OCEAN DRILLING PROGRAM

LEG 166 SCIENTIFIC PROSPECTUS

THE BAHAMAS TRANSECT

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This Scientific Prospectus is based on pre-cruise JOIDES panel discussions. 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 Superintendent 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 Planning Committee and the Pollution Prevention and Safety Panel.

ABSTRACT

Although sea-level fluctuations are known to have occurred throughout the earth's history, their global synchroneity, amplitude, and rate are still largely unknown. A better understanding of global changes in sea level is contingent upon coverage in a variety of tectonic and sedimentary settings, such as the deep sea, carbonate platforms and atolls, and continental margins.

The primary objective of Leg 166 will be to address fundamental questions regarding sea level. To attain this objective, five sites in the Straits of Florida will be drilled during Leg 166, completing a transect through prograding carbonate sequences formed in response to sea-level fluctuations along the western margin of the Great Bahama Bank. Two boreholes drilled previously on the western Great Bahama Bank as part of the Bahamas Drilling Project represent the shallow-water sites of the transect. The primary goal of the transect is to document the platform-margin record of the Neogene–Holocene sea-level changes by determining the ages of the major unconformities and to compare the timing of these unconformities with ages predicted from the oxygen isotopic record of glacio-eustasy. Core borings along the complete transect will document the facies variations associated with oscillations of sea level and, thus, the sedimentary response of the carbonate environment to sea-level changes. The correlation between the two independent records of sea-level changes, sequence stratigraphy and oxygen isotope proxy, has the potential to evaluate rate and amplitude of eustatic vs. relative sea-level changes and to establish a causal link between glacio-eustasy and the stratigraphic pattern.

Leg 166 also will core a number of holes through the sediments on the upper slope to measure the composition of the recharged waters retained in the sediment to assess rate and flow mechanisms through the bank. One of the distal sites of the transect will be deepened to determine the onset of the Florida Current, acquire a low-latitude record of the Paleogene "Doubthouse" and its transition into the Neogene "Icehouse," potentially sample the Cretaceous/Tertiary (K/T) boundary, and core the middle Cretaceous sequence boundary to assess the cause of the platform demise in the middle Cretaceous.

INTRODUCTION

Understanding global changes in sea level has been recognized as a first-order priority in global studies by several planning committees of the Ocean Drilling Program (Conference on Scientific Ocean Drilling II, Joint Oceanographic Institutions, Inc./United States Science Advisory Committee Workshop El Paso, and Sea Level Working Group [SL-WG]). To gather the necessary data to address questions surrounding sea-level changes, a global coverage is needed in a variety of tectonic and sedimentary settings. Analysis of material from the deep sea, carbonate platforms and atolls, and continental margins provides three independent ways to measure sea-level changes:

1. The deep-sea sediments provide a proxy for glacio-eustasy through variations in foraminiferal $\delta^{18}O$.

2. Aggradational packages separated by exposure horizons on atolls and platforms record variations in sea-level-like dipsticks.

3. Continental margin sediments preserve the changes of sea-level variations by means of unconformities and stratigraphic patterns within the sediments.

To completely understand changes in sea level, the drilling objectives of transects across the continental margins should address four major issues: (1) dating sea level-related stratigraphic events; (2) establishing the stratigraphic response to sea-level oscillations; (3) estimating the magnitudes and rates of sea-level changes through time; and (4) understanding the mechanisms of sea-level change.

As a short term strategy, the SL-WG recommended testing the synchrony of stratigraphic events in the Neogene, where optimum age control and a calibrated signature of sea level are best constrained. Leg 150 on the siliciclastic New Jersey margin was the first transect in this Ocean Drilling Program (ODP) drilling effort. Drilling the Neogene of the Bahamas carbonate province is the appropriate next step because it offers a geographically close test of the ability to correlate stratigraphic events between two areas of contrasting sedimentary settings.

The Potential of the Bahamas Transect to Investigate Global Changes in Sea Level

A major requirement for studying the sedimentary record of sea-level changes are transects from a marginal marine to deep-basin environment. As such, alternative platforms for near-shore sites are necessary. In the case of the Bahamas Transect (Figs. 1, 2), these shallow-water drill sites are in hand. These cores were drilled from a self-propelled workover barge and provide the record at the proximal parts of the sequences (Figs. 2, 3). A second requirement, also met at the proposed drilling area, is a large set of seismic lines that provide good stratigraphic resolution and optimal locations for drill sites.

Probably the most important advantage of the proposed Bahamas Transect is its potential to combine all three independent methods of measuring sea-level changes. The Great Bahama Bank (GBB) is a flat-topped platform on a passive continental margin. Its flat top records sea level much as a dipstick, the prograding sequences record sea-level changes in their stratigraphic pattern, and the correlative deep-water deposits encode the $\delta^{18}O$ proxy of sea-level changes in their foraminiferal assemblages. The correlation of the oxygen isotopic record with the sequence stratigraphic pattern will, for the first time, document a causal link between glacio-eustasy and stratal pattern. This correlation also will provide insights in how high-frequency sea-level fluctuations are recorded in the sediments and how the stacking of these high-frequency cycles produces the lower-order seismic sequences.

The transect proposed in this prospectus is designed to document the facies variations related to sea-level oscillations from shallow water (about 300 m) to a water depth of approximately 700 m. This range allows us to fully assess the sedimentary response of carbonates to sea-level changes. Carbonate depositional sequences are, like their siliciclastic counterparts, unconformity-bounded depositional packages, but they record changes of climate and relative change of sea level in their own characteristic way, resulting in a system-specific depositional sequence architecture (Sarg, 1988; Eberli and Ginsburg, 1989; Schlager, 1991). For example, flat-topped carbonate platforms and shelves produce and export more sediment during sea-level highstands. This highstand shedding puts the carbonate environment out of phase with the siliciclastic environment in which most of the sediment is exported into deeper water during sea-level lowstands (Mullins, 1983; Droxler and Schlager, 1985; Schlager, 1991). The highstand shedding is most pronounced along steep-sided platforms such as the modern GBB. However, throughout most of the Neogene, the western margin of GBB had a ramplike profile. Consequently, the Bahamas Transect offers the opportunity to document the response of the carbonate environment to sea-level changes at different margin profiles. Finally, the sediments recovered along the transect can be compared with the siliciclastic sequences of the New Jersey Sea Level/Mid-Atlantic Transect (NJ/MAT) (ODP Leg 150) and sequence stratigraphic models (Posamentier and Vail, 1988) to assess the difference in sedimentary response for siliciclastic and carbonate margins.

Timing of unconformities along prograding carbonate platform margins can be achieved by an integrated age-dating effort that includes the incorporation of planktonic foraminiferal biostratigraphy, nannofossil biostratigraphy, strontium isotope stratigraphy, and magnetostratigraphy. In the proximal parts of the Bahamas Drilling Project (BDP) transect, dating was not an easy undertaking as a result of pulses of platform-derived sediments that dilute microfossil abundance. However, based on the results from ODP Leg 101 along the slopes of the Little Bahama Bank and in Exuma Sound, biostratigraphic dating will not be a problem in the slope settings (Melillo, 1988). Thus, precise age constraints on sequence boundaries, as well as demonstrating that the seismic reflections are synchronous, can be expected in the deep-water sites of the Bahamas Transect.

The GBB has a relatively predictable subsidence history (Williams et al., 1988) and is a suitable candidate for the evaluation of the amplitude of sea-level changes. In addition, the light-dependent sediment production of the carbonate environment provides carbonate platforms with an accurate paleobathymetric indicator. Because carbonate production in low latitudes is an order of magnitude higher than most sea-level changes, carbonate platforms and reefs are able to keep or catch up with sea-level rises and maintain a relatively flat platform top (Kendall and Schlager, 1981; Schlager, 1981). Sea-level falls usually expose the platform top, which results in the development of a suite of characteristic features that are easily recognized in the rock record (e.g., karst, red soils, caliche horizons, black pebble horizons, etc.) or of diagenetic zones with a typical petrologic and stable isotopic signal (e.g., Halley and Matthews, 1987). On the platform tops, sea-level highstands are recorded in the sediment between these exposure horizons. With the completion of the chronostratigraphy of the shallow drill sites, Unda and Clino, and of three other core borings from farther in the platform (McNeill et al., 1988; McNeill, 1989), recalculation of the subsidence curve of the GBB is possible. Thus, a relatively accurate measurement of the amplitude of sea-level changes can be achieved.

In summary, the Bahamas Transect offers the opportunity to address several fundamental questions regarding sea-level changes and to begin to acquire the global database needed for evaluating the timing and amplitudes of these changes. The proposed transect will provide the sedimentary record of sea-level changes in a carbonate environment on a passive continental margin. In addition, the $\delta^{18}O$ proxy in the foraminiferal assemblages of the basinal deposits can be correlated directly to the sedimentary record of sea-level change.

STUDY AREA

Regional Geologic Setting

The Bahamas archipelago is a carbonate province consisting of several isolated platforms situated on the southern end of the eastern continental margin of the United States. The margin formed in the Jurassic as a result of the opening of the Atlantic and underwent collision with the Caribbean plate during the late Cretaceous, culminating in the Eocene. During this time, the Bahamas were part of the foreland basin, which resulted in some folding, faulting, and increased subsidence in areas close to the plate boundary (Ball et al. 1985; Walles, 1993). With the shift of the plate boundary south of Cuba at the end of the Eocene, Cuba remained welded to the southern part of the American continental margin and tectonic activity ceased.

The foundation of the Bahamian platforms was and still is a subject of debate that centers around two major questions: (1) whether the Bahamian basement is continental or oceanic and (2) whether the modern platform pattern still reflects the graben and horst topography that formed during the Jurassic rift stage (Mullins and Lynts, 1977; Ladd and Sheridan, 1987; and references in both). The character of the basement underlying the platforms is unknown from drilling, but refraction seismic data indicate a 12- to 14-km-thick crust with a wave velocity of 7.2 km/s (Sheridan, 1972). These velocities can be interpreted as derived from either altered continental crust or oceanic crust.

Two fundamentally different concepts were proposed to explain the origin of the pattern of the Bahamian platforms. The graben hypothesis assumed that the modern array of platforms reflects the block-faulted topography of the Jurassic rift stage in which the intra-platform seaways are remnants of the grabens, whereas the platforms are located on ancient horsts (Mullins and Lynts, 1977). The megabank hypothesis proposed that the Bahamian platforms were part of a much larger extensive shallow-water carbonate platform under which inherited rift topography was buried in an early stage of platform evolution (Sheridan et al., 1981). This megabank was drowned during the middle Cretaceous, and only small, isolated platforms reestablished and became the foundation of the modern platforms (Schlager and Ginsburg, 1981). One of the objectives of ODP Leg 101 was to test these hypotheses, but coring results did not entirely settle the debate. They did, however, confirm the existence of a larger platform in the Bahamas/Blake Plateau area at the end of the Early Cretaceous, but also a deep-water reentrant at the location of the modern Northeast Providence Channel (Austin, Schlager, et al., 1988).

In the late 1980’s, seismic reflection profiles across the top of the GBB revealed the anatomy of part of the bank, and to a large extent, settled the debate. The seismic profiles show that the modern pattern is neither the reflection of a topography that formed in the Jurassic nor in the middle Cretaceous, but is modified continuously by destructive and prograding processes (Eberli and Ginsburg, 1987, 1989). The profiles document that tectonism controlled the initial pattern of the platforms, and progradation subsequently filled some of the seaways. In addition, seismic stratigraphy indicates a repetition of the process of tectonic segmentation and depositional coalescence which continuously modifies the platform pattern (Eberli and Ginsburg, 1987, 1989). The repetition of segmentation implies that tectonic events related to the American/Cuban collision are important in the development of the GBB. The productive bank, however, covers faults and buries the tectonic relief by the infilling of intraplatform seaways and bank margin progradation. In the GBB, extensive progradation advanced the modern western bank edge to 27 km basinward over the original fault (Eberli and Ginsburg, 1989). The Bahamas Transect is located on this western prograding margin of the GBB (Figs. 1, 2).

Results of the Bahamas Drilling Project

BDP operations on the western margin of the GBB aimed to address (1) the nature of progradational facies, and the source of sediment, (2) the timing and the rate of progradation, (3) the role of sea level in controlling progradation, and (4) the cause of seismic reflections in such a pure carbonate environment.

The Seismic Record

The holes of the BDP were positioned on a multichannel seismic grid that crossed the GBB platform margin (Fig. 1). The geometry and internal architecture of eight sequences seen on this line (Fig. 3) is interpreted to reflect the following general relative sea-level history. A lowering of sea level during the deposition of the basal sequence *h* at the middle/upper Miocene boundary(?) shifted the platform edge more than 10 km basinward. Two subsequent sea-level changes created little accommodation space on the platform during the rise, but deep incisions were created during the falls of sea level. Thus, the three basal sequences are thought to be deposited during a long-term relative lowstand of sea level. A major backstep of the margin is observed in the following sequence, indicating a high-amplitude sea-level rise (during the late early Pliocene) with which the platform could not keep pace. With a decrease of the rate of rise, the platform was able to fill all the accommodation space in an aggradational/progradational pattern. The subsequent sea-level rises overstep the platform only slightly. As a result, a situation similar to a forced regression was created that led to the major prograding pulses seen in the upper Pliocene and Pleistocene sequences c, b, and a.

The Sedimentary Record

The two shallow-water cores (Unda and Clino) of the BDP were positioned on the prograding western margin, where a high sedimentation rate yields a high chronostratigraphic resolution. Clino penetrated mostly inclined slope deposits, whereas Unda, the more proximal site, penetrated platform deposits and a buried platform margin. Continuous cores were made using a wireline system with a triple-tube core barrel 3.05 m (10 ft) long that recovered cores of 6.3 cm (2.5 in) in diameter. Core Clino was drilled 677.71 m (2222.0 ft) below the mud pit datum (7.3 m, 24 ft above sea level). Recovery in Clino averaged 80.8%. Core Unda was drilled 454.15 m (1489 ft) below the mud pit (5.2 m, 17 ft above sea level). Recovery in Unda averaged 82.9%.

Detailed sedimentologic studies in two core borings revealed multiple, punctuated depositional sequences with different frequencies that are interpreted as the sedimentary record of relative sea-level changes (Fig. 4). In the shallow portions, caliche crusts, karst, and black pebble conglomerates are taken as indicators of exposure horizons, whereas, in the slope section, changing sediment composition is correlated to fluctuations in sea level.

Unda consists of three successions of shallow-water platform sands and reefal deposits (108.1–8.6 m, 354.7–292.8 m, 453–443.5 m), making up ~40% of the core, that alternate with sand and silt-sized deeper marginal deposits (Fig. 4). The upper two platform/reefal intervals show evidence of repeated episodes of shoaling and/or subaerial exposure. The intervals between the three platform/reefal units consist of fine-grained skeletal to mixed skeletal/nonskeletal silts and sands. The intervals are arranged in several successions that are interpreted as depositional sequences reflecting changes in relative sea level. The tops of five of the successions contain marine Fe/Mn hardgrounds or condensed layers with concentrations of phosphate and/or reworked benthic foraminifers.

In Clino, a single unit of platform/reefal sediments overlying a thick succession of slope sediments was recovered (Fig. 4). The shallow platform section (98.5–21.6 m) has at least seven parasequences, each of which is capped by a horizon of subaerial exposure. In the reefal unit (197.4–98.5 m), there is an upward progression from deep reef/fore slope to fore reef to reef crest and, finally, to back reef. The nearly 480 m of slope sediments (676.6–197.4 m), consists predominantly (80%) of monotonous background sediment of fine sand- to silt-sized skeletal and non-skeletal grains interrupted by 12 intervals of coarse-grained skeletal sands; five of these intervals are associated with marine hardgrounds or firm grounds. The alternating intervals of skeletal interruptions, overlain by intervals of background sediment, reveal a pattern of three larger depositional sequences with an average thickness of ~170 m, each containing two to three smaller scale sequences with a thickness ranging from 25 to 90 m. The sediment composition of the interruptions with reworked foraminifers, lithoclasts, and coarse skeletal debris indicates deposition during sea-level lowstands. Flooding events are expressed as marine hardgrounds and/or deposits of reworked material. Sedimentation during times when the platform is flooded is characterized by the fine-grained mixed skeletal and peloidal packstones and wackestones.

The Correlation Between Cores and Seismic Sections

A vertical seismic profile and a synthetic seismic profile derived from the sonic and density logs were used to tie the cores Unda and Clino to the seismic sequences. Within the resolution of the seismic reflection, all but one seismic sequence boundary correlated with a lithologic facies change (Figs. 4 and 5). The lithologic indications of sea-level changes coincide with the interpretation drawn from the sequence stacking pattern. At the platform interior site Unda, four sequence boundaries are associated with subaerial exposure horizons. Within the slope section Clino, the inferred positions of the seismic sequence boundaries coincide with a hardground and/or an erosional contact (Fig. 4). Both surfaces are overlain by coarse-grained redeposited grainstones and packstones that probably were deposited during relative lowstands of sea level.

Chronostratigraphy of the Core Borings

High-resolution chronostratigraphy is obtainable in prograding-margin carbonate through a combined age-dating approach involving micropaleontology, strontium isotope stratigraphy, and magnetostratigraphy. This integrated dating showed that an understanding of the slope dynamics and depositional system is critical toward interpretation of the biostratigraphic data, as extreme dilution by platform-derived sediments occurs during margin progradation. As such, the occurrence and highest abundance of microfossils is restricted to the thin units of pelagic-rich sediment deposited during temporary intervals when platform sediment supply was shut down. Consequently the conventional open-ocean biostratigraphic approach must be used with caution because of the possibility of time erroneous first and last appearance datums (FADs and LADs, respectively). These biostratigraphic datums can be either premature LADs or delayed FADs resulting from the overwhelming dilution of shallow-platform-derived sediment. Although low in abundance, microfossils found in the platform-rich prograding units usually appear to be good indicators of depositional age and still provide a most powerful tool for age determination.

The data from BDP cores define six units in one hole and five in the other, bracket the biozones present and their ages, and show that they are correlative between the holes. The ages range from a maximum of ~12.2 Ma to a minimum of ~1.6 Ma, but they include numerous periods of inferred erosion and/or nondeposition. The largest condensed interval/hiatus (~1.2 Ma) occurs at the Miocene/Pliocene boundary.

The biozones range sequentially from middle Miocene *Globoratalia fohsi robusta* Zone N12 to at least the uppermost Pliocene part of *G. crassaformis viola* Subzone N22, but the foraminifers indicate that deposition was not continuous. Recognition of *G. tosaensis tosaensis* Zone N21 is very tentative and suggest that the biozone may have accumulated on the shelf, but its absence on the slope is consistent with a widespread regional unconformity.

Sedimentation rates and positions of series boundaries vary widely in both holes. At the margin, the Miocene/Pliocene boundary is placed at a depth of 542 to 532 m in a condensed section; the lower/upper Pliocene boundary occurs at or near 444 m; and the Pliocene/Pleistocene boundary occurs within the top 366 m of the hole, a reasonable assessment considering an exceptionally high rate of sedimentation (536 m/m.y.) for the interval. On the bank top, the Miocene/Pliocene boundary lies between 295 and 278 m; the lower/upper Pliocene boundary is more precisely placed at or near a depth of 236 m; and the Pliocene/Pleistocene boundary lies within the top 110 m in the hole. Bank-top sedimentation rates ranged from near zero at the condensed interval to a late Pliocene high of 279 m/m.y.

The availability of a high-resolution chronostratigraphy enables the development of well-constrained platform evolution and sea-level records. Three major progradational episodes were delineated using seismic stratigraphy, lithostratigraphy, and depositional age information. Progradation occurred during the late Miocene, late early Pliocene, and latest Pliocene, a time period considered a "lowstand" on much of the shallow platform. In the Pliocene shelf/ramp setting, margin progradation initiates during the highstand but also occurs in a forced regression-type situation during a fall in sea level. Rapid reef progradation occurred near the end of the Pliocene and early Pleistocene when the platform had infilled the proximal slope sufficiently to provide a near-horizontal migration surface. The transformation from a shelf/ramp platform topography to a horizontal top platform started during the late Pliocene and culminated in the middle Pleistocene. As a result, the distinction between highstand and lowstand was much less distinct during much of the late Cenozoic because the GBB had a gently dipping shelf/ramp morphology. The steep platform margin and the associated abrupt on/off nature of sea-level highstand/lowstand seen today, and through much of the middle and late Pleistocene, are fairly recent developments. Pre-middle/upper Pleistocene basin/periplatform deposits around the Bahamas should be interpreted with this new understanding of platform topography.

Ages of Sequence Boundaries

Sequence boundaries (SB) identified in multi-channel seismic lines before drilling (Fig. 4), and refined after coring and well-logging, can now be examined in a chronostratigraphic framework. The age of seismic reflections forming sequence boundaries are summarized below in Table 1.

Table 1 Ages of seismic sequence boundaries.

Sequence Boundary 1		Depth (m/ft below mud pit)		Estimated age of seismic sequence boundary
		Unda	Clino	
SB-7	g/h	441.9/1450	NR	middle Miocene <12.6 Ma
SB-6	f/g	365.8/1200	NR	late Miocene, 5.9–8.9 Ma
SB-5	e/f	292.6/960	545.6/1790	Miocene/Pliocene, 5.35–4.71 Ma
SB-4	d/e	149.4 /490	377.9/1240	late Pliocene, ~2.1–2.48 Ma
SB-3	c/d	50.3/165	118.9/390	early Pleistocene, 1.66–0.83 Ma
SB-2	b/c	30.5/100	33.5/110	late Pleistocene, <0.83 Ma
SB-1		-------	21.3/70	late Pleistocene, <0.83 Ma

Note: NR = not recorded

Relevance of the BDP to Questions of Sea-Level Changes

Clino and Unda, in conjunction with other shallow core borings in the Bahamas, provide a first step in deciphering the record, timing, and magnitude of sea-level change. The oldest sea level event recorded is a middle Miocene (<12.6 Ma) highstand event that flooded an existing shallow platform and resulted in slope/open-shelf facies near Unda. This highstand flooding gave way to a prolonged upper middle Miocene condensed/hiatal interval, capped by shallow-water facies and a distinct discontinuity surface. These middle Miocene sea-level changes occurred before the latest Miocene (Chron 3An, 5.9 Ma). A subsequent late Miocene event deposited shallow-water reefal sediment near Unda, perhaps as part of a major rise in eustatic sea level. Similar upper late Miocene age deposits have been recovered and dated from much shallower portions of other Bahamian platforms. The early Pliocene consisted of a major sea-level rise that forced eastward backstepping of the shallow-water platform. The subsequent highstand resulted in major progradation of the western margin of the GBB. The late Pliocene again saw progradation of the margin and the westward shift of the clinoform depocenter. This late Pliocene highstand event was interrupted by a fall in sea level, temporarily reducing sediment production on the platform and resulting in a marine hardground on the proximal slope. At Clino, deposition of a pelagic-rich unit occurred during this drop in sea level, followed by extremely high sedimentation related to the westward shift of the upper-shelf zone of sediment production. This lowstand is correlative to the buildup of Northern Hemisphere glaciers and the worldwide drop in eustatic sea level. The late Pliocene/Pleistocene lowstand is consistently recorded in Bahamian platforms as well as around the world. The numerous subaerial exposure horizons in the upper portion of both Unda and Clino provide a record of the frequent middle and late Pleistocene highstand flooding events.

Seismic reflections and major sequence boundaries appear to be synchronous within the age-dating resolution of the chronostratigraphy of the BDP (Fig. 5). Especially well-constrained is the late Miocene sequence boundary, the late Pliocene sequence boundary, and a Pliocene/Pleistocene sequence boundary. The late Miocene and late Pliocene sequence boundaries both represent periods of erosion and/or nondeposition on the slope, and can be tied to major changes in sea level.

As recommended by the SL-WG, a complete transect from the shallow to the distal part of a continental margin is required to collect the necessary data to address questions surrounding sea-level changes. The results of the BDP summarized above provide the shallow-water sites for such a transect of a carbonate platform. Thus, one of the primary objectives of Leg 166 is to provide a transect from the proximal to the distal part of the Bahamas platform so that questions surrounding sea-level changes can be fully addressed.

SCIENTIFIC OBJECTIVES AND METHODOLOGY

The Bahamas Transect has three objectives: (1) to retrieve the record of Neogene–Quaternary sea-level fluctuations in prograding carbonates; (2) to study the fluid flow through the margin of an isolated platform; and (3) to assess the paleoceanographic changes in the Straits of Florida since the middle Cretaceous.

Primary Objectives

Sea -level Objective

The main objective of the proposed drilling transect along the western margin of Great Bahama Bank is to study the record of Neogene–Quaternary sea-level fluctuations in the prograding sequences. Within this sea-level objective are the following goals.

1. Determine the timing of the sequence boundaries and relative sea-level fluctuations to acquire the necessary data base for the possible global synchroneity of these fluctuations.

2. Determine the stratigraphic response of carbonates to sea-level changes of variable frequency by analyzing the facies of the stacked depositional sequences. A special emphasis will be placed on documenting the amount and nature of lowstand deposits in carbonates and the hierarchical stacking of high-frequency cycles into seismic sequences.

3. Retrieve the low-latitude isotopic signals of the Ice House World in the Neogene and Quaternary and compare it with the stratigraphic record potentially to document a causal link between eustasy and sequence stratigraphic pattern.

4. Estimate magnitude and rate of sea-level changes using age and recovered facies for a precise subsidence analysis.

Fluid -flow Objective

There is increasing evidence of active fluid movement deep within carbonate platforms. This evidence was derived from BDP results and also from recent ODP legs on the Queensland Plateau and in the Pacific (Elderfield et al., 1993; Paull et al., 1995). Based on drilling on the western portion of the Great Bahama Bank, it is now known that the majority of the alteration from metastable carbonates to low-Mg calcite and dolomite occurred in a regime dominated by seawater rather than meteoric fluids (Melim et al., in press), suggesting the presence of massive seawater circulation in the subsurface of the Bahamas. Further evidence for circulation was derived from the analysis of borehole fluids retrieved during the drilling. The chemical analyses of borehole fluids reveal that in some areas there is a rapid buildup of Sr, resulting from the recrystallization of carbonate, yet in other areas the Sr content is not elevated. The absence of gradients, despite substantial carbonate recrystallization, indicates areas in which active circulation is taking place, whereas in other areas where Sr content is elevated, circulation is stagnant or not as active. In summary, the samples collected during the BDP confirmed the existence of fluid movement, but there is still insufficient information to resolve the fundamental question about the flow mechanism within the platform. The goal is to assess the processes responsible for fluid circulation in platforms by sampling slope sediments and analyzing their pore-water chemistry.

Paleoceanographic Objectives

Since the middle Cretaceous, several major changes occurred in Earth climate, fauna, and ocean circulation. The sediments in the seaways of the Bahamian archipelago potentially record most of these events, many of which are important global problems. For example:

1. The onset of the Gulf Stream current: The Bahamas Transect is located on the periphery of the modern-day Florida Current/Gulf Stream current that influences global climate and ocean circulation. The timing of the onset of this circulation, however, still is not precisely determined. Leg 101 documented the existence of the Florida Current from the Oligocene onward (Austin et al., 1988), but it probably started sometime in the Late Cretaceous. The breakup of the carbonate-platform system on the Nicaraguan Rise in the middle to late Miocene might have strengthened the current (Buffler et el., 1994). Drift deposits on seismic lines are observed to interfinger with the distal portions of the prograding sequences. Thus, the sediments retrieved in distal holes of the Bahamas Transect potentially record the onset and changes in strength of the Florida Current.

2. The record of the Paleogene "Doubthouse" Earth: The latest Paleocene to Middle Eocene is an interval that has at least two unconformity-generating events. However, this time interval is controversial, with climatic interpretations ranging from glacial to nonglacial. A comparison of the $\delta^{18}O$ proxy of sea-level change for this interval with the isotopic values of the overlying Neogene can test their similarity with both nonglacial and glacial events. Because these

unconformities occur at a time of relatively frequent magnetic polarity changes, they can be dated accurately and are suitable to evaluate synchroneity.

3. The influence of the Cuban collision: The collision of Cuba with the North American plate in the (?) Late Cretaceous/early Cenozoic to Late Eocene transformed the Bahamian archipelago into a foredeep. The onset of the collision and the timing of the subsequent collisional events are not well constrained. In the relatively distal location of the Bahamas transect, these tectonic events probably are recorded in increased subsidence because of loading, and will be observed in the sedimentary record as variations in sediment thickness with an increase of mass-gravity flows.

4. The K/T boundary: The K/T boundary potentially is preserved in the Straits of Florida, although the boundary was not preserved at ODP Site 627 north of Little Bahama Bank.

5. The middle Cretaceous drowning of the megabank: Toward the end of the Early Cretaceous, a large megabank was established along the eastern and southern margins of the North American continent. This "megabank" segmented and partially drowned in the Albian to Cenomanian. Documenting the extent of the megabank, as well as the cause and timing of its disintegration, was one of the major objectives of Leg 101. The drilling was intended to resolve the controversy between scientists who interpreted the modern platform configuration as a reflection of the Early Jurassic rift topography (Mullins and Lynts, 1977), and those who viewed the modern archipelago as a remnant of a large megabank that drowned in the middle Cretaceous (Sheridan et al., 1981, Ladd and Sheridan, 1987; Schlager and Ginsburg, 1981). The debate continues in the wake of Leg 101 because drilling failed to reach the Mid-Cretaceous Sequence Boundary (MCSB) in the Straits of Florida and Northeast Providence Channel. Drilling the MCSB along the Bahamas transect would add important information to the controversy and would achieve a goal that was intended, but never attained during, Leg 101. Time limitations, however, might prevent Leg 166 from reaching this target horizon.

Drilling Approach

To understand the sedimentary response to sea-level changes and achieve a well-dated record, a transect of holes is needed from the shallow platform (proximal) to the adjacent deep water (distal). The two core borings, Unda and Clino, in conjunction with three shallow borings on islands (McNeill and Ginsburg, 1992) on the platform provide the record in the proximal part of the sequences (Fig. 2). The deeper water sites (relative to the BDP holes) are planned to be drilled by the *JOIDES Resolution* during Leg 166. A transect of four sites is planned to retrieve the sedimentary record of the sequences in several locations. An additional lateral site is intended to test continuity and lateral facies variations of the prograding lobes. The thick Quaternary sediment package on the leeward slope of the GBB will provide a high-resolution record of the climate and short-term sea-level fluctuations in the Quaternary. The target horizon is the base of the Neogene. Successful drilling of the deep-water sites by the *JOIDES Resolution* will generate a data set that can be compared with the NJ/MAT of Leg 150 for a test of the synchroneity of sea-level changes.

A deep drill hole penetrating the MCSB is required to answer the paleoceanographic objectives. The most basinward drill site of the proposed northern transect described above is situated on the periphery of the Florida Current, permitting the determination of the influence of the Florida Current on the deposition of the sequences and possible changes of its intensity during the Neogene. The periphery of the Florida Current is the ideal location for answering questions regarding evolution of the current. Unfortunately, such a location is prone to have large hiatuses due to winnowing, thus it is less suitable for all the other objectives. Therefore, a location closer to the platform, the second most distal site, is chosen as the location for a deep hole. The target depth is approximately 1400 m.

It is assumed that in areas where unconsolidated muddy sediments are onlapping onto older cemented rocks, fluids are moving into or out of the platform and may partially move through the sediment. Coring the sediment and squeezing its waters can provide an idea of the composition of these fluids. As one progresses away from the platform, the influence of advection probably will lessen and the pore water chemistry will become dominated by diffusion. It is proposed to sample interstitial waters along two transects away from the platform edge. The first transect will partially coincide with the northern transect and utilize the same sites as the two most proximal sites. Penetration will be approximately 100–300 m depending on thickness of the unconsolidated sediment at each location. The second transect, consisting of three sites, will be located further to the south, where the Holocene sediment wedge is somewhat thinner (Fig. 1).

DRILLING STRATEGY

Leg 166 Transect Summary

Leg 166 will drill two main transects to answer the sea-level and fluid-flow objectives. The first transect will be along an extension of the Western Geophysical line on which the holes Unda and Clino were drilled. The holes follow a transect from shallow to deeper water (BT-1 through BT-4) (Figs. 2, 6, 7, 9). These holes primarily will address the sea-level objectives. One additional hole (BT-20) will be drilled along strike to examine lateral variation in facies. Also drilled along this first transect will be F-3, a hole designed to address the fluid-flow objectives. As a result of time constraints, Site F-3 will be a single advanced hydraulic piston corer (APC) hole and Sites BT-2, BT-1 and BT-4 will be APC and extended core barrel (XCB) holes. The second transect, located to the south of the first transect, consists of three holes, F-4, F-5, and F-6, extending from shallow to deep water (Figs. 1, 8). These three sites will be single APC holes. Due to shallow-water drilling-safety considerations, the drilling strategy for the two shallowest sites (BT-1, 290 m; and F-4, 245 m) may have to be modified.

Schedule and Sequence of Drilling

Leg 166 is scheduled to proceed from San Juan to Panama. The transit time from San Juan to the first site is projected at 3.2 days (Table 2). The first site will be BT-2 because of few expected drilling difficulties and a procedure of drilling from deeper to shallow water on parts of this transect for safety precautions. In addition, the projected drilling time of 7.4 days should allow the science party to become fully acquainted with shipboard routine and laboratories. BT-2 will be followed by Sites F-3, BT-1/F-1, BT-4, BT-20 and BT-3. Site BT-3 will be left as the last site of the first transect because it will be the deepest objective, thus allowing us to ascertain the possibility of deepening the hole to achieve the middle Cretaceous objective at this stage. The final three sites in the southern transect should require 3.5 days. If time savings are attained, we have contingency plans that will enable us to deepen sites (Table 3) or drill alternate sites (Table 3).

The drilling at each site will follow a strategy in which the sites initially are cored using the APC/XCB until refusal or target depth is met. If deeper objectives are required, the strategy will be to wash down using the rotary core barrel (RCB) and to begin coring slightly above the interval last cored with XCB. If time permits we will in some instance triple APC the upper interval. Cores will be orientated during the APC interval of the first hole at Sites BT-2, BT-3, and BT-4.

Logging Plan

Three standard logging runs (Quad-combination, Formation MicroScanner, and geochemical tool strings) are planned for all sites except the shallow penetration fluid-flow sites (all sites labeled F). The geological high-sensitivity magnetic tool (GHMT) is planned at two sites, and a vertical seismic profile (VSP) experiment will be conducted at three sites.

The Quad-combination string provides measurements of sonic velocity, porosity, density and electrical resistivity that will aid in characterizing lithology, sediment fabric, degree of lithification, and diagenetic alteration. The Formation MicroScanner (FMS) produces electrical-resistivity images that can be used to distinguish thin beds, sedimentary structures, diagenetic features, and fractures. Once calibrated to cores and to other logs, FMS images can help characterize facies variations within the different sequences. The geochemical logging tool (GLT) will be useful to delineate mineralogical changes (e.g., dolomite/calcite) downhole. The standard suite of logging measurements will utilize site-to-site correlation along the transect.

Continuous susceptibility measurements by the GHMT can be used to detect changes in magnetic-grain concentration. Provided that the magnetization of the sediments is not too weak, the total field data in conjunction with the magnetic susceptibility can be used to derive a magnetic-reversal sequence for the logged interval.

The integration of core and logging data to the high-resolution multi-channel seismic-reflection data will be done via synthetic seismograms generated from the sonic velocity and density logs together with core measurements. At three holes, a VSP "check shot" survey will be conducted to calibrate the time-depth relationships and sonic velocity logs. (Further information on logging tools can be obtained from the Borehole Research Group home page at http://www.ldeo.columbia.edu).

MEASUREMENT STRATEGY

A major objective of Leg 166 will be to establish if there is advection of fluids in the margin of the GBB. This will be achieved through a combination of temperature measurements and the analysis of fluids.

Temperature Measurements

Temperature measurements will be made using the APC heat-flow coring shoe (ADARA) tool during APC operations. ADARA measurements will be made on all sites on the first APC core starting on Core 4 to a depth of 100 meters below seafloor (mbsf). Below this depth to APC refusal, ADARA samples will be taken every third core. During XCB coring, temperature measurements will be made using the water sampler temperature probe (WSTP) on every fifth core starting with the first XCB core.

Interstitial Water Measurements

To achieve one of the primary objectives of Leg 166, high-resolution sampling of interstitial waters will be required. Interstitial water samples will be taken by squeezing 5-cm whole-round samples every core over the upper 100 m of the first hole at each site Below 100 m, pore waters will be collected from whole-round samples every third core. In addition, 5-cm whole-round samples will be taken every section in the first two cores at the fluid flow sites, BT1/F1, BT2, F3, F4, F5, and F6. In the deeper, more consolidated sections obtained using XCB 10-cm whole-round sections may be necessary. These samples may be combined with physical property samples taken on vertically orientated cores.

Physical Property Samples

To study the origin of bedding and seismic reflections and the correlation between slope carbonates and physical properties, high-quality, reliable sonic velocities are required. For evaluating anisotropy, vertical samples are required. One hundred vertically orientated minicores will be taken from 7-cm whole sections of selected lithologies. Where possible, these will be shared with the interstitial water whole round samples. Samples will be taken to study the relationship among form of slope curvature, sediment composition, and failure of carbonate slopes. Twenty whole-round samples with a length of 15 to 20 cm will be obtained to measure triaxial shear strength and consolidation for the modeling of slope failure conditions.

X-Ray

X-ray diffraction (XRD) analysis will be performed on selected samples analyzed for head-space analysis. Quantitative XRD will be performed using standards supplied by the University of Miami X-ray diffraction laboratory.

X-ray fluorescence will be performed on every third core below 100 mbsf to obtain representative major-and minor-elemental analysis, primarily for calibration to the GLT.

PROPOSED SITES

The proposed sites (Table 2; Figs. 1, 2) are located on the basinward part of the existing seismic line. Six sites, arranged in two transects, are planned for the fluid-flow objectives. BT3 also is the site where the paleoceanographic objectives are addressed.

Primary Sites

Sea-level and Paleoceanographic Objectives

The location of the Bahamas Transect along the western margin of the GBB fulfills the requirements for a transect suitable to answer sea-level-related questions. The margin is constructed by stacked prograding sequences with a sedimentation rate high enough to be recorded as seismic sequences. The internal architecture of the sequences is well defined and allows an interpretation of highstand vs. lowstand deposits. Thus, a transect of cores will recover the vertical and lateral facies variations in each sequence that potentially give the record of sea-level fluctuations along the margin. Two boreholes (Unda and Clino) on the platform top give the record in the proximal part of the sequences. The holes drilled during Leg 166 will provide the sedimentary and stratigraphic record of the more distal portions of the prograding sequences.

The primary sites for the sea-level objectives consist of a four-site transect (BT-1 through BT-4) and a lateral site (BT-20). The four transect sites are positioned on the basinward part of the existing seismic line in order to have a direct correlation to the shallow-water drill sites, Unda and Clino. One site (BT-20) is placed on a strike line 5 km to the north of BT-2 to evaluate the lateral variation of facies and sediment thickness in the individual sequences.

BT-1/F-1: (24°34.12’ N; 79°13.64’ W)

BT-1 currently is positioned at a water depth of 290 m at the crossing of seismic Lines 106 and 123, approximately 850 m from the modern platform edge on the upper slope. Operational safety considerations may require relocation of this site to deeper water. The site will penetrate the thickest portion of the prograding Neogene sequences seen on the seismic line; the total thickness is approximately 1035 m. The upper Pliocene/Quaternary package alone is estimated to be about 240 m thick. The high sedimentation rates allow for a detailed analysis of the high-frequency climate and sea-level changes. The objectives of BT-1 are (1) to date precisely the sequence boundaries, (2) to determine the facies within the different systems tracts, especially the nature of the onlapping units that are currently interpreted as lowstand deposits, (3) to evaluate the fluid flow in this uppermost part of the slope, and (4) to retrieve a high-resolution record of climate and sea-level fluctuations for the Quaternary and late Pliocene.

To achieve these objectives, two APC/XCB cores are planned through the unconsolidated sediment; one core for high-resolution stratigraphy, and one core for interstitial-water analysis. Possible hard layers encountered will be penetrated with the XCB. Rotary drilling will be used to deepen the hole to a target depth of 1035 m, if necessary. BT-1 also serves as the proximal site for the fluid flow transect (i.e., it also is site F-1).

BT-2: (24°32.71’ N; 79°15.58’ W)

BT-2, at the crossing of seismic Lines 106/108A, is located approximately 2.5 km further basinward than BT-1. It is positioned on the middle and lower slopes of the sequences. The middle and lower portions of the slopes generally are characterized by abundant mass-gravity flow deposits (e.g., turbidites). The seismic data show a stacking of seismic reflections with continuous reflections alternating with channelized and discontinuous reflection patterns, indicating redeposition. The timing of the main deposition of redeposited carbonates still is controversial. Classical sequence stratigraphic models predict an increase of mass gravity flow deposits during sea-level lowstands (e.g., Sarg 1988) whereas carbonate sedimentologists point out that offbank transport of sediment off carbonate platforms is highest during sea-level highstands when the platform is flooded (Droxler and Schlager, 1985; Schlager 1991).

The main objective of this site is to evaluate facies of lowstand vs. highstand deposits, in particular, to determine the respective amount of redeposited strata in both systems tracts. Additional objectives are (1) to refine the ages of the sequence boundaries, (2) determine the nature of a prominent unconformity on top of a low-amplitude to transparent seismic zone at 0.75 s two-wat traveltime (twt) that is interpreted to be the top of the early Pliocene, and (3) produce a high-resolution isotope stratigraphy of the Neogene to Holocene. Furthermore, this site serves as the distal site for the fluid-flow transect. Interstitial waters in combination with heat-flow and temperature measurements should help assess the direction of possible fluid flow through this portion of the margin. This site also is designed as a calibration site in which an extended downhole logging program will be run to produce an optimal correlation between the cores and the geophysical data. To achieve this goal a VSP experiment will be performed.

BT-3: (24°30.26’ N; 79°19.34’ W)

BT-3, at the crossing of seismic Lines 106/125, is positioned on an undisturbed portion of the lower slope of the western GBB at a water depth of 630 m. At this site the core mostly will penetrate the lower slope portions of the prograding sequences. We expect to find a higher content of microfossils in these foresets than in the proximal sites BT-1 and BT-2. Therefore, the main objective of this site in regards to sea level is to assemble a data set suitable to compare the sedimentary record with the $\delta^{18}O$ record of the Neogene to Recent sea-level fluctuations. To assure a precise correlation between the seismic and sedimentary record, a VSP experiment will be performed at this site.

By deepening BT-3, the Lower Tertiary and Upper Cretaceous section will be penetrated. A major seismic reflection horizon at a depth of 1413 m (i.e., 2.0 s twt) is interpreted to be the MCSB which is a major regional reflection horizon in the seaways of the Bahamas archipelago and the Gulf of Mexico. The section between the base of the Neogene and the MCSB gives the opportunity to address several paleoceanographic objectives: (1) to acquire a low-latitude record of the Paleogene "Doubthouse" and its transition into the Neogene "Icehouse;" (2) determine the onset of Florida Current; and (3) potentially to sample the K/T boundary.

In addition, during Late Cretaceous–Paleocene/Eocene Cuba collided with the southern end of the Bahamas archipelago. The Paleocene/Eocene section is expected to record this plate-tectonic event by changes in the subsidence rate. The primary goal is to determine the onset of the collision, which is still a matter of debate. Because of time constraints, the primary target horizon was set at the K/T boundary, which is estimated to be approximately 1000 mbsf. If time permits, the hole will be deepened to the MCSB to assess the cause of the platform demise in the middle Cretaceous.

BT-4: (24°28.36’ N; 79°22.17’ W)

BT-4, at crossing of seismic Lines 106/101B, approximately 12 km from the modern platform margin, is the basinward end of the Bahamas Transect. It is positioned to penetrate a broad channel-like feature that fills the depression between the eastern end of a broad mound in the axis of the Florida Straits and the distal portions of the prograding clinoforms. The mound and the channel-like feature are interpreted to be sediment drifts deposited by the Florida Current. These drift deposits overlay, interfinger, and onlap the distal lobes of the prograding sequences. The position of the site at the periphery of the Florida Current allows us to address the three main objectives: (l) to retrieve the facies of the basinal deposits within the prograding sequences; (2) to assess and date the onset, deposition, and erosional gaps associated with the Florida Current, and (3) to establish the relationship between sea-level fluctuations and the changes in the vigor of the Florida Current.

BT-20: (24°35.41’ N; 79°15.56’ W) at crossing 112/108A

BT-20 is positioned 5 km north of BT-2 on the middle slope of the western margin. The site is chosen to evaluate the lateral facies variations in the prograding sequence. Because carbonate margins generally act as a sediment source along their entire length, the prograding clinoforms are less likely to develop individual lobes than siliciclastic fans. The strike lines along the margin confirm this general pattern but also display small mounds that indicate the existence of small coalesced lobes. The main objectives of this site are (1) to assess the lateral continuity, or the lack thereof, of facies within the prograding carbonate sequences and (2) to test the consistency of the ages of the sequence boundaries in this lateral position.

Fluid-flow Objectives

For the fluid-flow objectives it is proposed to sample along two transects away from the platform edge. The first transect will partially coincide with the sea-level transect and utilize BT-1 = F-1 as the starting point and BT-2 as end point of the transect. F-3 (24°33.28’N; 79°14.95’W) is located between BT-1 and BT-2 on the same dip line. The main goal is to retrieve pore-water chemistry as an indication for the fluid flow through the margin.

A second transect is planned further south on the margin of the western GBB where the onlapping sediment package is somewhat thinner. The reason for choosing a second transect is to assess possible variations in the fluid-flow pattern. The chosen sites are:

F-4: (23°36.92’ N; 79°02.66’ W) at crossing FS4/FS7 (operational safety conditions may require relocating this site to deeper water).

F-5: (23°36.80’ N; 79°03.36’ W) at crossing FS4/FS2

F-6 (23°36.64’ N; 79°05.01’ W) at crossing FS4/FS1

Secondary Sites

Sea-level Objectives and Paleoceanographic Objectives

BT-10: (24°36.40’ N; 79°13.75’ W)

BT-10 is the alternative site to BT-1. The site is located on the crossing of Lines 112/123 in 310 m of water. Objectives and drilling strategies are the same as for BT-1.

BT-20 (Hole C): (24°32.71’ N; 79°15.58’ W)

BT-20 (Hole C) is designed as an alternate hole to BT-2. If the target depth of 852 m is not reached in BT-2, BT-20 will be deepened to a depth of 822 m, the base of the Neogene.

BT-21: (24°22.96' N; 79°15.52' W) at crossing 126/108B

BT-21 is an alternative site to BT-2. Objectives and drilling strategies are the same as for BT-2.

BT-30 : (24°33.00' N; 79°19.05' W) at crossing 112/125
BT-31: (24°32.60' N; 79°45.70' W) at crossing 132/131

BT-30 and BT-31 are alternative sites to BT-3. BT-30 is further to the north along the same strike line as BT-3. BT-31 is located on the western side of the Straits of Florida on the buried eastern edge of a former larger Cay Sal Bank. The target horizon, the MCSB, is seen as part of a drowned platform at about 2 s (twt) in a water depth of approximately 845 m. Thus, BT-31 is not part of a transect and the sea-level objectives could not be fully addressed.

BT-40: (24°20.02' N; 79°21.95' W) at crossing 115/101B
BT-41: (24°33.34' N; 79°22.05' W) at crossing 128/101A

BT-40 and BT-41 are alternative sites to BT-4. They are located north and south, respectively, of BT-4 but on the same strike line. Objectives and strategies are the same as for BT-4.

Fluid-flow Objectives

F-2: (24°33.70 N; 79°14.23 W) at crossing 119B/106
F-21 (24°36.00 N; 79°14.56) at crossing 130/112.

F-2 and F-21 are secondary sites to F-3.

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TABLE 2 - PRIMARY SITE TIME ESTIMATES

Site Name	Latitude N Longitude W	Water Depth (m)	Penetration (mbsf)	Drilling Operations (days)	Logging *Type	Logging (days)	Transit Time (days)
Transit San Juan to BT-2							3.2
BT-2	24°32.71'N 79°15.58'W	470	852	5.5	Q, F, Gc, T, M, V	1.9	
Dynamic Positioning Move							0.0
F-3	24°33.28'N 79°14.95'W	410	341	0.7	T		
Dynamic Positioning Move							0.1
BT-1/F-1	24°34.12'N** 79°13.64'W	290	1035	6.7	Q, F, Gc, T, V	1.5	
Transit -BT-1/F-1 to BT-4							0.1
BT-4	24°28.36'N 79°22.17'W	675	753	4.3	Q, F, Gc, T, V	1.3	
Transit -BT-4 to BT-20							0.1
BT-20	24°35.41'N 79°15.56'W	475	822	2.7	Q, F, Gc, T	1.3	
Transit -BT-20 to BT-3							0.0
BT-3	24°30.26'N 79°19.34'W	660	1413	7.7	Q, F, Gc, T, M, V	3.1	
Transit-BT-20 to F-6							0.2
F-6	23°36.64'N 79°05.01'W	430	352	0.9	T		
Transit-F-6 to F-5							0.1
F-5	23°36.80'N 79°03.36'W	335	371	0.9	T		
Dynamic Positioning Move							0.0
F-4	23°36.92'N** 79°02.66'W	245	358	1.2	T		
Transit F-4 to Colon, Panama							4.3
Transit Canal 11 Apr '96							1.0
Total				30.6		9.1	9.1
Total Days at Sea = 48.8		(Available Time = 48.0)					

* Q=Quad combo log, F=FMS log, Gc=Geochemical log, T=ADARA or WSTP temperature measurements, M=magnetic tool (GHMT), V=VSP;
T measurement times have been incorporated into drilling operations
**Operational safety considerations may require relocating this site to deeper water

TABLE 3 - ALTERNATE SITE TIME ESTIMATES

Proposed Site	Latitude N Longitude W	Water Depth (m)	Penetration (mbsf)	Drilling Operations (days)	Logging *Type	Logging (days)
			Alternate Sites			
F-2	24°33.70'N 79°14.23'W	355	404	1.3	T	
BT-10	24°36.40'N 79°13.75'W	310	960 (Alt for BT-1)	6.5	Q, F, Gc, T, V	1.9
BT-21	24°22.96'N 79°15.52'W	480	883 (Alt for BT-2)	6.4	Q, F, Gc, T, V	1.5
BT-30	24°33.00'N 79°19.05'W	620	1300 (Alt for BT-3)	7.7	Q, F, Gc, T, M, V	3.1
BT-31	24°32.60'N 79°45.70'W	845	1491 (Alt for BT-3)	8.0	Q, F, Gc, T, M, V	3.1
BT-40	24°20.02'N 79°21.95'W	640	835 (Alt for BT-4)	4.3	Q, F, Gc, T	1.3
BT-41	24°33.34'N 79°22.05'W	680	732 (Alt for BT-4)	4.3	Q, F, Gc, T	1.3
F-21	24°36.00'N 79°14.56'W	390	358 (Alt for F-2)	1.3	T	
			Alternative Strategies for Primary Sites (Time Available Basis)			
F-3	24°33.28'N 79°19.34'W	355	341 (2nd APC)	0.5		
BT-1	24°34.12'N** 79°13.64'W	290	3rd APC (refusal)	0.6		
BT-4	24°28.36'N 79°22.17'W	675	deepen to 753 m with RCB	2.0	Q, F, Gc	1.3
BT-20	24°35.41'N 79°15.56'W	475	deepen to 822 m with RCB	2.4	Q, F, Gc	1.1
F-5	23°36.80'N 79°03.36'W	355	471 (2nd APC) XCB to 500	2.6	Q, F, Gc	1.3
F-6	23°36.64'N 79°05.01'W	430	352 (2nd APC)	0.5		

* Q=Quad combo log, F=FMS log, Gc=Geochemical log, T=ADARA or WSTP temperature measurements, M=magnetic tool (GHMT), V=VSP; T measurement times have been incorporated into drilling operations

**Operational safety considerations may require relocating this site to deeper water

FIGURE CAPTIONS

Figure 1. Location of the two general areas to be drilled during Leg 166. Location of cores Unda and Clino drilled during the BDP (Bahamas Drilling Project) also are shown. Sites BT-1 through BT-4, F-3 and BT-20 are located in the upper large box. Sites F-4 through F-6 are located in the lower box. Boxes correspond to areas represented on Figs. 6 and 8.

Figure 2. Schematic cross-section showing the Bahamas Transect. The two proximal sites, Unda and Clino, were drilled during the Bahamas Drilling Project. BT-1 through BT-4 are planned to be drilled during Leg 166.

Figure 3. Line drawing of the prograding sequences at the western margin of the GBB with drilling locations of Unda and Clino. Sequences h-a are late Miocene to Holocene in age. Miocene/Pliocene boundary is on top of sequence f. Sequence boundaries are indicated by truncations (sequences h, g, f) and/or onlap patterns (sequences e-a). Stippled areas are onlapping packages; white areas are prograding downlapping units.

Figure 4. Correlation of ages, sedimentary successions, seismic reflectors and sequences, and gamma-ray signature of Clino and Unda.

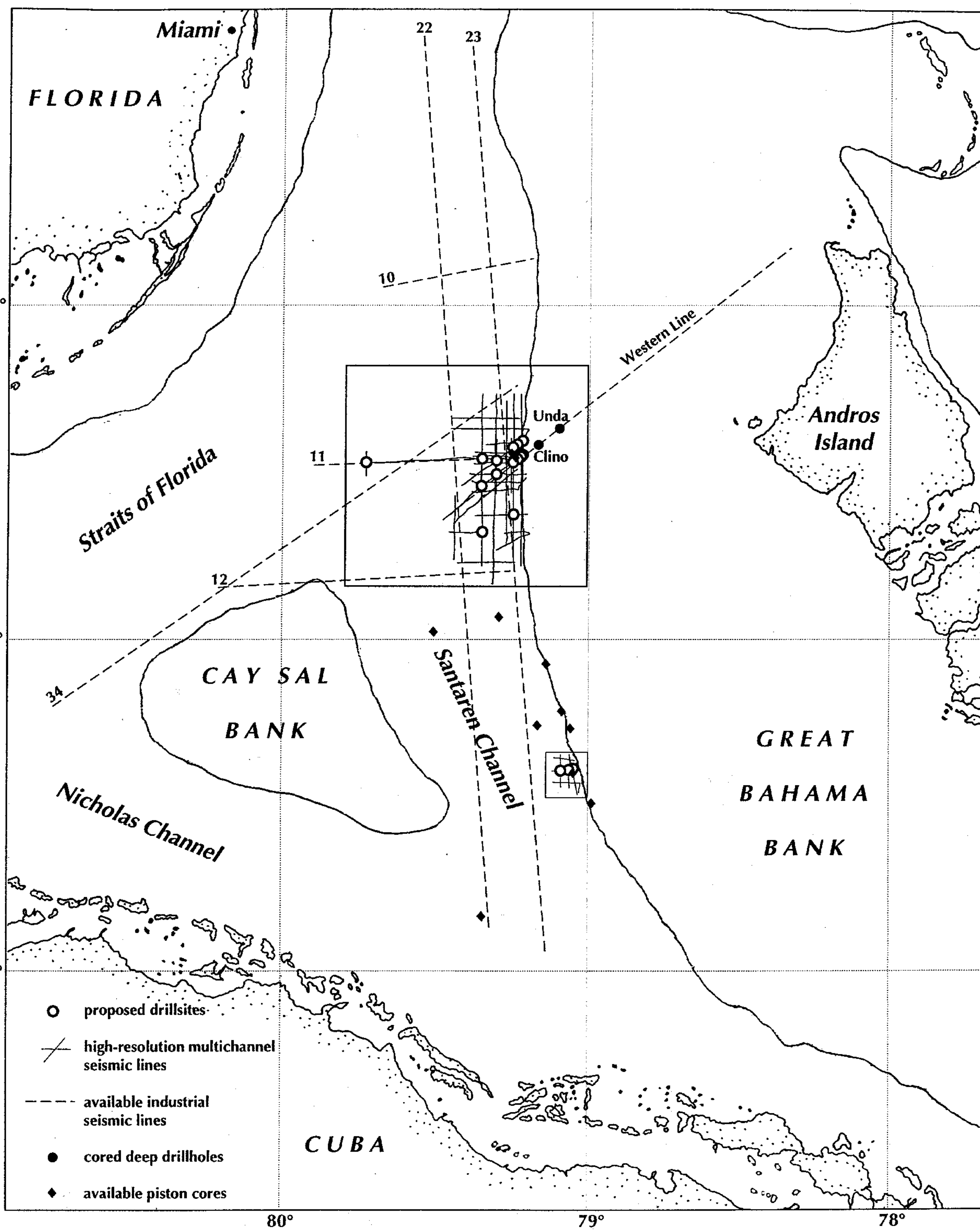
Figure 5. Generalized correlation between Unda and Clino using the integrated age model. Seismic sequence boundaries (shaded lines labeled with SB) appear to be conformable within the resolution of the time lines (from McNeil et al., in press).

Figure 6. Location of seismic lines and drill sites of the Bahamas Transect (see Fig. 1). BT-1 through BT-4, BT-20, and F-3 are primary sites. BT-1 through BT-4 are positioned on the same seismic line as Unda and Clino; BT-20 is intended to assess lateral variability. F-3 is a site with fluid-flow objectives.

Figure 7. Bathymetric map showing location of BDP sites.

Figure 8. Location of seismic lines at the southern area (see Fig. 1). F-6 through F-4 are the locations of the fluid flow transect.

Figure 9. Seismic line showing the drill sites of the Bahamas Transect (BT-1 through BT-4) and the sites of the fluid-flow objectives (BT-1, F-2, F-3, BT-2), and intended depths of penetration.



Miami
FLORIDA
22
23
10
25°
Western Line
Unda
Clino
Andros
Island
11
Straits of Florida
12
24°
CAY SAL
BANK
Santaren Channel
34
GREAT
BAHAMA
BANK
Nicholas Channel
23°
proposed drillsites
high-resolution multichannel
seismic lines
available industrial
seismic lines
cored deep drillholes
available piston cores
CUBA
80°
79°
78°

Figure 1

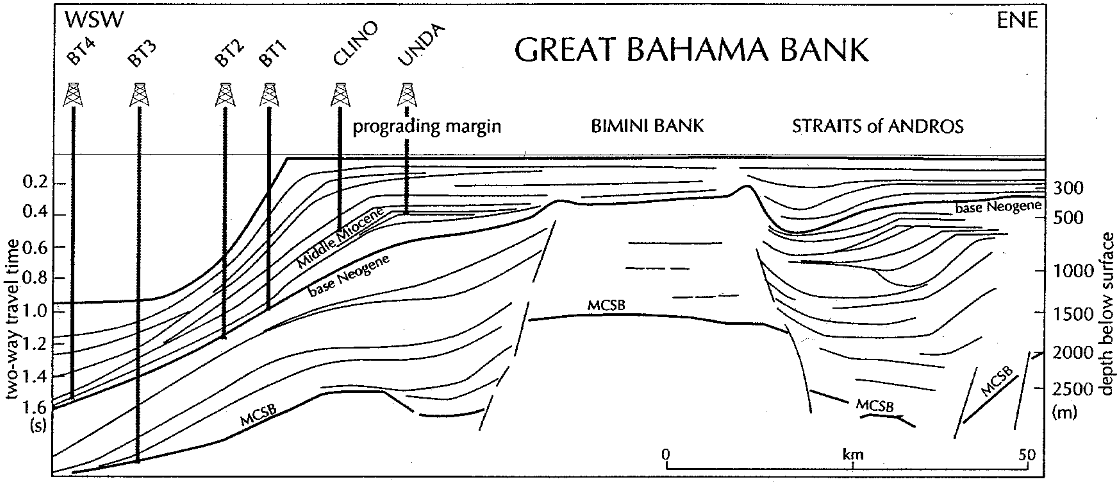
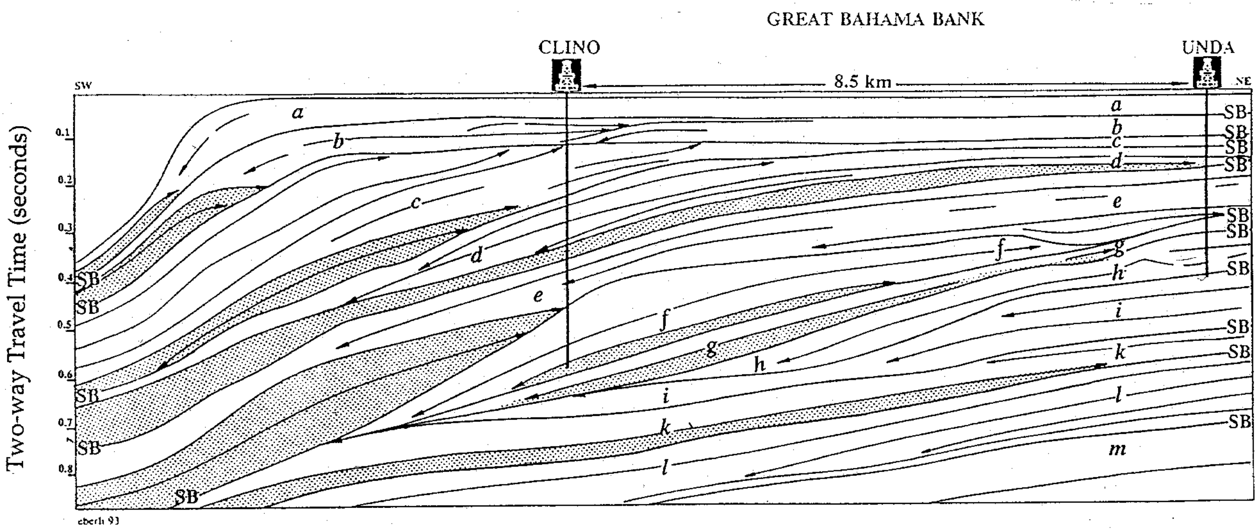

WSW
ENE
GREAT BAHAMA BANK
BT4
BT3
BT2
BT1
CLINO
UNDA
prograding margin
BIMINI BANK
STRAITS of ANDROS
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
(s)
two-way travel time
300
500
1000
1500
2000
2500
(m)
depth below surface
Middle Miocene
base Neogene
base Neogene
MCSB
MCSB
MCSB
MCSB
0
km
50

Figure 2



GREAT BAHAMA BANK
CLINO
UNDA
8.5 km
SW
NE
Two-way Travel Time (seconds)
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
a
b
c
d
e
f
g
h
i
k
l
m
SB
eberli 93

Figure 3

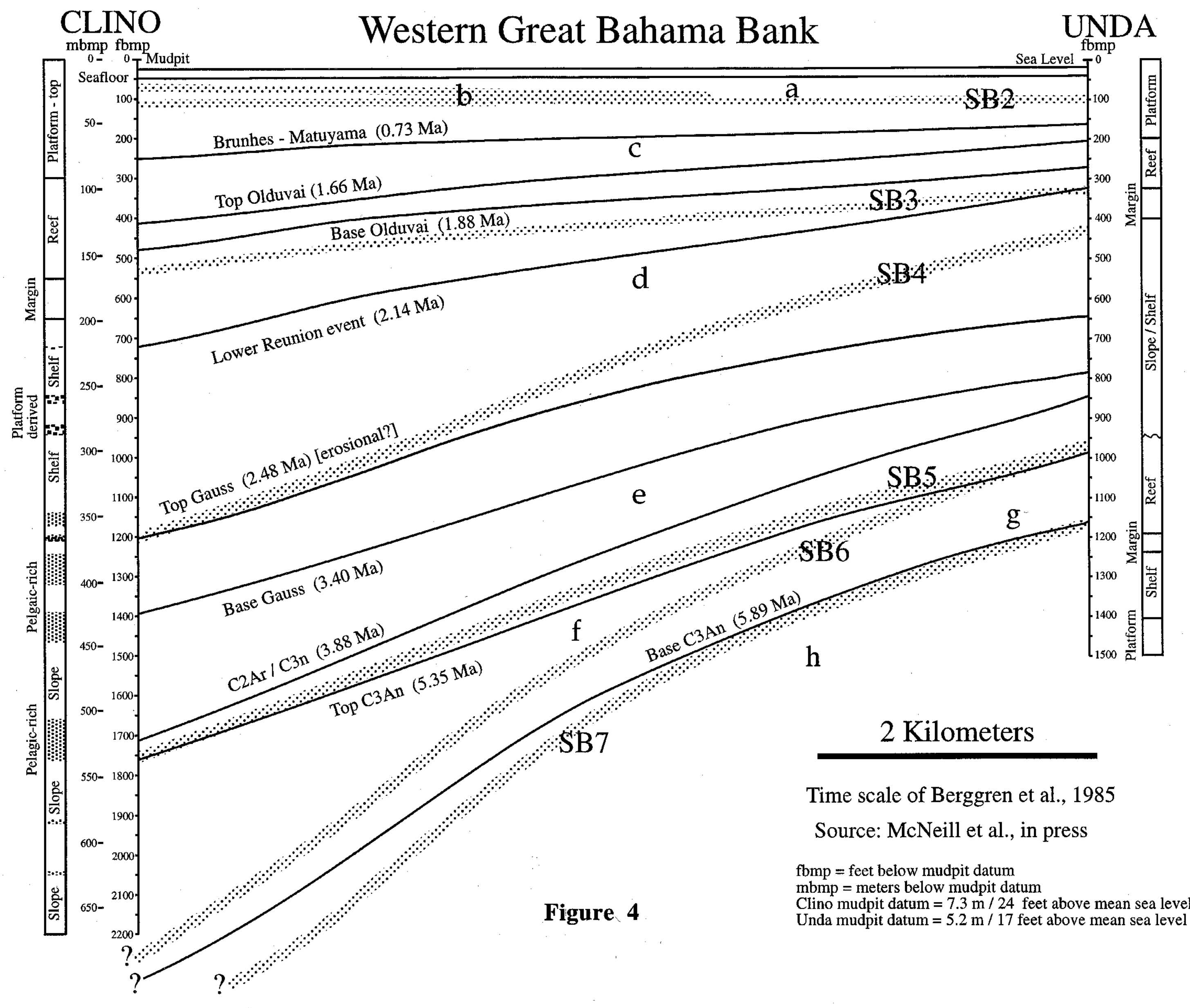
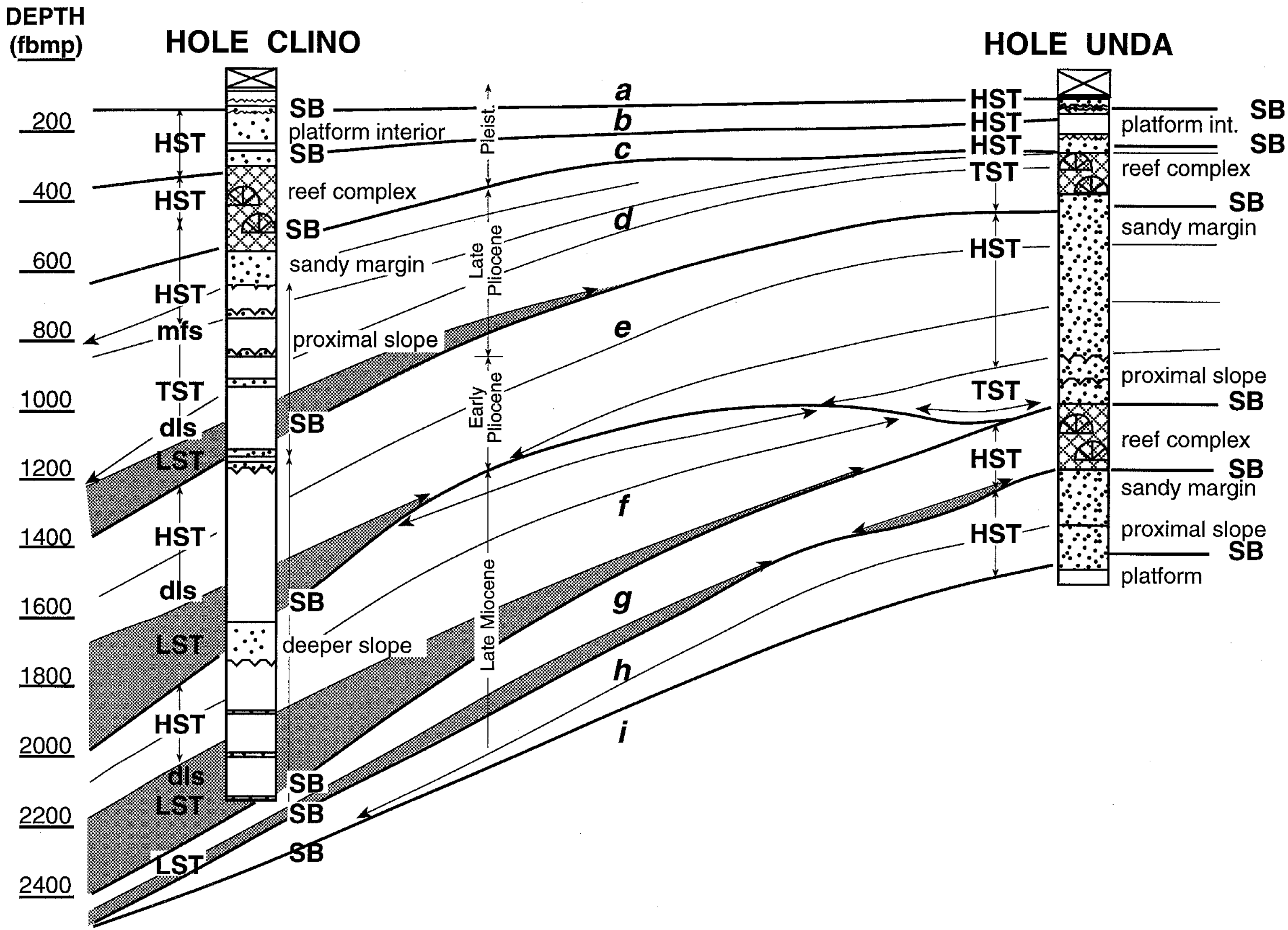

Western Great Bahama Bank
CLINO
mbmp fbmp
Mudpit
Seafloor
UNDA
fbmp
Sea Level
Platform - top
Reef
Margin
Platform derived
Shelf
Pelgaic-rich
Slope
Pelagic-rich
Platform
Reef
Margin
Slope / Shelf
Reef
Margin
Shelf
Platform
a
b
SB2
Brunhes - Matuyama (0.73 Ma)
c
Top Olduvai (1.66 Ma)
SB3
Base Olduvai (1.88 Ma)
d
SB4
Lower Reunion event (2.14 Ma)
Top Gauss (2.48 Ma) [erosional?]
e
SB5
g
SB6
Base Gauss (3.40 Ma)
f
C2Ar / C3n (3.88 Ma)
Base C3An (5.89 Ma)
h
Top C3An (5.35 Ma)
SB7
2 Kilometers
Time scale of Berggren et al., 1985
Source: McNeill et al., in press
fbmp = feet below mudpit datum
mbmp = meters below mudpit datum
Clino mudpit datum = 7.3 m / 24 feet above mean sea level
Unda mudpit datum = 5.2 m / 17 feet above mean sea level

Figure 4



DEPTH
(fbmp)
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
HOLE CLINO
HOLE UNDA
a
b
c
d
e
f
g
h
i
SB
platform interior
SB
reef complex
SB
sandy margin
proximal slope
SB
SB
deeper slope
SB
SB
SB
HST
HST
HST
mfs
TST
dls
LST
HST
dls
LST
HST
dls
LST
LST
Pleist.
Late Pliocene
Early Pliocene
Late Miocene
HST
HST
HST
TST
HST
TST
HST
HST
SB
platform int.
SB
reef complex
SB
sandy margin
proximal slope
SB
reef complex
SB
sandy margin
proximal slope
SB
platform

Figure 5

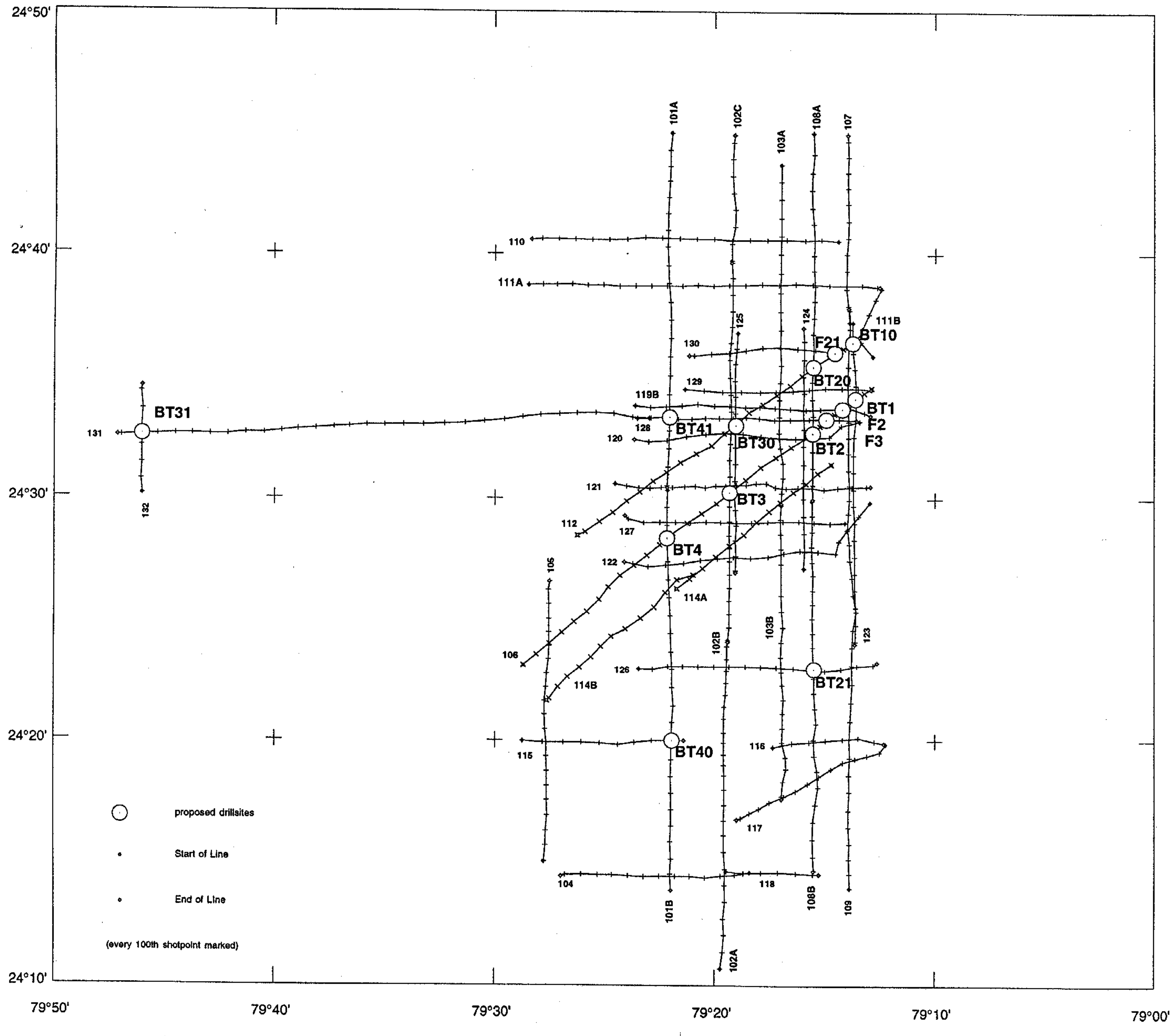

24°50'
24°40'
24°30'
24°20'
24°10'
79°50'
79°40'
79°30'
79°20'
79°10'
79°00'
101A
102C
103A
108A
107
110
111A
111B
125
124
130
F21
BT10
BT20
129
119B
BT1
BT31
BT41
131
128
BT30
F2
120
BT2
F3
121
BT3
132
112
127
BT4
105
122
114A
103B
102B
123
106
126
BT21
114B
115
BT40
116
117
104
118
101B
108B
109
102A
proposed drillsites
Start of Line
End of Line
(every 100th shotpoint marked)

Figure 6

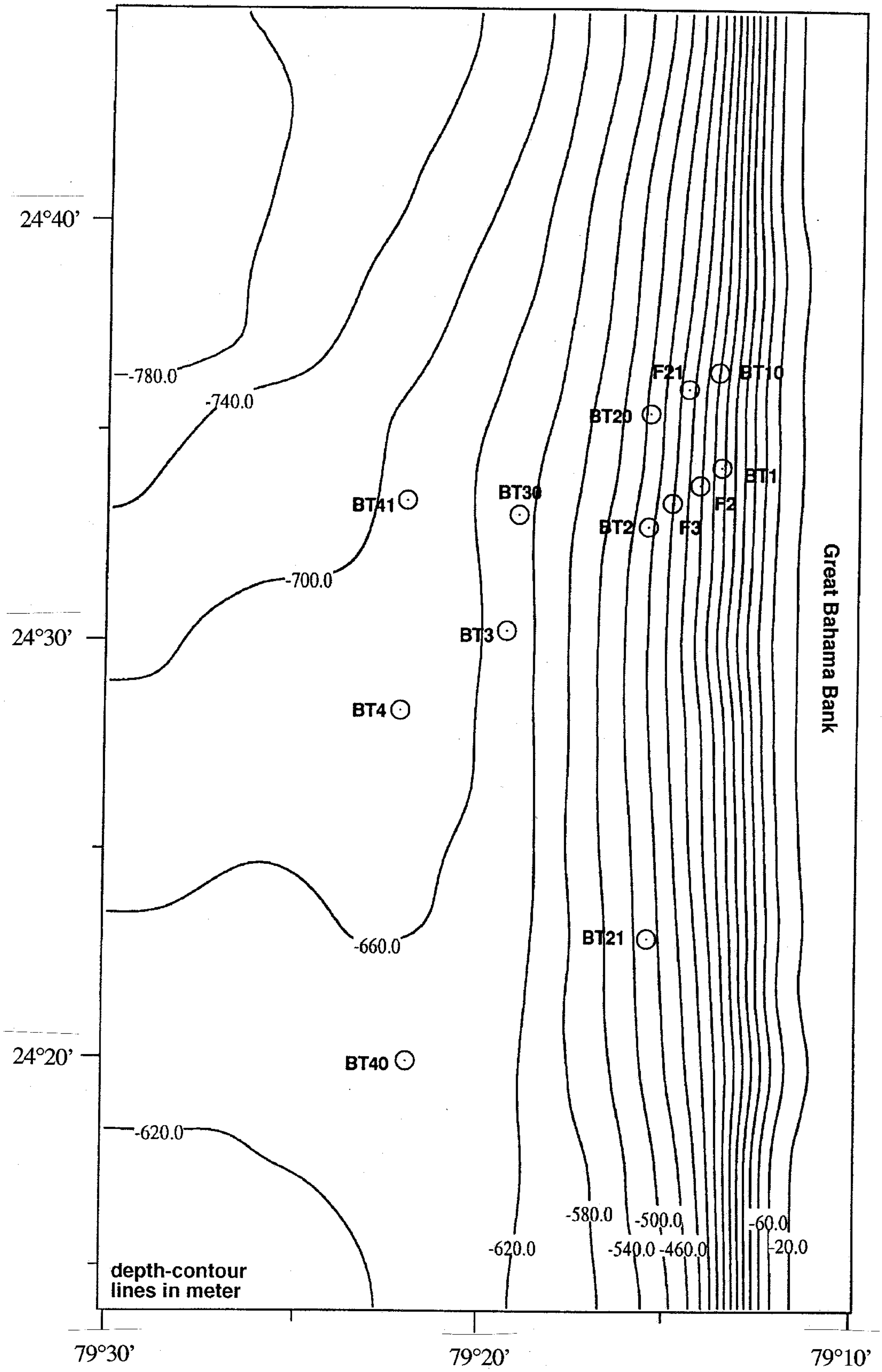
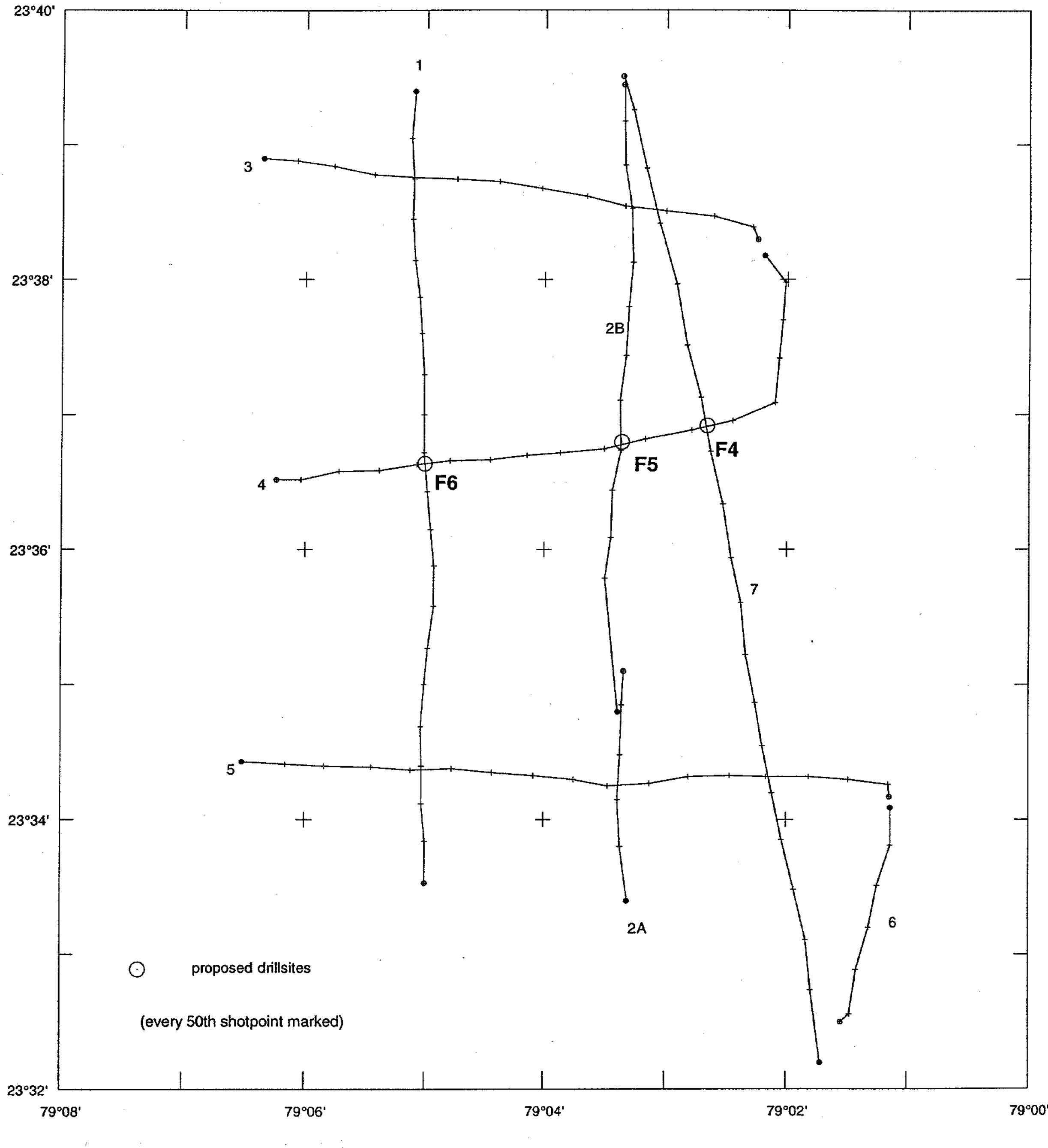

24°40'
24°30'
24°20'
79°30'
79°20'
79°10'
-780.0
-740.0
-700.0
-660.0
-620.0
-620.0
-580.0
-540.0
-500.0
-460.0
-60.0
-20.0
F21
BT10
BT20
BT1
BT41
BT30
F2
BT2
F3
BT3
BT4
BT21
BT40
Great Bahama Bank
depth-contour lines in meter

Figure 7



23°40'
23°38'
23°36'
23°34'
23°32'
79°08'
79°06'
79°04'
79°02'
79°00'
1
2A
2B
3
4
5
6
7
F4
F5
F6
proposed drillsites
(every 50th shotpoint marked)

Figure 8

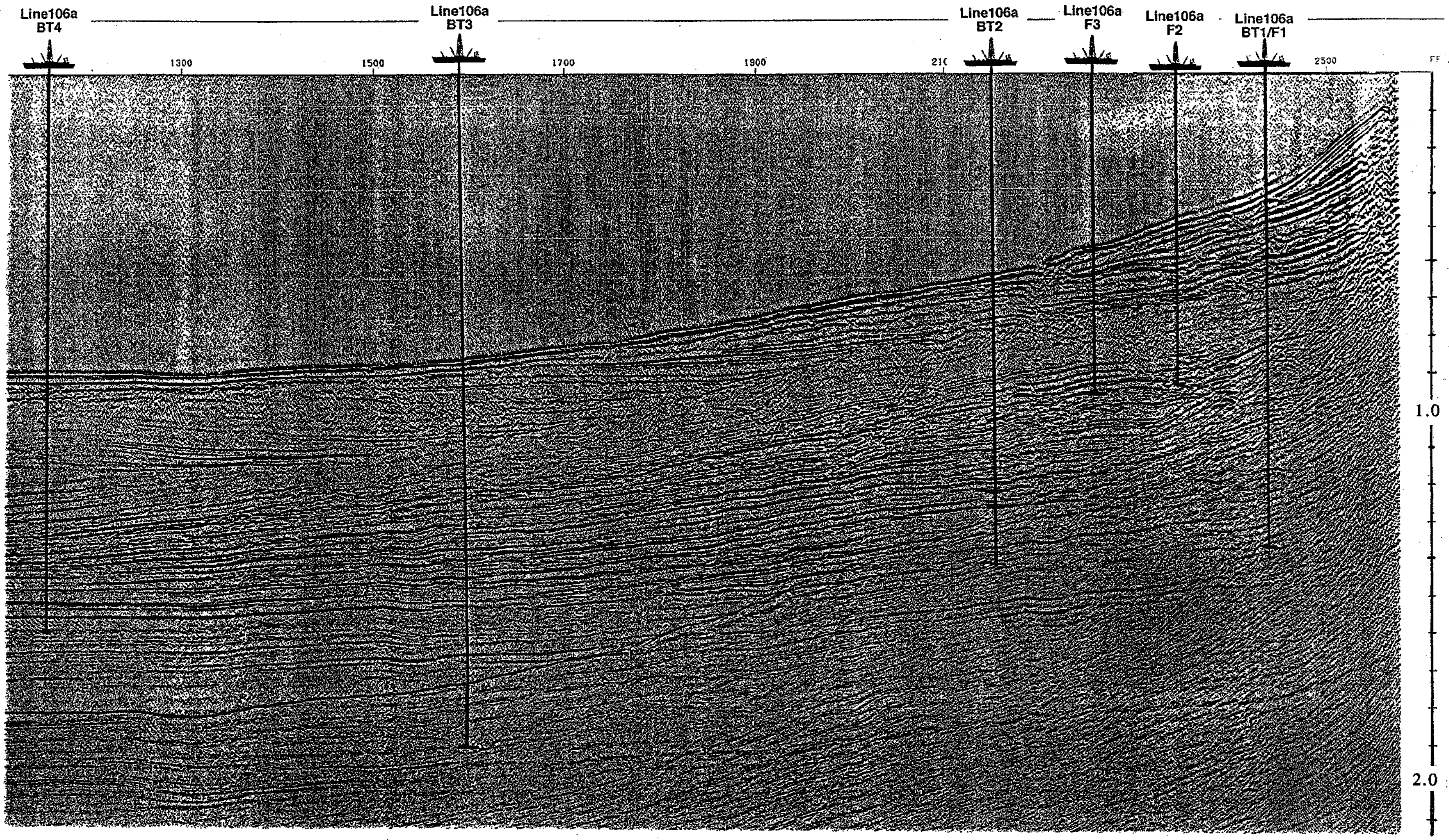

Line106a
BT4
Line106a
BT3
Line106a
BT2
Line106a
F3
Line106a
F2
Line106a
BT1/F1
1300
1500
1700
1900
2500
1.0
2.0

Figure 9

SITE SUMMARIES:
PROPOSED PRIMARY SITES

Site: BT-2

Priority: 1

Position: 24°32.71'N; 79°15.58'W

Water depth: 470 m

Sediment thickness: >8000 m

Total penetration: 852 mbsf (approved to a depth of 1050 mbsf)

Seismic coverage: High-resolution multichannel siesmic (MCS) survey, industrial seismic line

Objectives: The objectives of BT-2 are to:

1. obtain sedimentary record, determine the facies within the differing systems especially evaluate facies of lowstand vs. highstand deposits; and determine the nature of the unconformity at 0.85 s (twt);

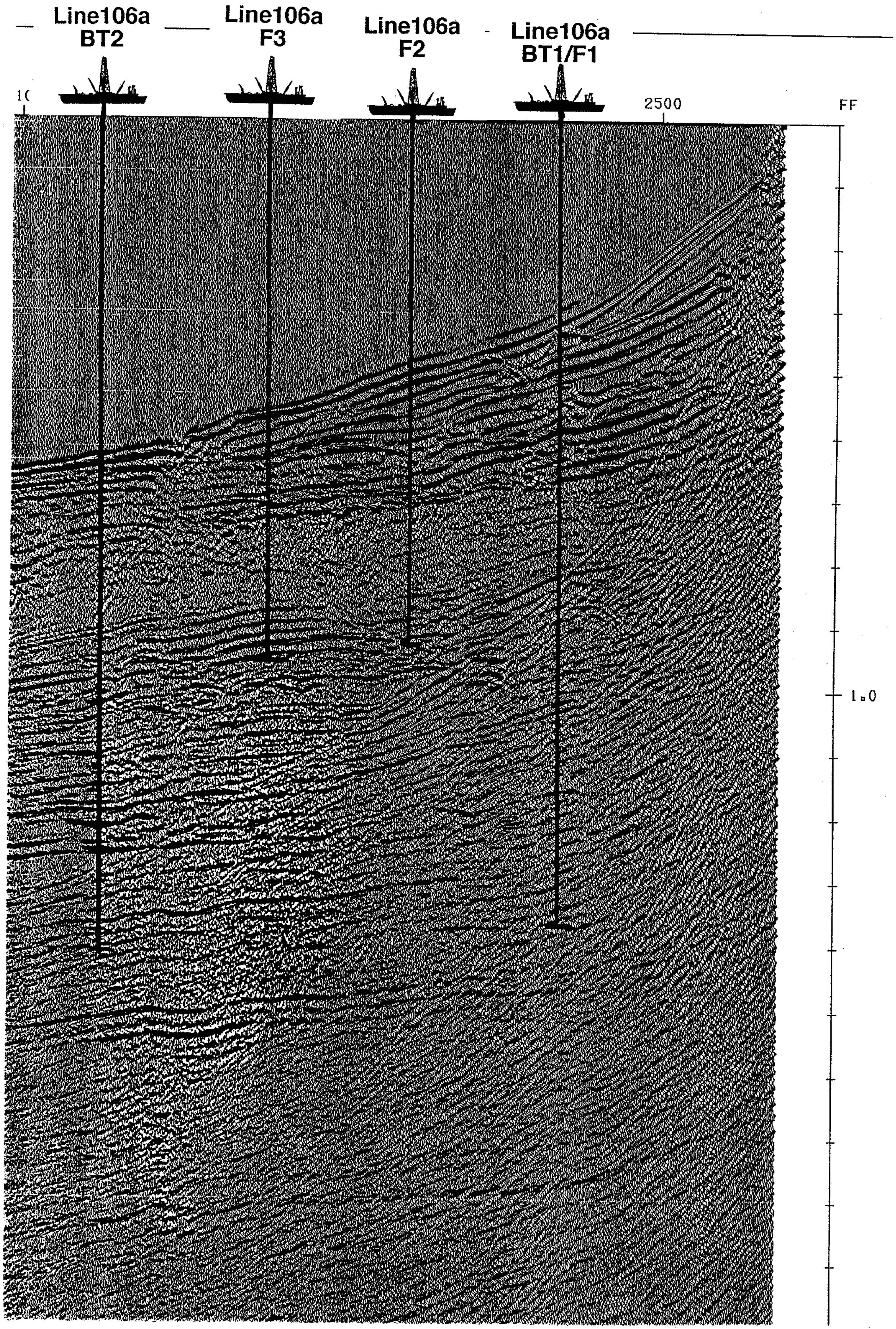
2. refine the age of the seismic sequence boundaries;

3. retrieve material for a high-resolution isotope stratigraphy of the Neogene to Holocene; and
4. determine possible fluid flow through this portion of the margin

Drilling program:
Hole A: APC/XCB to refusal.
Hole B: Core using APC.
Hole C: Wash down to XCB depth and RCB to 852 mbsf.

Logging and downhole: ADARA heat-flow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. The hole will be logged using four logging strings (Quad-Combination, geochemical logging tool [GLT], the Formation MicroScanner [FMS]), and the geological high-sensitivity magnetic tool (GHMT), and a vertical seismic profile (VSP) experiment will be performed.

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.



Line106a
BT2
Line106a
F3
Line106a
F2
Line106a
BT1/F1
2500
FF
1.0

Site: F-3

Priority: 1
Position: 24°33.28'N; 79°14.95'W
Water depth: 410 m
Sediment thickness: >8000 m
Total penetration: 341 mbsf (approved to a depth of 550 mbsf)
Seismic coverage: High-resolution MCS survey

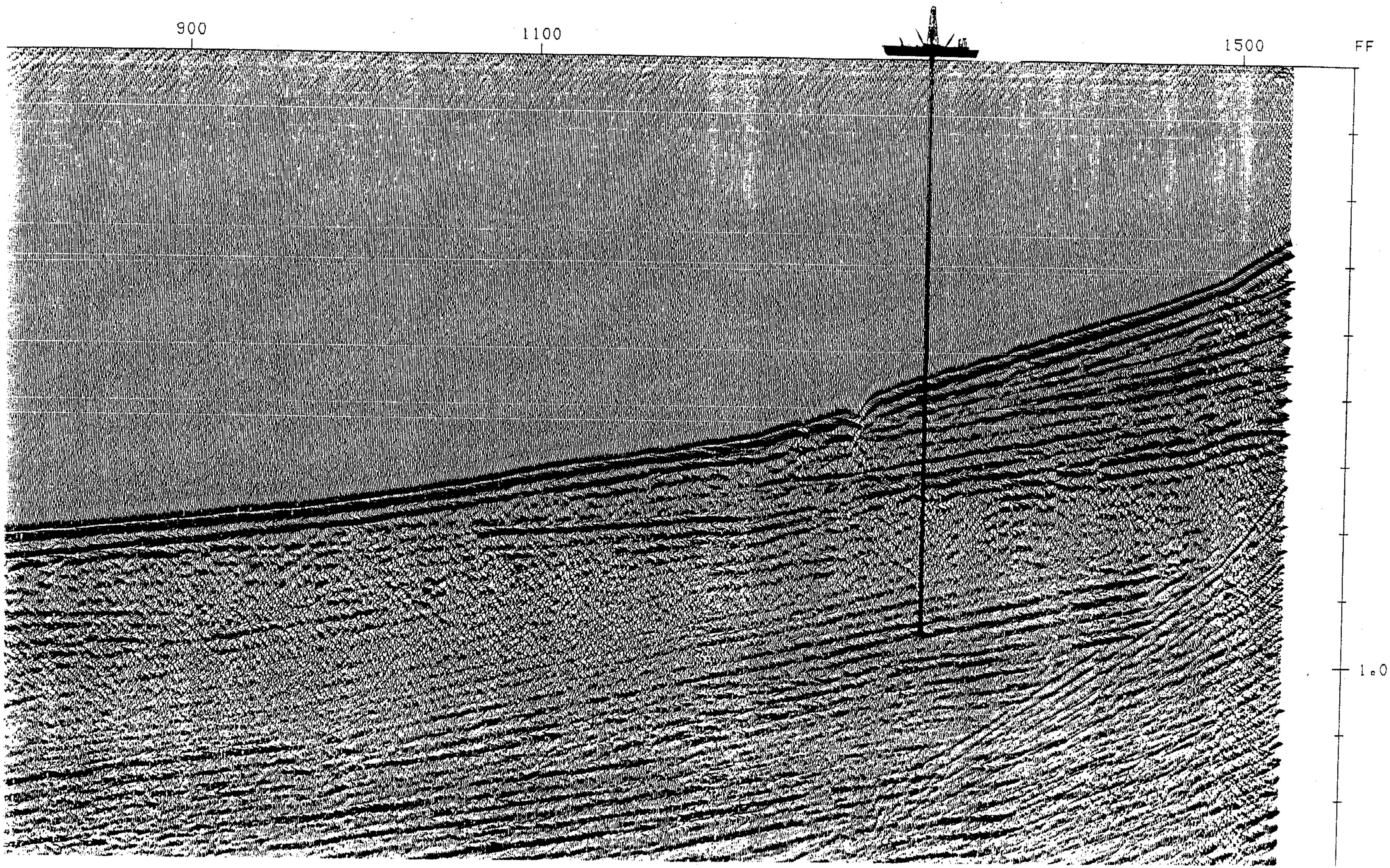
Objectives: The objective of F-3 is to reveal possible fluid flow through this portion of the margin

Drilling program: APC to refusal.

Logging and downhole: ADARA heat flow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. No wireline logging anticipated.

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.

Line128a
F3



Site: BT-1/F1

Priority: 1
Position: 24°34.12'N; 79°13.64'W*
Water depth: 290 m
Sediment thickness: >8000 m
Total penetration: 1035 mbsf (approved to a depth of 1200 mbsf)
Seismic coverage: High-resolution MCS survey, industrial seismic line

Objectives: The objectives of BT-1 are to:

1. date precisely seismic sequence boundaries;

2. determine the facies within the different systems tracts, especially the nature of the onlapping units that are currently interpreted as lowstand deposits;

3. evaluate the fluid flow in this uppermost part of the slope; and

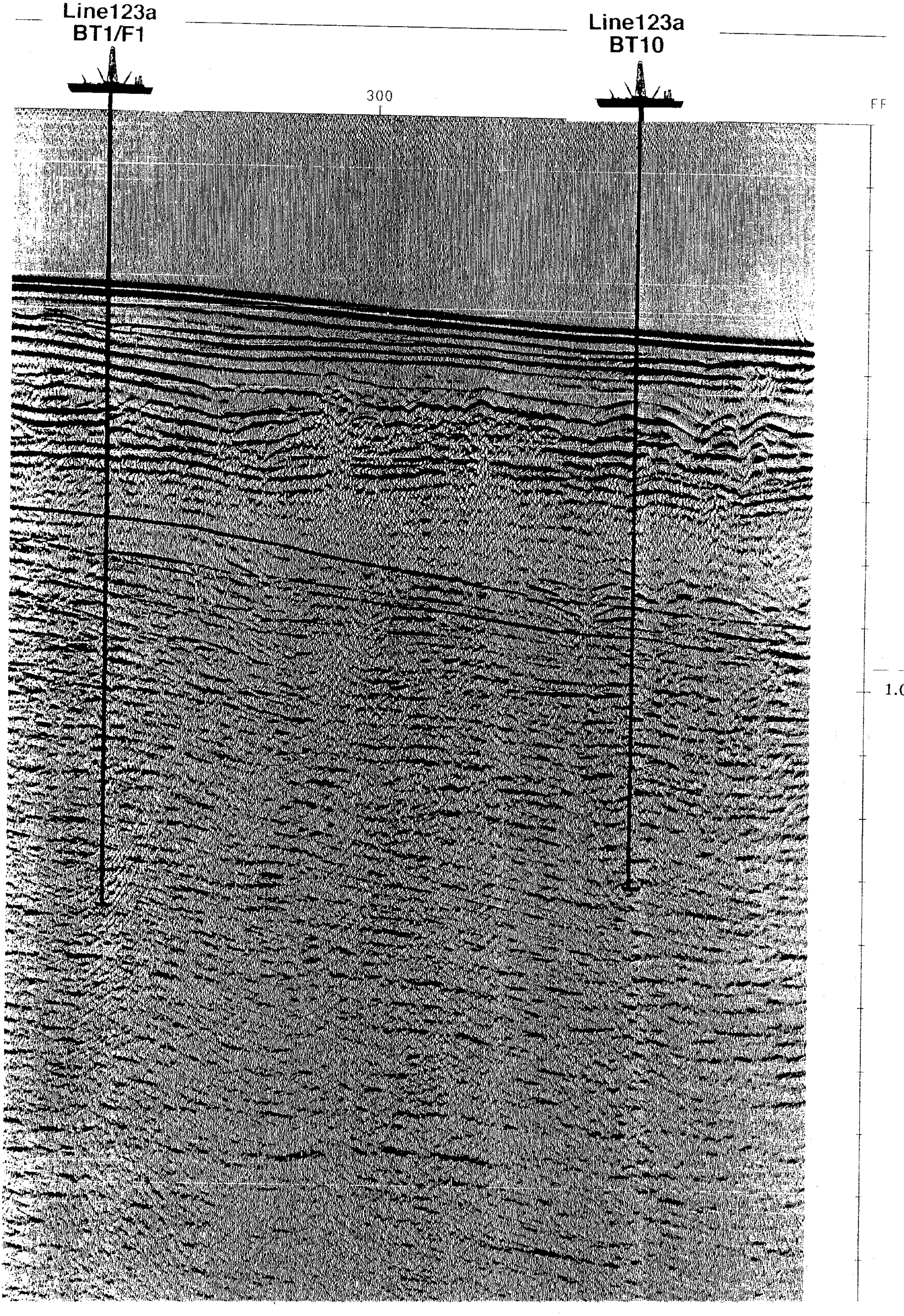
4. retrieve a high-resolution record of climate and sea-level fluctuations for the Quaternary and Late Pliocene.

Drilling program:
Hole A and B: APC/XCB to refusal
Hole C: Wash to XCB depth and RCB to total depth; a third APC will be drilled if time permits.

Logging and downhole: ADARA heat flow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. Three logging runs using the standard logging packages (Quad-Combination, GLT, and FMS) and a VSP experiment will be performed.

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.

*Operational safety considerations may require relocating this site to deeper water.


Line123a
BT1/F1
Line123a
BT10
300
FF
1.0

Site: BT-4

Priority: 1

Position: 24°28.36'N; 79°22.17'W

Water depth: 675 m

Sediment thickness: >8000 m

Total penetration: 753 mbsf (approved to a depth of 953 mbsf)

Seismic coverage: High-resolution MCS survey

Objectives: The objectives of BT-4 are to:

1. obtain a record of the facies of the basinal deposits associated with the prograding sequence and

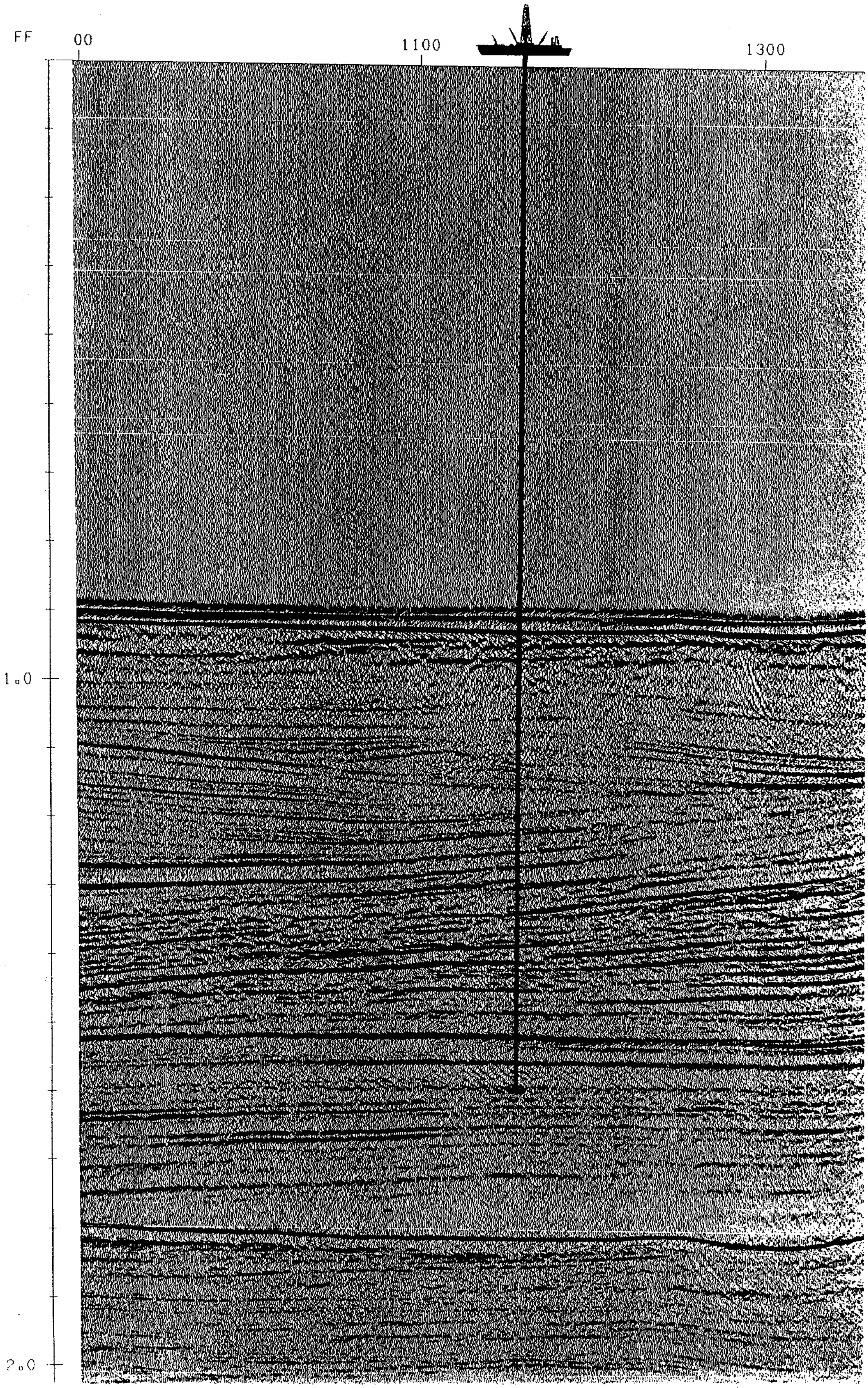
2. assess and date the record of fluctuations in the strength of the Florida Current.

Drilling program:
Hole A: APC/XCB to refusal.
Hole B: APC to refusal.
Hole C: RCB to 753 m, if time permits.

Logging and downhole: ADARA heat flow measurements will be made on the first eight APC cores below Core 3, and one every third core thereafter. WSTP will be performed on every fifth XCB core. The hole will be logged using the three standard logging strings(Quad-Combination, GLT, and FMS). A VSP experiment will be performed, if time permits.

Nature of Rock Anticipated: Periplatform ooze occasionally mixed with coarser grained units.

Line106a
BT4



Site: BT-20

Priority 1
Position: 24°35.41'N; 79°15.56'W
Water depth: 475 m
Sediment thickness: >8000 m
Total penetration: 822 mbsf (approved to a depth of 1020 mbsf)
Seismic coverage: High-resolution MCS survey

Objectives: The objectives of BT-20 are to:

1. assess lateral variability in facies within the prograding sequences.

2. test the lateral consistency of ages of the sequence boundaries;

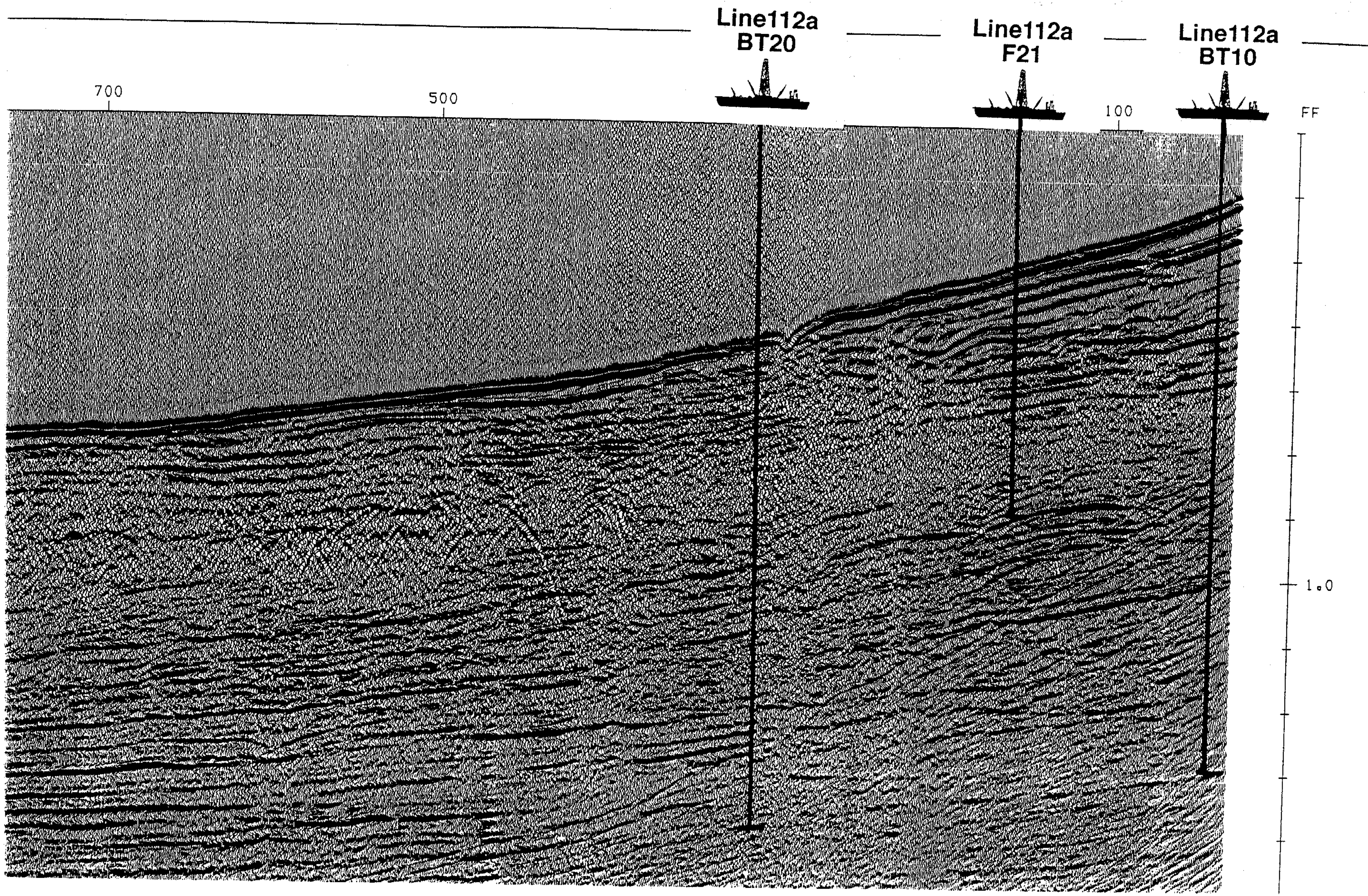
3. obtain material to produce a high-resolution isotope stratigraphy of the Neogene to Holocene; and

4. reveal possible fluid flow through this portion of the margin.

Drilling program:
Hole A: APC/XCB to refusal.
Hole B: APC to refusal.
Hole C: RCB to the target depth of 822 mbsf, if necessary and if time permits.

Logging and Downhole: ADARA heat flow measurements will be made on the first eight APC cores below cCre 3 and one every third core thereafter. The hole will be logged using three standard logging strings (Quad-Combination, GLT, FMS)).

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.



Line112a
BT20
Line112a
F21
Line112a
BT10
700
500
100
FF
1.0

Site: BT-3

Priority: 1
Position: 24°30.26'N; 79°19.34'W
Water depth: 660 m
Sediment thickness: >8000 m
Total Penetration: 1413 mbsf (approved to a depth of 1613 mbsf)
Seismic Coverage: High-resolution MCS survey

Objectives: The objectives of BT-3 are to:

1. retrieve a high-resolution isotope stratigraphy to potentially tie the sedimentary record to the oxygen isotope record of the Neogene to recent sea-level fluctuations;

2. obtain sedimentary record of the lower slope portions of the prograding sequences;

3. refine the age of the sequence boundaries; and

4. reveal possible fluid flow through this portion of the margin.

Additional secondary objectives:

1. To acquire a low-latitude record of the Paleogene;

2. To determine the timing of the onset of the Florida current;

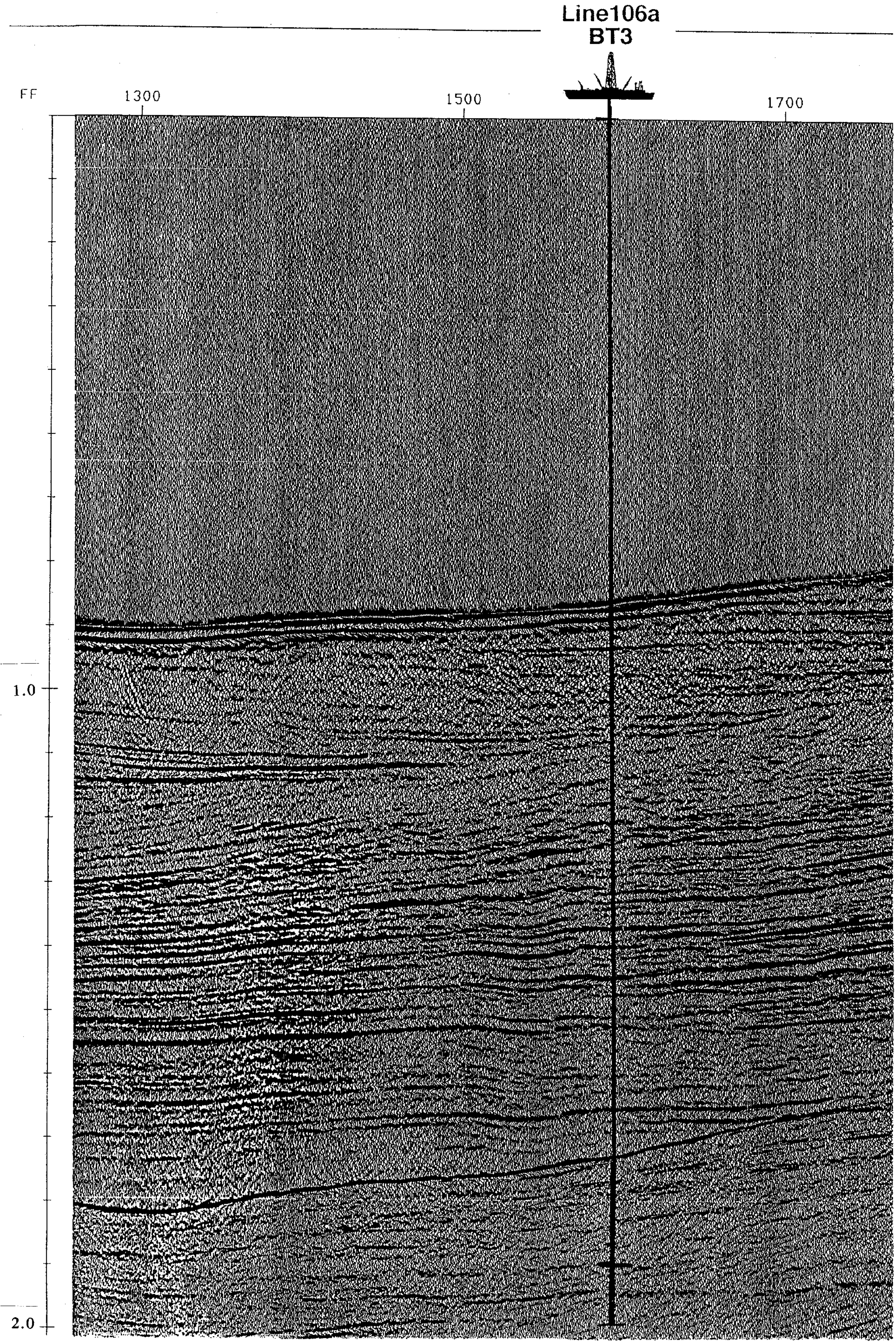
3. To potentially sample the K/T boundary; and

4. To assess the cause of the platform demise in the middle-Cretaceous (MCSB).

Drilling program:
Hole A: APC/XCB to refusal.
Hole B: APC to refusal.
Hole C: Washed down to XCB depth, followed by RCB to a depth of 1000 mbsf. The hole will be deepened, if time permits, to a depth of 1413 mbsf.

Logging and downhole: ADARA heat flow measurements will be made on the first eight APC cores below Core 3, and one every third core thereafter. WSTP will be performed on every fifth XCB core. The hole will be logged in four runs (Quad-Combination, GLT, FMS, and GHMT), and a VSP experiment will be performed.

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser units.



Line106a
BT3
FF
1300
1500
1700
1.0
2.0

Site: F-6

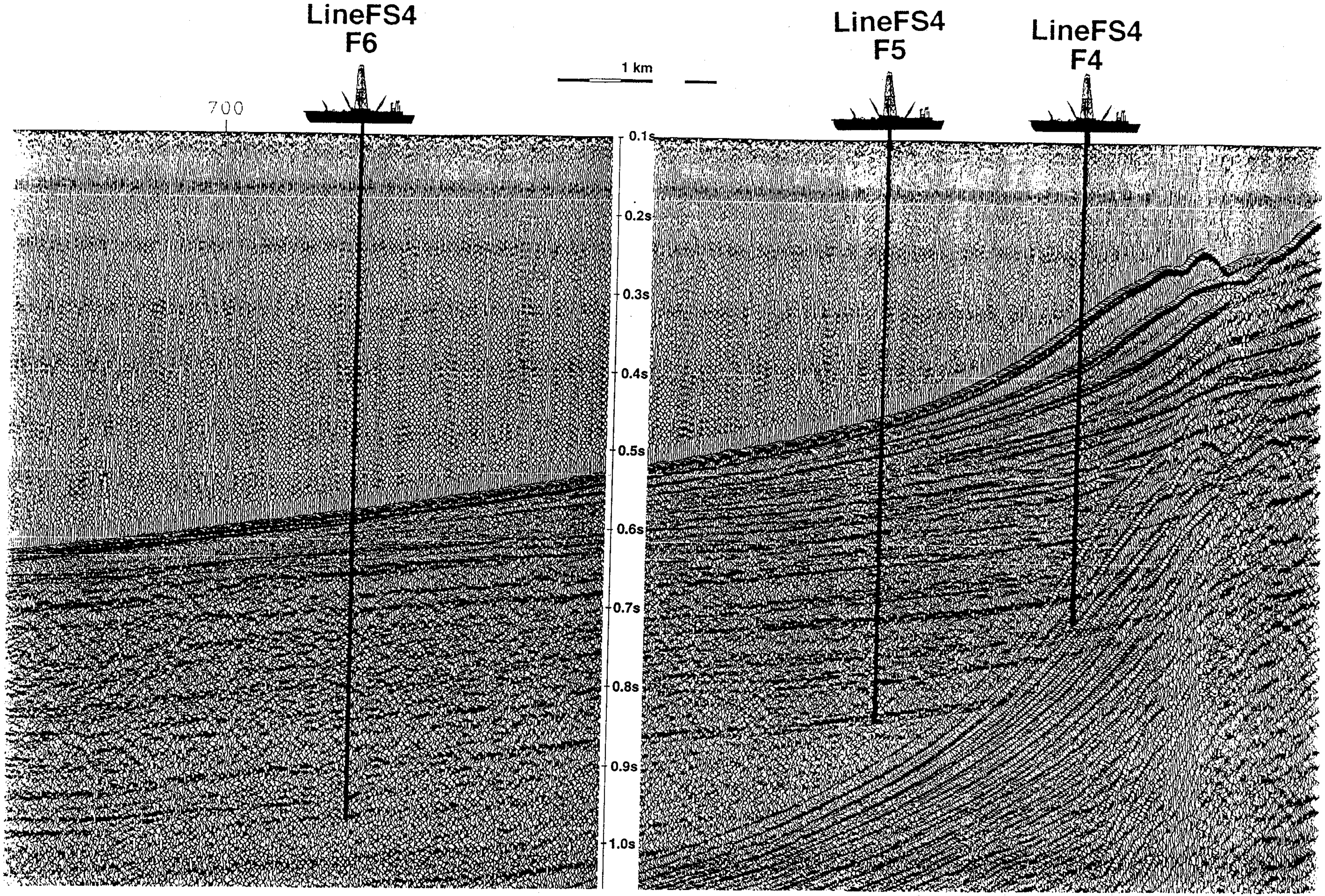
Priority: 1
Position: 23°36.64'N; 79°05.01'W
Water depth: 430 m
Sediment thickness: >8000 m
Total penetration: 352 mbsf (approved to a depth of 550 mbsf)
Seismic coverage: High-resolution MCS survey

Objectives: To reveal possible fluid flow through the lower slope portion of the margin.

Drilling program: APC to refusal.

Logging and downhole: ADARA heat flow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. No wireline logging anticipated.

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.


LineFS4
F6
LineFS4
F5
LineFS4
F4
1 km
700
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s

Site: F-5

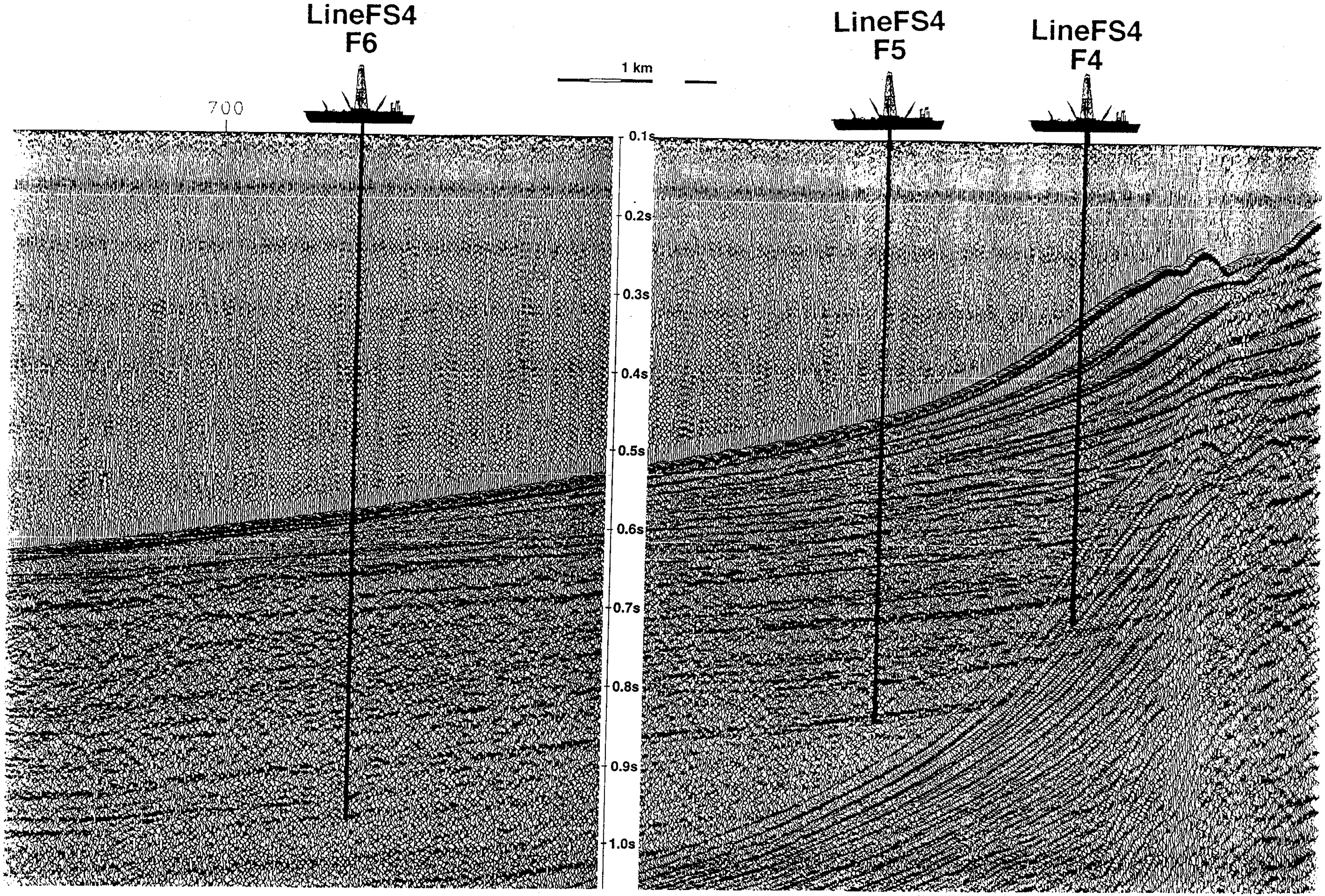
Priority: 1
Position: 23°36.80'N; 79°03.36'W
Water depth: 335 m
Sediment thickness: >8000 m
Total penetration: 371 mbsf (approved to a depth of 471 mbsf)
Seismic coverage: High-resolution MCS survey

Objectives: To reveal possible fluid flow through the middle slope portion of the margin

Drilling Program: APC to refusal. XCB to 471 m if time permits.

Logging and Downhole: ADARA heat flow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. Three logging runs (Quad-Combination, GLT, andFMS), if time permits.

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.


LineFS4
F6
LineFS4
F5
LineFS4
F4
1 km
700
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s

Site: F-4

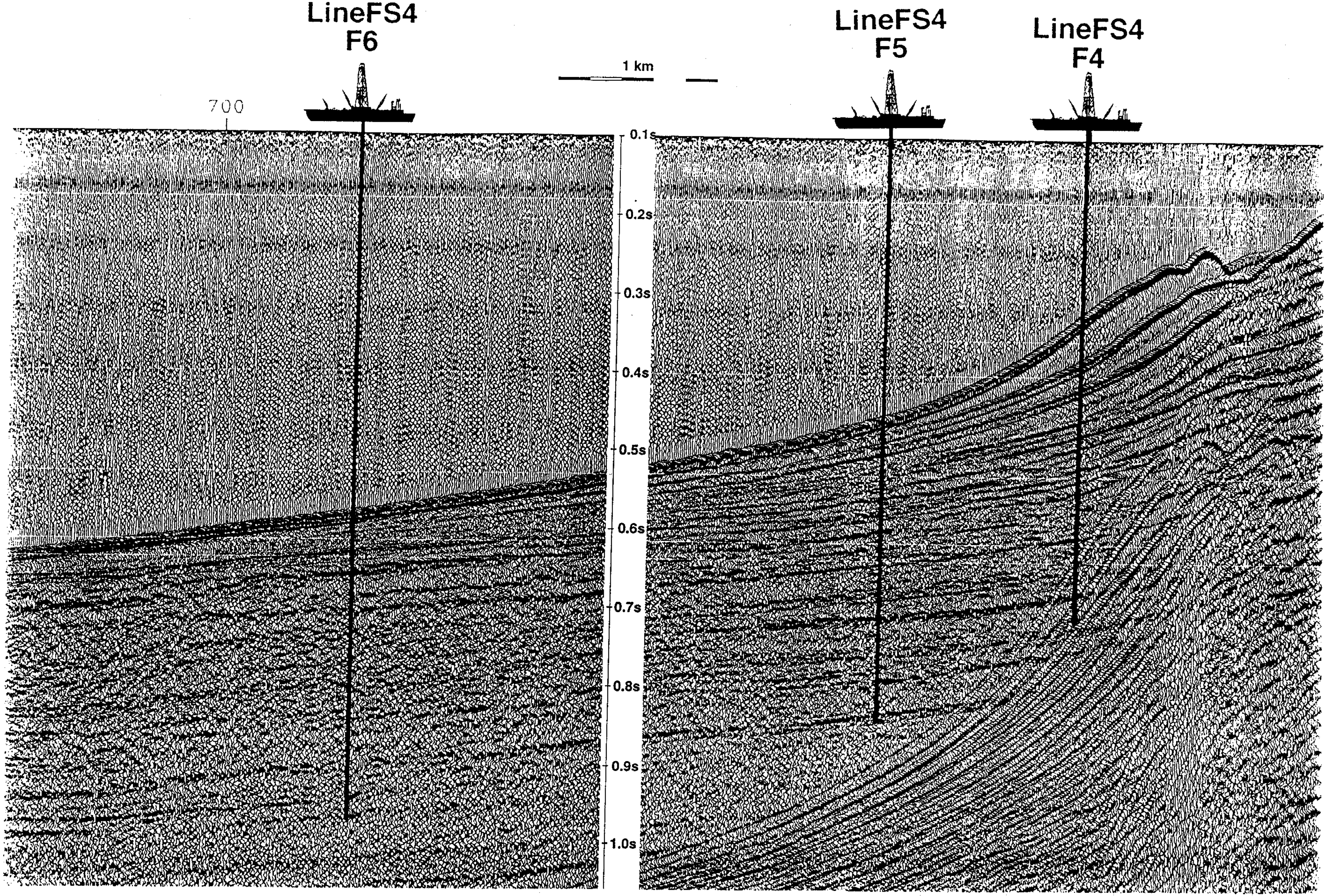
Priority: 1
Position: 23°36.92'N; 79°02.66'W*
Water depth: 245 m
Sediment thickness: >8000 m
Total Penetration: 358 mbsf (approved to a depth of 500 mbsf)
Seismic Coverage: High-resolution MCS survey

Objectives: To reveal possible fluid flow through the upper slope portion of the margin

Drilling program: APC to refusal.

Logging and downhole: ADARA heatflow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. No wireline logging anticipated.

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.


LineFS4
F6
LineFS4
F5
LineFS4
F4
1 km
700
0.1s
0.2s
0.3s
0.4s
0.5s
0.6s
0.7s
0.8s
0.9s
1.0s

SITE SUMMARIES:
PROPOSED SECONDARY SITES

(No prioritization of sites should be inferred)

Site: F-2 (Alternate)

Priority: Secondary site alternate to F3
Position: 24°33.70'N; 79°14.23'W
Water depth: 355 m
Sediment thickness: >8000 m
Total Penetration: 404 mbsf (approved to a depth of 600 mbsf)
Seismic Coverage: High-resolution MCS survey

Objectives: The objective of F-2 is to reveal possible fluid flow through the upper portion of the margin

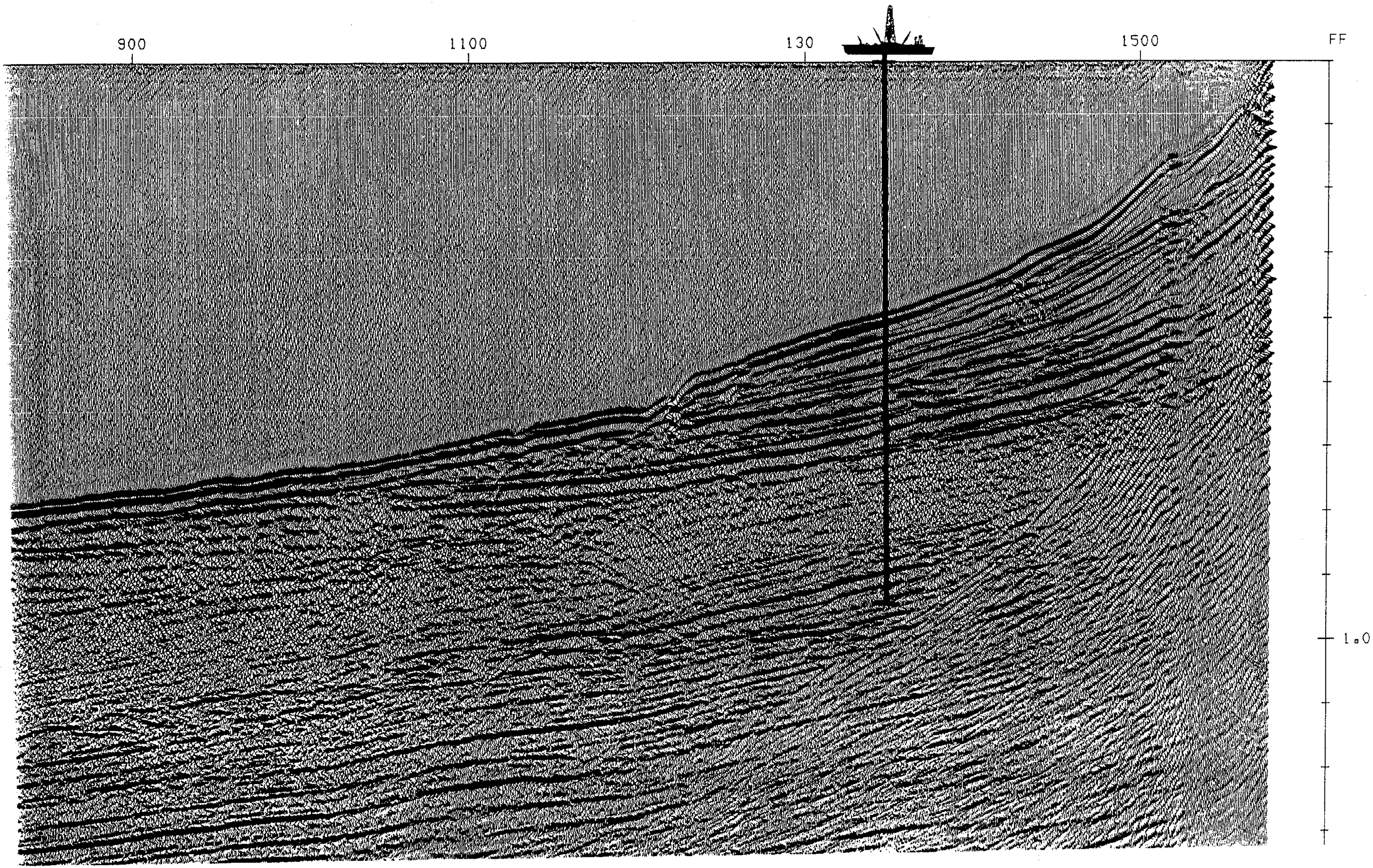
Drilling Program:

Hole A: APC to refusal.

Logging and Downhole: ADARA heatflow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. No wireline logging anticipated.

Nature of Rock Anticipated: Periplatform ooze occasionally mixed with coarser grained units.

Line119b
F2



Site: F-21 (Alternate)

Priority: Secondary site alternate to F3
Position: 24°36.00'N; 79°14.56'W
Water depth: 390 m
Sediment thickness: >8000 m
Total Penetration: 358 mbsf (approved to a depth of 560 mbsf)
Seismic Coverage: High-resolution MCS survey

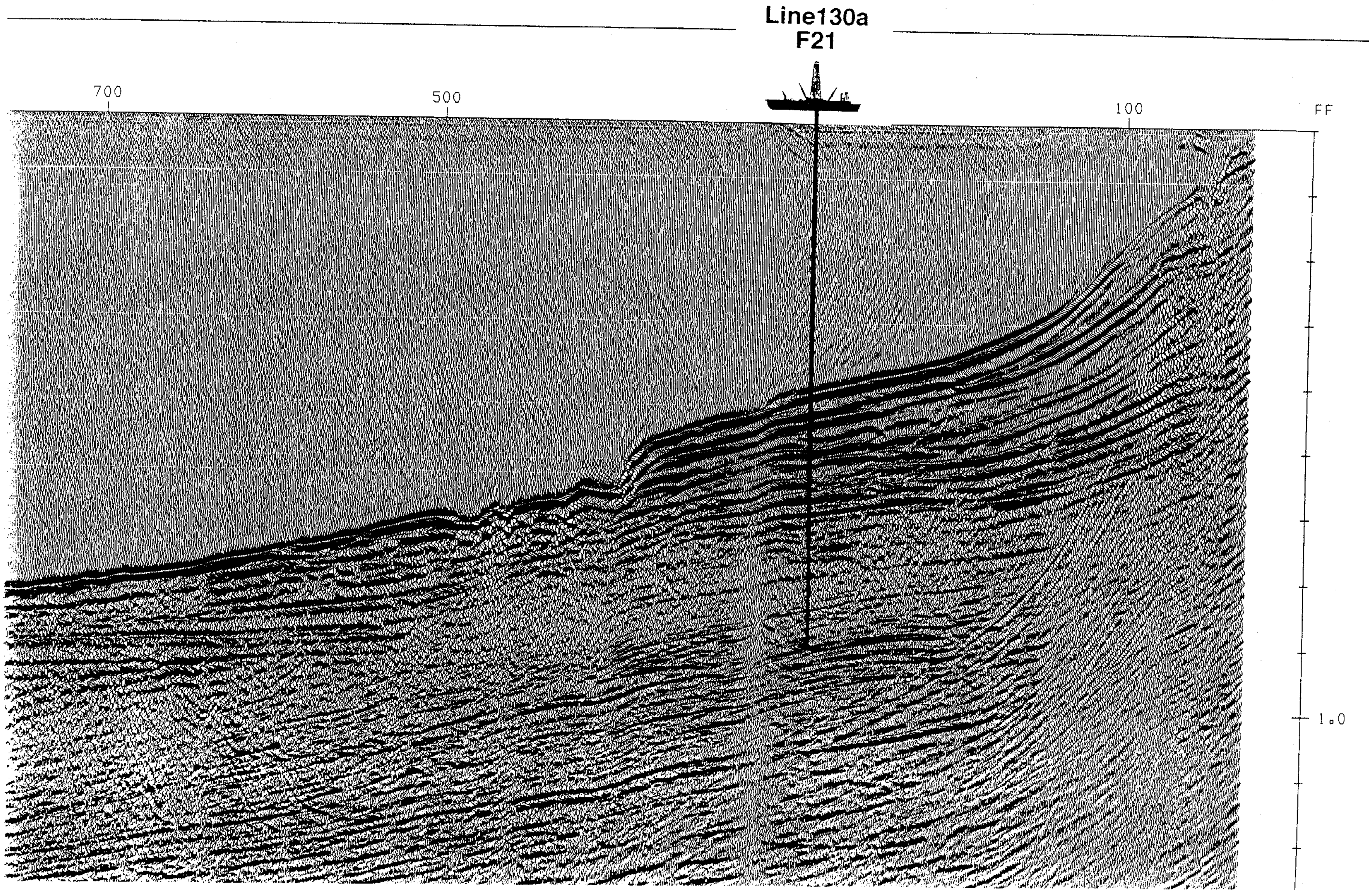
Objectives: The objective of F-21 is to reveal possible fluid flow through this portion of the margin

Drilling program:

Hole A: APC to refusal.

Logging and downhole: ADARA heatflow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. No wireline logging anticipated.

Nature of Rock Anticipated: Periplatform ooze occasionally mixed with coarser grained units.



Line130a
F21
700
500
100
FF
1.0

Site: BT-10

Priority: Secondary site (Alternate to BT-1)
Position: 24°36.40'N; 79°13.75'W
Water depth: 310 m
Sediment thickness: >8000 m
Total penetration: 960 mbsf (approved to a depth of 1160 mbsf)
Seismic coverage: High-resolution MCS survey

Objectives: The objectives of BT-10 are to:

1. date precisely sequence boundaries;

2. determine the facies within the different systems tracts, especially the nature of the onlapping units that are currently interpreted as lowstand deposits;

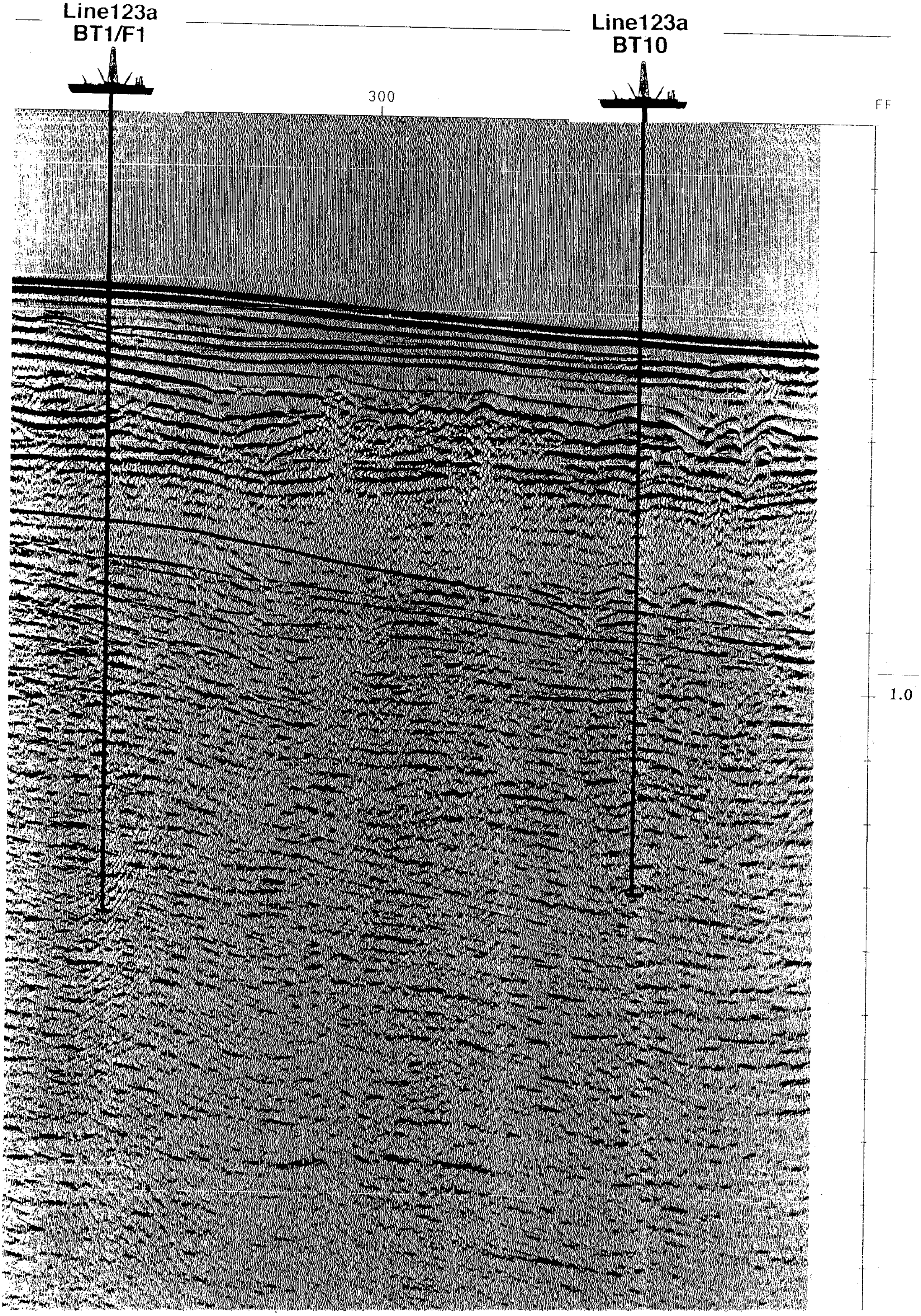
3. evaluate the fluid flow in this uppermost part of the slope; and

4. retrieve a high-resolution record of climate and sea-level fluctuations for the Quaternary and Late Pliocene.

Drilling program:
Holes A and B: Double APC/XCB to refusal
Hole C: Wash to XCB depth and RCB to a depth of 960 mbsf. A third APC to refusal will be drilled, if time permits.

Logging and downhole: ADARA heatflow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. The hole will be logged using the three standard logging strings (Quad-Combination, GLT, and FMS).

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.



Line123a
BT1/F1
Line123a
BT10
300
FF
1.0

Site: BT-21

Priority: 1 (Alternate to BT-2)
Position: 24°22.96'N; 79°15.52'W
Water depth: 480 m
Sediment thickness: >8000 m
Total penetration: 883 mbsf (approved to a depth of 1090 mbsf)
Seismic coverage: High-resolution MCS survey

Objectives: The objectives of BT-21 are to:

1. obtain sedimentary record and determine facies within the different systems;

2 refine the age of the seismic sequence boundaries;

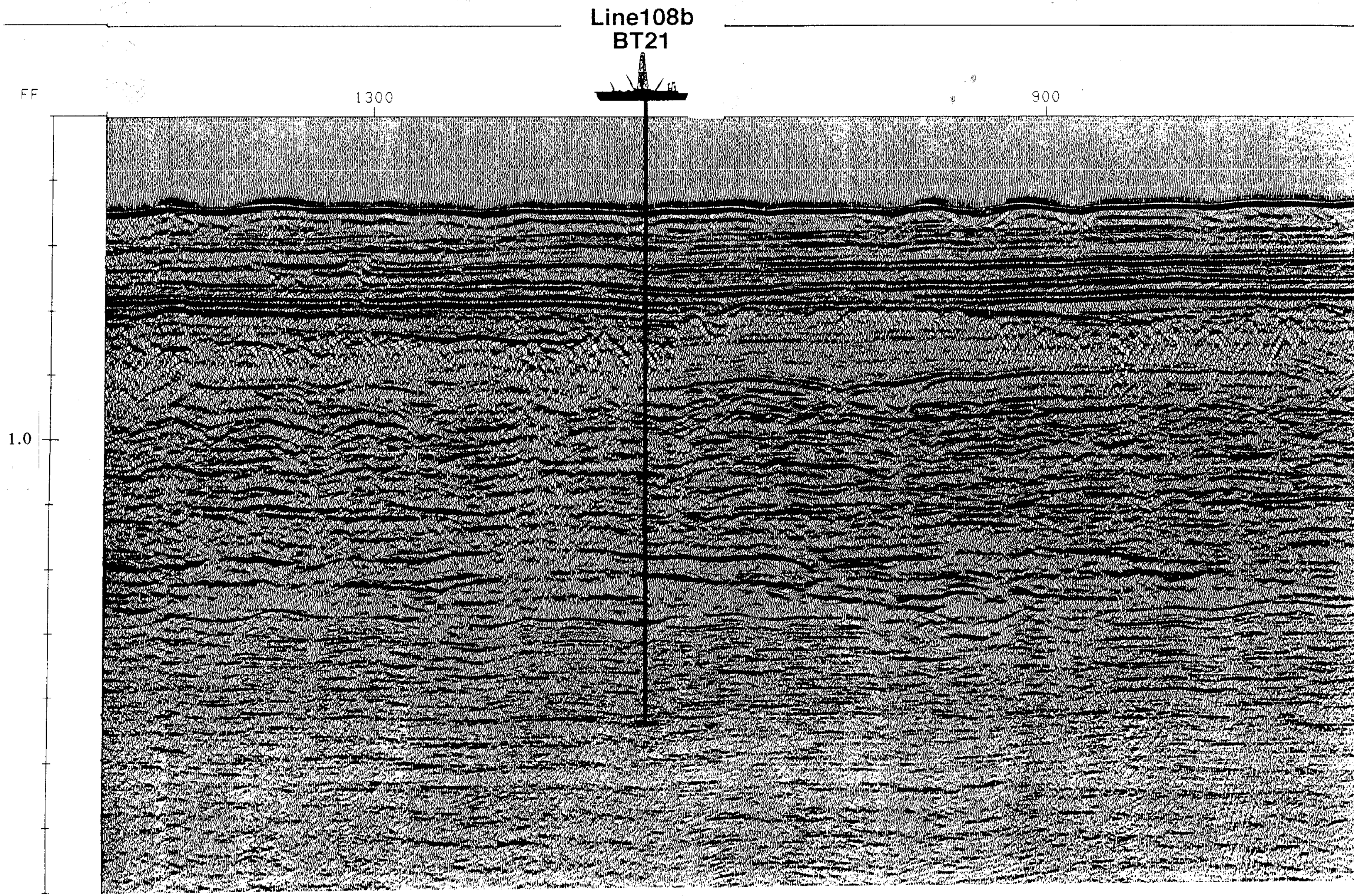
3. retrieve material to produce a high-resolution isotope stratigraphy of the Neogene to Holocene; and

4. reveal possible fluid flow through this portion of the margin

Drilling program:
Hole A: APC/XCB to refusal.
Hole B: APC to refusal.
Hole C: Wash to XCB depth, then drill using RCB to target depth of 883 mbsf, if required time permits.

Logging and downhole: ADARA heatflow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. The hole will be logged using four logging strings (Quad-Combination, GLT, FMS, GHMT).

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.



Line108b
BT21
FF
1300
900
1.0

Site: BT-30

Priority: 1 (Alternate to BT-3)
Position: 24°33.00'N; 79°19.05'W
Water depth: 620 m
Sediment thickness: >8000 m
Total penetration: 1300 mbsf (approved to a depth of 1500 mbsf)
Seismic Coverage: High-resolution MCS survey

Objectives: The objectives of BT-30 are to:

1. obtain material to produce a high-resolution isotope stratigraphy of the Neogene to Holocene for a correlation between sedimentary and isotopic record of sea-level changes;

2. obtain sedimentary record of the lower slope portions of the sequences;

3. refine the age of the sequence boundaries; and

4. reveal possible fluid flow through this portion of the margin.

Additional secondary objectives are to:

1. acquire a low-latitude record of the Paleogene;

2. determine the timing of the onset of the Florida current;

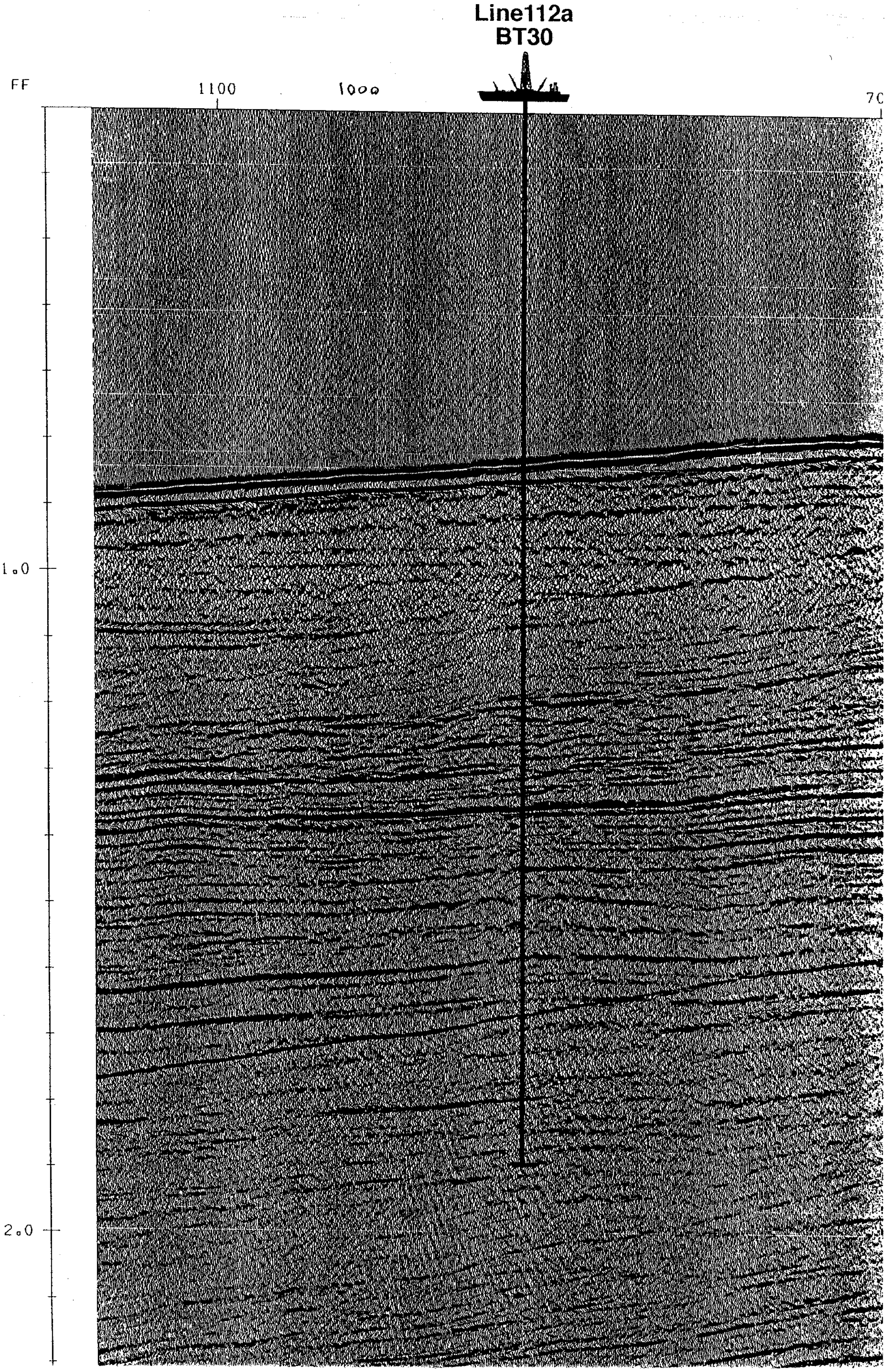
3. potentially sample the K/T boundary; and

4. assess the cause of the platform demise in the middle-Cretaceous.

Drilling program:
Hole A: APC/XCB to refusal.
Hole B: APC to refusal.
Hole C: Wash to XCB depth and RCB to a depth of 1300 m, if time permits.

Logging and downhole: ADARA heatflow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. WSTP will be performed on every fifth XCB core. The hole will be logged using four logging strings (Quad-Combination, GLT, FMS, GHMT), and a VSP experiment will be performed

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.



Line112a
BT30
FF
1100
1000
70
1.0
2.0

Site: BT-31

Priority: 1 (Alternate to BT-3)
Position: 24°32.60'N; 79°45.70'W
Water depth: 845 m
Sediment thickness: >8000 m
Total penetration: 1491 mbsf (approved to a depth of 1700 mbsf)
Seismic coverage: High-resolution MCS survey

Objectives: The objectives of BT-31 are to:

1. define age of regional reflectors;

2. obtain material to produce a high-resolution isotope stratigraphy of the Neogene to Holocene;

3. determine the timing of the onset of the Florida current.

4. acquire a low-latitude record of the Paleogene

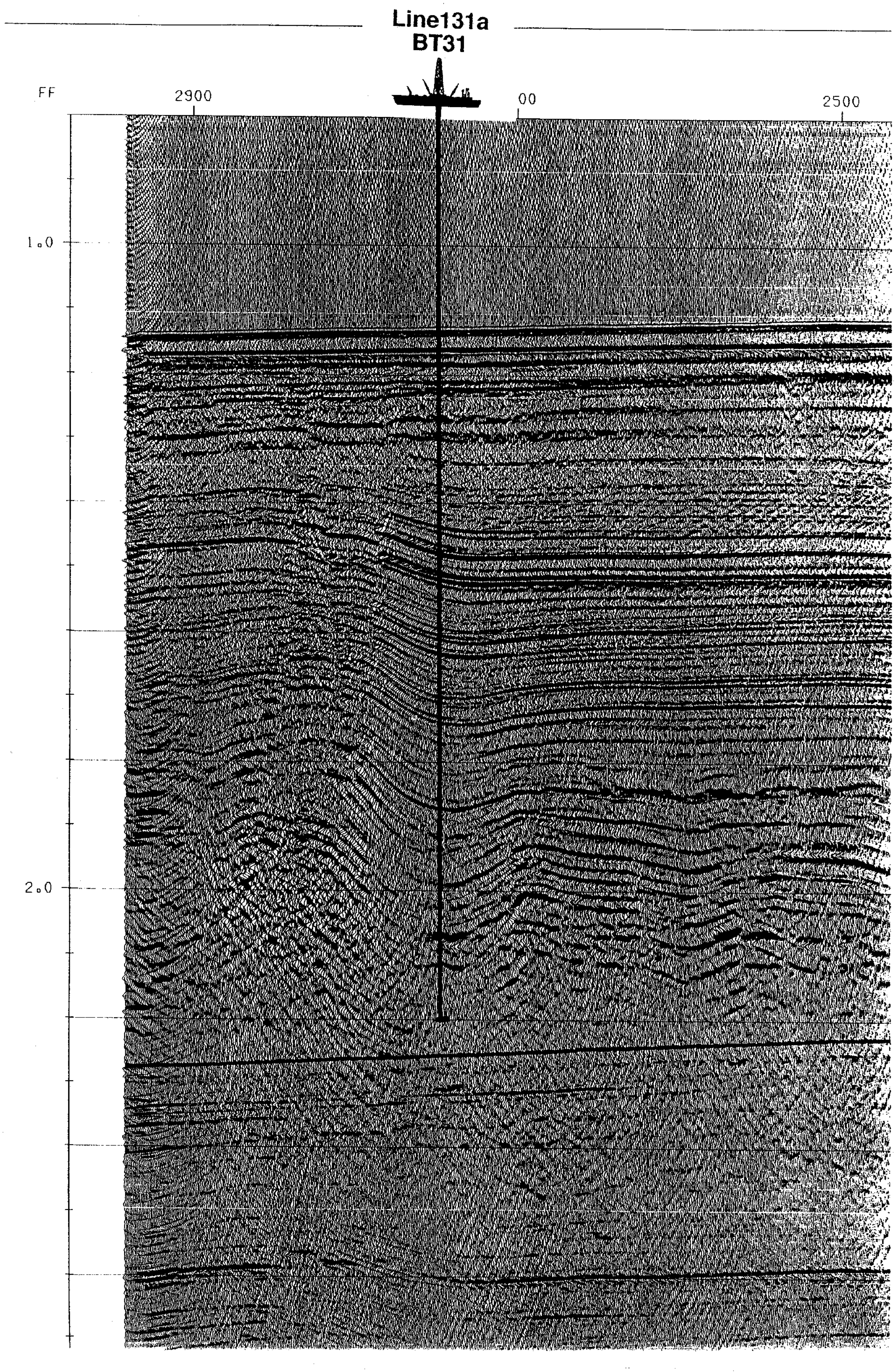
5. potentially sample the K/T boundary; and

6. assess the cause of the platform demise in the middle Cretaceous.

Drilling program:
Hole A: APC/XCB to refusal.
Hole B: APC to refusal.
Hole C: Wash to XCB depth and RCB to a depth of 1491 m, if time permits.

Logging and downhole: ADARA heatflow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. WSTP will be performed on every fifth XCB core. The hole will be logged using four logging strings (Quad-Combination, GLT, FMS, GHMT) and a VSP experiment will be performed.

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.


Line131a
BT31
FF
2900
00
2500
1.0
2.0

Site: BT-40

Priority: 1 (Alternate to BT-4)
Position: 24°20.02'N; 79°21.95'W
Water depth: 640 m
Sediment thickness: >8000 m
Total penetration: 835 mbsf (approved to a depth of 1035 mbsf)
Seismic coverage: High resolution MCS survey

Objectives: The objectives of BT-40 are to:

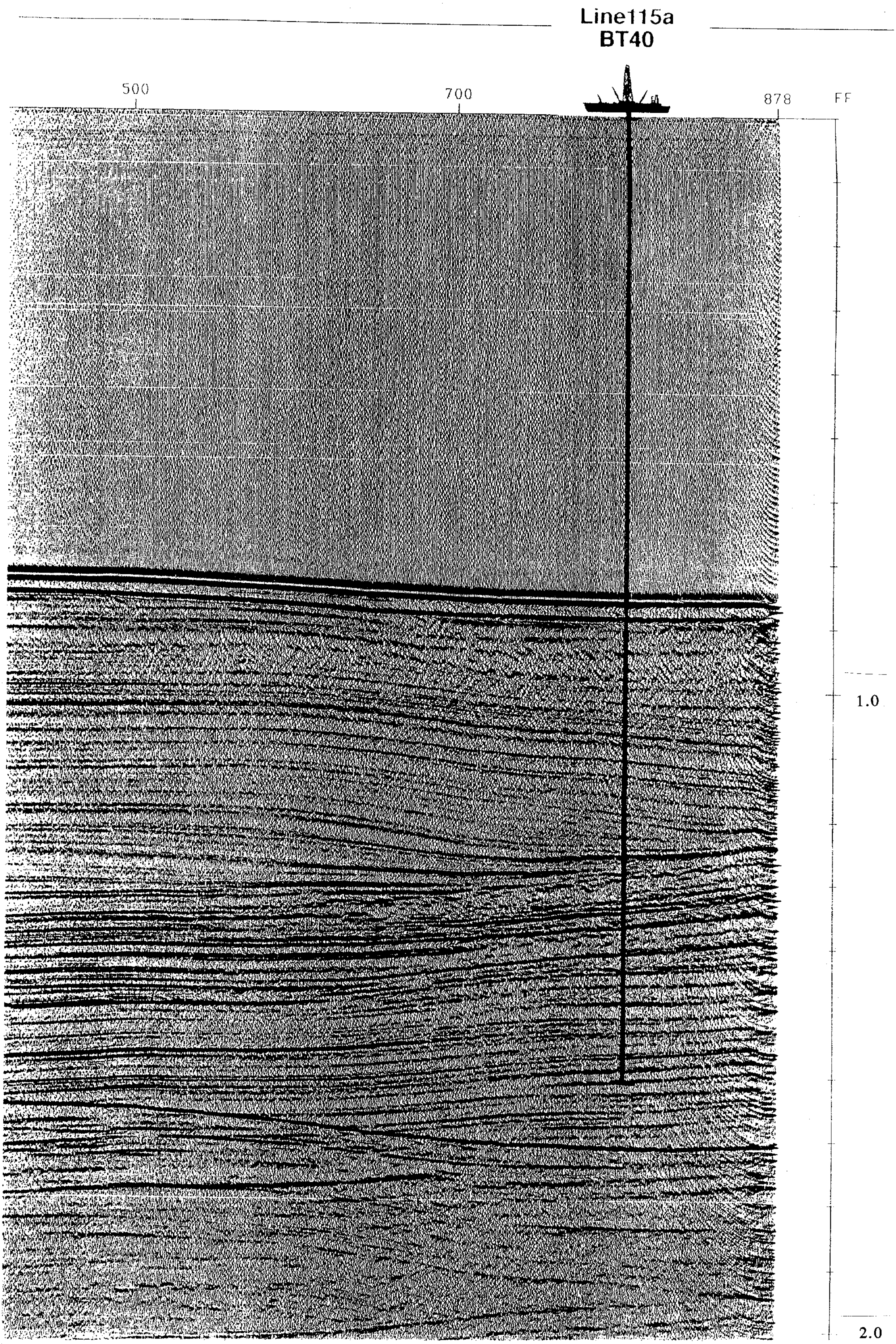
1. obtain a record of the facies of the basinal deposits associated with the prograding sequence, and

2. assess and date the deposition and erosional gaps associated with the Florida Current.

Drilling program:
Hole A: APC/XCB to a depth refusal or a depth of 835 of mbsf.
Hole B: APC to refusal.
Hole C: RCB to 835 m, if target depth not reached by XCB and only if time permits.

Logging and downhole: ADARA heatflow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. WSTP will be performed on every fifth XCB core. The hole will be logged using the three standard logging strings (Quad-Combination, GLT, FMS).

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.



Line115a
BT40
500
700
878
FF
1.0
2.0

Site: BT-41

Priority: 1 (Alternate to BT-4)
Position: 24°33.34'N; 79°22.05'W
Water Depth: 680 m
Sediment Thickness: >8000 m
Total Penetration: 732 mbsf (approved to a depth of 932 mbsf)
Seismic Coverage: High-resolution MCS survey

Objectives: The objectives of BT-41 are to:

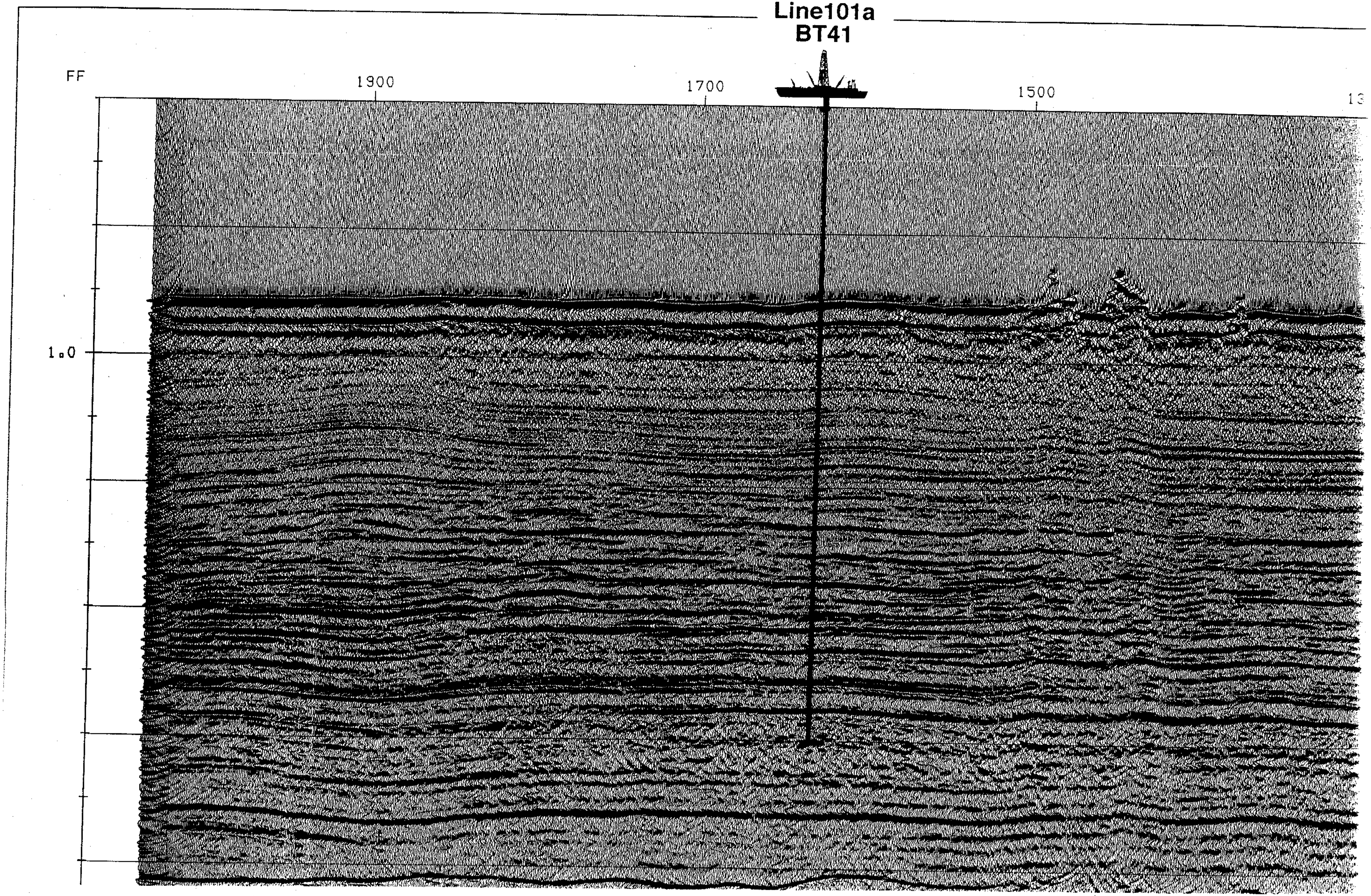
1. obtain a record of the facies of the basinal deposits associated with the prograding sequence, and

2. assess and date the deposition and erosional gaps associated with the Florida Current.

Drilling program:
Hole A: APC/XCB to a depth refusal or a depth of 732 of mbsf.
Hole B: APC to refusal.
Hole C: RCB to 732 m, if target depth not reached by XCB and only if time permits.

Logging and downhole: ADARA heatflow measurements will be made on the first eight APC cores below Core 3 and one every third core thereafter. WSTP will be performed on every fifth XCB core. The hole will be logged using the three standard logging strings (Quad-Combination, GLT), FMS).

Nature of rock anticipated: Periplatform ooze occasionally mixed with coarser grained units.



Line101a
BT41
FF
1900
1700
1500
13
1.0

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