OCEAN DRILLING PROGRAM

LEG 188 SCIENTIFIC PROSPECTUS

PRYDZ BAY-COOPERATION SEA, ANTARCTICA:

GLACIAL HISTORY AND PALEOCEANOGRAPHY

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This Scientific Prospectus is based on precruise JOIDES panel discussions and scientific input from the designated Co-chief Scientists on behalf of the drilling proponents. The operational plans within reflect JOIDES Planning Committee and thematic panel priorities. During the course of the cruise, actual site operations may indicate to the Co-Chief Scientists and the Operations Manager that it would be scientifically or operationally advantageous to amend the plan detailed in this prospectus. It should be understood that any proposed changes to the plan presented here are contingent upon approval of the Director of the Ocean Drilling Program in consultation with the Science and Operations Committees (successors to the Planning Committee) and the Pollution Prevention and Safety Panel.

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ABSTRACT

The main objectives of our proposed drilling campaign in the Prydz Bay region are to

1. Date the earliest evidence of glacial activity in Prydz Bay and obtain evidence on the Paleogene environment of Antarctica.
2. Link events in the East Antarctic Ice Sheet with changes in the Southern Ocean by drilling Oligocene and younger sediments beneath the continental rise that are distal counterparts of sediments beneath the Prydz Bay continental shelf and slope.
3. Recover a record of late Miocene and younger ice advances and interglacial periods from the Antarctic continental slope by coring sequences in the trough mouth fan built by advances of the Lambert Glacier-Amery Ice Shelf.

Three primary drilling sites and alternatives have been identified to achieve these objectives. The drilling strategy consists of the following:

1. Drill one primary site (Site PBS-2A) on the Prydz Bay continental shelf to core the stratigraphic interval between the deepest Paleogene glacial sediments recovered at Ocean Drilling Program (ODP) Site 742 and the shallowest Cretaceous coal-bearing sediments acquired at ODP Site 741 to date the onset of glaciation in Prydz Bay and assess late Mesozoic and early Cenozoic preglacial environments.
2. Drill one primary site (Site PDB-12B) on the continental rise to sample a section of drift deposits and underlying units that extend back to the earliest time (early Oligocene) when ice reached the continental shelf edge and caused a major change in sedimentation on the rise. Glacial events recorded here will be compared with those seen in slope and shelf drill sites, including those drilled during Leg 119.
3. Drill one primary site (Site PBF-6A) on the continental slope to recover a section through the Prydz Channel Fan that was built by sediment carried in the base of the Lambert Glacier when it advanced to the shelf. Cores from this site should record the number of times the East Antarctic Ice Sheet has expanded to the shelf edge since late Miocene time.

Alternative drilling strategies have been developed to fulfill the Leg 188 objectives in case ice conditions prevent access to preferred drilling areas. If time permits, the leg will acquire a high-resolution Holocene environmental record by coring a section of biosiliceous Holocene sediments on the Mac Robertson Shelf west of Prydz Bay. This section should have a resolution comparable to ice cores and similar sediments cored in Palmer Deep during Leg 178.

INTRODUCTION

The Antarctic Ice Sheet is a key component of the world's climatic system and has a major influence on global sea levels. To test models of its behavior, it is necessary to examine its fluctuations during episodes of climate change (Fig. 1). A precise date for the onset of Antarctic glaciation has yet to be determined, and there is little known of the preglacial biota (Abreu and Anderson, 1998). There is only a small amount of data pertaining to whether the current ice sheet will grow or diminish with global warming, and there is controversy over the stability of the East Antarctic Ice Sheet, particularly during the Pliocene (Webb et al., 1984; Sugden et al., 1993) and Pleistocene (Schere, 1998). Knowledge of its fluctuations during the Pleistocene is confined to areas such as the Ross Sea and Transantarctic Mountains. Establishing a detailed history of ice-sheet growth and decay will depend on drilling the sedimentary record of the Antarctic continental margin and an understanding of how the ice sheet behaves in response to changes in the adjoining ocean. Estimates of the volume of glacially eroded sediments delivered to the continental margin during different phases of the continent's history is a significant factor in modeling ice sheet behavior through time.

To address these problems, the Scientific Committee for Antarctic Research supports the ANTOSTRAT committee, which has fostered the development of a series of Antarctic drilling proposals. Each proposal has been designed to address different aspects of Antarctic glacial history. Leg 178 scientists examined the glaciation history of the Antarctic Peninsula, which is covered by small ice masses that developed during the Neogene and respond rapidly to climate changes. Leg 188 is designed mainly to address the history of the East Antarctic Ice Sheet, which is long lived and responds relatively slowly to major climate events. In particular, Leg 188 results, in conjunction with the results of Leg 119, can provide insights into the state of the interior of East Antarctica (Fig. 2).

BACKGROUND

Prydz Bay and its adjacent continental rise is a key area for understanding the history of Antarctic glaciation. It is the downstream end of the Amery Ice Shelf-Lambert Glacier ice drainage system, which drains about 22% of the East Antarctic ice sheet. The Lambert Glacier responds to fluctuations of the interior of the East Antarctic ice sheet that are then reflected in the sediments of Prydz Bay (Figs. 3, 4). Included in the drainage basin are the Gamburtsev Subglacial Highlands, which may have been the nucleus of the earliest Antarctic glaciation. The underlying structure of the Lambert Graben has focused drainage into Prydz Bay at least since the Mesozoic. Early glaciers would have delivered sediment into the bay and later ice expansion would have caused the glaciers to flow into the bay, making it an excellent place to detect the earliest Cenozoic glacial sediments on the Antarctic shelf.

During some, but not all, Cenozoic glacial episodes, the Lambert Glacier advanced to various points on the shelf, prograding the shelf and building a large trough mouth fan that records these major advances since the late Miocene-middle Pliocene (Figs. 1B, 4). Interglacial sediments are probably preserved on the slope foresets; thus, the Prydz Channel Fan contains a measure of the major sediment pulses caused by peaks in Antarctic ice volume over the last 4-5 m.y.

The continental rise adjacent to Prydz Bay exhibits large sediment drifts deposited under the influence of turbidity currents from the continental shelf and deep currents in the Southern Ocean (Fig. 4). These drifts are a fine-grained distal equivalent to shelf and upper slope sediments and record fluctuations in the ratio of continent-derived terrigenous sediments to oceanic material and record the fluctuations of oceanic current activity (Fig. 5). The amount of terrigenous material rises strongly with major ice expansions so that interbedding of terrigenous-rich and biogenic-rich horizons tend to reflect glacial-interglacial cycles. The longevity of these drifts and the presence of seismic horizons that can be projected back to the continental slope and shelf mean that these drifts can provide a link between continental glaciation and changes in the ocean back through time to the Paleogene.

Regional Setting

Prydz Bay is a re-entrant in the East Antarctic coastline between 68°E and 78°E (Figs. 2, 4). The bay shape and glacier flow patterns reflect the underlying geological structures, the Lambert Graben and Prydz Bay Basin (Fedorov et al., 1982; Stagg, 1985). The Lambert Graben extends about 600 km inland, is as much as 200 km wide, and contains more than 5 km of sediment, based on magnetic and seismic refraction data (Fedorov et al., 1982). The Lambert Graben-Prydz Bay Basin fill consists of two lower sequences of parallel bedded units that onlap or are faulted against basement beneath the northwestern and southeastern sides of the bay (Fig. 6). These sequences were penetrated at Ocean Drilling Program (ODP) Sites 740 and 741 drilled during Leg 119 and consist of Cretaceous coal-bearing nonmarine sediments overlying nonmarine redbeds (Turner and Padley, 1991; Turner, 1991). Cenozoic sequences overlying the Cretaceous have foreset and topset beds that prograde the continental shelf (Cooper et al., 1991a, 1991b).

West of Prydz Bay, the Mac Robertson Shelf is a passive margin that probably formed during the Mesozoic. It is narrow compared to the Prydz Bay shelf and is rugged, having experienced erosion by glaciers during glacial episodes and by iceberg scouring and geostrophic currents during interglacials (Harris and O’Brien, 1996).

Sedimentary Environments

The Prydz Bay continental slope and rise are underlain by thick (more than 6000 m) post lower Cretaceous sediments. Some of the sediment drifts in Prydz Bay are elongated ridges aligned along the margins of deep channels, others have no clear correlation with channels, but all of them are elongate approximately orthogonal to the continental margin (Fig. 4). The features and seismic patterns of sediment drifts suggest that they have been basically deposited as a result of the interaction of downslope mass flow and strong bottom (contour) currents (Fig. 5). The drifts are composed of a mixture of sediment derived from the continent and biogenic material. Drilling of drifts beneath the continental rise during ODP Leg 178 showed that they preserve alternating clastic-rich and biogenic-rich intervals that reflect alternations of glacial and interglacial conditions. Such records can be compared to the proximal records of the continental shelf and upper slope to understand the relationship between oceanographic conditions and the advance and retreat of the ice sheet.

The most conspicuous sediment drifts are developed in the western part of Cooperation Sea between Wilkins and Wild Canyons and are referred to as the Wilkins and Wild Drifts (Figs. 4, 7). Kuvaas and Leitchenkov (1992) recognized two major seismic unconformities (P1 and P2). Additional data and reinterpretation have allowed the mapping of a third surface younger than P1 and P2 and a better understanding of the likely age and paleoceanographic significance of the surfaces (Fig. 8). Surface P1 within these sediments marks the transition from a lower homogenous part of the section with mostly irregular reflectors to an upper heterogenous one in which a variety of well-stratified seismic facies are present. New more distal data suggests that P1 may be as old as

Cretaceous. Surface P2 marks a change to submarine canyons and related channel and levee deposits and chaotic seismic facies. This transition appears to reflect a dramatic change in the continental margin depositional environment that resulted from the onset of continental glaciation in the Eocene or the arrival of grounded ice sheets at the shelf edge in the early Oligocene, as indicated by ODP Sites 739 and 742 (Barron et al., 1991). This sedimentation change produced thick, prograding foresets above the P2 unconformity beneath the Prydz Bay outer shelf (Kuvaas and Leitchenkov, 1992).

Surface P3, above P2, represents the base of deposits containing abundant, well-stratified sediment drift facies, including sediment waves. Such features imply that strong, presumably westerly flowing, bottom currents played a significant role in drift formation. The changes at this level could have been related to initiation of the Antarctic Circumpolar Current after the opening of Drake Passage around the Oligocene/Miocene boundary or may relate to the a major ice expansion during the Oligocene or Miocene.

A major change in Prydz Bay shelf progradation took place in the late Miocene to middle Pliocene when a fast-flowing ice stream developed and excavated a channel across the shelf on the western side of Prydz Bay, where a surface can be mapped from the shelf to the continental rise (Surface PP15, Fig. 9; Surface A of Mizukoshi et al., 1988). Basal debris carried to the shelf edge deposited in a trough mouth fan on the upper slope (Fig. 10; Boulton, 1990; Larter and Cunningham, 1993). This change may reflect the earliest growth of thick ice on the Antarctic coast deflecting the Lambert Glacier when it advanced (O'Brien and Harris, 1996). This trough mouth fan must contain a reasonably complete record of glacial history because it received siliciclastic sediment when the shelf eroded during major ice advances and hemipelagic material during interglacials and smaller glaciations. Preliminary optical stimulate luminsecence (OSL) dating of sediments from the surface of the fan and ¹⁴C Atomic Mass Spectrometer (AMS) dating of last glacial maximum grounding zone deposits on the shelf (Domack et al., 1998) suggest that the Lambert Glacier last grounded at the shelf edge at 80-120 ka, indicating that not every glacial episode produces a major expansion of the East Antarctic Ice Sheet. This raises questions as to which glacial episodes produced a major advance and what conditions were necessary to produce a major advance.

The Antarctic continental shelf displays many glacially excavated valleys that reach depths of several hundred to more than 2000 m. Some of these valleys have acted as sediment traps in areas of high biological productivity and have accumulated Holocene sedimentary sections with resolution approaching that of ice cores. These sedimentary sections typically consist of biosiliceous oozes with a minor terrigenous component. These oozes record changes in phytoplankton that reflect sea-surface conditions such as temperature and sea-ice cover (Domack and McClennen, 1996). The first of these sections to be cored by ODP in the Palmer Deep off the Antarctic Peninsula provide a high-latitude record comparable to other important ODP Holocene cores such as the Santa Barbara Basin (Kennett, Baldauf, et al., 1994).

The Iceberg Alley shelf valley is a U-shaped glacial valley crossing the Mac Robertson Shelf at 63°E offshore from Mawson Station (Fig. 11). It is as deep as 500 m, and part of the valley on the outer shelf is floored by about 50 m of unconsolidated sediments (Fig. 12). Gravity cores from this area recovered siliceous mud and ooze, some of which show decadal-scale fluctuations in diatom floras (Taylor, 1999).

SCIENTIFIC OBJECTIVES

The main objectives of our proposed drilling campaign in the Prydz Bay region are to

1. Date the earliest evidence of glacial activity in Prydz Bay and obtain evidence of the Paleogene environment of Antarctica.
2. Link events in the East Antarctic Ice Sheet with changes in the Southern Ocean by drilling Oligocene and younger sediments beneath the continental rise that are distal counterparts of sediments beneath the Prydz Bay continental shelf and slope.
3. Acquire a record of late Miocene and younger ice advances to the shelf edge and interglacial deposits from the Antarctic continental slope by penetrating sequences in the trough mouth fan built by advances of the Lambert Glacier-Amery Ice Shelf.

PROPOSED SITES

The primary sites for Leg 188 are (Table 1; Figs. 13, 14)

- A 600-m-deep hole (Site PBS-2A) on the shelf within Prydz Bay aimed at coring the earliest glacial and latest preglacial sediments identified by seismic mapping using the results of Leg 119.
- A 1020-m-deep hole (Site PBD-12B) on the continental rise that will provide a record of drift formation comparable to shelf and slope records obtained during this leg and Leg 119.
- A 620-m-deep hole (Site PBF-6A) to provide a record of sedimentation in the Prydz Channel Fan.

Site PBS-2A

The Mesozoic and Paleogene sediments beneath outer Prydz Bay form a series of seaward dipping sequences (Figs. 6, 14). Cooper et al. (1991a) recognized sequence PS.2A as Cenozoic glacial sediments and the underlying Sequence PS.2B as preglacial, mostly nonmarine Mesozoic sediment. Site 742 reached middle Eocene-lower Oligocene glacial sediments in Sequence PS.2A without reaching the base of the sequence or nonglacial facies (Hambrey et al., 1991). Hambrey et al. (1991) suggest that the base of the glacial interval was close because they interpreted preglacial alluvial sediment mixed into the lowermost unit in the hole by subglacial deformation.

Proposed Site PBS-2A was chosen to recover core from the Cenozoic sediments below the horizon reached in Site 742 into the top of Sequence PS.2B, the uppermost Mesozoic sediments identified at Site 741. This site should provide an age for the arrival of glaciers in Prydz Bay, a record of changes in depositional environments with the onset of glaciation, and an indication of changes in biota. Site PBS-2A is the primary site because of its thin Quaternary diamict section and a slightly thicker Paleogene section than at Site 742 and should be a more complete record. Site PBS-2A is expected to encounter a thin Quaternary section of diamict and mud overlying an interval of upper Eocene-lower Oligocene stratified diamictite with sandstone and mudstone interbeds similar to sediments in Site 742 below 173 mbsf. Below the interval equivalent to the lower part of Site 742, the lithologies are unknown, but the presence of reworked dinoflagelates and pebbles of ferruginous marine marl, both of Eocene age, at ODP Sites 739 and 742 (Jenkins and Alibert, 1991; Truswell, 1991) suggests a section containing shallow marine sediments. This site should reach Cretaceous nonmarine sediments.

Site PBD-12B

Drilling beneath the Antarctic Peninsula continental rise during Leg 178 showed that the drifts are likely to provide fine-grained equivalents to continental slope and rise sediments. They should also have microfossils for age estimates and interpretation of paleoceanography. Site PBD-12B was selected to acquire a reasonably complete section of the drift record that includes Oligocene and younger sediments. The site is located on the western flank of the Wild Drift (Fig. 14) where Surface P3, which is thought to represent the arrival of grounded ice at the shelf edge during the late Oligocene to early Miocene?, can be reached at about 1000 mbsf. It will also intersect Surface PP.15 that marks the major late Miocene?-late Pliocene? change in glaciation on the shelf and the base of the Prydz Channel Fan. The sediments expected at Site PBD-12B are fine grained hemipelagic clays and distal turbidites with a higher biogenic component in intervals deposited in interglacial periods compared to glacial intervals. Ice-rafted detritus should also be present.

Site PBF-6A

The slope site is aimed at the clinoforms of the Prydz Channel Trough Mouth Fan (Fig. 14). Construction of the fan started in the late Miocene to middle Pliocene when the Lambert Glacier formed a fast-flowing ice stream on the western side of Prydz Bay. The fan grew most during episodes when the Lambert Glacier grounded at the shelf edge, delivering basal debris to the fan apex. This material was then redistributed by sediment gravity flows and meltwater plumes. Between such ice advances, the fan surface has received hemipelagic sediment. Thus, the alternation of facies recovered from the fan should reflect the number of times the East Antarctic Ice sheet has expanded to the shelf edge since late Miocene time. The age of inception of the trough mouth fan will also indicate the time of a major change in glaciation style, probably related to a major increase in the importance of coastal ice masses caused by cooling.

Gravity cores from the fan surface indicate that the section should consist of mud, turbidites, and some debris flows deposited during glacial advances separated by finer, more biogenic intervals. Microfossils present in gravity cores are diatoms and planktonic foraminifers. The optimum position for drilling is in the mid fan, where mapped sequences are all present but not excessively thick. Proposed Site PBF-6A is the primary site in this area.

Contingency Drilling

The development of climatic models and the prediction of future short-term climate changes requires detailed records of past climates to determine what processes operated in the oceans and atmosphere and to document the natural variability of global climate for the Holocene. Ice cores have been the only source of such detailed information. Recent ODP drilling in Saanich Inlet, the Santa Barbara Basin, Cariaco Basin, and Palmer Deep have yielded sedimentary sections with annual resolution comparable to ice cores. Other sites around Antarctica have the potential to provide similar sections. Having more than one sedimentary section from Antarctica would provide the opportunity to study decadal and interannual variability of such climatic features as the Circumpolar Wave and El Niño-Southern Oscillation. Deep valleys on the Mac Robertson Shelf west of Prydz Bay (Fig. 11) contain thick Holocene ooze deposits that probably have such resolution (Fig. 12). Therefore, if time permits, we will try to recover a high-resolution Holocene environmental record by coring biogenic deposits on the outer Mac Robertson Shelf (proposed Site PBS-3A).

The Holocene sequence in Iceberg Alley north of Mawson Station (Site PBS-3A) consists of a flat-lying fill within a U-shaped valley cut in older sediments and metamorphic basement (Harris and O'Brien, 1996). Holocene sediments have been imaged by 3.5-kHz echo sounder and intermediate resolution seismic and sampled by gravity coring (Fig. 12). The gravity cores recovered laminate biosiliceous ooze showing laminations, some of which represent monospecific algal or resting spore concentrations. Taylor (1999) interpreted down-core changes in diatom floras as reflecting decadal-scale changes in productivity and water column characteristics during the Holocene. Seismic data indicate that the ooze is about 50 m thick along the valley axis so that cores extending through the full thickness of the deposit should have close to annual resolution. Site PBS-3A is the primary contingency site, but there are a number of locations along the valley axis that contain similar sediments (Fig. 12).

DRILLING STRATEGY

The primary sites will be drilled first on the rise (Site PBD-12B), then on the shelf (Site PBS-2A), and finally on the slope (Site PBF-6A). Depending on ice conditions, this plan will be modified as necessary. Shallow-water guidelines do apply to some of the alternate sites. Because of these guidelines, we may be unable to meet the site objectives if the heave constraints are exceeded.

Average conditions in Antarctic waters can be predicted with reasonable confidence; however, interannual variability can be high and the situation at a specific location can vary dramatically. Therefore, we have several layers of contingencies. The primary drilling strategy consists of three sites (Table 1; Fig. 14) with alternates fairly close by that will allow drilling in case of small scale ice problems and drilling difficulties (Fig. 15). We propose an additional strategy to meet the objectives in a less than ideal way in case very heavy ice conditions are encountered on the Prydz Bay shelf. Proposed Site PBD-15A was selected to drill to a depth at which Eocene sediments are thought to occur. A second site was selected on the Mac Robertson Shelf (proposed Site PBS-5A) at which middle Eocene fossils were recovered by gravity coring. If the primary objectives are achieved, time is still available, and ice conditions permit, the Holocene sequence in Iceberg Alley will be cored.

The Prydz Bay shelf site (proposed Site PBS-2A) will be cored by rotary core barrel (RCB) from the outset because poor results were achieved during Leg 119 using the advanced hydraulic piston corer (APC) on the shelf. For the slope and rise sites (Sites PBF-6A and PBD-12B), coring will be with APC to refusal then extended core barrel (XCB) coring to refusal. A new hole will be drilled for RCB coring to total depth. If time permits, we will attempt to triple APC the Mac Robertson Shelf site (Site PBS-3A).

LOGGING

Wireline logging will be carried out at all three sites. At the drift site, Site PBD-12B, and fan (slope) site, Site PBF-6A, we will run a triple or quad combination (from natural gamma, porosity, density, resistivity, and sonic velocity tools), and the geological high-sensitivity magnetometer (GHMT; magnetic tool string: magnetic field, magnetic susceptibility, and natural gamma). If time becomes available, running the Formation MicroScanner (FMS) toolstring (a micro-resistivity imager), and/or performing some check shots using the well seismic tool (WST) will provide valuable additional information for these sites. At the shelf site, Site PBS-2A, we will run the triple combination (natural gamma, porosity, density, and resistivity tools), FMS-sonic, and GHMT (as above) tool strings.

Logging-while-drilling-light tool (LWD-L; compensated dual resistivity [CDR] tool: natural gamma and resistivity tools) will be used strategically for intervals at Sites PBS-2A and PBF-6A where core recovery is anticipated to be poor and in the top 80 to 100 mbsf, where the bottomhole assembly (BHA) prevents wireline log acquisition. At Site PBS-2A, we will use LWD-L down to 100 mbsf, as previous ODP holes in similar Antarctic shelf environments (Legs 119, 178) have had very poor core recovery in the top 100 m. At Site PBF-6A, we will use LWD-L to 330 mbsf, while drilling ahead at the RCB hole to the depth achieved at the XCB hole.

The logs will provide continuous in situ records of the physical and chemical properties of the sediment, which can be interpreted in terms of sediment lithology. This information can be used to complement core data, fill gaps in core recovery, and enable core data to be located at its correct depth position. The continuous nature of the log data makes it ideal for studies of cyclicity (where every cycle counts). The GHMT is likely to provide a magnetic polarity stratigraphy at the drift site, and possibly also at the fan site (depending mostly on the sediment grain size). The FMS resistivity images can be used to identify diamictites, fine-scale bedding, and fabric, including orientation. Synthetic seismograms (and WST check shots, if taken) can be used to correlate hole depths with travel times on the seismic section.

UNDERWAY GEOPHYSICS

To ensure that sites are precisely located, particularly for sites selected on seismic lines that were shot prior to the advent of the Global Positioning System (GPS), some additional seismic data will be collected on approaching these sites. Standard ODP practice of collecting 3.5-kHz and 12-kHz data will be followed at all sites and in transit and an 80 cu. inch water gun and hydrophone streamer line will be run across each site.

SAMPLING PLAN

For Leg 188, almost all sampling will probably be accomplished during the cruise; no postcruise sample party is planned. Most sites consist of a single hole, where fairly standard sampling is envisaged. Nonstandard sampling at some of the sites might include high-resolution whole-round sampling for physical properties and geochemical studies, U-channel sampling for paleomagnetism, and microbiological sampling.

All sampling to be conducted during Leg 188 must be approved by the sampling allocation committee (SAC), consisting of the co-chiefs, staff scientist, and curatorial representative. Sampling plans are subject to modification depending upon the actual material recovered and collaborations that may evolve between scientists during the leg.

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FIGURE CAPTIONS

Figure 1. **A.** Geographic extent of a stable Antarctic Ice Sheet for different mean temperatures at sea level (5, 9, 10, 15, 19, and 20 K) above current temperatures (Huybrechts, 1990). The higher temperature models provide a guide as to which areas would have developed ice cover during the earliest phases of Cenozoic cooling. At the highest model temperature (+20 K), the ice sheet is small, centered in the Gamburtsev Mountains, from which drainage flows into Prydz Bay. At lower temperatures, the ice extends toward the coast, first reaching it in Prydz Bay and the Ross Sea. **B**. Development of shelf sequence geometry under the influence of glacial ice. When ice extends to the shelf break, sediment in basal ice is delivered to the upper slope, which then progrades. The shelf may erode or receive a blanket of compact till forming topsets. During periods of reduced ice cover, the shelf and slope receive siliciclastic sediment from icebergs and biogenic sediment from phytoplankton production in the water column.

Figure 2. **A.** Overview map of the proposed primary Leg 188 drill sites in respect to port of origin (Freemantle) and final port (Hobart). **B.** Map of the East Antarctic coastline between 50°E and 90°E, showing the location of Prydz Bay, the Mac Robertson Shelf, Mawson Station, Leg 119 drill sites (squares), and proposed priority one (red circles [web]/black circles [print]) and contingency (white circles [web]/gray circles [print]) drill sites for Leg 188.

Figure 3. Map of Antarctic ice sheets showing drainage divides and flow lines. Prydz Bay is the downstream end of the Lambert Glacier-Amery Ice Shelf drainage basin, which originates entirely in the East Antarctic Ice Sheet. The convergent flow lines feeding the Amery Ice Shelf mean that it responds more sensitively to changes in the interior than other parts of the east Antarctic coast.

Figure 4. Location of Prydz Channel Trough Mouth fan and Wilkins and Wild Drifts. Arrows indicate flow lines of Lambert Glacier during major ice advances.

Figure 5. Model of sediment drift formation along the Antarctic continental margin (Rebesco et al., 1997). During glacial maxima, till transported to the shelf edge slumps, forming sediment gravity flows. Turbidity currents thus formed move down the slope to the rise, where suspended fine sediments are entrained by west-flowing bottom currents and deposited in the drifts west of the submarine canyons.

Figure 6. Interpretation of seismic line through Leg 119 drill sites in Prydz Bay (Cooper et al., 1991a). Shaded area is the part of seismic Sequence PS.2A not sampled by Site 742. Sequence PS.2B comprises Cretaceous nonmarine sediments and Site 742, which bottomed in Eocene glacial sediment. Thus, the lower part of Sequence PS.2A will be drilled to date the oldest glacial sediments in Prydz Bay and to sample any preglacial Cenozoic deposits.

Figure 7. Map showing bathymetry of the Wild Drift, seismic lines, and proposed drill sites.

Figure 8. Seismic section across Wilkins Drift. Seismic horizons:
P3 – Onset of current influenced drift deposition (Oligocene?)
P2 – Onset of Antarctic glaciation? (Eocene?)
P1 – Cretaceous?

Figure 9. Seismic section (north-south) through the Prydz Channel trough mouth fan showing Surface PP.15, which marks the start of trough mouth fan sedimentation and the first cutting of the Prydz Channel.

Figure 10. Model of trough mouth fan sedimentation. **A.** When the ice stream extends to the continental shelf edge, debris in basal ice and the mobile debris layer at the glacier sole mostly bypass the shelf and are delivered to the shelf edge, where they are redistributed by debris flows and turbidity currents. Fine sediment is entrained in buoyant meltwater plumes and settles on the fan surface. **B.** During interglacials, the ice has retreated inshore from the shelf edge. Biogenic sedimentation, ice rafting, and minor reworking by slope processes predominate. Ice keel ploughing at the shelf edge results in some remobilization of glacial sediment.

Figure 11. Bathymetric map showing the location of Iceberg Alley, proposed ODP sites, seismic lines, and gravity cores.

Figure 12. **A.** Seismic line collected with a generator-injector (GI) gun source (Line 186/1901) along the axis of Iceberg Alley. Siliceous mud and ooze appears as a faint horizontally layered unit overlying dipping Paleogene sediments. Proposed ODP sites are indicated. **B.** A 3.5-kHz echo

sounder line collected along the axis of Iceberg Alley. The sediments show horizontal layering in sileceous mud and diatom ooze (SMO) deposits. Proposed ODP sites and existing gravity cores indicated.

Figure 13. Generalized section across Prydz Bay illustrating the Leg 188 drilling strategy. The strategy consists of (1) one hole (Site PBS-2A) drilling the lower part of the Paleogene section (Sequence PS.2A); (2) one hole (Site PBF-6A) drilling the Prydz Channel trough mouth fan to date the development of cross-shelf channels and trough mouth fans and determine the number of times the Lambert Glacier reached the shelf edge from the late Miocene? to the present; and (3) one hole (Site PBD-12B) to investigate glacial-interglacial variations in continental rise sedimentation from the Oligocene to Pleistocene.

Figure 14. Location of primary drill sites on the Prydz Bay shelf, slope, and rise.

Figure 15. Location of alternate sites on the Prydz Bay shelf, slope, and rise.

Table 1. Drill sites

	Shelf (Paleocene section)	Rise (Oligocene-Pleistocene)	Slope (late Miocene and younger)	Mac Robertson Shelf (Holocene section)
Primary sites	PBS-2A	PBD-12B	PBF-6A	
Alternate sites	PBS-1A	PBD-13A	PBF-5A	PBS-3A
	PBS-6A		PBF-4B	PBS-4A
	PBS-7A		PBF-7A	
	PBD-15A			
	PBS-5A			

blank

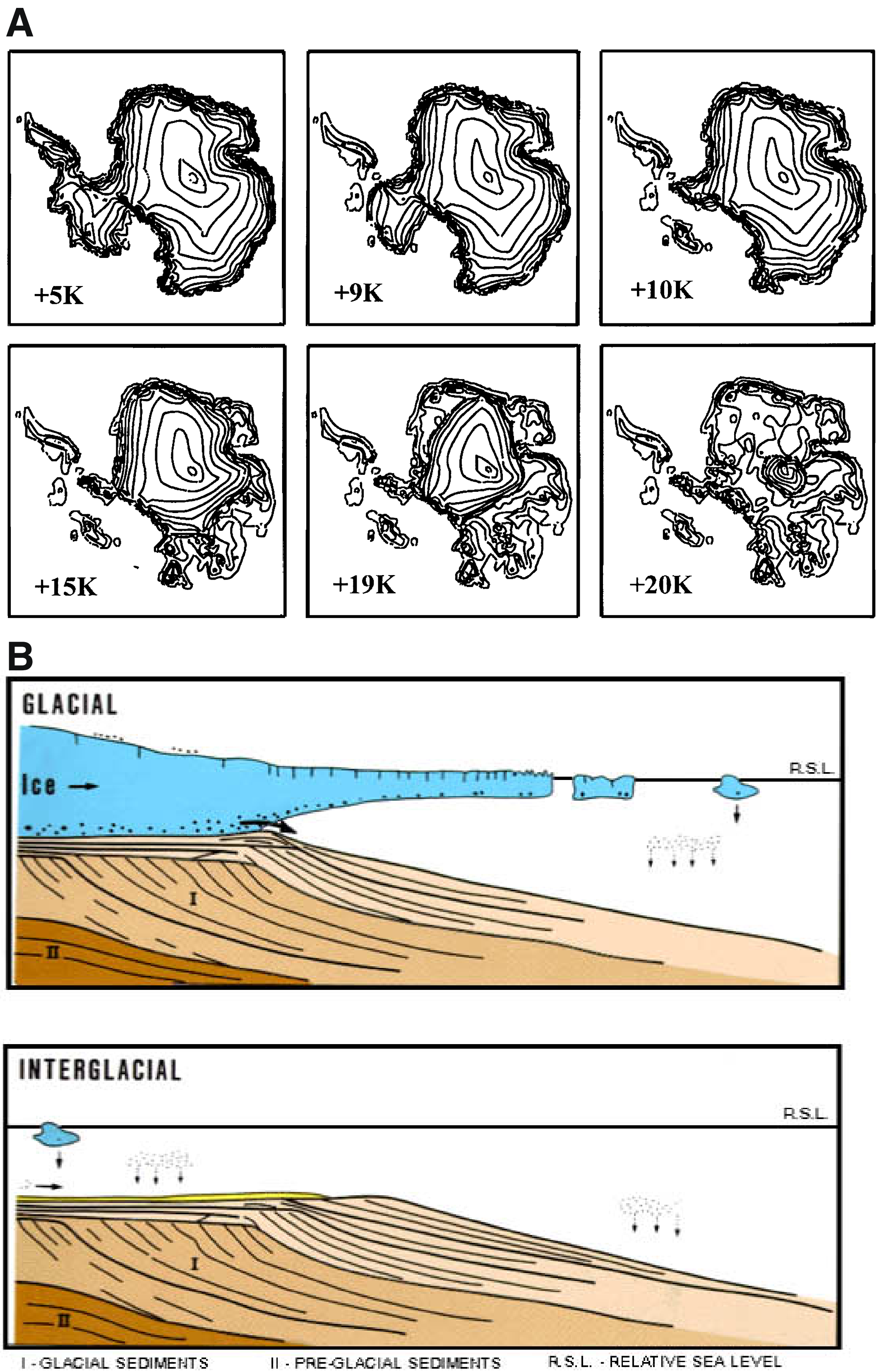
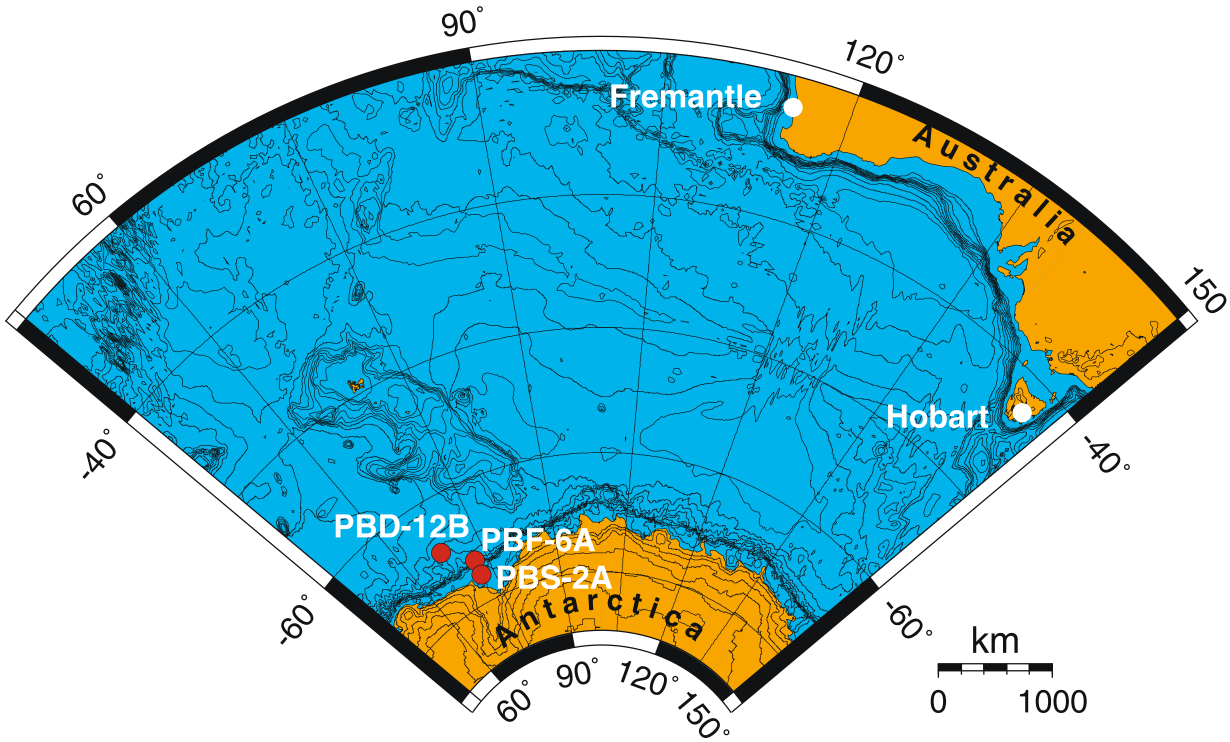

A
+5K
+9K
+10K
+15K
+19K
+20K
B
GLACIAL
Ice
R.S.L.
I
II
INTERGLACIAL
R.S.L.
I
II
I - GLACIAL SEDIMENTS
II - PRE-GLACIAL SEDIMENTS
R.S.L. - RELATIVE SEA LEVEL

Figure 1


Fremantle
Australia
Hobart
PBD-12B
PBF-6A
PBS-2A
Antarctica
km
0
1000

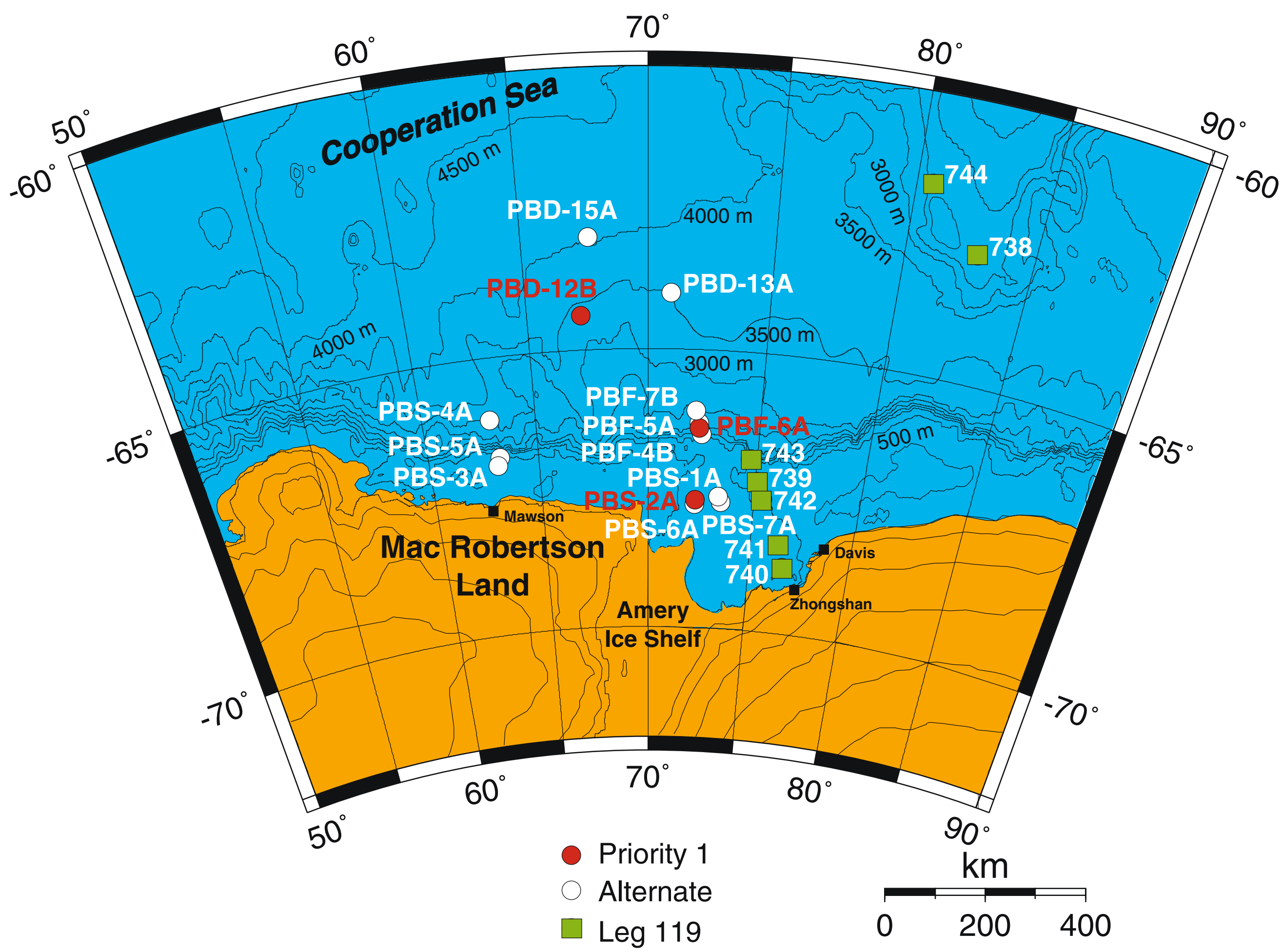

Cooperation Sea
4500 m
4000 m
3000 m
3500 m
744
738
PBD-15A
PBD-12B
PBD-13A
3500 m
3000 m
4000 m
PBF-7B
PBF-5A
PBF-6A
PBF-4B
PBS-4A
PBS-5A
PBS-3A
743
739
742
PBS-1A
PBS-2A
PBS-6A
PBS-7A
741
740
500 m
Mawson
Davis
Zhongshan
Mac Robertson Land
Amery Ice Shelf
Priority 1
Alternate
Leg 119
km
0
200
400

Figure 2

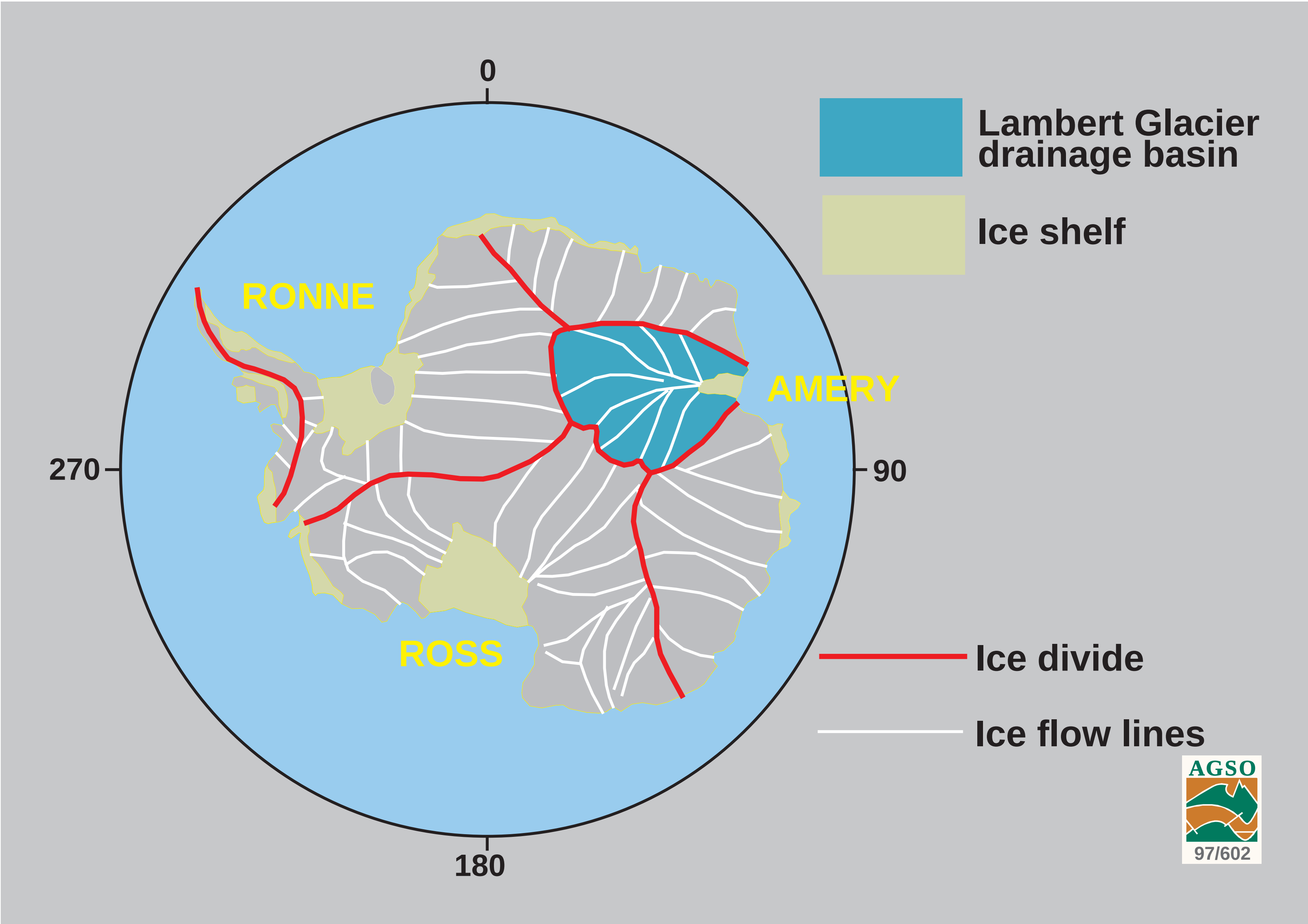

0
90
180
270
RONNE
AMERY
ROSS
Lambert Glacier drainage basin
Ice shelf
Ice divide
Ice flow lines
AGSO
97/602

Figure 3

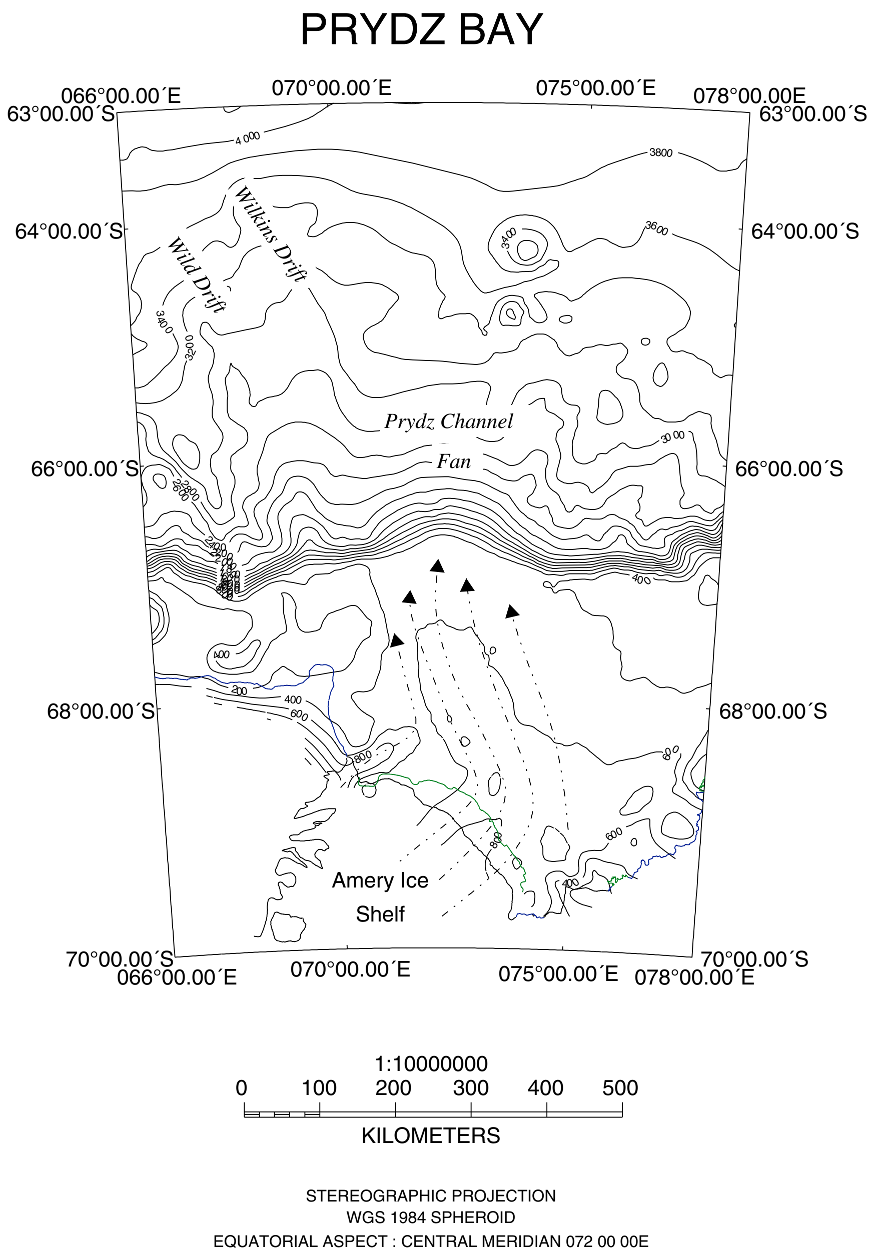

PRYDZ BAY
066°00.00´E
070°00.00´E
075°00.00´E
078°00.00E
63°00.00´S
64°00.00´S
66°00.00´S
68°00.00´S
70°00.00´S
Wilkins Drift
Wild Drift
Prydz Channel
Fan
Amery Ice
Shelf
1:10000000
0 100 200 300 400 500
KILOMETERS
STEREOGRAPHIC PROJECTION
WGS 1984 SPHEROID
EQUATORIAL ASPECT : CENTRAL MERIDIAN 072 00 00E

Figure 4

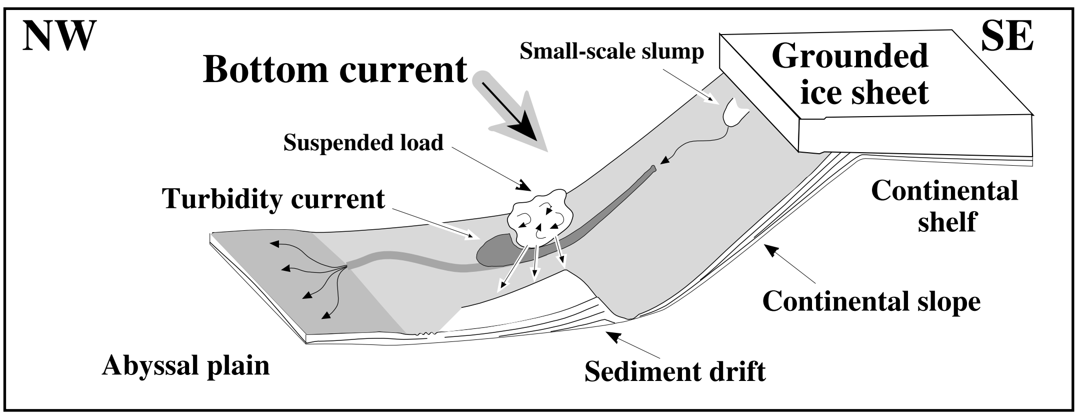

NW
SE
Bottom current
Small-scale slump
Grounded
ice sheet
Suspended load
Turbidity current
Continental
shelf
Continental slope
Abyssal plain
Sediment drift

Figure 5

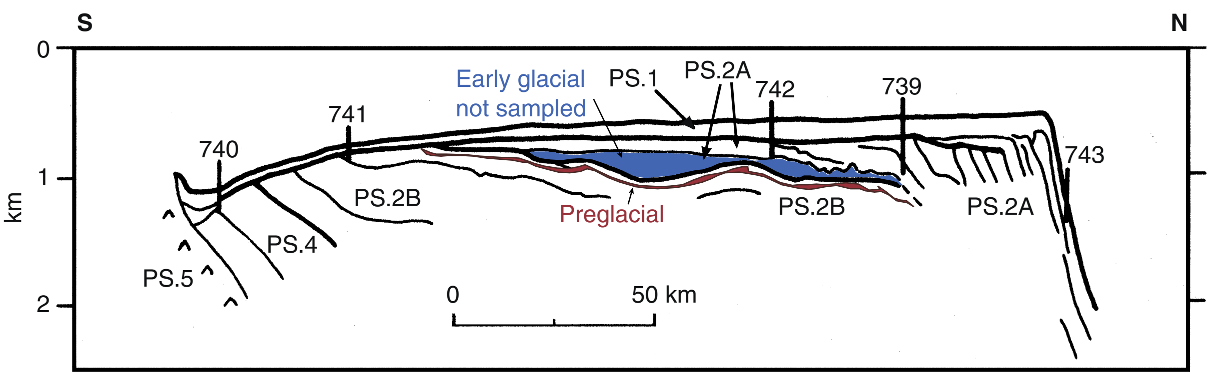

S
N
0
1
2
km
Early glacial
not sampled
PS.1
PS.2A
742
739
741
740
743
PS.2B
Preglacial
PS.2B
PS.2A
PS.4
PS.5
0
50 km

Figure 6

Drift Sites

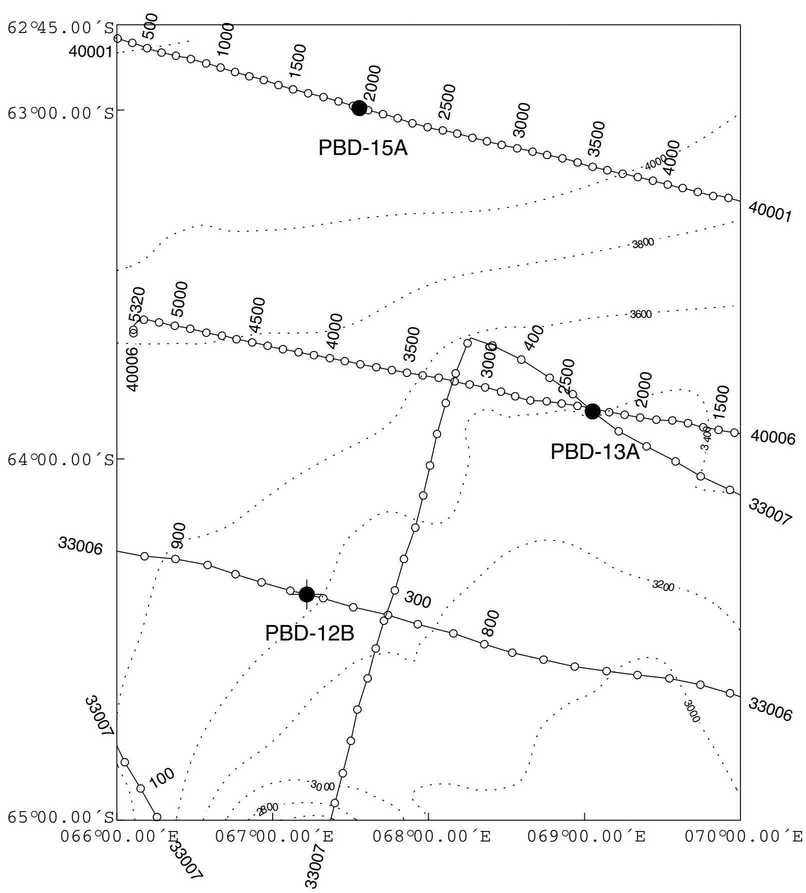


Figure 7

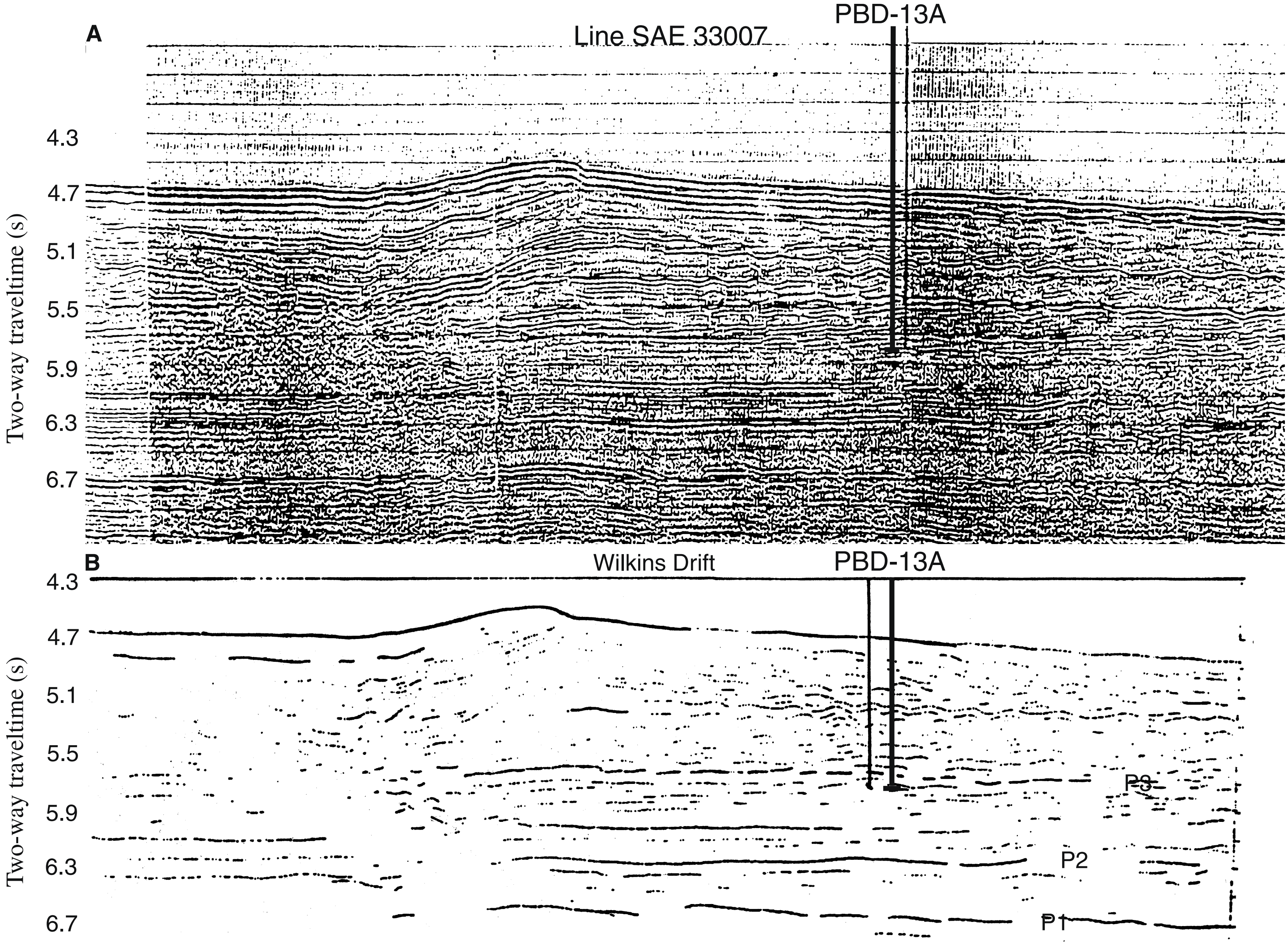

A
Line SAE 33007
PBD-13A
Two-way traveltime (s)
4.3
4.7
5.1
5.5
5.9
6.3
6.7
B
Wilkins Drift
PBD-13A
Two-way traveltime (s)
4.3
4.7
5.1
5.5
5.9
6.3
6.7
P3
P2
P1

Figure 8

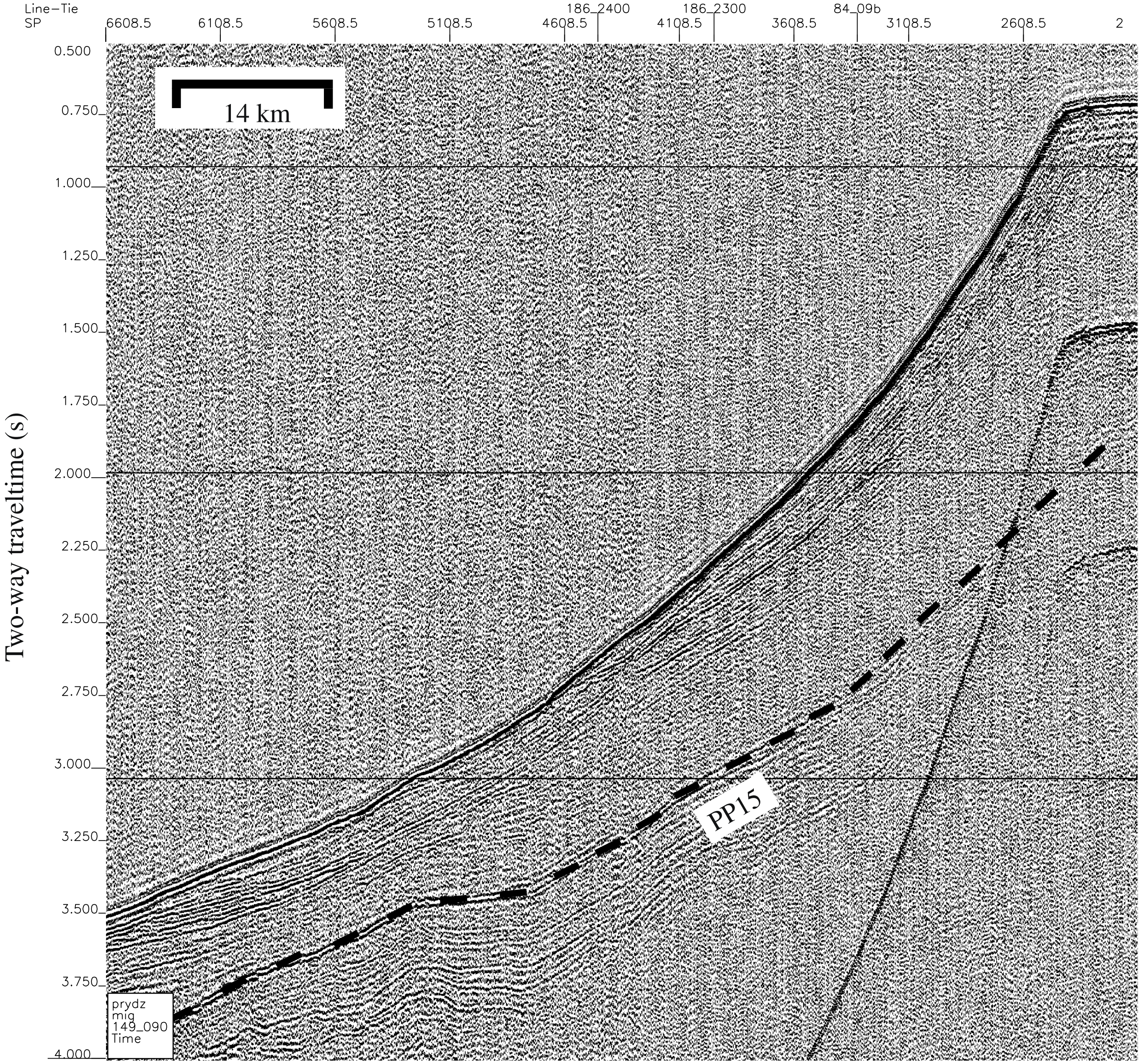
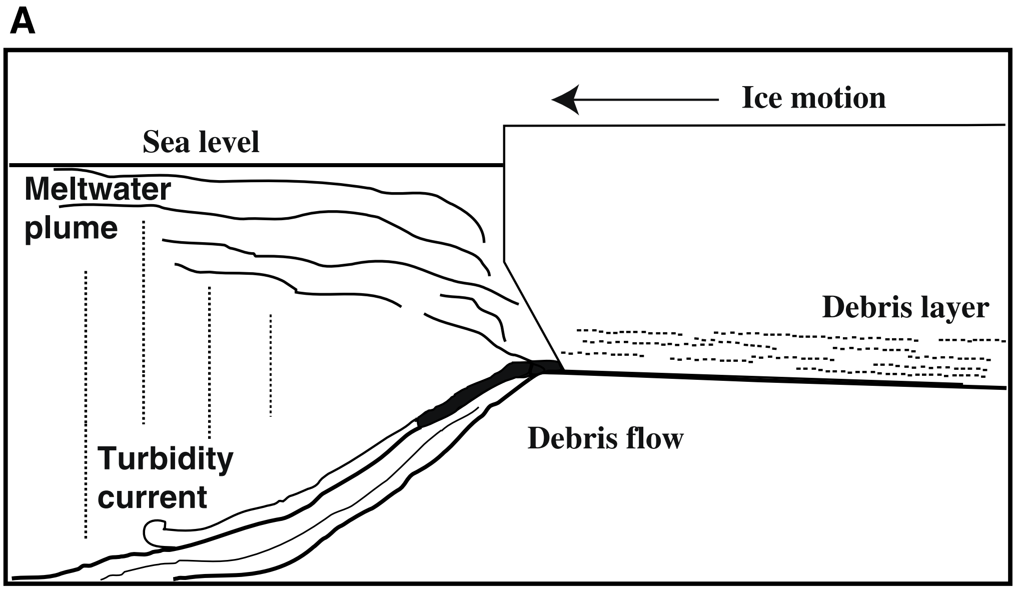
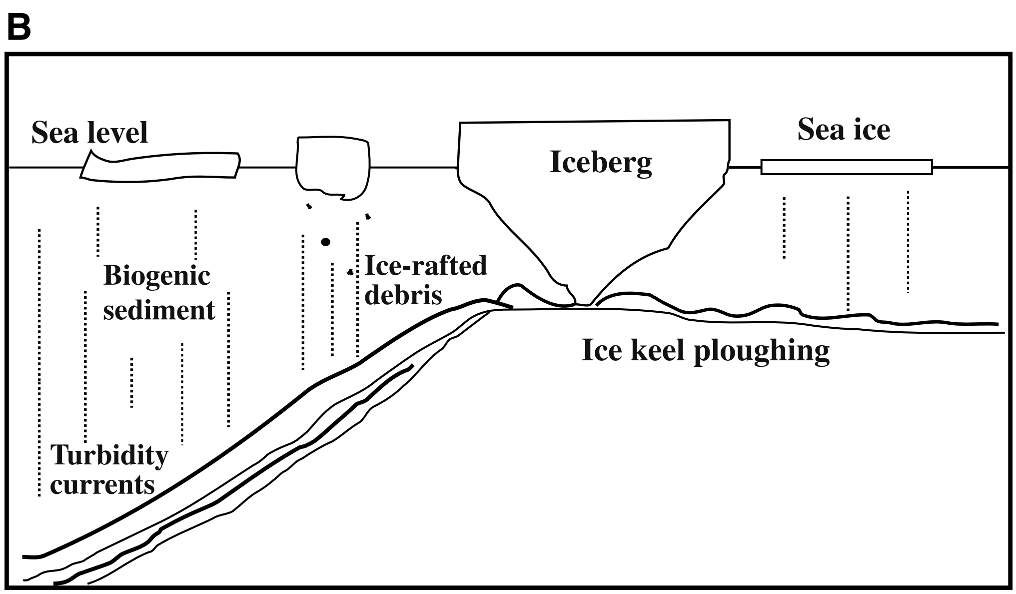

Line-Tie
SP
6608.5
6108.5
5608.5
5108.5
186_2400
4608.5
186_2300
4108.5
3608.5
84_09b
3108.5
2608.5
2
14 km
Two-way traveltime (s)
0.500
0.750
1.000
1.250
1.500
1.750
2.000
2.250
2.500
2.750
3.000
3.250
3.500
3.750
4.000
PP15
prydz
mig
149_090
Time

Figure 9



Glacial maxima - Ice grounded at shelf edge



Interglacial conditions - High sea level, ice near coast

Figure 10

Iceberg Alley Sites

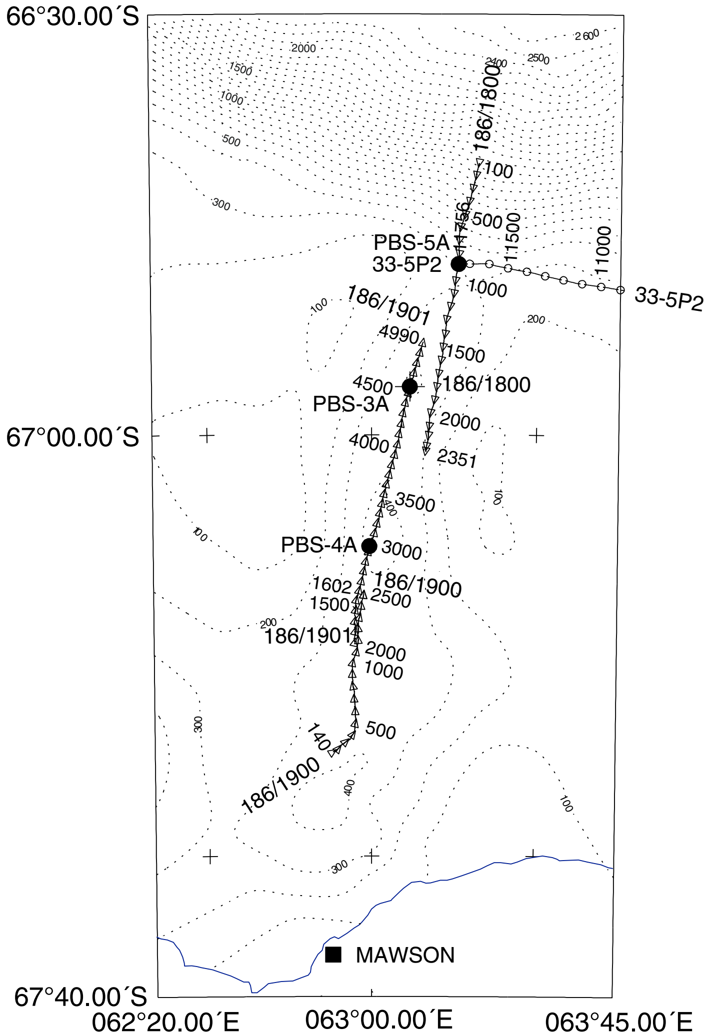


Figure 11

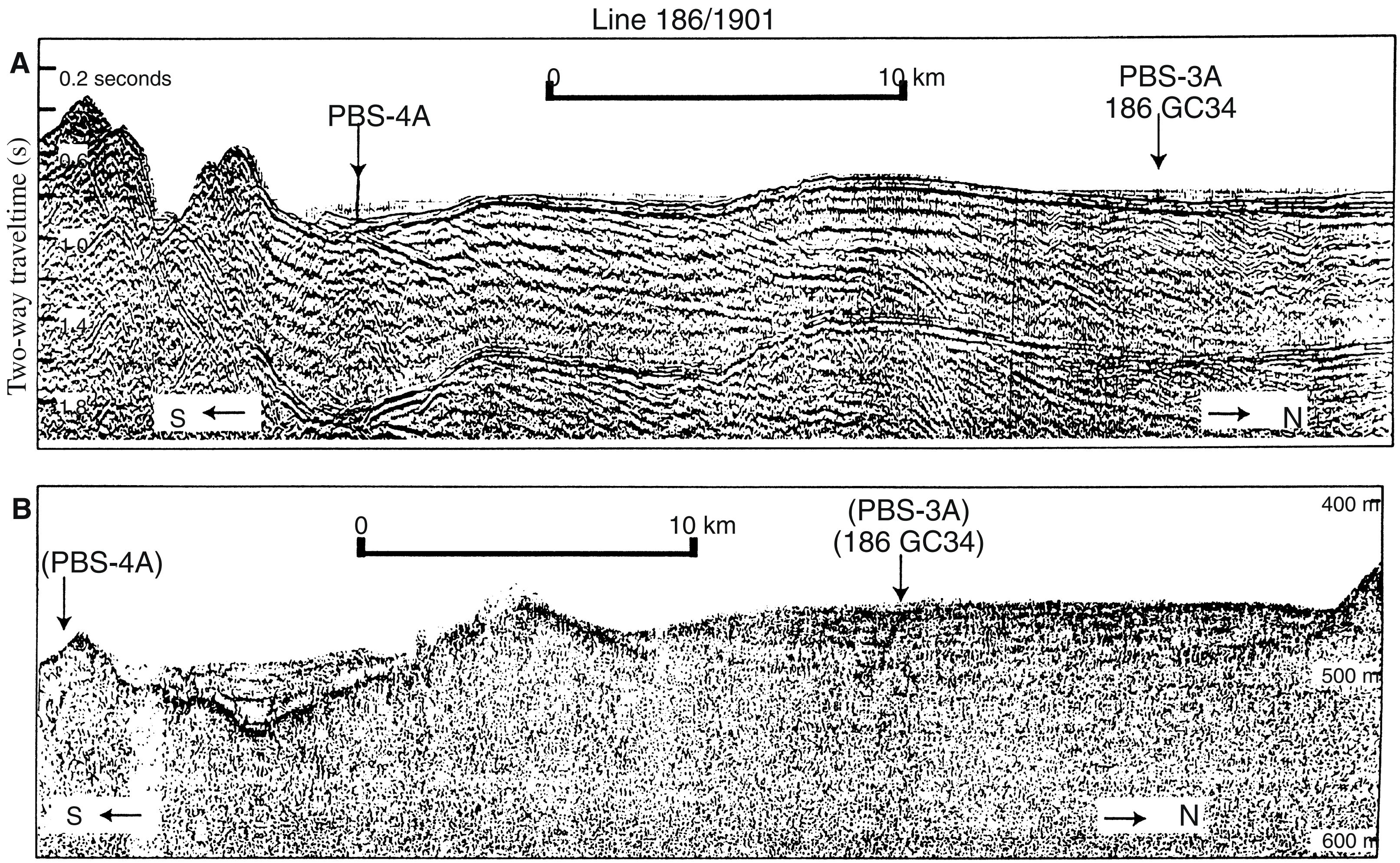

Line 186/1901
A
0.2 seconds
0.6
1.0
1.4
1.8
Two-way traveltime (s)
0
10 km
PBS-4A
PBS-3A
186 GC34
S
N
B
400 m
500 m
600 m
(PBS-4A)
(PBS-3A)
(186 GC34)

Figure 12

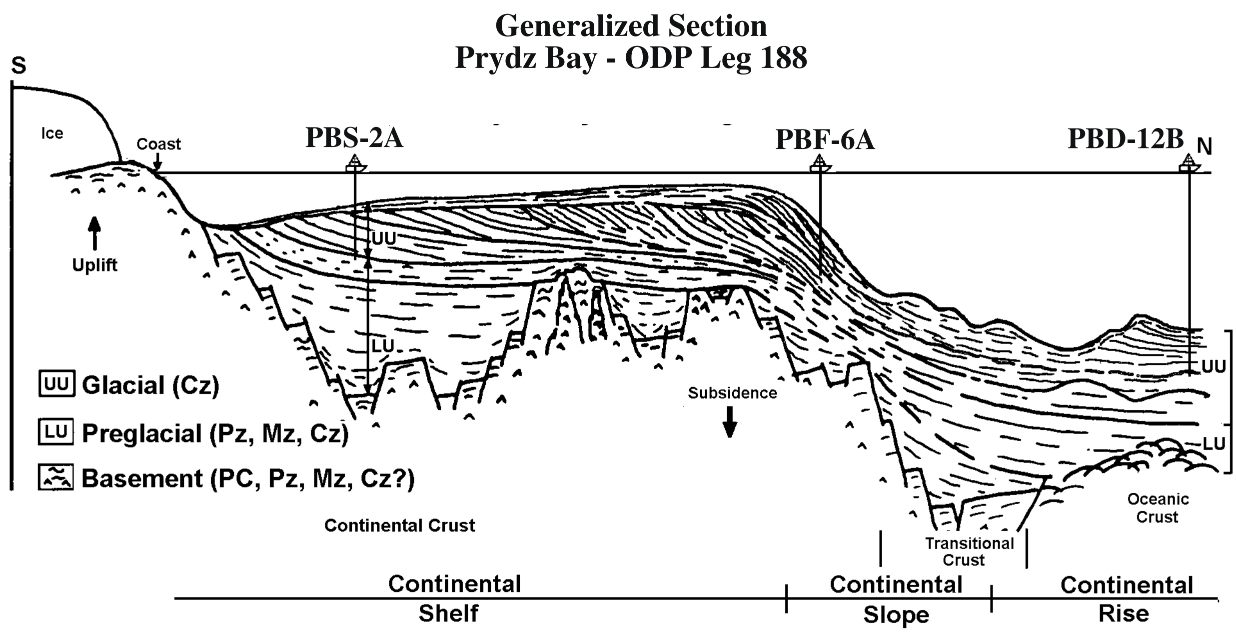

Generalized Section
Prydz Bay - ODP Leg 188
S
N
Ice
Coast
PBS-2A
PBF-6A
PBD-12B
Uplift
UU
LU
Glacial (Cz)
Preglacial (Pz, Mz, Cz)
Basement (PC, Pz, Mz, Cz?)
Subsidence
Continental Crust
Transitional Crust
Oceanic Crust
Continental Shelf
Continental Slope
Continental Rise

Figure 13

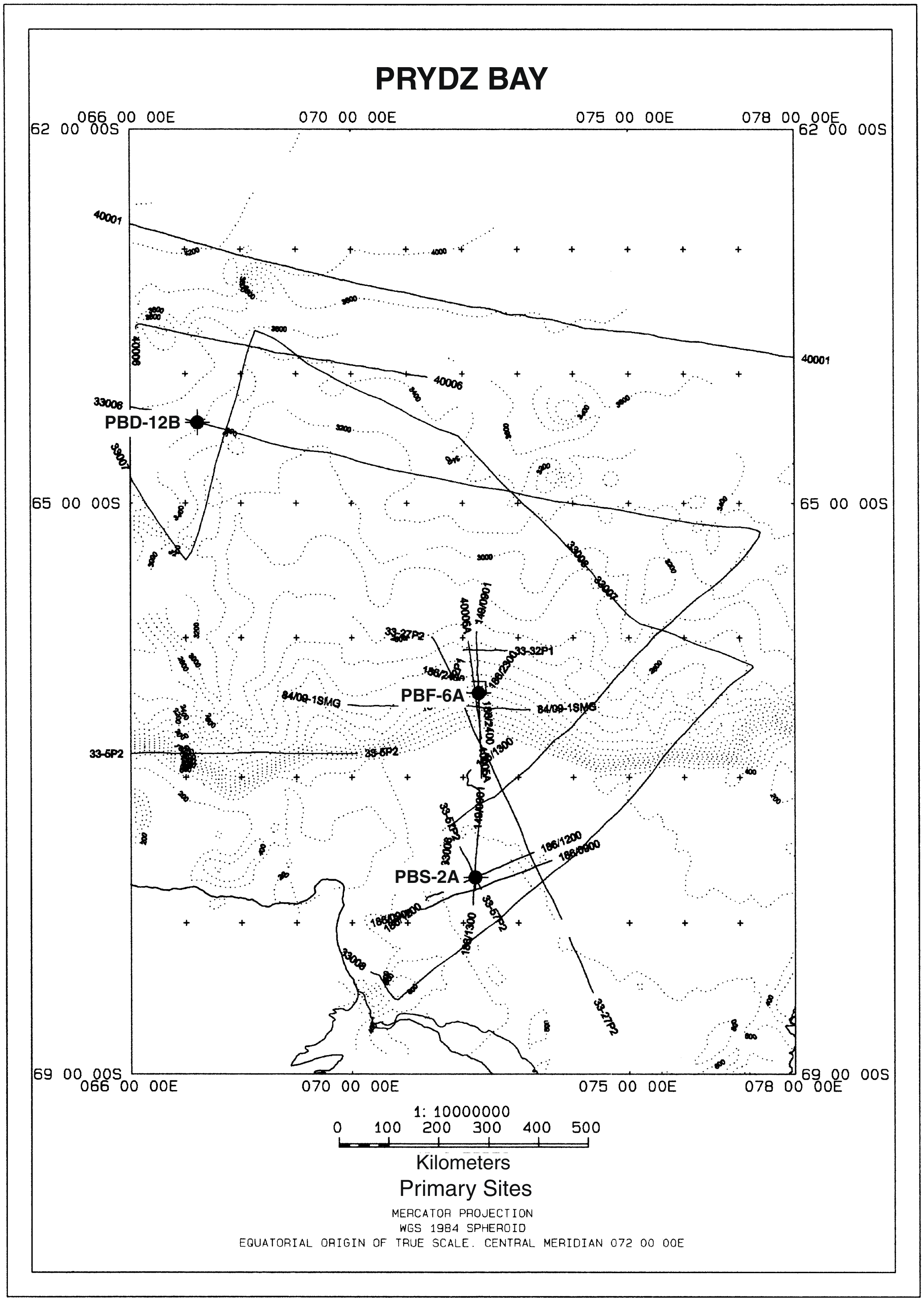

PRYDZ BAY
066 00 00E
070 00 00E
075 00 00E
078 00 00E
62 00 00S
65 00 00S
69 00 00S
40001
40006
33006
33007
PBD-12B
PBF-6A
PBS-2A
33-27P2
33-32P1
84/09-1SMG
33-5P2
33-5TP2
186/1200
186/0900
186/1300
1: 10000000
0 100 200 300 400 500
Kilometers
Primary Sites
MERCATOR PROJECTION
WGS 1984 SPHEROID
EQUATORIAL ORIGIN OF TRUE SCALE. CENTRAL MERIDIAN 072 00 00E

Figure 14

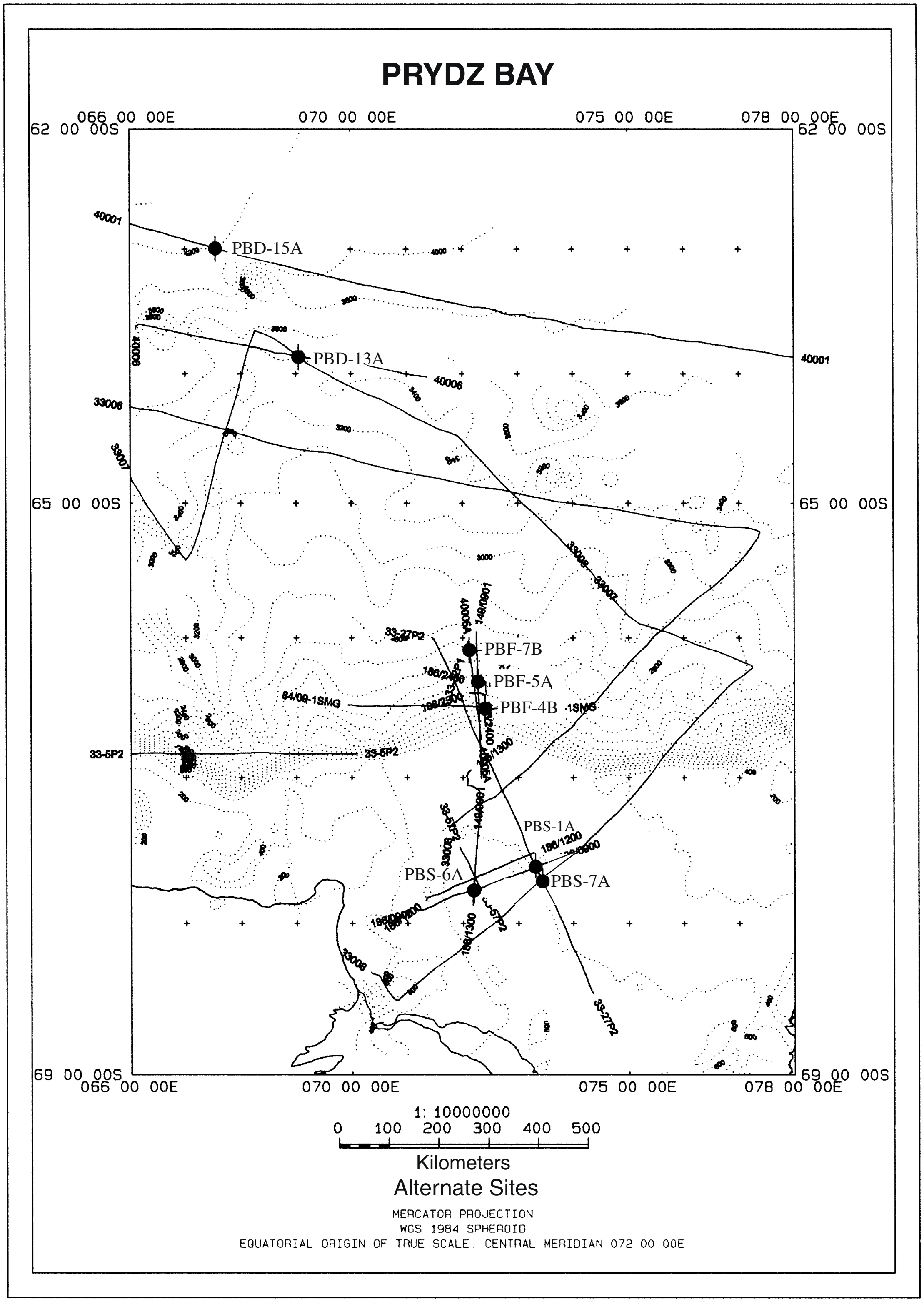

PRYDZ BAY
066 00 00E
070 00 00E
075 00 00E
078 00 00E
62 00 00S
65 00 00S
69 00 00S
PBD-15A
PBD-13A
PBF-7B
PBF-5A
PBF-4B
PBS-1A
PBS-6A
PBS-7A
40001
40006
33006
33007
33-27P2
33-5P2
84/09-1SMG
1: 10000000
0 100 200 300 400 500
Kilometers
Alternate Sites
MERCATOR PROJECTION
WGS 1984 SPHEROID
EQUATORIAL ORIGIN OF TRUE SCALE. CENTRAL MERIDIAN 072 00 00E

Figure 15

Table 2A. Leg 188 - Prydz Bay Operations Plan and Time Estimate

Site No.	Location Lat/Long	Water Depth	Operations Description	(hr)	Transit[1] (days)	Drilling (days)	Wireline Logging	Total On site
PRIMARY SITES								
Fremantle	32.1°S		Transit 2710 nmi from Fremantle to PBD-12B @ 8.5 kt	317.0	13.2			
	115.4°E							
PBD-12B	64°22.775'S	3525m	Pre-site survey	6.0		13.9	1.0	14.9
(Drift Site)	67°13.125'E		A-APC to 200 mbsf, XCB to 570 mbsf, plug hole with mud/cem.	118.0				
			B-Drill w/center bit to 550 mbsf, RCB core to 1020 mbsf, FFF	208.6				
			Wireline logging only in Hole "B" (23.0 hr) to include:					
			1-Quad Combo: BHC, HLDT, DITE, and Sonic	12.0				
			2-GHMT: NGT, CNT-G, AACT, and GST	11.0				
			Plug hole with mud and cement					
			Transit 235 nmi from PBD-12B to PBS-2A @ 9.0 kt	26.0	1.1			
PBS-2A	67°41.450'S	697m	Pre-site survey	3.0		5.9	1.1	7.0
(Shelf Site)	72°13.080'E		A-RCB core to 600 mbsf, FFF	112.4				
			Wireline logging in Hole "A" (27.0 hr) to include:					
			1-TripleC-acoustic (BHC), lithodensity (HLDT), resistivity (DITE)	9.0				
			2-FMS (Formation Microscanner) - Sonic	10.0				
			3-GHMT (geol high-sen mag. tool (NGT, CNT-G, AACT, GST)	8.0				
			Plug hole with mud and cement					
			B-LWD light to 100 mbsf	26.1				
			Plug hole with mud and cement					
			(NOTE: To combine LWD light with a 200-m ADCB test would					
			require an additional 42 hr and deployment of a FFF)					
			Transit 78 nmi from PBS-2A to PBF-6A @ 9.5 kt	8.0	0.3			
PBF-6A	66°24.036'S	1695m	Pre-site survey	3.0		7.2	0.7	7.9
(Slope Site)	72°17.064'E		A-APC to 150 mbsf, XCB to 350 mbsf, plug hole with mud/cem.	49.9				
			B-Drill w/LWD to 330 mbsf, RCB core to 620 mbsf, FFF	119.3				
			Wireline logging in Hole "B" (18.0 hr) to include:					
			1-Quad Combo: BHC, HLDT, DITE, and Sonic	8.7				
			2-GHMT: NGT, CNT-G, AACT, and GST	8.7				
			Plug hole with mud and cement					
Hobart	42.54°S		Transit 2780 nmi from PBF-6A to Hobart @ 11.0 kt[2]	255.0	10.6			
	147.18°E							
					25.2	**27.0**	**2.8**	**29.8**

Note: 1-Transit times/distances provided by Capt. Ribbens

Note: 2-Transit time into Hobart includes 2 hr for advancing clocks

Note: 3-Leg is scheduled for total length of 55.0 days (1320 hr)

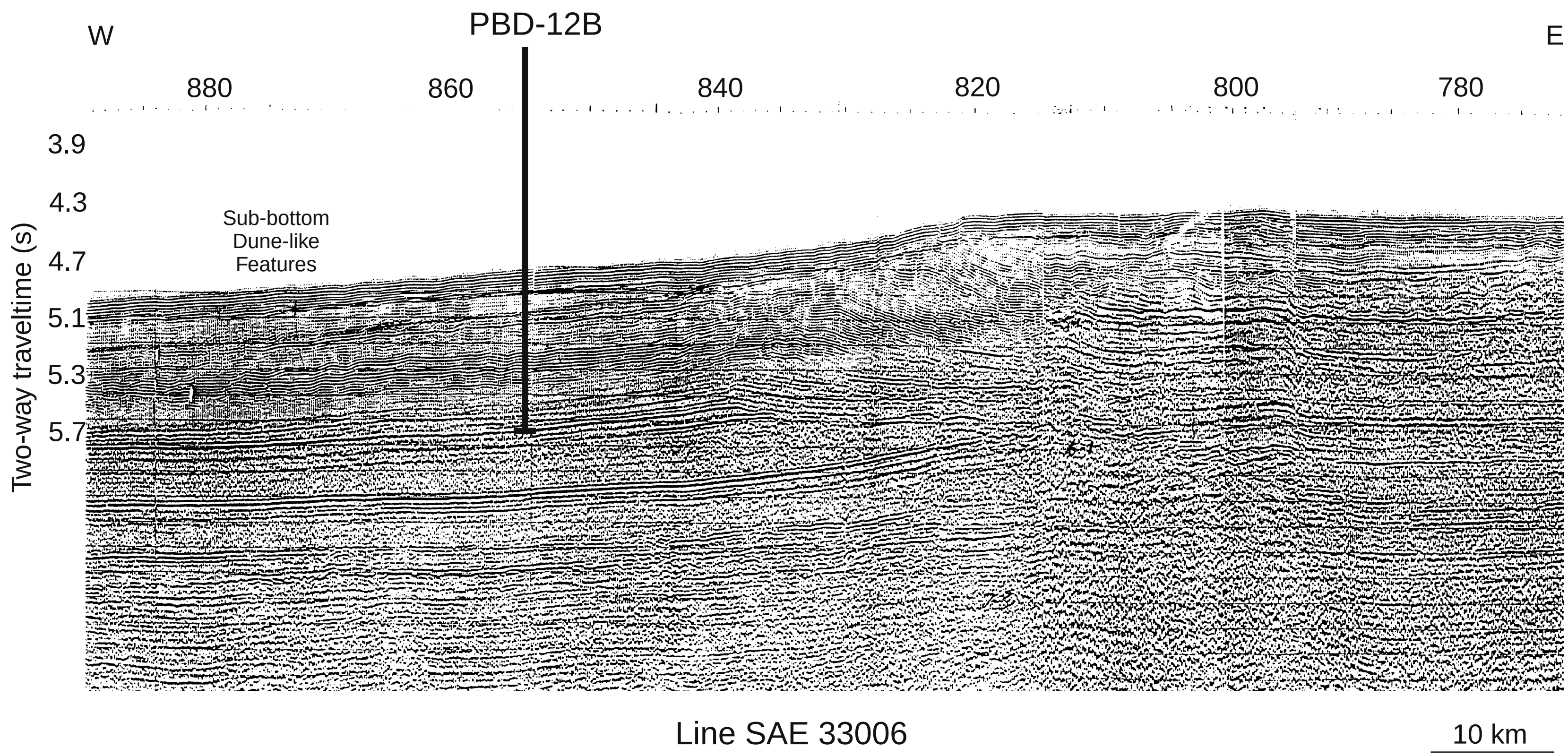
Note: 4-Estimate <u>does not include</u> time for Adara or DVTP temperature measurements

TOTAL DAYS 55.0

Table 2B. Leg 188 - Prydz Bay Operations Time Estimate

Prospectus Alternate Sites

Site No.	Location Lat/Long	Water Depth	Operations Description	Drilling (days)	Logging (days)	Total On site
PBD-13A	63°59.807' S	3450m	A-APC to 200 mbsf, XCB to 570 mbsf, plug hole with mud/cement	13.6	1.6	15.2
Alt f/PBD-12C	70°56.519' E		B-Drill w/center bit to 550 mbsf, RCB core to 1020 mbsf, FFF			
			Wireline logging to include triple-combo, FMS-sonic, and GHMT then plug hole			
PBD-15A	63°00.00' S	4125m	A,B-APC to refusal, RCB core to 850 mbsf, FFF	12.5	1.5	14.0
Alt f/PBS-2A	67°38.00' E		Wireline logging to include triple-combo, FMS-sonic, and GHMT then plug hole			
PBF-4B	66°30.5652' S	1305m	A-APC to 150 mbsf, XCB to 350 mbsf, plug hole with mud/cement	6.5	1.2	7.7
Alt f/PBF6A	72°24.0954' E		B-Drill w/center bit to 330 mbsf, RCB core to 699 mbsf, FFF			
			Wireline logging to include triple-combo, FMS-sonic, and GHMT then plug hole			
PBF-5A	66°19.003' S	1920m	A-APC to 150 mbsf, XCB to 350 mbsf, plug hole with mud/cement	6.5	1.2	7.7
Alt f/PBF-6A	72°16.618' E		B-Drill w/center bit to 330 mbsf, RCB core to 578 mbsf, FFF			
			Wireline logging to include triple-combo, FMS-sonic, and GHMT then plug hole			
PBF-7B	66°05.267' S	3775m	A-APC to 150 mbsf, XCB to 350 mbsf, plug hole with mud/cement	5.5	1.0	6.5
Alt f/PBF-6A	72°7.297' E		B-Drill w/center bit to 330 mbsf, RCB core to 417 mbsf, FFF			
			Wireline logging to include triple-combo, FMS-sonic, and GHMT then plug hole			
PBS-1A	67°36.95' S	600m	A-RCB core to 648 mbsf, FFF	4.7	1.1	5.8
Alt f/PBS-2A	73°18.34' E		Wireline logging to include triple-combo, FMS-sonic, and GHMT then plug hole			
PBS-3A	66°56.55' S	470m	A,B,C-Triple APC core to 50 mbsf, plug holes with heavy mud	1.2	0.0	1.2
	63°6.93' E		No wireline logging			
PBS-4A	67°7.92' S	555m	A,B,C-Triple APC core to 50 mbsf, plug holes with heavy mud	1.2	0.0	1.2
Alt f/PBS3A	62°59.57' E		No wireline logging			
PBS-5A	66°47.808' S	315m	A-RCB core to 50 mbsf	0.5	0.0	0.5
Alt f/PBS-2A	63°15.597' E		No wireline logging			
PBS-6A	67°46.638' S	697m	A,B-APC to refusal, RCB core to 294 mbsf	5.0	0.7	5.7
Alt f/PBS-2A	72°11.529' E		Wireline logging to include triple-combo, FMS-sonic, and GHMT then plug hole			
PBS-7A	67°42.91' S	592m	A,B-APC to refusal, RCB core to 276 mbsf	5.0	0.7	5.7
Alt f/PBS-2A	73°26.112' E		Wireline logging to include triple-combo, FMS-sonic, and GHMT then plug hole			


PBD-12B
W
E
880
860
840
820
800
780
3.9
4.3
4.7
5.1
5.3
5.7
Two-way traveltime (s)
Sub-bottom
Dune-like
Features
Line SAE 33006
10 km

PRIMARY SITES

Site: PBD-12B

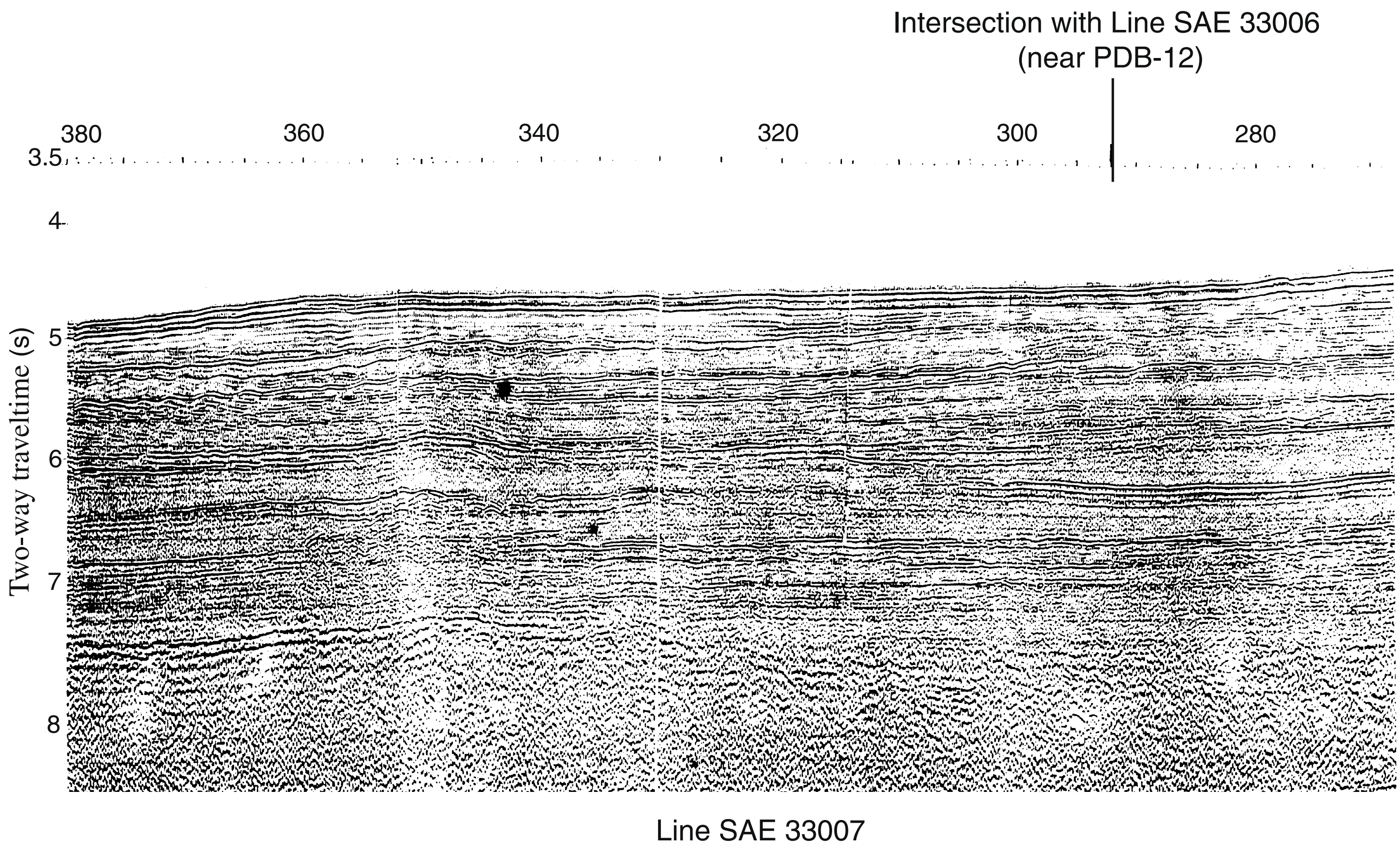
Priority: 1
Position: 64°22´46.5"S, 067°13´7.5"E
Water Depth: 3525 m
Sediment Thickness: >2 km
Target Drilling Depth: ~1020 mbsf
Approved Maximum Penetration: 1140 mbsf
Seismic Coverage: SAE 33006 SP 855 (Moved from intersection with SAE 33007 to avoid closure formed by drift topography)

Objectives: To obtain a cored section to the base of the sediment drift on the continental rise to date the major change in sedimentation that led to drift formation (Oligocene?) and to compare the history of sedimentation on the shelf and slope with oceanic sedimentation on the rise.

Drilling Program: APC Hole A to refusal (~200 mbsf), continue with XCB to refusal (~570 mbsf) then RCB Hole B to ~1020 mbsf.

Logging Program: Quad combo (BHC, HLDT, DITE, and sonic) and GHMT

Nature of Rock Anticipated: Mud, ooze, fine sand, and ice-rafted pebbles


Intersection with Line SAE 33006
(near PDB-12)
380
360
340
320
300
280
3.5
4
5
6
7
8
Two-way traveltime (s)
Line SAE 33007

Site: PBF-6A

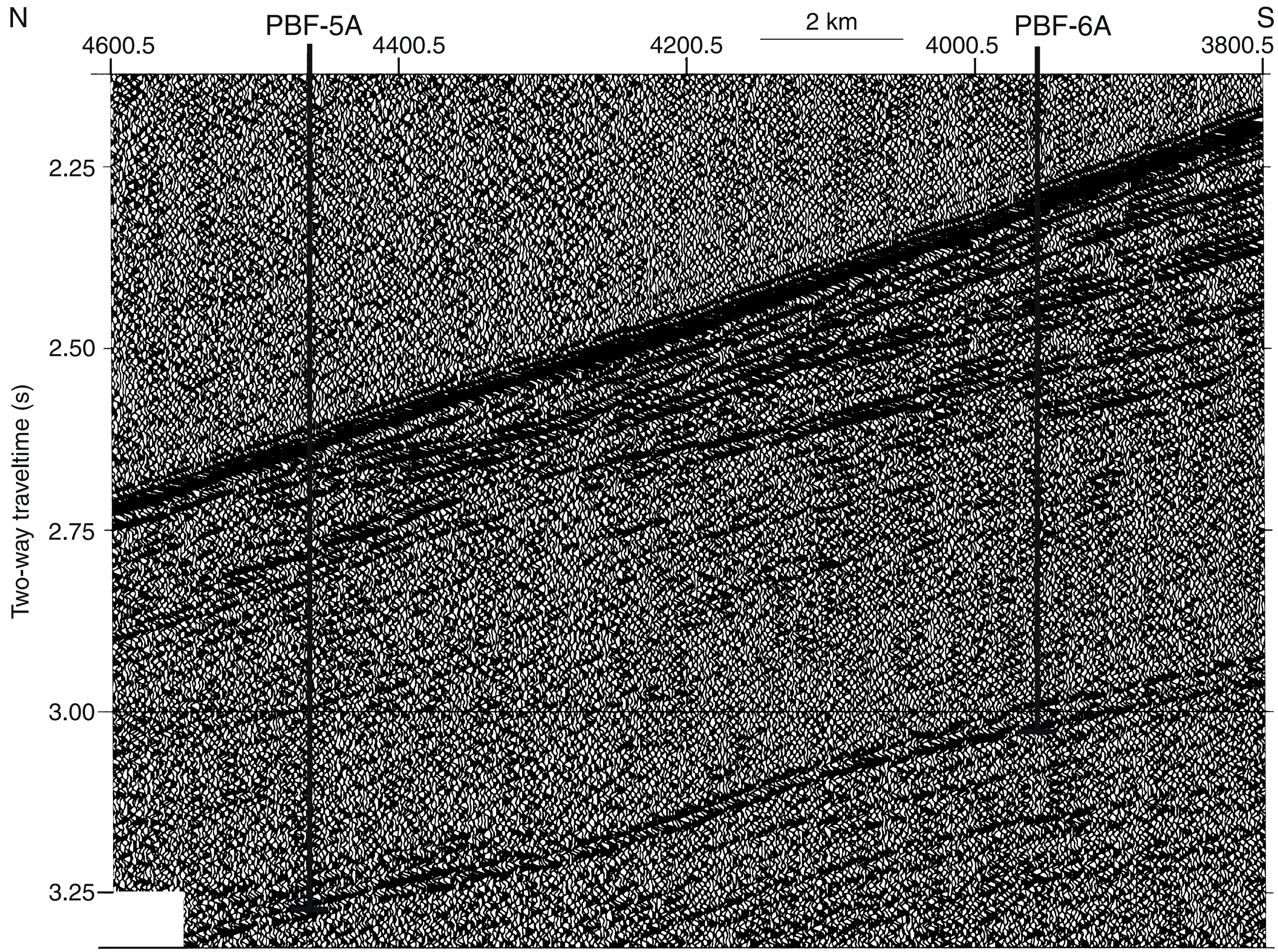
Priority: 1
Position: 66°24.036´S, 072°17.064´E
Water Depth: 1695 m
Sediment Thickness: >2 km
Target Drilling Depth: ~620 mbsf
Approved Maximum Penetration: 620 mbsf
Seismic Coverage: AGSO 149/0901, SP 3957; AGSO 186/2300 SP 545

Objective: Document the number of major advances of the East Antarctic Ice Sheet to the shelf edge since late Miocene to middle Pliocene time by coring a succession of sediments comprised of siliciclastic intervals deposited by output from the Lambert Glacier when it was grounded at or near the shelf edge. The siliciclastic intervals are separated by ooze and hemipelagic mud deposited when the ice was further inshore.

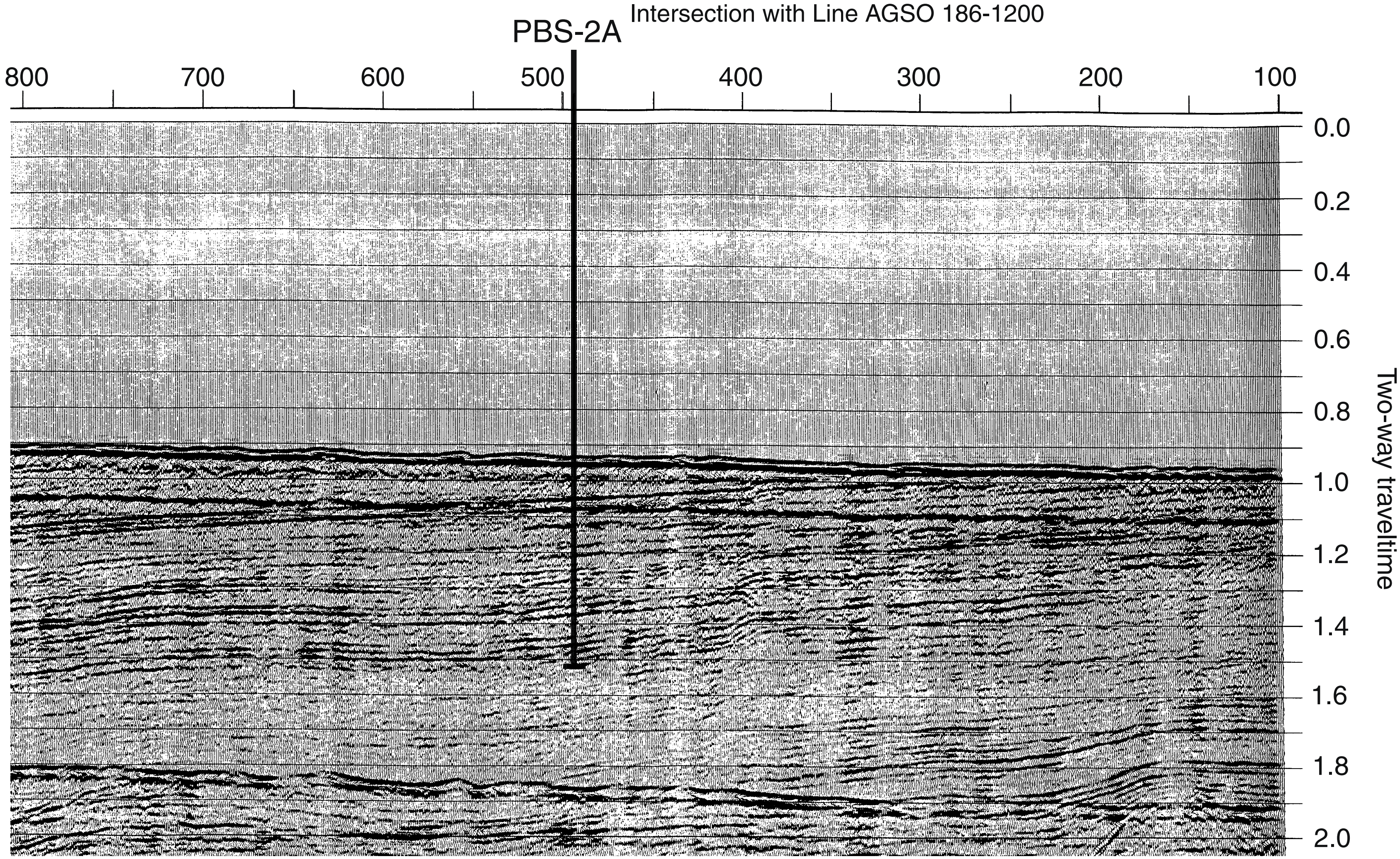
Drilling Program: APC Hole A to refusal (~150 mbsf), continue with XCB to refusal (~350 mbsf) then RCB Hole B to ~620 mbsf.

Logging Program: Quad Combo (BHC, HLDT, DITE, and sonic) and GHMT; LWD-light

Nature of Rock Anticipated: Mud, ooze, diamict, and sand interbeds



Line AGSO 49/0901



Water Depth = 677 m
TD: 700 m

Line BMR 33-57 P2

Site: PBS-2A

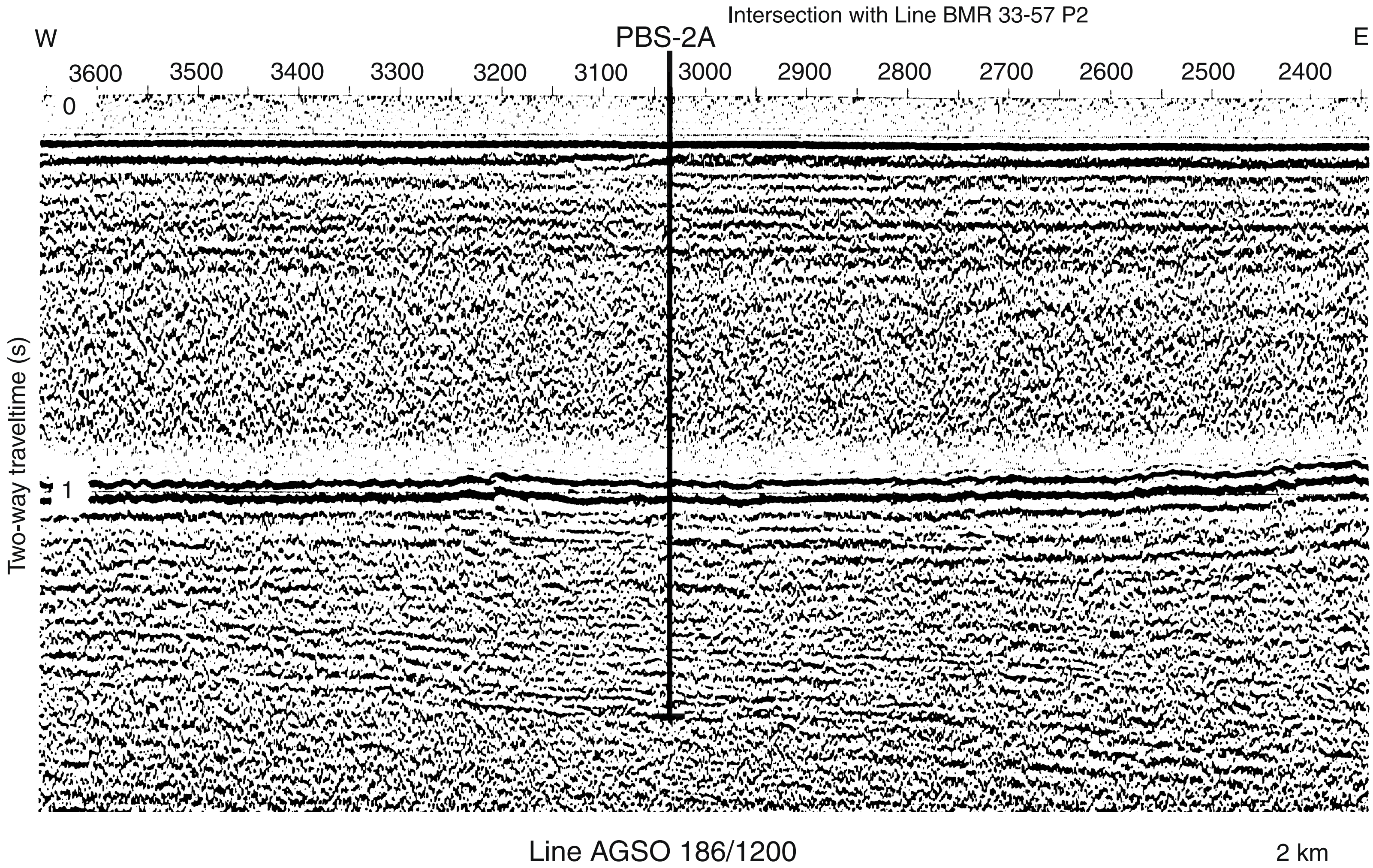
Priority: 1
Position: 67°41.45´S, 072°13.08´E
Water Depth: 697 m
Sediment Thickness: 1700 m
Target Drilling Depth: ~600 mbsf
Approved Maximum Penetration: 698 mbsf
Seismic Coverage: BMR 33-57P2 SP 493, AGSO 186/1200 SP 3038

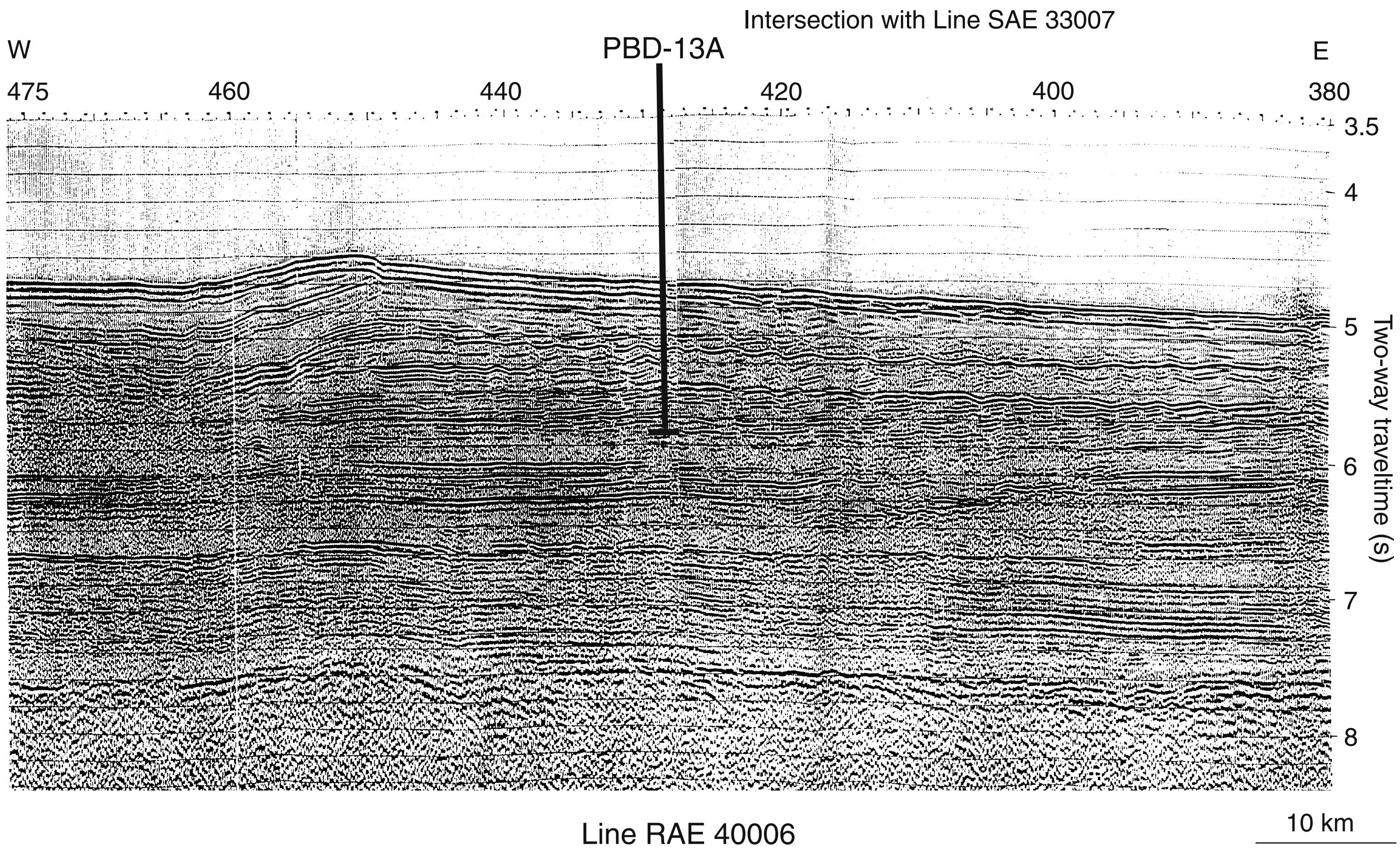
Objective: Sample the oldest glacial and youngest preglacial Cenozoic sediments in Prydz Bay.

Drilling Program: RCB Hole A to ~600 mbsf. Hole B will be drilled to ~100 mbsf using the logging-while-drilling-light (LWD-L) tool, which contains resistivity and natural gamma.

Logging Program: Hole A will use the triple combo, FMS-sonic, and GHMT tools; LWD-light in Hole B.

Nature of Rock Anticipated: Diamict, diatom ooze, sand, and mud. Possible sandstone and mudstone in preglacial section.


Intersection with Line BMR 33-57 P2
W
PBS-2A
E
3600
3500
3400
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
0
1
Two-way traveltime (s)
Line AGSO 186/1200
2 km


Intersection with Line SAE 33007
W
PBD-13A
E
475
460
440
420
400
380
3.5
4
5
6
7
8
Two-way traveltime (s)
Line RAE 40006
10 km

ALTERNATE SITES

Site: PBD-13A

Priority: 2 (alternative to PBD-12B)
Position: 63°59.807´S, 070°56.519´E
Water Depth: 3450 m
Sediment Thickness: >2 km
Target Drilling Depth: ~1020 mbsf
Approved Maximum Penetration: 1150 mbsf
Seismic Coverage: SAE 33007 SP 429, RAE 40006 SP 117.

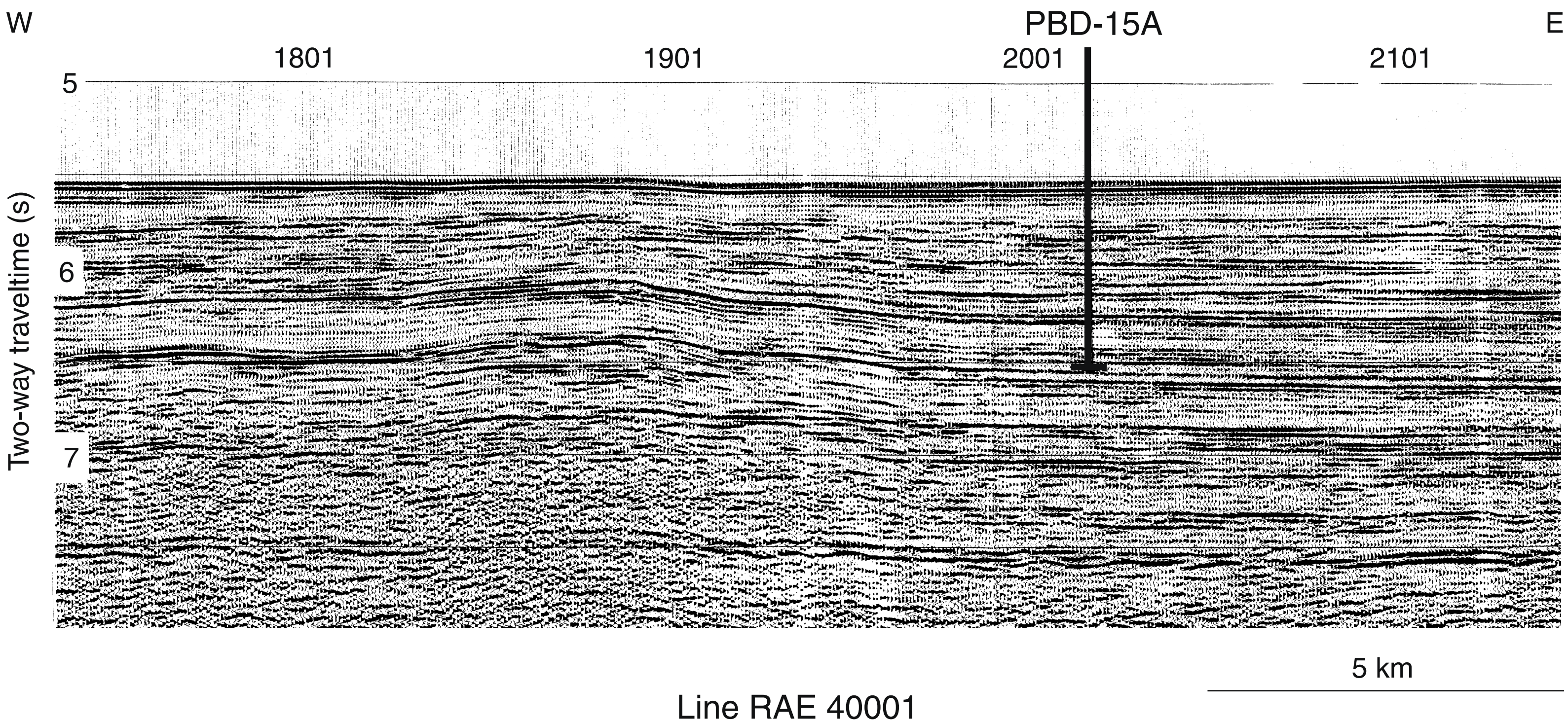
Objectives: To obtain a cored section to the base of the sediment drift on the continental rise to date the major change in sedimentation that led to drift formation (Oligocene?) and to compare the history of sedimentation on the shelf and slope with oceanic sedimentation on the rise.

Drilling Program: Same as for PBD-12B.

Logging Program: Same as for PBD-12B.

Nature of Rock Anticipated: Mud, ooze, fine sand, and ice rafted pebbles

See Figure 8 for cross line


W
PBD-15A
E
1801
1901
2001
2101
5
6
7
Two-way traveltime (s)
5 km
Line RAE 40001

Site: PBD-15A

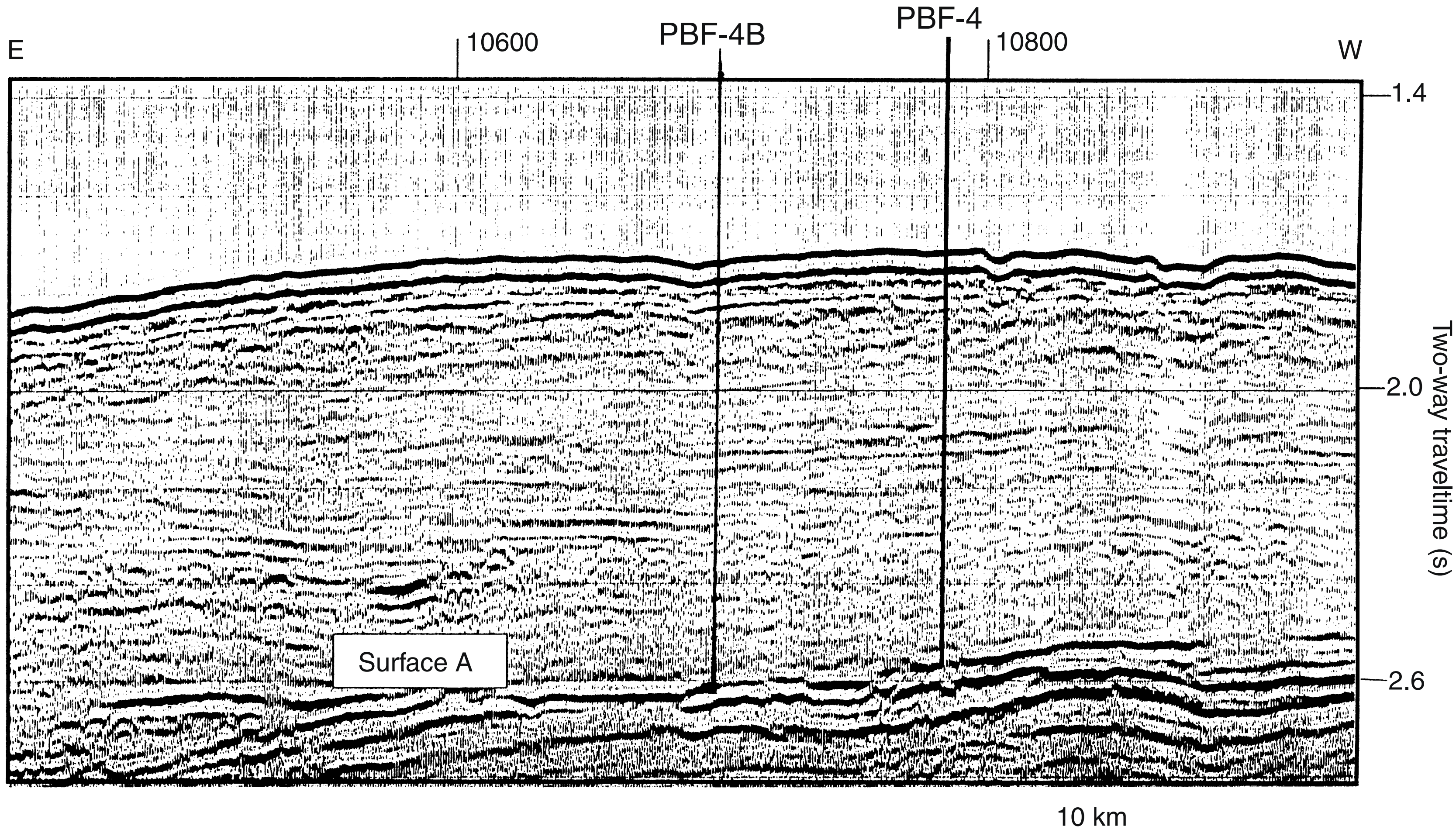
Priority: 2 (alternate to PBS-2A should Prydz Bay be inaccessible)
Position: 63°00´S, 067°38´E
Water Depth: 4125 m
Sediment Thickness: ~4000 m
Target Drilling Depth: ~850 mbsf
Approved Maximum Penetration: 850 mbsf
Seismic Coverage: RAE 40001 SP 100, RAE 40006 SP 117

Objective: Alternate to PBS-2A should Prydz Bay be inaccessible. Seismic surfaces thought to mark the onset of Cenozoic glaciation can be drilled in the relatively thin distal drift section at this location.

Drilling Program: Same as for PBD-12B

Logging Program: Triple Combo, FMS-sonic, GHMT

Nature of Rock Anticipated: Mud, silt, biogenic ooze, and rare sand



Line JNOC TH84/9-1SMG

Site: PBF-4B

Priority: 2 (alternate to PBF-6A)
Position: 66°30.5652´S, 072°24.0954´E
Water Depth: 1305 m
Sediment Thickness: ~4000 m
Target Drilling Depth: ~699 mbsf
Approved Maximum Penetration: 699 mbsf
Seismic Coverage: JNOC 84/9-1-SMG SP 10700, AGSO 149/0901 (site moved from intersection by PPSP to avoid potential hydrocarbon trap)

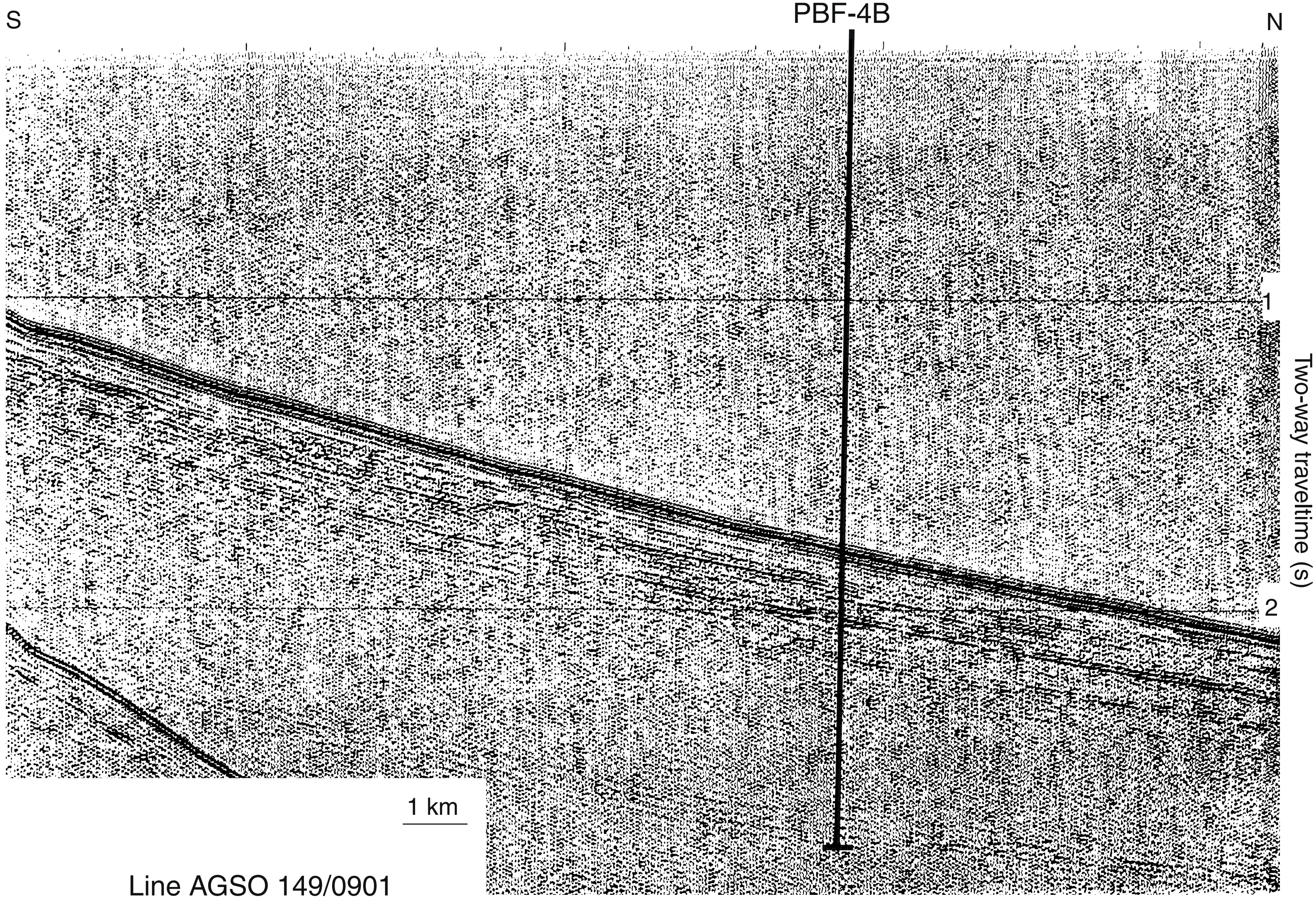
Objectives: Same as for PBF-6A.

Drilling Program: Same as for PBF-6A

Logging Program: Same as for PBF-6A

Nature of Rock Anticipated: Mud, ooze, diamict, and sand interbeds

See seismic line for PDF-6A



Line AGSO 149/0901

Site: PBF-5A

Priority: 2 (alternate to PBF-6A)
Position: 66°19.003´S, 072°16.618´E
Water Depth: 1920 m
Sediment Thickness: ~4000 m
Target Drilling Depth: ~578 mbsf
Approved Maximum Penetration: 578 mbsf
Seismic Coverage: AGSO 149/0901 SP 4463, AGSO 186/2400 SP 976

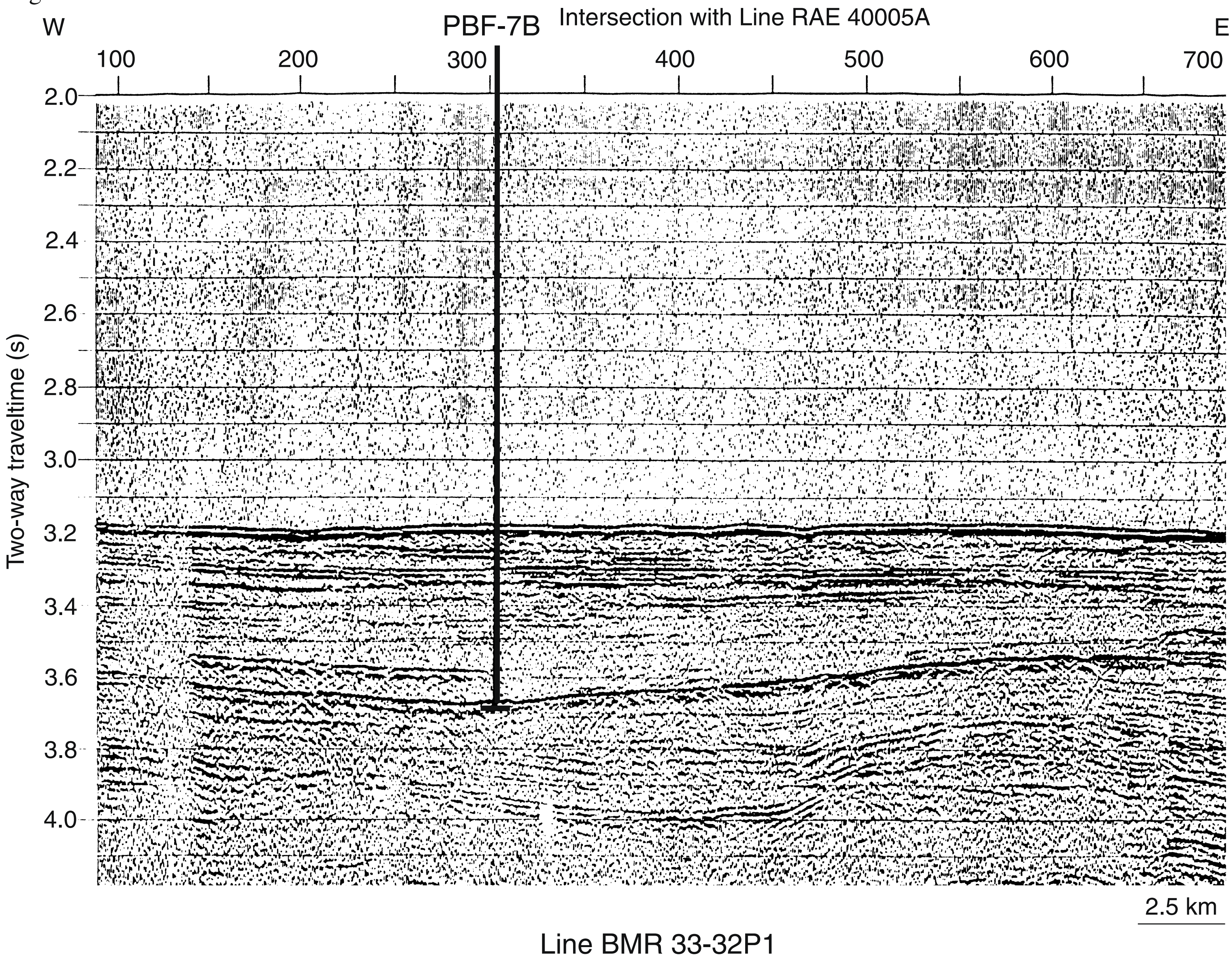
Objective: Same as for PBF-6A.

Drilling Program: Same as for PBF-6A

Logging Program: Same as for PBF-6A

Nature of Rock Anticipated: Mud, ooze, diamict, and sand interbeds

See seismic line for PDF-6A


W
PBF-7B
Intersection with Line RAE 40005A
E
100
200
300
400
500
600
700
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
3.8
4.0
Two-way traveltime (s)
2.5 km
Line BMR 33-32P1

Site: PBF-7B

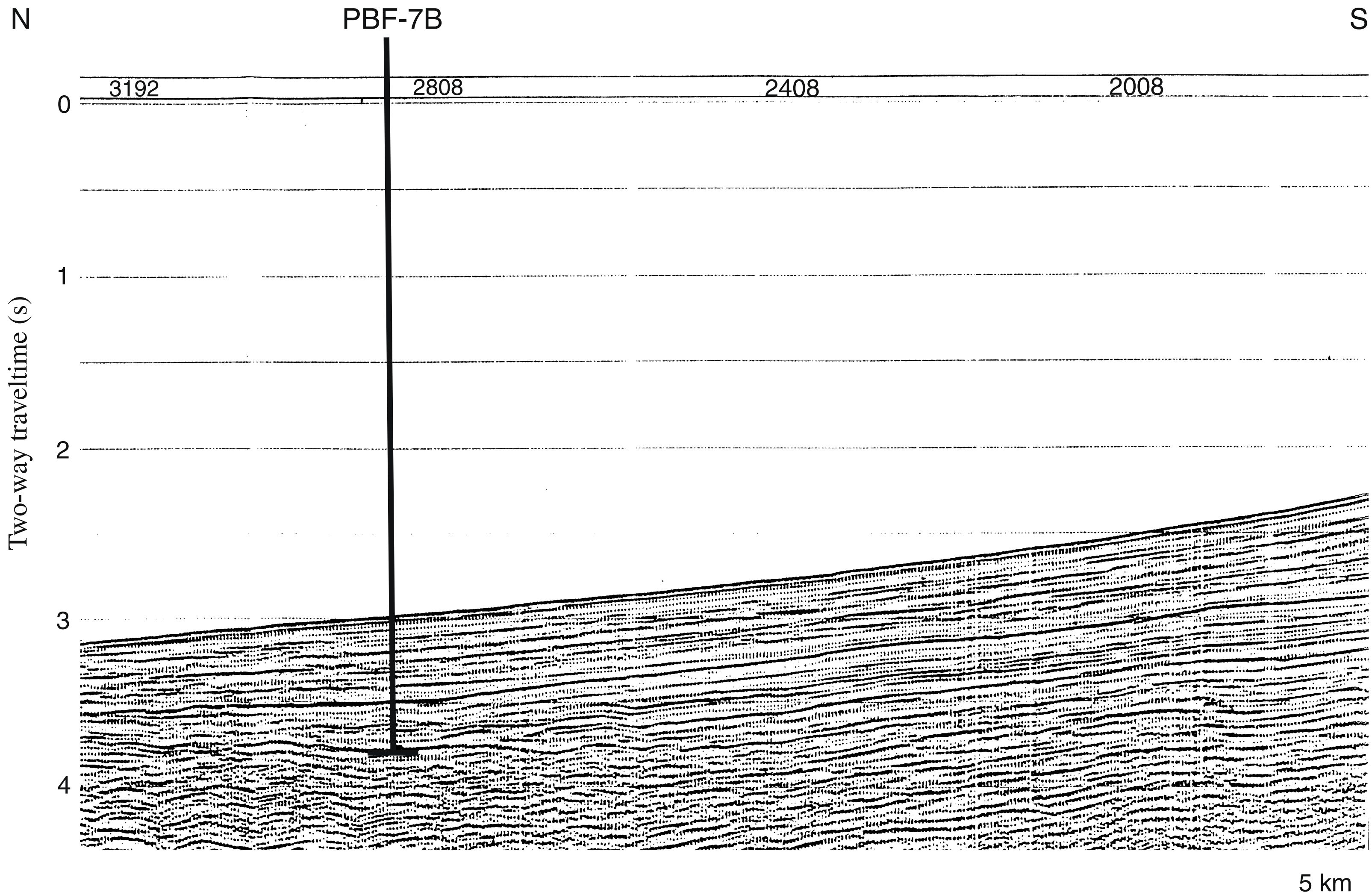
Priority: 2 (alternate to PBF-6A, chosen to be further away from PBF-6A than other alternates as suggested by ODP)
Position: 66°05.267´S, 072°07.297´E
Water Depth: 3775 m
Sediment Thickness: ~4000 m
Target Drilling Depth: ~417 mbsf
Approved Maximum Penetration: 417 mbsf
Seismic Coverage: RAE 40005A SP 2872, BMR 33-32P1 SP 304

Objective: Same as for PBF-6A. Thinner section would make for a less complete record and structural position might make the section sandier.

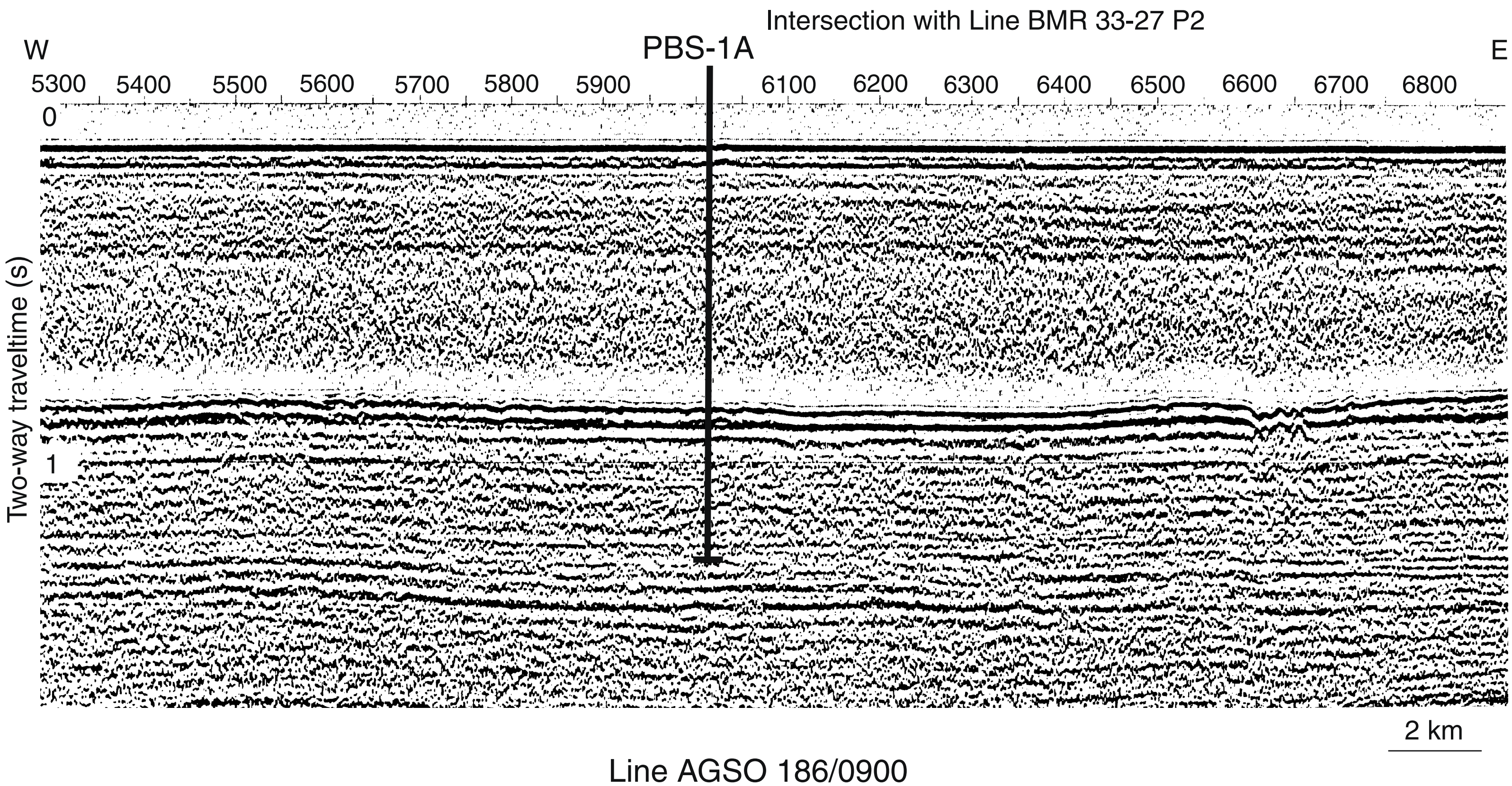
Drilling Program: Same as for PBF-6A

Logging Program: Same as for PBF-6A

Nature of Rock Anticipated: Mud, ooze, diamict, and sand interbeds



Line RAE 40005A


Intersection with Line BMR 33-27 P2
W
PBS-1A
E
5300
5400
5500
5600
5700
5800
5900
6100
6200
6300
6400
6500
6600
6700
6800
0
1
Two-way traveltime (s)
2 km
Line AGSO 186/0900

Site: PBS-1A

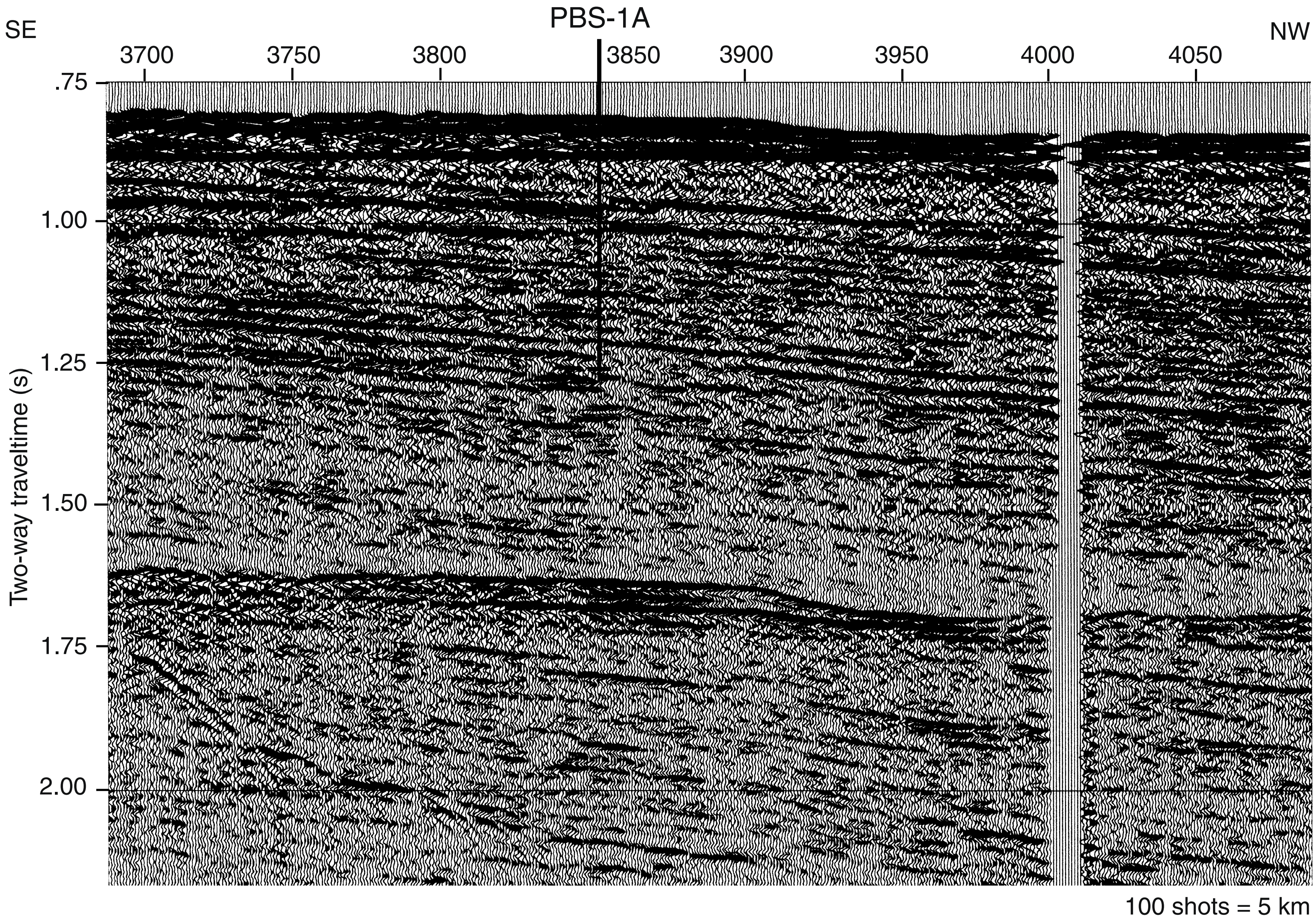
Priority: 2 (alternate to PBS-2A if PBS-2A site is inaccessible)
Position: 67°36.95´S, 073°18.34´E
Water Depth: 600 m
Sediment Thickness: 2000 m
Target Drilling Depth: ~648 mbsf
Approved Maximum Penetration: 648 mbsf
Seismic Coverage: BMR 33-27P2 SP3850, AGSO 186/0900 SP 6013

Objectives: Same as for PBS-2A

Drilling Program: Same as for PBS-2A

Logging Program: Same as for PBS-2A

Nature of Rock Anticipated: Same as for PBS-2A



Line BMR 33-27-P2

Site: PBS-3A

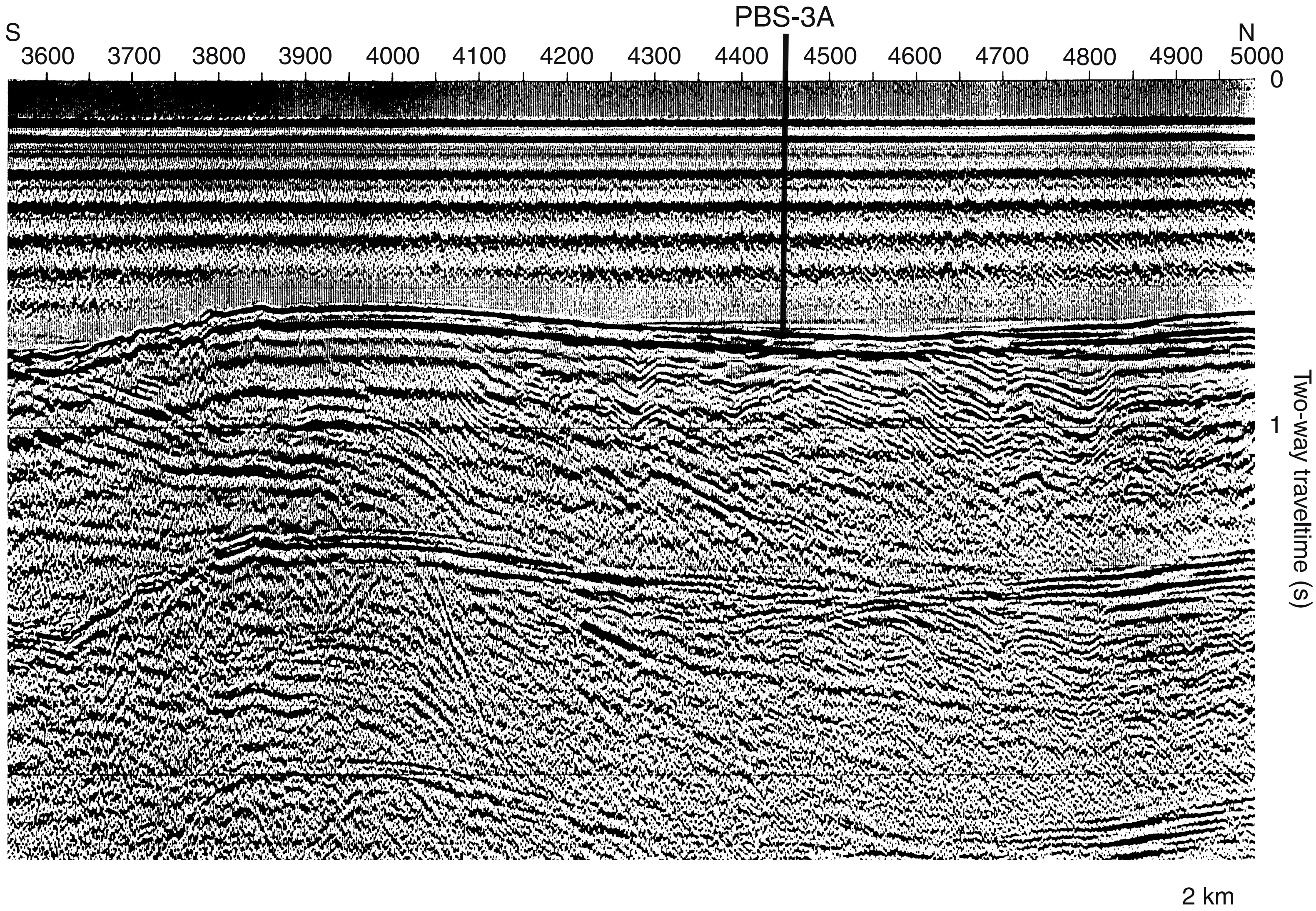
Priority: 2
Position: 66°56.55´S, 063°6.93´E
Water Depth: 470 m
Sediment Thickness: >1 km (ooze section = 50 m)
Target Drilling Depth: ~50 mbsf
Approved Maximum Penetration: 50 mbsf
Seismic Coverage: AGSO 186/1901 SP 4450

Objective: To obtain a continuous cored section to the base of the thick Holocene biosiliceous ooze section to provide a marine sedimentary record of environmental change with similar resolution to that of ice cores.

Drilling Program: Three APC holes to TD to provide a complete succession.

Logging Program: None

Nature of Rock Anticipated: Biosiliceous ooze, silt, clay, and ice-rafted pebbles.


PBS-3A
S
N
3600
3700
3800
3900
4000
4100
4200
4300
4400
4500
4600
4700
4800
4900
5000
0
1
Two-way traveltime (s)
2 km

blank

Site: PBS-4A

Priority: 2 (alternate to PBS-3A).
Position: 67°07.92´S, 062°59.57´E
Water Depth: 555 m
Sediment Thickness: >1 km (ooze section 50 m)
Target Drilling Depth: ~50 mbsf
Approved Maximum Penetration: 50 mbsf
Seismic Coverage: AGSO 186/1901 SP 2901

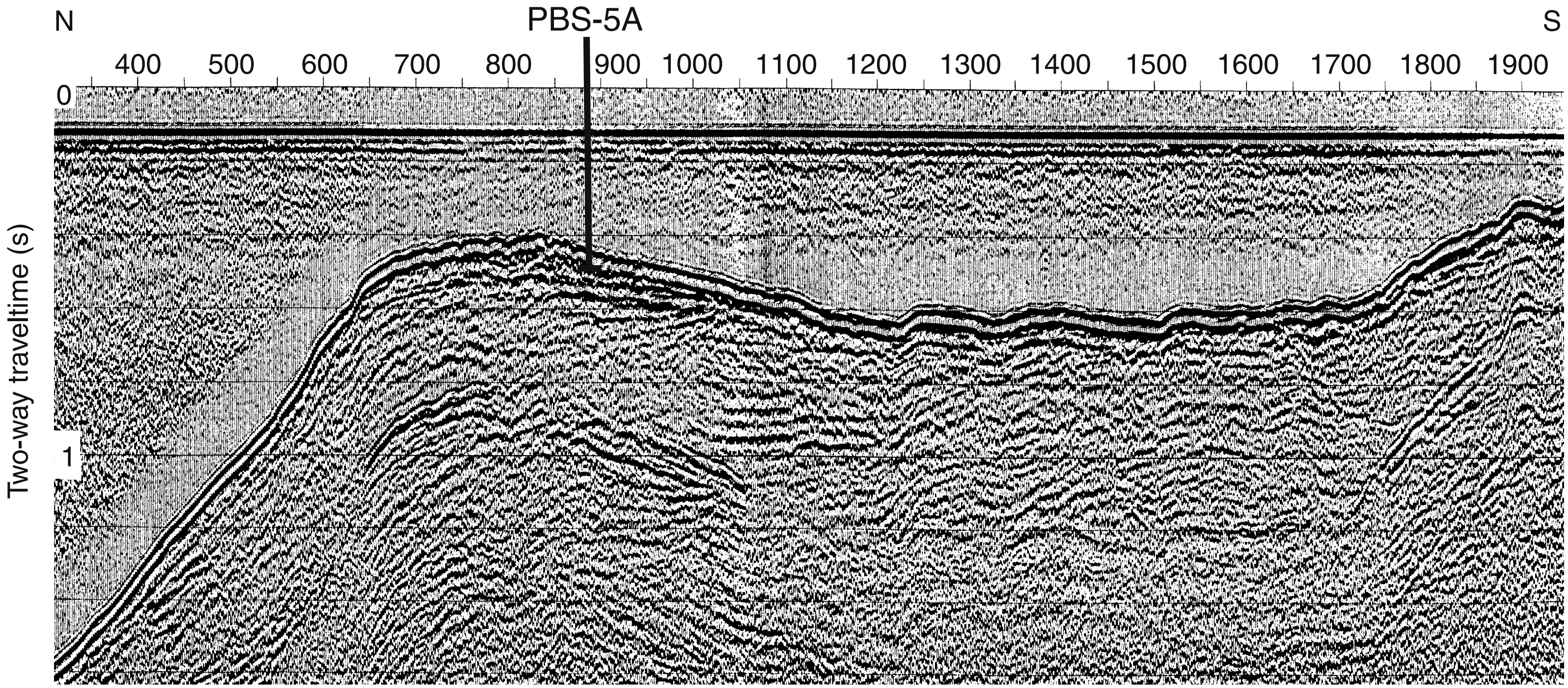
Objectives: Same as PBS-3A

Drilling Program: Three APC holes to TD to provide a complete section

Logging Program: None

Nature of Rock Anticipated: Biosiliceous ooze, silt, clay, and ice-rafted pebbles

See Figure 12 for seismic cross section



Line AGSO 186/1800

Site: PBS-5A

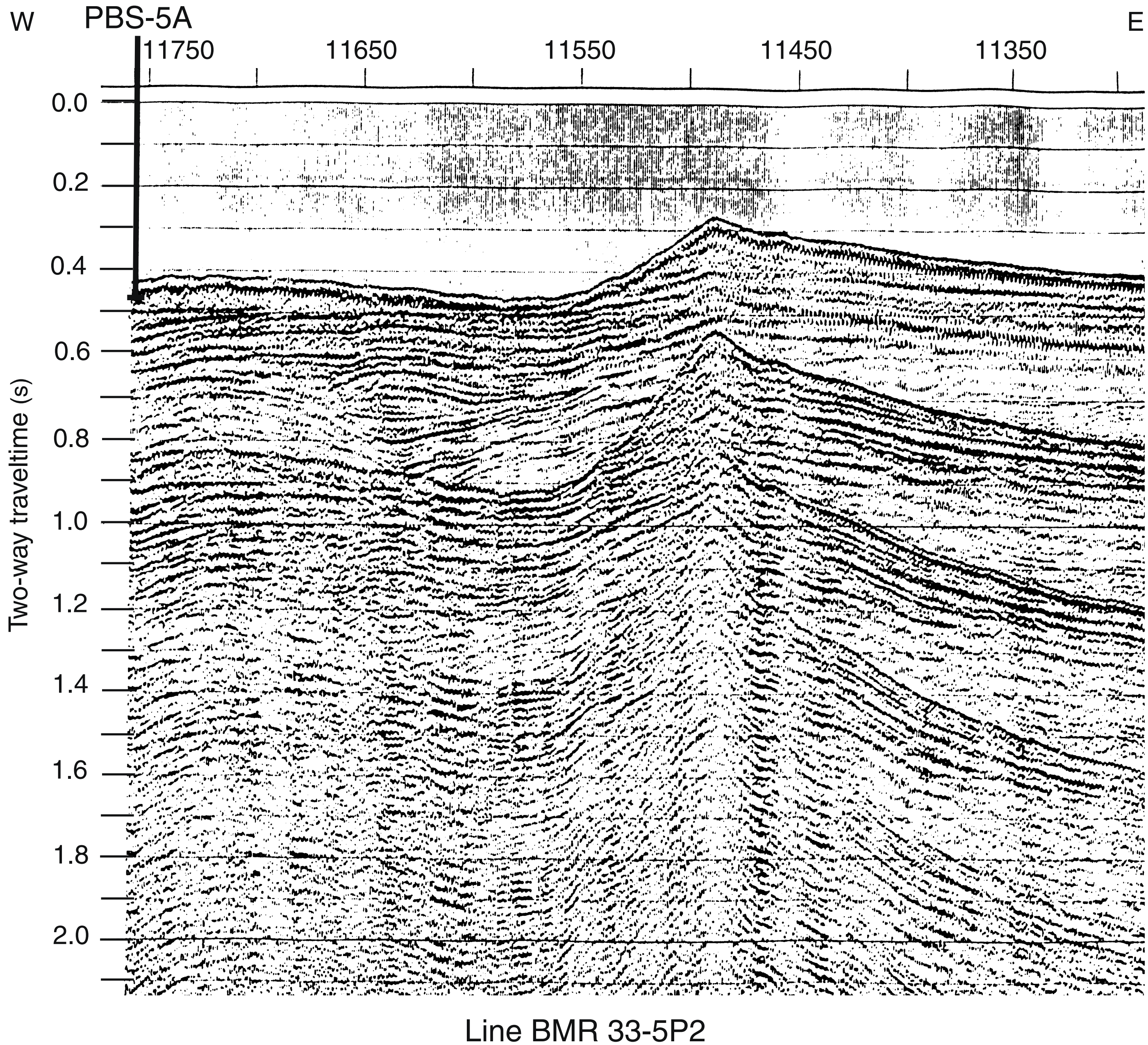
Priority: 2 (alternate to PBS-2A should Prydz Bay be inaccessible)
Position: 66°47.808´S, 063°15.597´E
Water Depth: 315 m
Sediment Thickness: ~1 km
Target Drilling Depth: ~50 mbsf
Approved Maximum Penetration: 50 mbsf
Seismic Coverage: AGSO 186/1800 SP 883, BMR 33-5P2 SP 11760

Objectives: Alternate to PBS-2A if Prydz Bay is inaccessible. Gravity cores containing Paleogene marine fossils indicate that a shallow hole at PBS-5A may recover mid-Eocene sediments.

Drilling Program: RCB to TD

Logging Program: None

Nature of Rock Anticipated: Diamict at surface, then siltstone, sandstone, and mudstone


W
PBS-5A
E
11750
11650
11550
11450
11350
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Two-way traveltime (s)
Line BMR 33-5P2

Site: PBS-6A

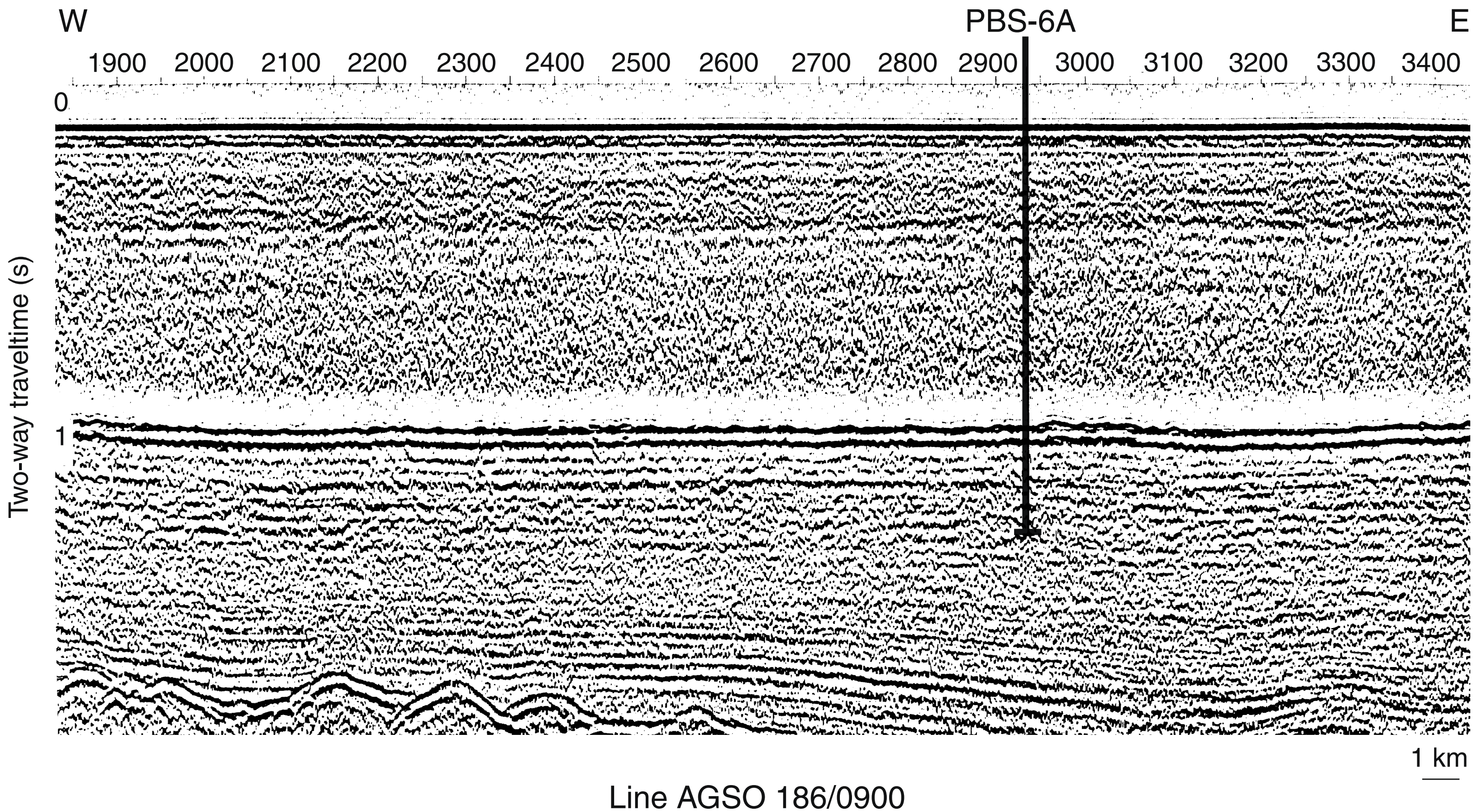
Priority: 2 (alternate to PBS-2A should that hole be unable to reach total depth TD)
Position: 67°46.638´S, 072°11.529´E
Water Depth: 697 m
Sediment Thickness: 1400 m
Target Drilling Depth: ~294 mbsf
Approved Maximum Penetration: 294 mbsf
Seismic Coverage: AGSO 186/0900 SP 2939, AGSO 186/1300 SP 678

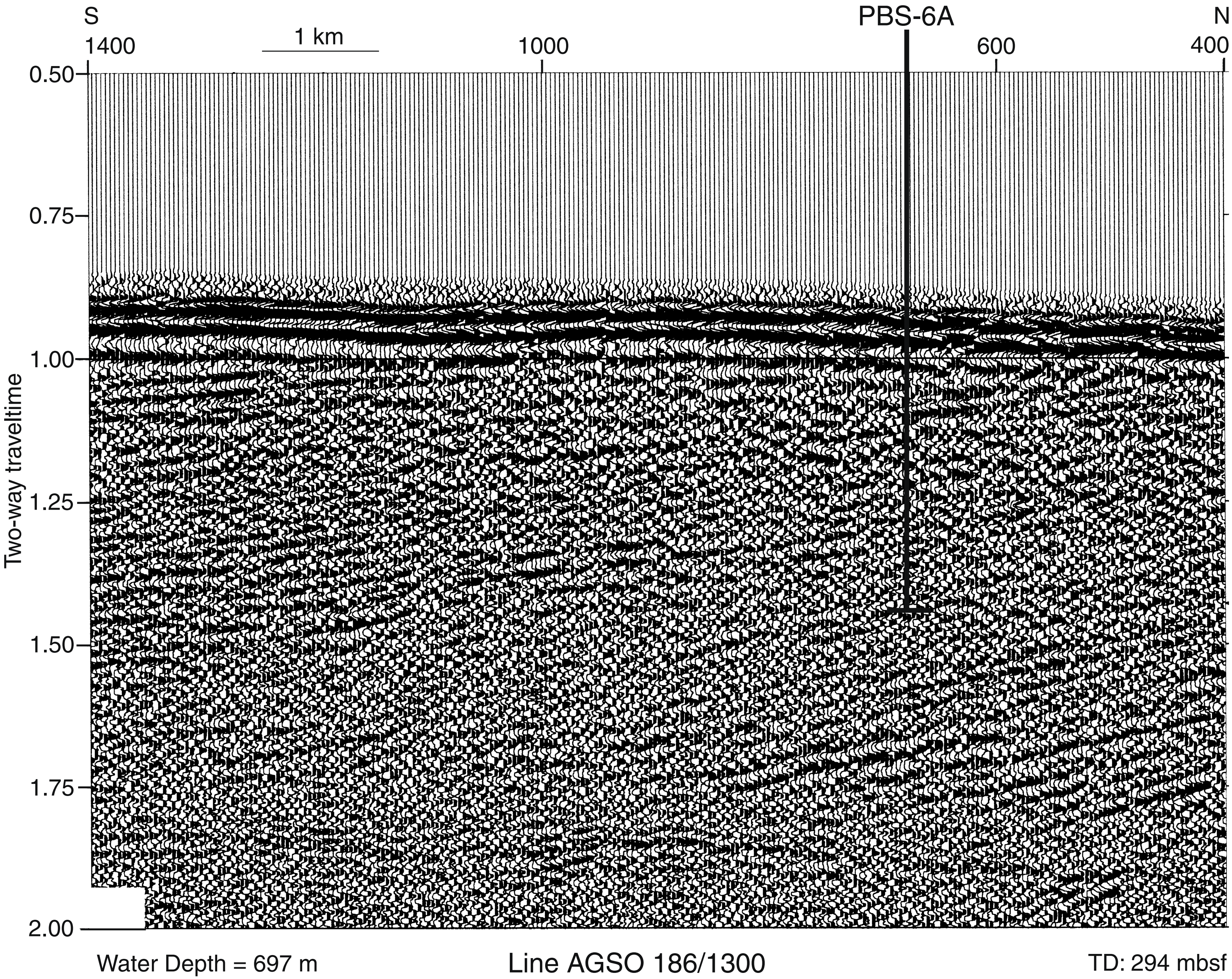
Objectives: Alternate to PBS-2A should that hole be unable to reach TD. PBS-6A is updip from PBS-2A and intersects the lower part of the Cenozoic section to be drilled at PBS-2A.

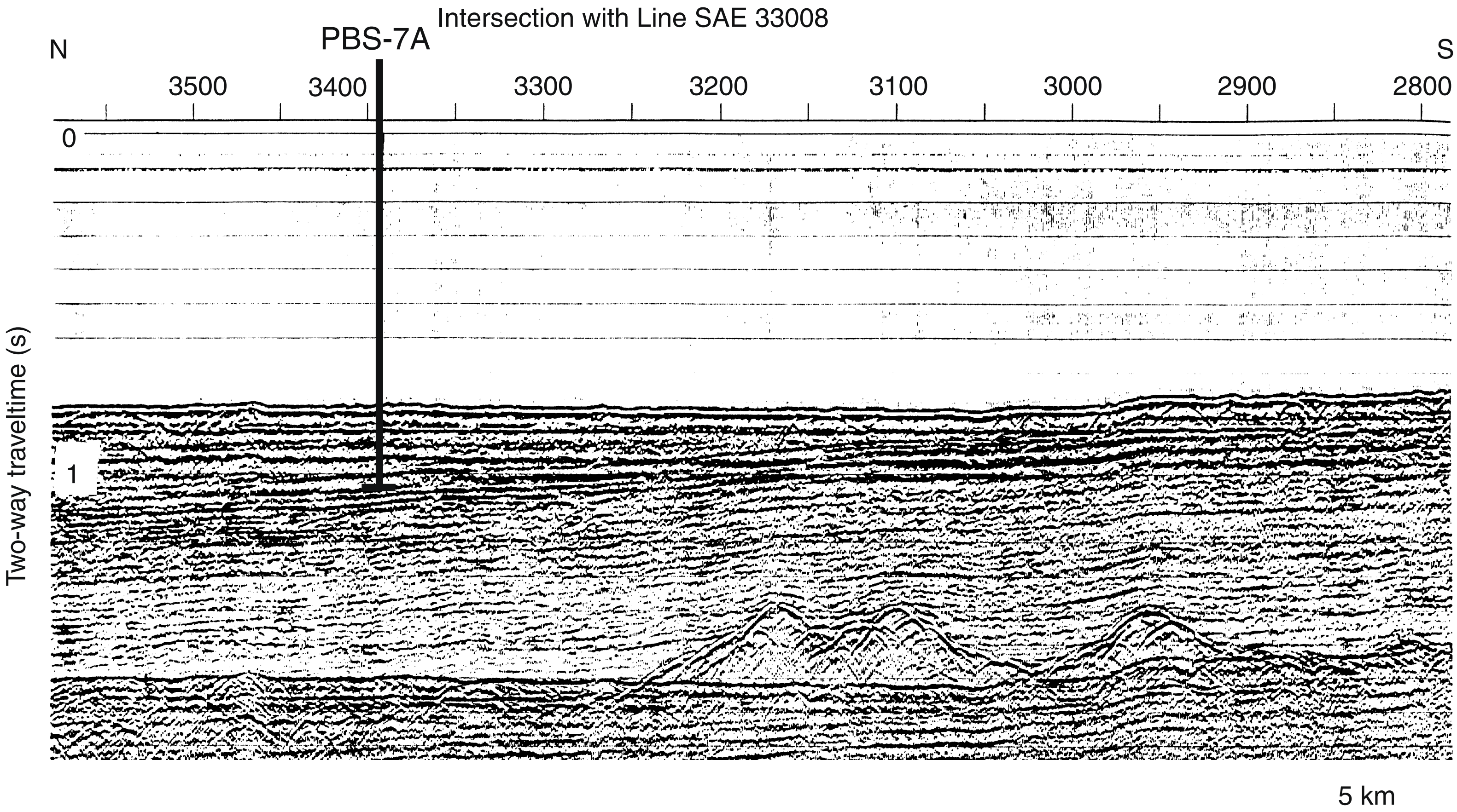
Drilling Program: Same as for primary site

Logging Program: Same as for primary site

Nature of Rock Anticipated: Diamict, mud, mudstone, and sandstone


W
PBS-6A
E
1900
2000
2100
2200
2300
2400
2500
2600
2700
2800
2900
3000
3100
3200
3300
3400
0
1
Two-way traveltime (s)
1 km
Line AGSO 186/0900


S
PBS-6A
N
1400
1 km
1000
600
400
0.50
0.75
1.00
1.25
1.50
1.75
2.00
Two-way traveltime
Water Depth = 697 m
Line AGSO 186/1300
TD: 294 mbsf



Line BMR 33-27-P2

Site: PBS-7A

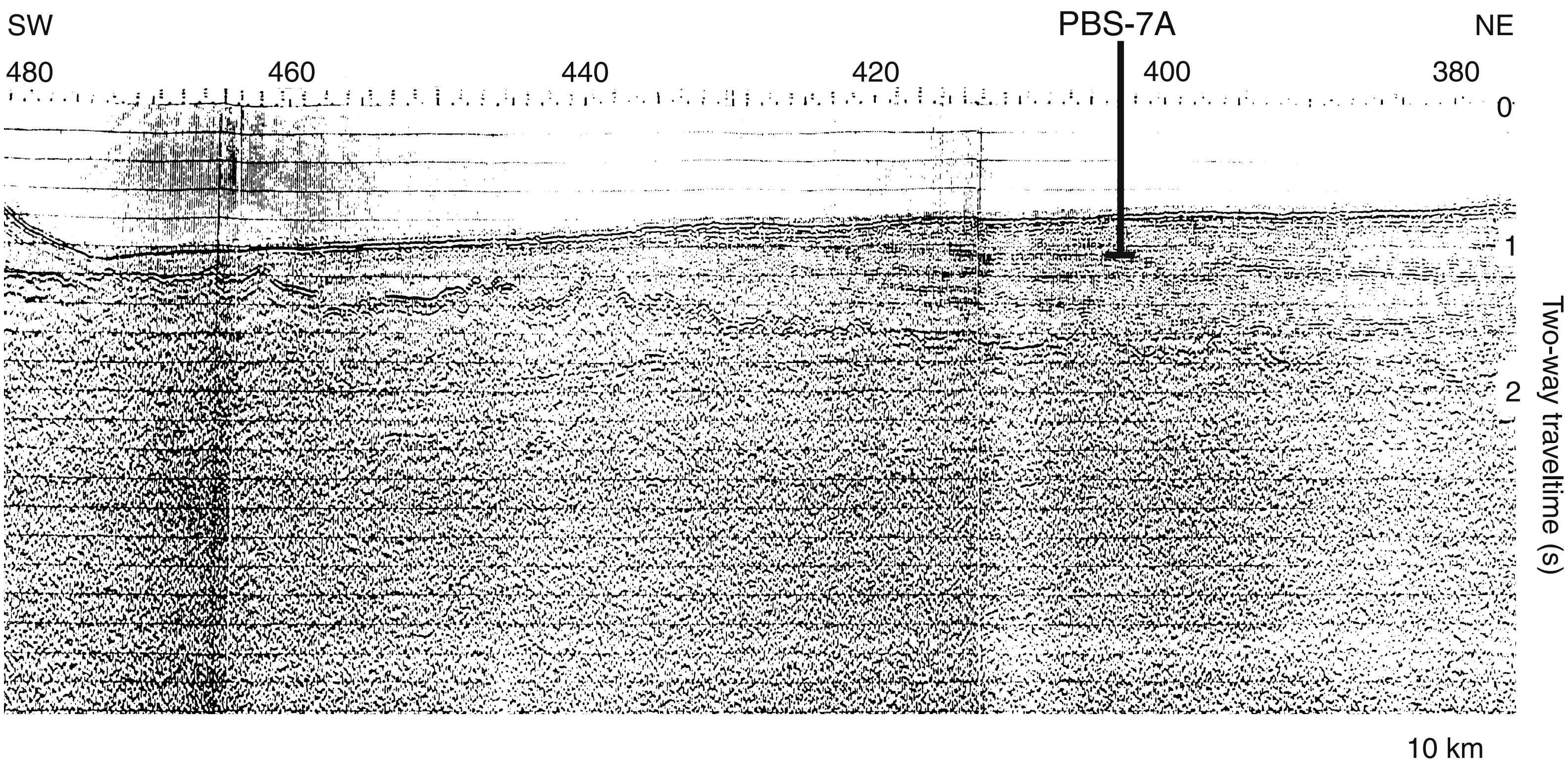
Priority: 2 (alternate to PBS-1A or PBS-2A should that hole be unable to reach TD)
Position: 67°42.91´S, 073°26.112´E
Water Depth: 592 m
Sediment Thickness: 1460 m
Target Drilling Depth: ~276 mbsf
Approved Maximum Penetration: 276 mbsf
Seismic Coverage: BMR 33-27P2 SP 3393, SAE 3308 SP 403.23

Objectives: Alternate to PBS-2A or PBS-1A should we be unable to reach TD at those sites. PBS-7A is updip from PBS-1A and intersects the lower part of the Cenozoic section to be drilled in PBS-1A.

Drilling Program: Same as for PBS-2A or PBS-1A

Logging Program: Same as for PBS-2A or PBS-1A

Nature of Rock Anticipated: Clay, silt, biosiliceous ooze, sand, and diamict. Possible sandstone and mudstone in preglacial section



Line SAE 33008

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