INTERPRETATION OF DEEP SEISMIC REFLECTION DATA, BEAUFORT SEA, ARCTIC, CANADA

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Note: Field tapes and demultiplexed shot record tapes (437 tapes in total), CDP gathers (223 tapes in total), and final stack data (9 tapes in total) for the 1987 deep seismic lines are stored at the Core and Sample Repository, Institute of Sedimentary and Petroleum Geology, 3303-33rd St. N.W., Calgary, Alberta. The data tapes are available (for loan) for tape copying at user expense.

INTRODUCTION

As part of the Geological Survey of Canada's Frontier Geoscience Program (FGP) in the Beaufort Sea - Mackenzie Delta region of northwestern Arctic Canada, 750 km of deep seismic reflection data have been acquired in two separate seismic programs. The seismic data were acquired to provide new information on the deep structure and tectonic evolution of the petroleum-resource rich Beaufort-Mackenzie Basin. The first data acquisition phase in 1986 included a 158 km land transect across the outer Mackenzie Delta from Inuvik to the Beaufort Sea coast. The interpretations of this data have been discussed by Cook et al. (1987a, b). A second phase of data acquisition in 1987 consisted of 550 km of marine reflection profiling. The marine seismic data were acquired along 4 regional profiles across different portions of the southern Beaufort Sea shelf and upper continental slope (lines 87-1, 2, 3 and 4; Fig. 1). This report describes the acquisition, processing and interpretations of the 4 marine lines.

ACQUISITION - PROCESSING

The marine seismic data were acquired and processed (under contract) by Geophysical Services Incorporated. The data were collected in August to October, 1987, by the seismic vessel M/V GSI Explorer. The seismic source was a tuned airgun array with a total volume of 99 litres (6100 cu. in.), towed at a 12 metre depth. Hydrophone receiver groups were spaced at 15 metre intervals along a 3600 metre, 240 channel streamer, towed at 12.5 metres depth. Twenty seconds of data were recorded at a 4 millisecond sample rate, with high and low cut recording filters of 64 Hz (at 72 db/octave) and 8 Hz (at 18 db/octave).

The data processing by GSI consisted of the following sequence: demultiplex (16 seconds of data), 2:1 trace mix, first break mute, true amplitude recovery, shot domain velocity filter, designature, receiver domain velocity filter, deconvolution, velocity analyses (every 3 km), statics correction, NMO and 30 fold CDP stack. Post-stack processing included time variant frequency filtering, amplitude scaling and a 5:1 running trace mix. The AGC scaling produced amplitude balanced sections. Two display scales of the final stack sections are included in this open file. The small-scale interpreted sections (Plates 1 to 3) display every 6th trace at 1.5 cm/sec. The larger scale sections (Appendix 1) display every 3rd trace at 2.5 cm/sec.

The stack sections produced by GSI were subjected to further post-stack processing at the Lithoprobe Seismic Processing Facility (LSPF) at the University of Calgary. The LSPF processing included migration (to 10 seconds) of all four lines and coherency filtering of line 87-1. The migrated and coherency filtered sections (not included in this report) were used to help in the interpretation of the stack sections, discussed below.

INTERPRETATION

Marine reflection line 87-1 crosses the eastern margin of the (Cretaceous-Tertiary) Beaufort-Mackenzie Basin, while lines 87-2, 3 and 4 are located near the basin's depocentre. The geological setting of the Beaufort-Mackenzie Basin and it's margins has been described in numerous papers, with good regional summaries presented by Young et al. (1976), Norris and Yorath (1981), and Dixon et al. (1985). The 1987 FGP seismic data were interpreted within the framework of the structural and stratigraphic information derived from these and other previous studies. In addition, the interpretation of the FGP lines was helped by the integration of (unpublished) 6.0 and 8.0 second industry seismic data. The industry seismic lines provided direct ties between the FGP lines and several petroleum exploration wells, thereby providing good stratigraphic control for the interpretation of the upper 3.0 to 4.0 seconds of each section. The industry seismic data base also provided the areal control for the regional mapping of upper crustal structure trends (Fig. 2). Reflection lines 87-2 and 4 are intersected by a regional seismic refraction profile acquired in 1987 (Stephenson et al., 1988). Velocity models of the refraction data provided constraints for the interpretation of the deeper portions of the reflection lines. Ongoing crustal modelling and analysis of regional gravity and aeromagnetic data also provided support to the reflection seismic interpretations. The potential field and refraction studies, while briefly referred to in this report, will be described in greater detail in future publications and open files.

LINE 87-1 (PLATE 1)

Line 1 is a 156 km long profile across the eastern Beaufort Sea shelf north of Tuktoyaktuk Peninsula. From southeast to northwest the line crosses three major geological elements: the Arctic Platform, the Platform margin (including the Eskimo Lakes Fault and the Outer Hinge Line) and the main depocentre of the northern Beaufort-Mackenzie Basin (Fig. 2).

The Arctic Platform consists of a 5 to 6 km thick sequence of mildly deformed Upper Devonian clastics (the Imperial Formation) and Lower Paleozoic carbonates. The seismic identification of the sequences corresponding to these units (Plate 1) has been confirmed by a tie to the Killanak A-77 well, located 11 km southwest of line 1. The Paleozoic rocks of the Arctic Platform are disrupted by normal and thrust faults. The faults are most clearly imaged by offsets of the strong reflection that is generated at the contact between the Paleozoic clastics and underlying carbonates. The thrust faults appear to terminate upwards into the Imperial clastic section and do not offset the overlying base-Albian unconformity. West of the Eskimo Lakes fault, a major thrust fault duplication of the entire Lower Paleozoic carbonate section has been interpreted on the basis of the apparent northwest side up offset of the top-carbonate reflection. Immediately east of the fault a thickening of the Imperial clastic section is apparent. Some of the lower reflections within this clastic wedge display southeast directed downlap, away from the (interpreted) thrust block. It is possible that the thrust block was emplaced during deposition of the Devonian Imperial Formation and acted as a local sediment source for the clastic wedge. The interpretation of Late Devonian compression in this area is consistent with similar observations of Devonian (Ellesmerian) deformation in the Tuktoyaktuk Peninsula area (Cook et al., 1987a, b; Wielens, 1988; Coflin et al., 1989). In both areas the compression appears to be predominantly east or southeast-directed.

The base of the Paleozoic succession on line 87-1 is interpreted to be at or near the strong, continuous reflection that dips northwest from reflection times of 2.5 to 3.5 seconds. The reflective strata unconformably underlying this sequence boundary are believed to be Proterozoic sediments and volcanics. The thrust faults and most of the normal faults that offset the Paleozoic rocks do not appear to extend into the underlying Proterozoic section. A major decollement surface may occur near the base of the Paleozoic section (perhaps within a thin ?Cambrian shale or evaporite unit). The low relief undulations in the upper Proterozoic reflections may be due to velocity pull-up anomalies associated with thickness variations in the overlying Paleozoic carbonates. The base of the Precambrian supracrustal succession is possibly imaged at the southeast end of line 1. Here, at reflection times of 6.0 to 6.5 seconds (approximately 16 to 17 km depth), a bundle of higher amplitude, discordant reflections may mark the top of crystalline basement. Deeper in the section, a discontinuous reflection zone at times of 11.0 to 11.5 seconds (35 to 37 km) is identified as a possible Moho level. The lower crust above this zone is locally reflective (eg. SP 800 to 1000, 9.5 to 10.5 sec). The crustal structure in the southeast part of line 87-1 is very similar to that observed on line 86-1, 300 km to the southwest. On line 86-1, near Inuvik, reflections at 6.0 seconds and 11.5 to 12.0 seconds were interpreted as "basement" and Moho levels respectively (Cook et al., 1987a, b). The 38 to 39 km depth to the Moho discontinuity on line 86-1 was confirmed by seismic refraction velocities (Stephenson et al., 1988).

Beneath the northwestern portion of the Arctic Platform along line 87-1, Proterozoic reflections diverge and dip more steeply basinward. This Proterozoic "ramp" is considered to be a fundamental Precambrian crustal structure that controlled the development of younger structures, including the Cretaceous Eskimo Lakes Fault Zone (Cook et al., 1987a, b). The ramp marks the position of a Precambrian continental margin of the North American craton.

The Arctic Platform is bounded to the west by the Platform margin, a 35 km wide zone that extends from the Eskimo Lakes Fault out to and slightly beyond the Outer Hinge Line (Fig. 2). Across the platform margin the top of the Arctic Platform succession increases in basinward dip and depth across several flexures and normal faults (dropping from 2.5 seconds to 7.0+ seconds in reflection time). The Eskimo Lakes Fault crossed by line 87-1 has relatively little normal fault displacement in comparison to the 2 to 3 km of throw on the fault in areas to the southwest (eg. near line 86-1). Most of the structural depression of the Arctic Platform beneath the northeastern Beaufort shelf is accommodated across one or two major flexures (and associated faults) basinward of the Eskimo Lakes Fault. Across the platform margin progressively older Paleozoic and Proterozoic strata appear to be truncated. The northwest subcrop edge of the Imperial Formation, for example, occurs near SP1975 on line 87-1. The entire Paleozoic-Proterozoic succession (which is up to 16 km thick along the Arctic Platform) is extremely thin or possibly completely truncated a short distance west of the Outer Hinge Line. The base of the Beaufort-Mackenzie basin-fill occurs at reflection times of 7.5 to 8.5 seconds (12 to 14 km) west of the Outer Hinge Line. The crust beneath the basin-fill in this area is distinctly different in seismic character than that beneath the Arctic Platform or it's margin. Discontinuous reflections with variable dips and numerous diffractions characterize this outermost crust. A number of extensional faults beyond the Outer Hinge Line disrupt the crust and appear to form a series of tilted half-grabens. These half-grabens appear similar to rift structures found within transitional crust along many passive continental margins. In this context, the crust west of the Outer Hinge Line is considered to be transitional or rift-stage crust, consisting of highly attenuated and deformed basement rocks. Gravity modelling (currently in progress) indicates that the crust thins rapidly northwest of the Outer Hinge Line, with the Moho rising from 35 km to 25 km or less, near the shelf edge. The "basement" beneath the 14 km thick basin-fill is (accordingly) 11 km or less in thickness northwest of SP 2500. On the seismic profile a dip reversal at the top-basement level occurs near the position (about SP 2500) where the crust has thinned substantially. Perhaps this dip reversal marks the position of a contact between basinward dipping oceanic crust to the northwest and faulted (and rotated) transitional crust to the southeast.

The Beaufort-Mackenzie basin-fill consists of a succession of Cretaceous-Tertiary clastic sediments up to 14 km thick (8.0 to 8.5 seconds) beneath the outer shelf and slope crossed by line 87-1. The lowermost portion of the basin-fill, above the faulted "transitional" crust, may consist of (?Early) Cretaceous shallow marine and non-marine synrift deposits. Overlying these sediments most of the basin-fill in the area of line 87-1 consists of mudstone-dominant, deep water slope and basinal deposits. Hummocky, discontinuous reflections at 1.3 to 2.7 seconds from SP 1300 to 1800 may be sandstone-prone submarine fan and/or channel deposits. Seismically imaged clinoforms, marking the transition from shallow marine shelf to slope deposition, are evident in the uppermost part of the section (generally above 1.0 to 1.5 seconds) Two major sequence boundaries are evident within the

Cretaceous-Tertiary basin fill. Above the Arctic Platform a submarine erosional unconformity occurs at the base of the Maastrichtian-Paleocene Fish River sequence. This unconformity truncates progressively older shales of the Smoking Hills and Albian (Arctic Red) formations in a northwesterly direction. Near the Eskimo Lakes Fault, Maastrichtian-Paleocene sediments directly overlie Paleozoic rocks. The basinward correlation of the base-Fish River unconformity is uncertain. An unconformity above the half-graben structures west of the Outer Hinge Line may be either the base-Fish River unconformity or a mid-Cretaceous unconformity. The second major sequence boundary within the Cretaceous-Tertiary section occurs at the base of the Plio-Pleistocene Iperk sequence. This unconformity is a major tectono-stratigraphic boundary recognized throughout most of the basin (eg. Dixon et al., 1985). The Tertiary basin-fill in the region of line 87-1 is relatively undeformed, in marked contrast to the intensely faulted and folded nature of portions of the basin-fill in areas to the southwest (Fig. 2). A number of small-offset normal faults are the only seismically visible structures within the Tertiary section along line 1. The normal faults that disrupt the Arctic Platform are clearly Cretaceous structures, as they are truncated in several places by the base-Fish River unconformity. The absence of large amplitude Tertiary structures along this part of the continental margin was a significant positive factor in the seismic imaging of deeper structures along line 87-1, including the basin-fill "basement" at the north end of the profile.

LINES 87-2 AND 3 (PLATE 2)

Lines 87-2 and 3 form a composite 170 km long transect across the central Beaufort Sea shelf and slope, out to the 1500 m isobath (Fig. 1). Line 2 is oriented SE-NW and ties to the southern end of the N-S oriented line 3. Both lines are located within the north-central Beaufort-Mackenzie Basin. Line 2 crosses a portion of the Tarsiut-Amauligak fault zone, an E-W trending zone of detached normal faults that disrupt Tertiary strata (Fig. 2). Both lines 2 and 3 are located within the Tertiary fold zone, an areally extensive arcuate array of shale-cored Early Tertiary anticlines. Line 2 is oriented approximately parallel to the Tertiary fold trends while line 3 is oriented perpendicular to the fold axes.

Line 87-2 imaged coherent reflections to times of 11.0 to 12.0 seconds (Plate 2). The Beaufort-Mackenzie basin-fill contains two major sequence boundaries, near reflection times of 1.0 and 4.0 seconds. Well data and industry seismic lines were used to identify these unconformities as Late Miocene and Middle Eocene in age. The Plio-Pleistocene Iperk sequence above the Late Miocene unconformity is a progradational succession of deltaic, slope and basin sediments. Seismically imaged clinoforms within the Iperk and underlying sequences mark the transition from outer shelf to slope deposits. The Upper Eocene to Miocene section contains at least 4 depositional sequences. These sequences are mudstone-dominant with the notable exception of the Oligocene Kugmallit deltaic deposits in the southeastern half of the section. The Kugmallit delta, imaged in the 2.0 to 3.5 second interval (SP 1800), contains thick delta-front sandstones interbedded with pro-delta mudstones. The Kugmallit sandstones are the main hydrocarbon reservoir in the offshore Beaufort-Mackenzie basin.

A Middle Eocene unconformity at depths of 6.0 to 6.5 km marks the base of the Upper Eocene-Miocene succession. This unconformity is the deepest stratigraphic horizon reliably identified from existing well ties. The reflective strata below this sequence boundary are probably shale-dominant shelf and basinal deposits of ?Cretaceous, Paleocene and Early Eocene age. It is uncertain what component of Cretaceous sedimentary strata occurs in the deeper portions of the western Beaufort-Mackenzie basin.

The normal faults of the Tarsiut-Amauligak Fault Zone displace Eocene to Miocene strata with both north- and south-side down offsets. The faults were intermittently active from Oligocene to Early Pliocene time. Most of the faults within the zone are listric and on line 87-2 they appear to sole out in mid-Tertiary shales, near the Middle Eocene unconformity. Significant hanging wall thickening and rotation of Oligocene-Miocene strata occurs along many of the fault strands east of line 87-2. The fault block rotations produced the structural traps for most of the hydrocarbon accumulations in the Amauligak area (Fig. 2). At the west end of the fault zone (near Tarsiut) the structural traps are more complex in geometry due to the oblique superposition of the fault zone on older Tertiary folds.

The basement to the (?)Cretaceous-Tertiary basin fill is interpreted to be an undulating horizon at reflection times of 6.0 to 8.0 seconds that locally separates more reflective strata above from less reflective strata below. At the southeast end of line 87-2 a reflection zone at 7.0 to 7.5 seconds is similar in appearance to reflections near 6.0 seconds at the northwest end of line 86-1 (Fig. 2). Although these profiles are 50 km apart the correlation of the two deep reflection zones seems reasonable. On line 86-1 the deep reflections correspond in depth (approx. 12 km) to a seismic refraction velocity boundary where average interval velocities increase from 4.6 to 5.8 km/s. A comparable refraction velocity boundary occurs near the interpreted 7.0 second "basement" level at SP 750 on line 87-2, with average interval velocities increasing from 4.6 to 6.0 km/s. Along line 87-2 the top of the basement horizon corresponds to depths of 12 to 16 km.

At the east end of the profile the sediment-basement interface and overlying Lower Tertiary (and ?Cretaceous) sediments are deformed into a broad, asymmetric syncline with hinge to trough axis relief of at least 1.0 second (2.0 to 2.5 km). This major structural depression appears to be unconformably overlain by the Middle Eocene sequence boundary and overlying strata.

The lower crust or basement beneath the basin-fill along line 87-2 has variable seismic reflection character. The crust is non-reflective beneath the southeast half of the line, in contrast to the reflective character of the crust to the northwest. The change in crustal seismic character occurs at about SP 1100. This location is coincident with the appearance of a northwest (basinward) dipping reflection at times of 9.0 to 10.0 seconds. Although it is recognised that there are possible imaging problems along line 2 with signal attenuation and offline reflections, the observed seismic images are, for the most part, considered to be basement features. One possible geological interpretation is that the inclined reflection is a basinward dipping fault separating two crustal blocks of different structural or lithological character.

The crust-mantle boundary is not clearly imaged along line 87-2. Based on seismic refraction velocities from a position near SP 750 on line 87-2, the Moho is estimated to occur at a depth of 25 km (about 11.5 seconds on line 2).

The N-S oriented line 87-3 crosses a portion of the Lower Tertiary fold zone beneath the present day continental slope (Fig. 2). The E-W trending anticlines are clearly imaged in the interval from 3.0 to 5.0 seconds (Plate 2). With the exception of one anticline, cut on it's basinward side by a high angle fault, these structures appear to be nearly symmetrical. Deformation and syndepositional thinning of Eocene to Miocene strata is evident across the fold zone. The folds are probably cored by (?overpressured) Lower Tertiary mudstones. The Tertiary folds are unconformably overlain by relatively undeformed Pliocene and Quaternary sediments. Seismic reflection flat spots (at times of 3.0 to 3.5 seconds) above two of the anticlines indicate that gas may be trapped in sediments draped over the structure crests. At the extreme north end of the section, reflections in Lower Tertiary strata are imaged to times of 6.5 seconds (7 km below sea bottom).

Few coherent (primary) reflections are imaged on line 87-3 below the Tertiary anticlines. North dipping water bottom and shallow sedimentary-generated multiples dominate the seismic record below about 5.0 seconds. Two deep-reflection zones have been identified on the section as possible primary events. The first occurs locally beneath the southern half of the section at reflection times of 6.0 to 7.0 seconds. This south dipping reflection zone appears detached from overlying Tertiary structures and may be an image of a near-basement decollement zone. The Tertiary sedimentary section is 8 to 9 km thick above this detachment. A second (deeper) reflection event may be present at times of 9.5 to 10.5 seconds beneath the northern part of the profile. This zone also dips to the south and depth estimates of 18 to 21 km suggest that the reflection(s) may be at or near the crust-mantle boundary.

Despite the recognition of two possible deep reflection events on line 87-3 it is clear that the seismic imaging of deep structures (reflections) below the highly deformed Tertiary sediments has not been particularly successful. A similar deep imaging problem is also evident on line 87-4 which crosses the Tertiary structures at intermediate angles (Fig. 2).

LINE 87-4 (PLATE 3)

Line 4 is a 200 km long, E-W oriented profile across the western Beaufort shelf and northern part of the Mackenzie Trough (Fig. 1). The trough is a bathymetric depression underlain by Quaternary glacial sediments.

Line 87-4 crosses the central portion of the arcuate Tertiary fold belt and extends as far west as the Herschel High (Fig. 2). The Herschel High is a structurally elevated component of the fold belt that has been modified by mid-Tertiary subsidence along it's southern flank. Similar to line 87-2, two prominent Tertiary sequence boundaries are evident along line 4 (Plate 3). The Late Miocene unconformity is a near-planar east-dipping reflection at times of 1.0 second and above. Plio-Pleistocene sediments above the unconformity are locally eroded beneath a late Pleistocene unconformity that forms the base of the Mackenzie Trough fill. The Upper Eocene to Miocene section along line 4 consists of gently folded mudstone-dominant shelf deposits. At the east end of the profile small-offset normal faults disrupt this section. The Middle Eocene unconformity separates the Upper Eocene-Miocene section from more intensely deformed underlying strata of ?Cretaceous, Paleocene and Early Eocene age. This sequence boundary occurs at reflection times (increasing eastward) from 1.0 to 4.0 seconds (1 to 6 km depth). The complex reflection patterns and locally steep reflection dips below the Eocene unconformity are generated by folds and thrust faults within the lower Tertiary section. The folds and faults intersect line 4 at angles varying from 30° to 70°, with some resulting distortion to true structural geometry. Nonetheless, the folds are imaged as asymmetric anticlines, locally cored by northeast verging thrust and reverse faults. Reflections within the Herschel High are interpreted to be images of north to northwest verging thrust structures. A hanging wall anticline and possible footwall cutoffs are evident at SP's 3050 to 3200. The southwest flanks of several of the anticlines crossed by line 4 (eg. at SP 1750 and 2000) are onlapped by wedges of reflections. Strata within these wedges may be syntectonic (?Early) Eocene sediments deposited during the main phase of folding. The thrust faults do not appear to extend up into overlying Upper Eocene-Oligocene strata. The low-relief folding of the Middle Eocene unconformity and overlying strata along line 4 may be due to diapiric reactivation of individual structures and/or continued postmid Eocene tectonic shortening. Well penetrations (eg. Tarsiut) indicate that Eocene and older mudstones are (at least locally) overpressured.

At the west end of line 4, near reflection times of 6.0 to 7.0 seconds, a zone of discontinuous sub-horizontal reflections is imaged beneath the Herschel High. These reflections are believed to be generated by a detachment zone at the base of the Early Tertiary folds and faults. In other areas along line 4, discontinuous reflections below times of 7.0 to 8.0 seconds also locally appear discordant to overlying Tertiary reflections. Similar seismic indications of deep (sub-Tertiary) detachment zones were noted in studies of other areas in the western and northern Beaufort Mackenzie Basin (Dixon et al., 1984; Dietrich et al., 1989). At the east end of line 87-4 an undulating reflection zone occurs at reflection times 7.5 to 8.0 seconds. These reflections tie to the interpreted "basement" reflections on line 87-2. On line 2 this reflection zone was identified as the boundary between sedimentary strata of the Beaufort-Mackenzie Basin and underlying transitional crust.

Few coherent reflections are imaged within the crust below the 12 to 15 km thick sedimentary section along line 87-4. Based on seismic refraction velocities (near SP650 of line 4) the Moho is estimated to occur at depths of 25 to 26 km. There is no obvious reflection on line 4 at this level (about 11.5 seconds).

SUMMARY

The Beaufort-Mackenzie Basin beneath the southern Beaufort Sea contains ?Cretaceous-Tertiary sedimentary strata up to 16 km thick. The basin-fill can be divided into three layers. The uppermost layer consists of relatively undeformed Pliocene to Recent sediments (up to 4 km thick) above a regional Late Miocene unconformity. Upper Eocene to Miocene strata (up to 5 km thick) comprise the second layer. The middle Tertiary strata are locally disrupted by basement-detached, listric normal faults. Below a major Middle Eocene unconformity a third layer of ?Cretaceous to Eocene sediments (up to 10 km thick) have been affected by regionally significant crustal shortening related to Early Tertiary (Laramide) deformation of the eastern Brooks Range. The shortening has produced an arcuate fold and thrust belt underlying much of the western Beaufort Sea. Folding of middle Tertiary strata above some of the Lower Tertiary-cored anticlines may be due to post-Laramide compression and/or diapiric reactivation of pre-existing fold structures. Seismically, the basin-fill is characterised by semi-continuous reflections of variable amplitude. The folded and thrust faulted portions of the basin-fill (eg. line 87-4) display complex reflection patterns. Major detachment horizons within the basin-fill are imaged on both the FGP seismic profiles and industry data. In the offshore portion of the basin a major detachment zone occurs in (?Cretaceous) strata near the base of the basin-fill.

The basement to the offshore basin-fill consists of Paleozoic-Proterozoic sedimentary strata east of the Arctic Platform Hinge Line and transitional and Cretaceous oceanic crust west of the hinge line. The transitional and oceanic basement is best imaged on lines 87-1 and 2. On line 1 the basement is characterised by low amplitude, discontinuous reflections below a variably dipping reflection interpreted as the sediment-basement contact. Diffractions occur at and below the basement top, a characteristic seismic feature of faulted or irregular surfaces. On line 2 the basement is non-reflective at the southeast end of the profile but contains low to moderate amplitude semi-continuous reflections along the northwest half of the profile. Top of basement on line 2 is interpreted as a pseudoconformable contact between more reflective ?Cretaceous-Tertiary strata above and less reflective strata below. At the intersection of line 2 and a crustal refraction profile, the reflection-interpreted basement horizon coincides with a refraction-modelled velocity boundary (average interval velocities increasing from 4.5 to 6.0+ km/s). On line 2 a basement trough (25 km wide) is imaged at the southeast end of the profile. The same basement structure is partly resolved at the east end of line 4. The basement trough appears to be oriented in a north to northeast direction and is coincident with a northeast trending magnetic low.

Gravity modelling indicates that the basement at the northwest end of line 87-1 is about 10 km thick, typical of oceanic crust. Seismically, the basement here is characterised by weak reflections, numerous diffractions and an irregular upper surface. In contrast, the basement beneath line 2 is 12 to 14 km thick, based on refraction estimates of Moho depth. The reflection character of the basement along the northwest half of line 2 is also different than line 1 (more reflective, pseudoconformable sediment-basement contact). Based on the thickness estimates, reflection character, and gravity and refraction modelling the basement beneath line 2 is interpreted to be transitional crust, thinning gradually from southeast to northwest. The possibility that oceanic crust occurs at the northwest end of line 2 cannot be ruled out, but if oceanic, it is atypical of oceanic crust described from other regions.

The interpreted differences in the nature and thickness of the basement on lines 87-1 and 2 (and line 86-1, onshore) reflect the dramatic difference in the structure of the continent-ocean transition between the northeastern and southwestern parts of the Beaufort-Mackenzie basin. The crustal transition along the northeastern margin (line 87-1) is abrupt, with transitional crust occurring in a narrow, 25 to 30 km wide rift zone. In contrast, the crustal transition beneath the southwestern part of the basin (the area of lines 87-2 and 86-1) is much wider and more structurally complex. The increased width and complexity of the transitional crust beneath the western Beaufort Sea and outer Mackenzie Delta occurs where the northeast-trending eastern Beaufort margin merges with the northwest trending north Alaska margin. The structure and tectonic evolution of this complex plate margin junction is the subject of ongoing studies.

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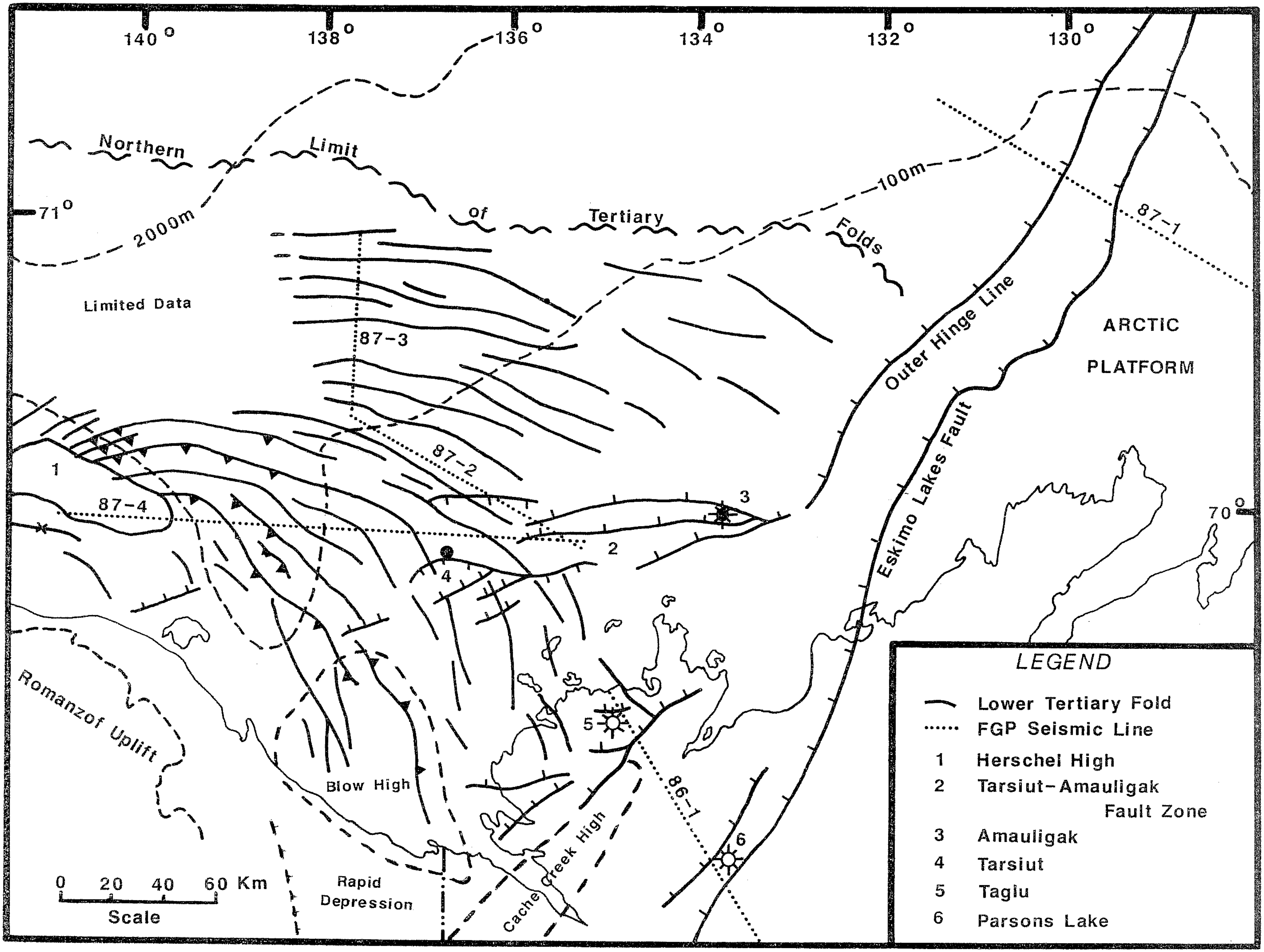
140°
138°
136°
134°
132°
130°
71°
70°
Northern Limit of Tertiary Folds
2000m
100m
Limited Data
87-1
87-2
87-3
87-4
86-1
Outer Hinge Line
Eskimo Lakes Fault
ARCTIC PLATFORM
Romanzof Uplift
Blow High
Rapid Depression
Cache Creek High
0 20 40 60 Km
Scale
LEGEND
Lower Tertiary Fold
FGP Seismic Line
1 Herschel High
2 Tarsiut-Amauligak Fault Zone
3 Amauligak
4 Tarsiut
5 Taglu
6 Parsons Lake

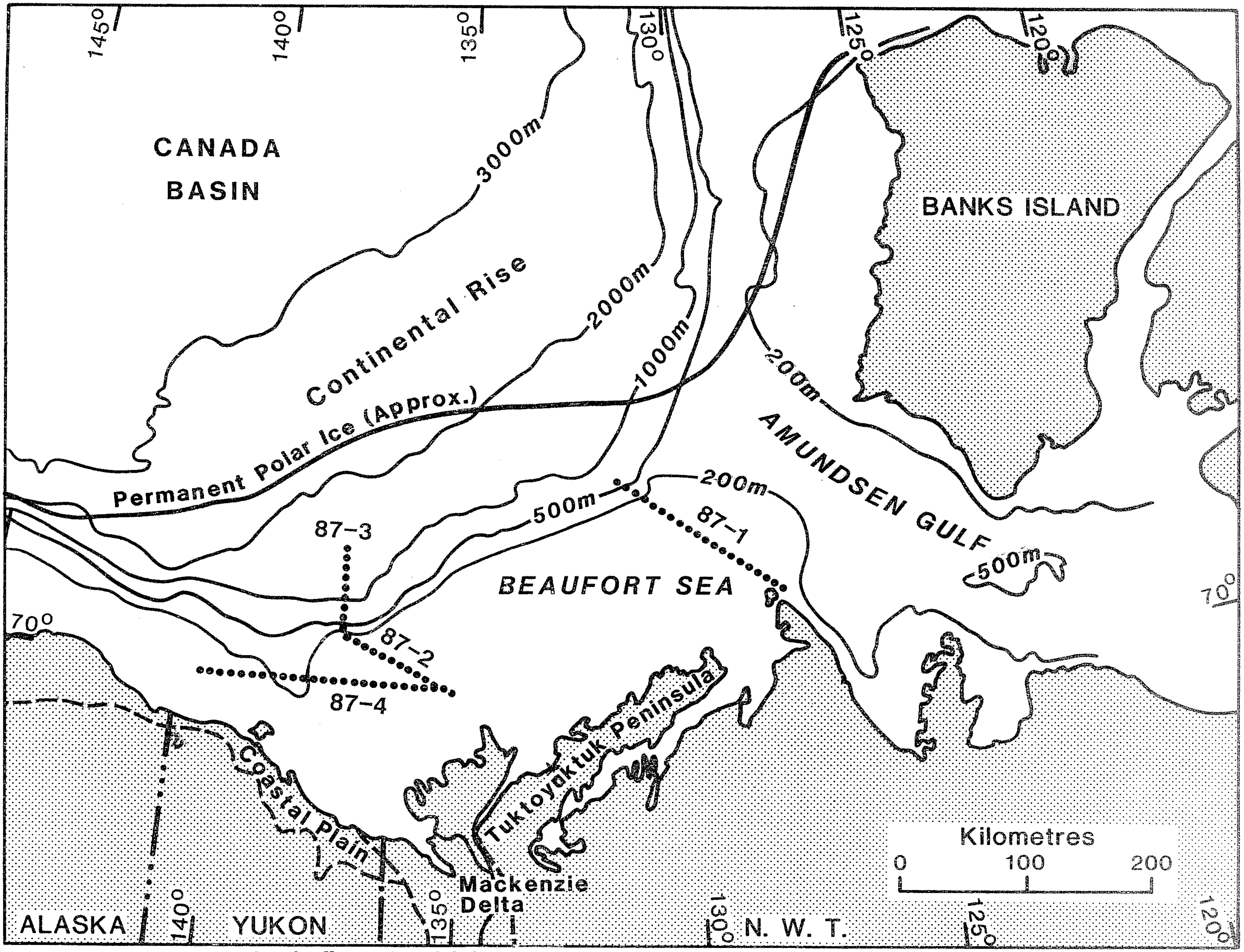

Figure 1. FGP seismic lines 87-1,2,3,4

GSC