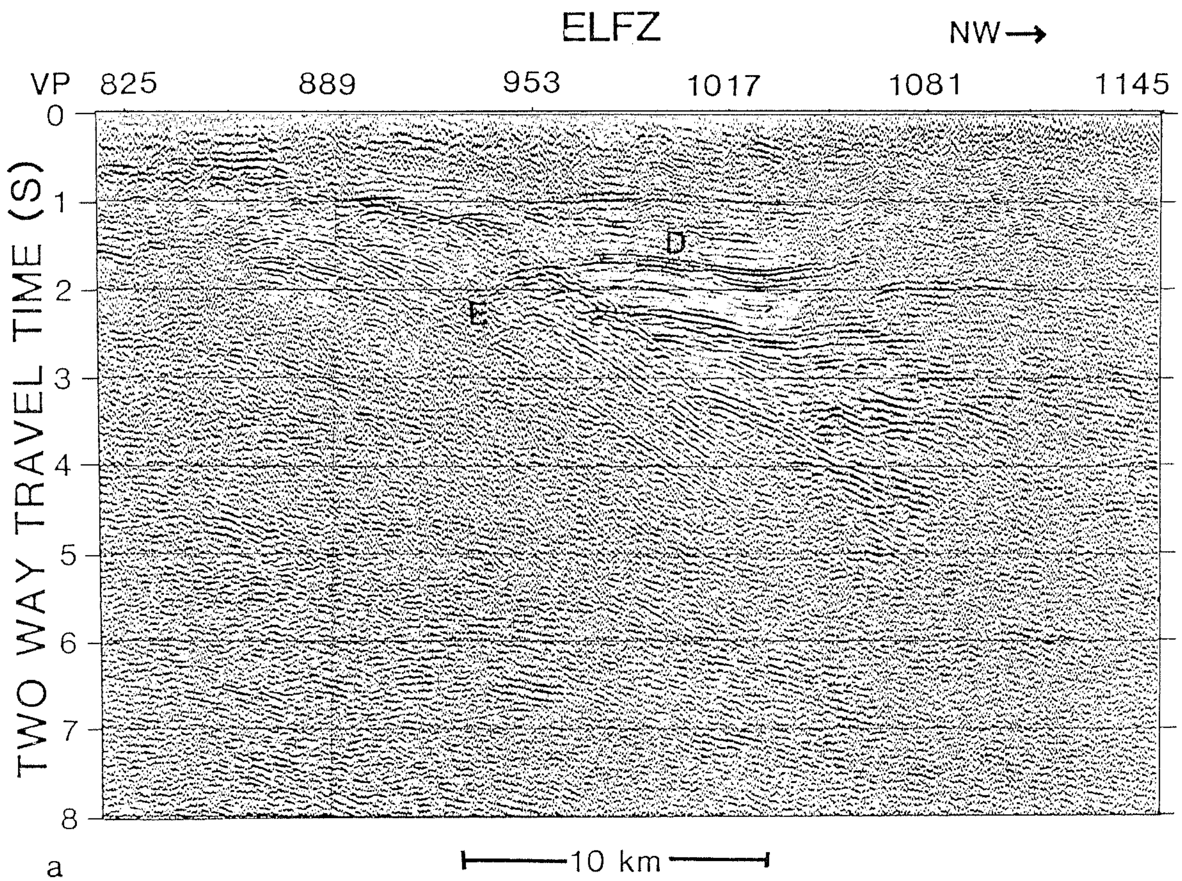



(a)
CAMPBELL UPLIFT
—NW→
ELFZ
251
D-54
P-60
G-04
1100
0
30
km (approx.)
50 km
Mesoz.
Paleoz.
M. Prot.
Prot.
Basement
Mantle
Interpreted
Assumed
Contacts
Faults

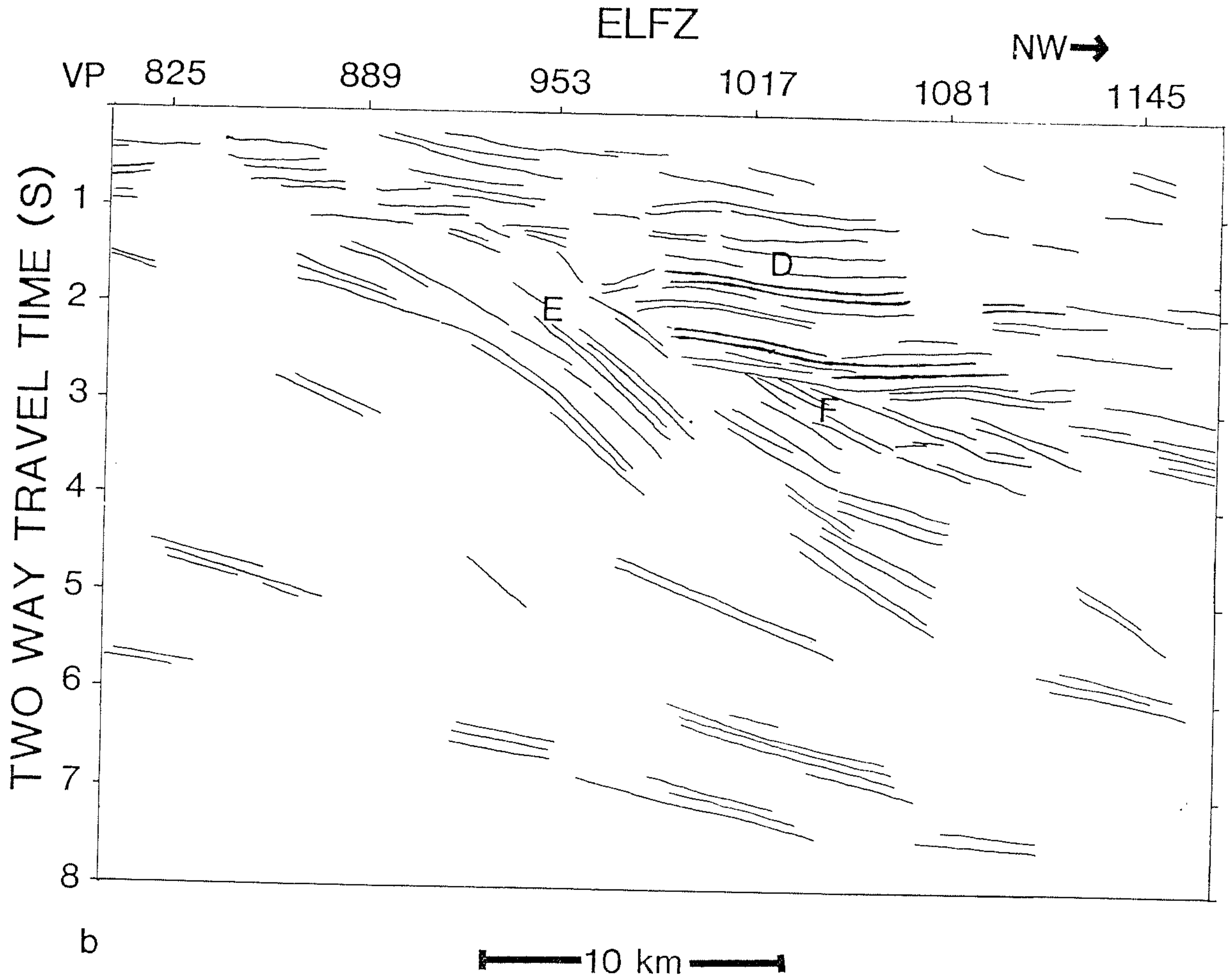
4a

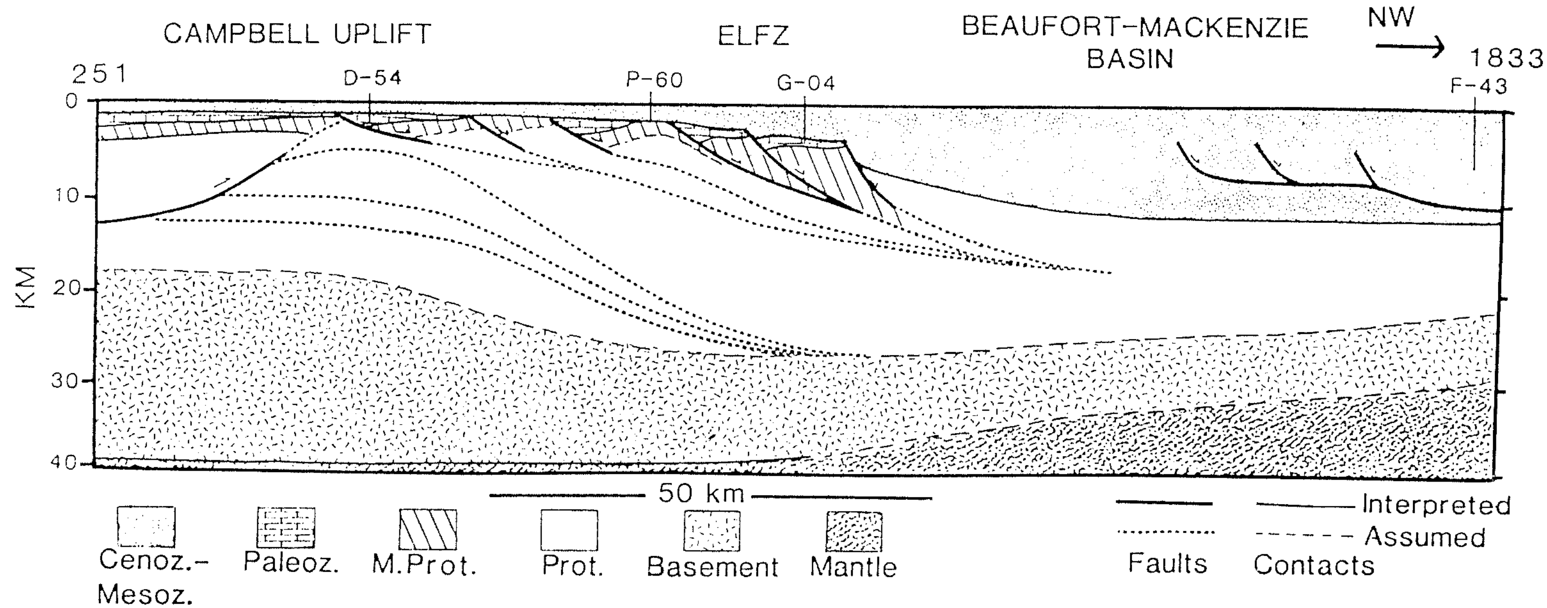

(b)
CAMPBELL UPLIFT
—NW→
251
D-54
P-60
ELFZ
G-04
1100
0
30
km (approx.)
50 km
Mesoz.
Paleoz.
M.Prot.
Prot.
Basement
Mantle
Contacts
Faults
Interpreted
Assumed

1/b


ELFZ
NW→
VP
825
889
953
1017
1081
1145
TWO WAY TRAVEL TIME (S)
0
1
2
3
4
5
6
7
8
D
E
10 km

a


ELFZ
NW
VP 825 889 953 1017 1081 1145
TWO WAY TRAVEL TIME (S)
1
2
3
4
5
6
7
8
D
E
F
b
10 km


CAMPBELL UPLIFT
ELFZ
BEAUFORT-MACKENZIE BASIN
NW
251
1833
D-54
P-60
G-04
F-43
KM
0
10
20
30
40
50 km
Cenoz.- Mesoz.
Paleoz.
M.Prot.
Prot.
Basement
Mantle
Faults
Contacts
Interpreted
Assumed

E