IG1502
Cruise Report

Appended to this cruise report for IG1502 is a secondary report (a short daily log) for IG1501 and IG1502.

ATLANTIC IPOD SITE 1 SURVEY

by

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DATA COLLECTION AND ANALYSIS

During May and June, 1975, 863 km of 24-fold and 104 km of 12-fold multichannel seismic data was collected at the base of the lower continental rise off Cape Hatteras (Fig. 1). Magnetic and bathymetic data was also collected along with seven unreversed digitally recorded sonobuoy lines. All IPOD data has been processed. The 12-fold seismic line along the Digicon track in the site area was not part of the site survey and has not been processed. Funds for processing the 12-fold seismic data (solid black lines in Fig. 1) connecting the IPOD area with the Blake Plateau and DSDP Hole 105 have been obtained from the National Science Foundation. This final IPOD site report was delayed until processing of the 12-fold CDP seismic line from the Blake Plateau to Site 1 was completed. This data adds greatly to the interpretation and significance of the data collected for IPOD.

For the purposes of this report seismic lines within the site survey have been designated on the basis of their orientation. Lines INW, 2NW, 3NW and 4NW are the northwesterly trending lines, from southwest to northwest, respectively. Lines INE, 2NE and 3NE are the northeasterly trending lines, from southeast to northwest, respectively. The line connecting the Blake Plateau with the IPOD site is designated BB-1. The line connecting the IPOD site with DSDP Hole 105 is called DS-105.

In the site survey the common-depth point data is nominally 24-fold with stacking bin widths of 46 meters. All seismic data was collected with a programmed gain and a low cut filter at 8 Hz with a 36db/octive slope.

Three air guns of 1500 cubic inches each firing at about 450 psi and all 24 channels of the streamer were operational throughout the survey. Data was recorded for 12.2 seconds after each shot except for Line 2NE where the recording length was 18.2 seconds. All the seismic data were stacked with normal moveout corrections derived from CDP velocity analyses and sonobuoy refraction information supplied by IPOD site survey management. Filter tests indicated that filtering did not significantly enhance the data. Line 2NE has a 17 Hz ringing at high recording gain. This line was deconvolved and filtered. A varing AGC window was found to be the best AGC function for the CDP data.

Sonobuoy data were recorded digitally. The hydrophone deployment on the sonobuoys was delayed 20 minutes to allow the buoy to clear the end of the streamer. The sonobuoy data were merged with navigation information during processing and filtered at 2 to 27 Hz for refraction signal enhancement and at 27 to 62 Hz for wide angle reflection enchancement. Sonobuoys SB2, 3 and 4 were collected along the Digicon track and SB 5, 6, 7 and 8 along Line 2NE parallel to the lower continental rise.

Magnetic and depth data have been merged with the navigation data and an appropriate merged-merged format tape has been supplied to IPOD site survey management. Appropriate charts, multichannel sections, sonobuoy recordings, and microfilm of the seismic monitor records and 3.5 KHz PDR data have also been supplied to IPOD site survey management.

GEOLOGY

The survey site is located on the contact between the present day Hatteras Abyssal Plain and lower continental rise at 33° N, 72° W. This is within the Jurrasic Quiet Zone where the crustal age has been estimated at 165 m.y. on the basis of extrapolation from DSDP Hole 105 which reached volcanic basement of about 153 m.y. (Hollister and others, 1972, Leg 11). The IPOD site was selected largely as a stratigraphic hole to sample the complete history of the North American continental margin back to the Jurassic and to obtain further information regarding the magnetic nature of the Jurassic crust.

The stratigraphy revealed in the seismic data is correlated with the DSDP Hole 105 to the northeast and landward along the BB-1 line to the Blake Plateau. The sedimentary units are divided into five sequences which are readily distinguishable by their seismic character. These are referred to as the Alpha, Bravo, Charlie, Delta and Echo Seismic Units. These names have no significance outside of this report and are only used for a more concise discussion.

The volcanic basement, although relatively smooth within the survey area, is composed of numerous overlapping hyperbolas. The basement relief is about 500 m (6700 to 7300 m, Fig. 2). There is no unequivocal evidence for subbasement reflectors. Two significant isolated highs are noted along Lines 1NW and 2NW. The origin of these features are not understood. We expect, at a later date, to migrate some of the data in an attempt to resolve reflections that may be obscured by the hyperbolic reflections.

The oldest sediments occur in the Alpha Seismic Unit which pinches out against basement in the survey area. The zero isopach extends north-northeast (Fig. 3) with only the southwestern third of the area containing a significant thickness of these sediments. A few thin, small patches are observed in basement depressions in the northeastern part of the site survey on volcanic basement of about 160 m.y. This makes the top of this unit Callovian (Upper Jurassic) or slightly younger in age. This Upper to Middle Jurassic sediment unit contains few internal reflecting horizons or even incoherent reflections. The reflector marking the top of this unit has been traced to the Blake Escarpment.

Velocity information on the Alpha Unit is sparse in the survey area but the velocity appears to be about 2.5 km/sec. On line BB-1 southwest of the IPOD area, velocities reach about 3.0 km/sec but have a high standard deviation (0.4 km/sec). The unit has a maximum thickness of about 400 meters, preferentially infilling lows in the basement.

This basically transparent unit thickens landward on the BB-1 line which suggests that the sequence is not wholly the result of pelagic sedimentation. Near the base of the Blake Escarpment the upper surface of this unit contain several strong reflectors (with a prograding geometry). The top part of the section may be equivalent to marly limestones of Lower Tithonian age encountered in drilling DSDP Hole 391 (Benson and others, 1976) to the south. Possibly the Alpha Unit is a combination of terrigenous and pelagic deposition with the terrigenous material more important nearer the continent.

Overlying this unit is the Bravo Seismic Unit (Neocomian to Upper Jurassic). Horizon Beta (the top of this unit) is a strong horizon in the survey area. The reflector geometry suggests that this horizon, may represent an erosional unconformity in some areas. Actual erosion in the survey area seems limited, less than 50 meters (Fig. 4), though the length of time of non-deposition is more difficult to evaluate. Internal reflectors are observed in the Bravo Unit but are of low amplitude compared to reflector Beta or the strong reflector at the top of the Alpha Unit.

The Bravo Seismic Unit has a velocity of about 2.5 km/sec and a maximum thickness of over 800 meters (Fig. 5) in a north-south basement depression. The isopach map bears little resemblance to the topography of Horizon Beta.

Horizon Beta correlates with the change from mid-Cretaceous black clays to Neocomian marly limestones (Hollister and others, 1972). The Neocomian time appears to mark a long period of predominately pelagic (calcareous) deposition. The low amplitude of the coherent reflectors in the Bravo Seismic Unit may be the result of partial diagenesis or more likely (from DSDP Hole 391 results) due to small changes in lithologic components in the limestones. Regionally, the reflector amplitude within the Bravo Unit strengthen landward on BB-1, possibly related to a larger terrigenous component in the limestones.

The Charlie Seismic Unit encompasses the sediments occurring between Horizon A and Horizon Beta of mid-Eocene to Neocomian age in this area (Ewing and others, 1966; Ewing and other, 1968; Hollister and other, 1972). Internal reflectors in the Charlie Unit are much more numerous than in the older units. There are also considerable lateral changes in the amplitude of these internal reflections.

The average velocity for this unit is 2.2 km/sec while southwestward on BB-1 it increases to 3.0 km/sec. This unit has a thickness of about 400 meters but ranges from 300 to 550 meters, thickening slightly to the south (Fig. 6). The sediment sequence thins internally landward and pinches out at 74.5° W on BB-1.

The sediments of this unit have been drilled in many parts of the North Atlantic Basin, though they have not been continuously sampled. Horizon A represent a cherty or siliceous zone in a turbidite sequence and has an age of about mid-Eocene in the basin. Towards the margin this reflector appears as an unconformity (Benson and others, 1976). Our seismic data, particularly in BB-1, show this unconformity plainly. Within the site area Horizon A was difficult to correlate directly with Horizon A near DSDP Hole 105. Horizon A is often considered the first prominant planer subbottom reflecting horizon in the western North Atlantic basin. This may not be the best definition. If this method was used at the IPOD site Horizon A would be time-transgressive in detail (see the NW trending lines). We define as A an individual reflector that could be traced over large distances. This does not always correspond with the standard definition of Horizon A, particularly towards the northeast (but is within 0.2 seconds).

Horizon A* (Hollister and others, 1972) has not been identified in the site survey area. We have not been able to correlate a reflector with that observed on the DS-105 line near Hole 105. Perhaps when processing of DS-105 is complete we will be able to make such a correlation.

Horizon A appears to represent a mid-Eocene abyssal plain with a terrigenous input from the north-northeast. This may indicate that the paleobasin was deeper to the south, probably due largely to differential filling of the basin first in the north where there was probably a much larger source of terrigenous material. The mid-Createaceous black clay unit which represents a period of reduced circulation in the deep North Atlantic basin may not have had any influence on the sedimentation patterns.

The post-Horizon A reflector complex includes the (1) Echo Seismic Unit containing the lower continental rise abyssal hills and abyssal plain contact and (2) the Delta Seismic Unit consisting of the Reflector X (Rona and Clay, 1968; Markl and others, 1970) to Horizon A sequence that changes facies within the survey area. The Delta Unit has numerous broken and discontinuous reflectors while the younger Echo Unit contains many closely spaced reflector horizons.

Both units have velocities of about 1.7 km/sec. The total thickness of the post-Horizon A sediments of the Delta and Echo Units varies from 500 to 900 meters, decreasing towards the southeast (Fig. 7). Reflector X is the top of a massive progradational wedge observed on BB-1 line. Within the survey area Reflector X becomes parallel to the abyssal plain type reflector indicating that at early Miocene(?) (Hollister and others, 1972) the lower continental rise-abyssal plain contact occurred within the survey site.

RECOMMENDATIONS

The objectives at this IPOD site were to drill 1 km of sediments and about 1 km into basement. We have demonstrated that the sediment cover at the proposed site is about 1800 meters (Fig. 8) in 5300 meters of water. The sediment thickness is much greater than originally expected for this site.

There has yet to be a complete stratigraphic hole drilled on the western Atlantic Margin. A stratigraphic hole would be of great significance in understanding the development of the Atlantic margin. Multichannel seismic surveys along the continental margin are rapidly expanding. Information on sedimentation and sedimentation patterns prior to Horizon A have been sparse near the continental margins. In data obtained on the BB-1 line soon to be published (Shipley, Buffler and Watkins) we have demonstrated that two significant reflection units are observed below Horizon Beta, the top of one being Upper Jurassic (Callovian(?)) and the other Lower (?) Jurassic. The geometry of these units when they have been further mapped by other multichannel experiments and sampled will add greatly to the early rifting geometry and history of the North Atlantic.

It will be difficult to sample the deepest and oldest unit within the western North Atlantic because of the sedimentary cover (the minimum cover to the top of the Lower (?) Jurassic unit is 3.5 km on the BB-1 line). The top of the Upper Jurassic reflector pinches out in the site survey area. The top part of this unit, which forms a strong reflector traceable to the Blake Escarpment, can be sampled in the IPOD area.

We recommend as the prime drilling site a location where Reflector X, Horizon A, Horizon Beta and the Upper Jurassic reflector can be readily observed. A proposed site is at 33.44° N, 72.38° W (Fig. 9). The total sediment thickness is estimated at 1875 meters with a water depth of 5225 meters or a total depth to basement of 7100 meters.

Several other sites will also meet these objectives and have similar depths to basement. Within the site survey the shallowest depth to normal basement is about 6800 meters. We would not recommend drilling on such a shallow site because the Upper Jurassic reflector (and Reflector X) would not be sampled. There would be no significant stratigraphic value in drilling on one of two isolated basement highs at depths of 6550 and 6580 meters. There is also a suggestion that these highs do not represent normal oceanic crust.

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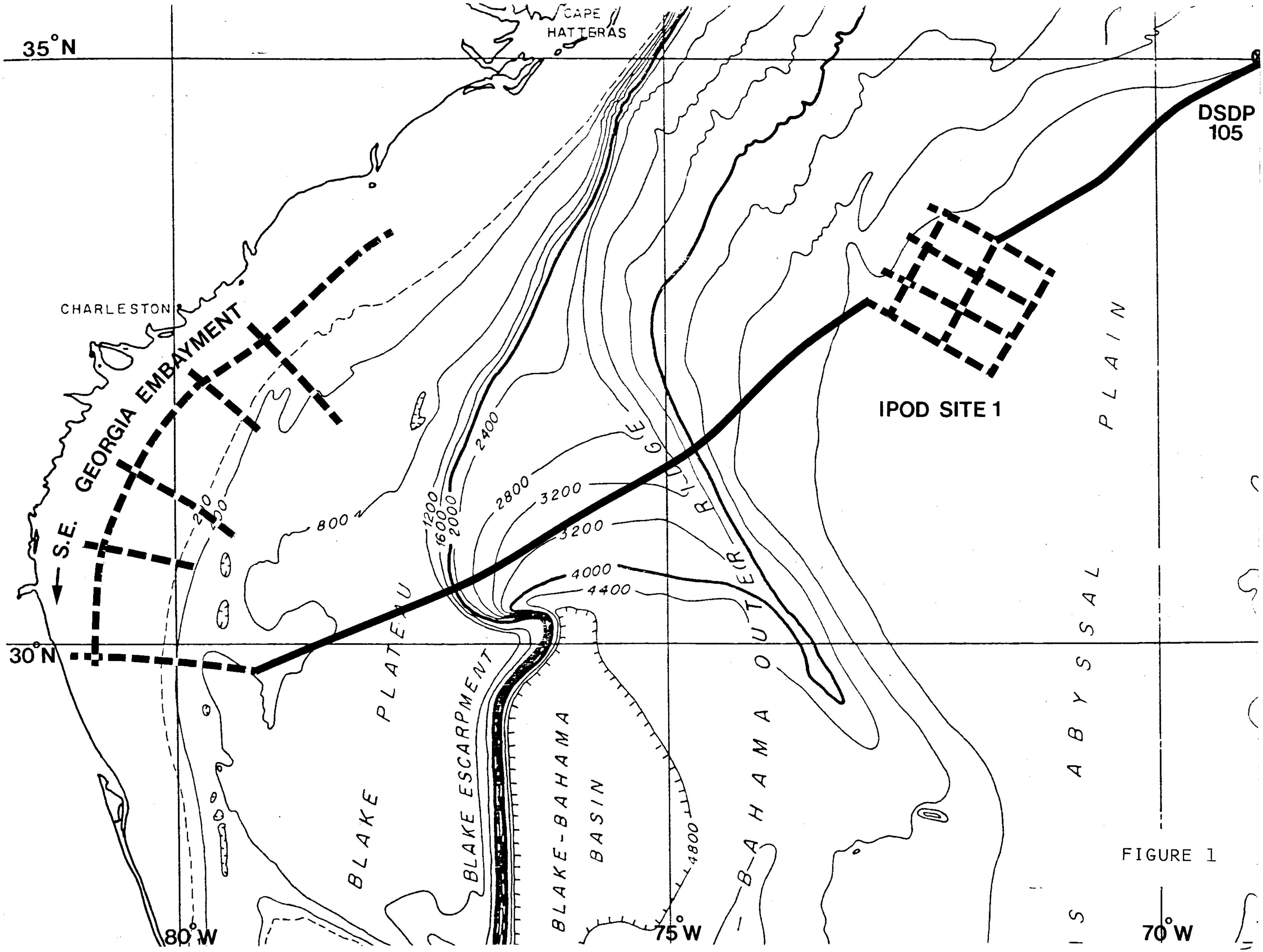

35°N
30°N
80°W
75°W
70°W
CAPE HATTERAS
CHARLESTON
GEORGIA EMBAYMENT
S.E.
DSDP 105
IPOD SITE 1
ABYSSAL PLAIN
BAHAMA OUTER RIDGE
BLAKE PLATEAU
BLAKE ESCARPMENT
BLAKE-BAHAMA BASIN
800
1200
1600
2000
2400
2800
3200
3200
4000
4400
4800

FIGURE 1

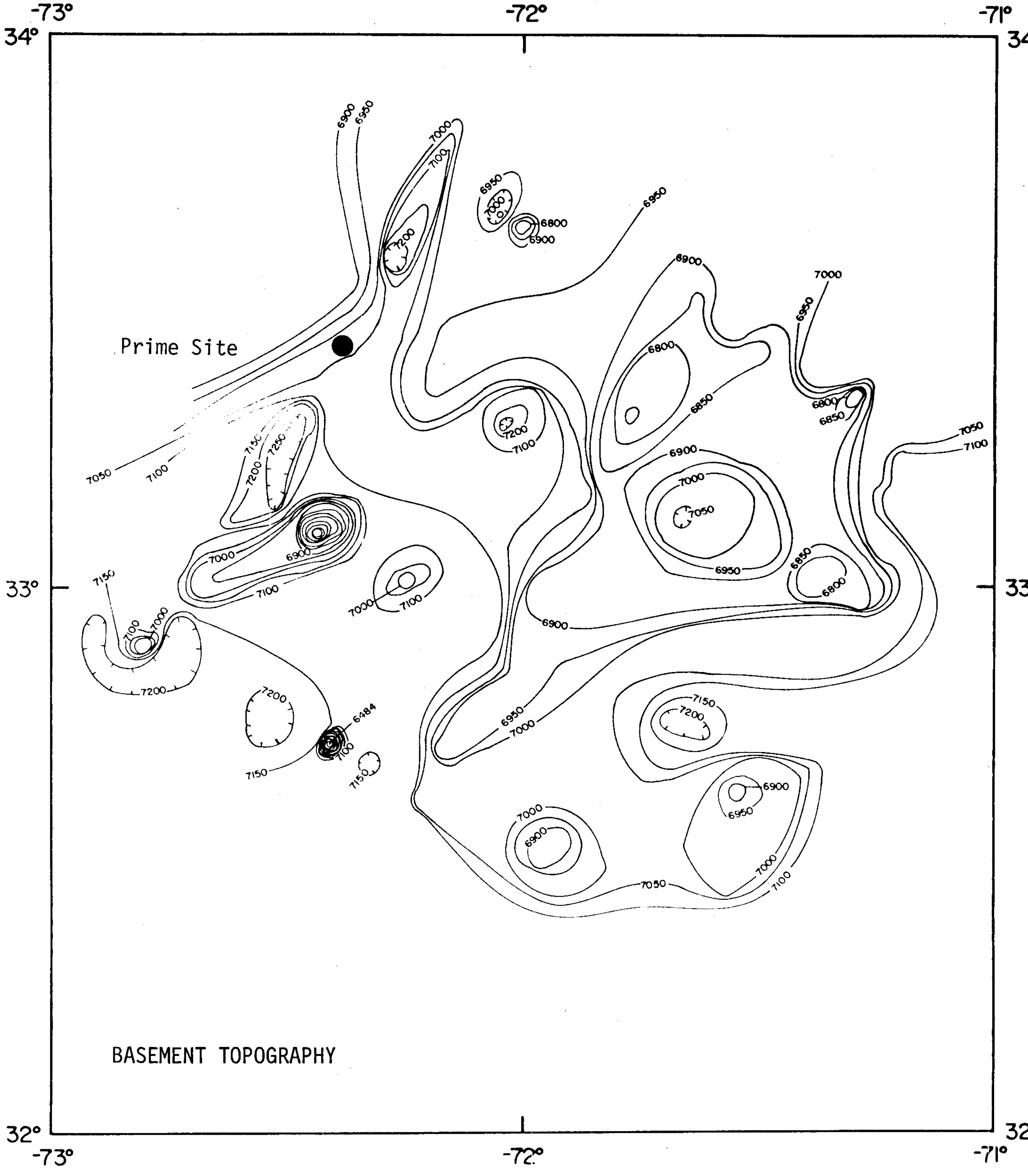


Figure 2 Generalized basement topography based on CDP reflection data and velocity analysis. Data points were spaced about 10 km along the seismic reflection lines (Fig. 1). Contours are in meters.

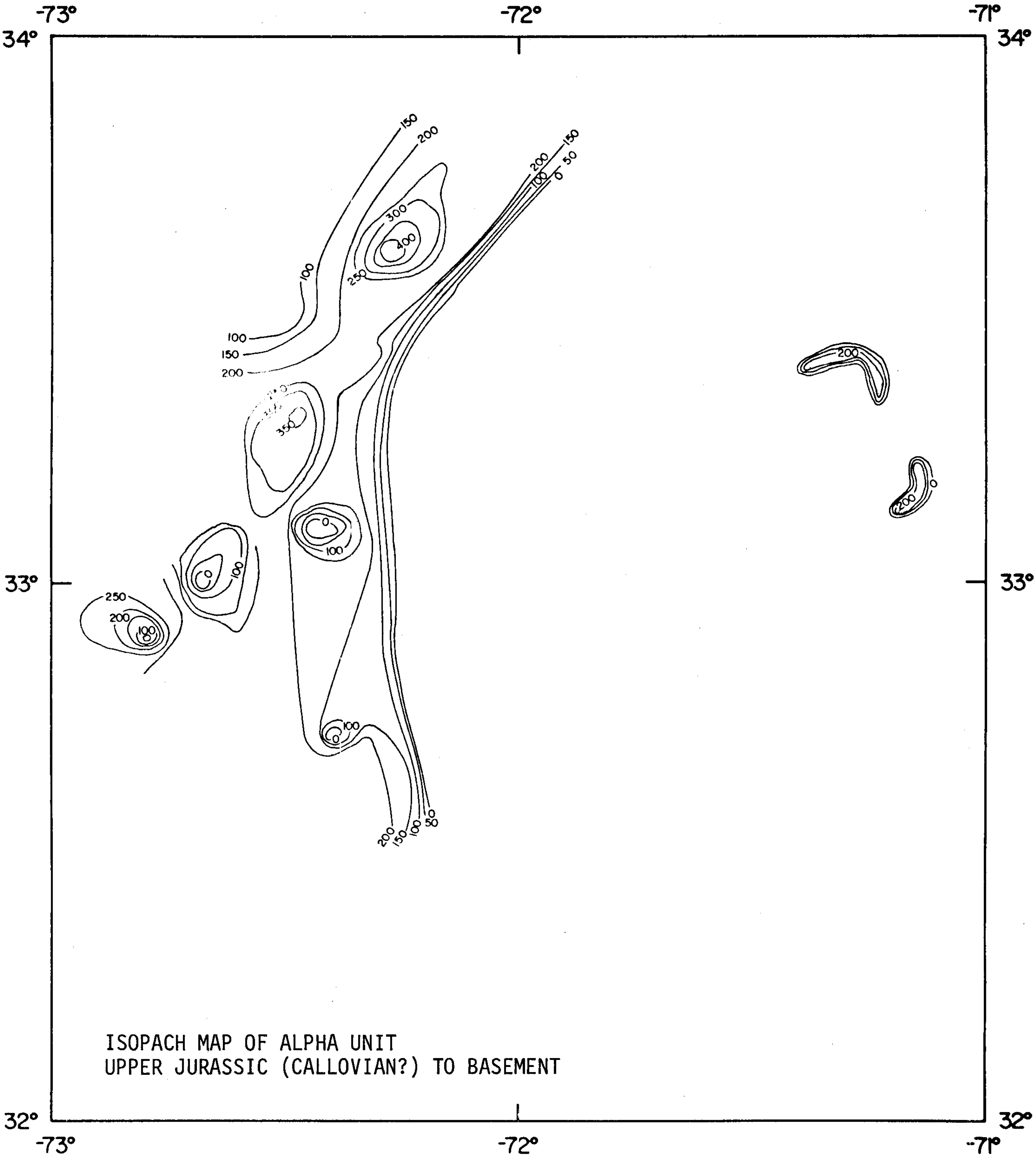


Figure 3 Generalized isopach map of the Upper Jurassic to basement sediments. Contours are in meters.

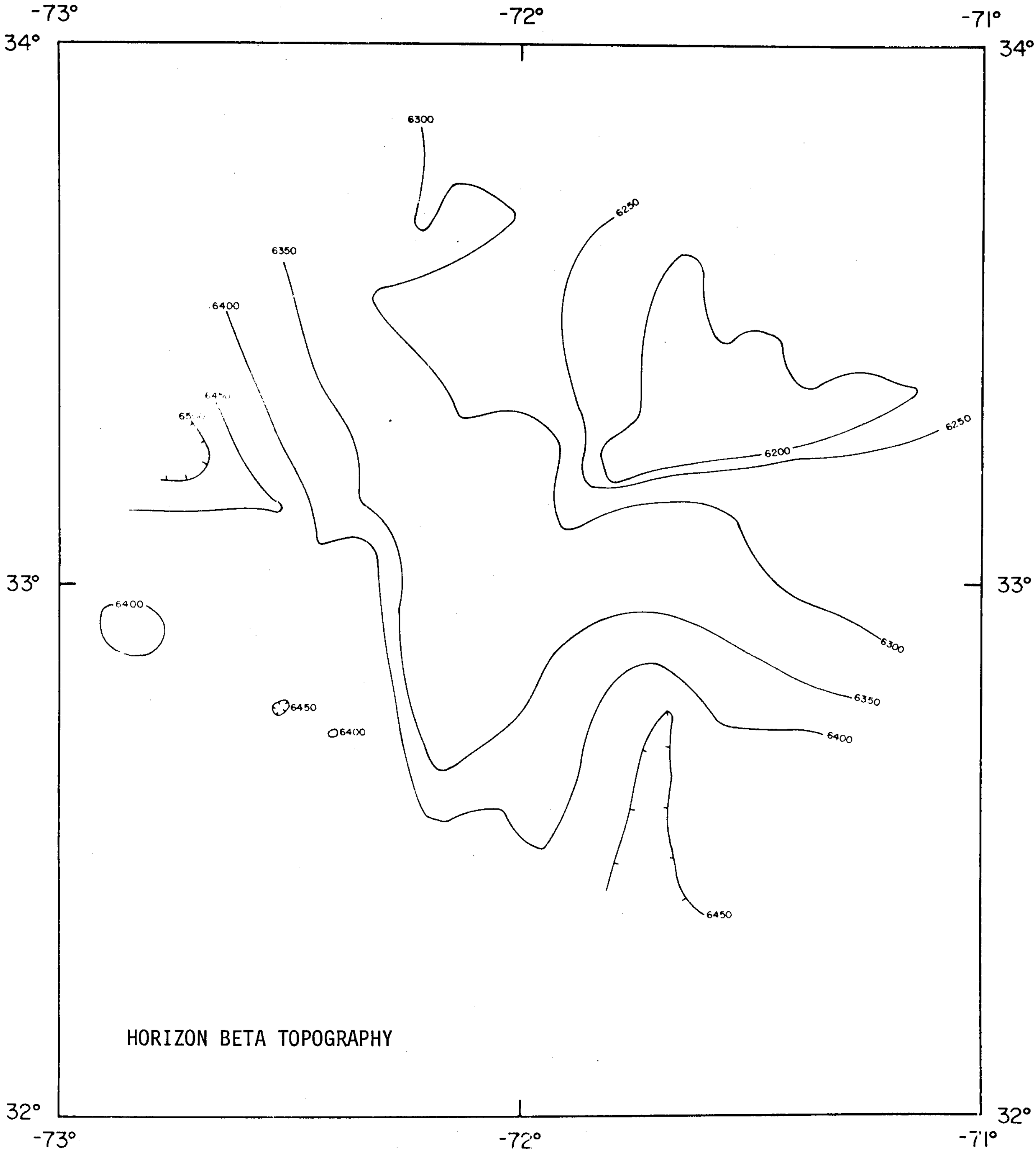


Figure 4 Depth to the Neocomian Horizon Beta. Data points used in construction of this figure were spaced about 10 km along the seismic lines.

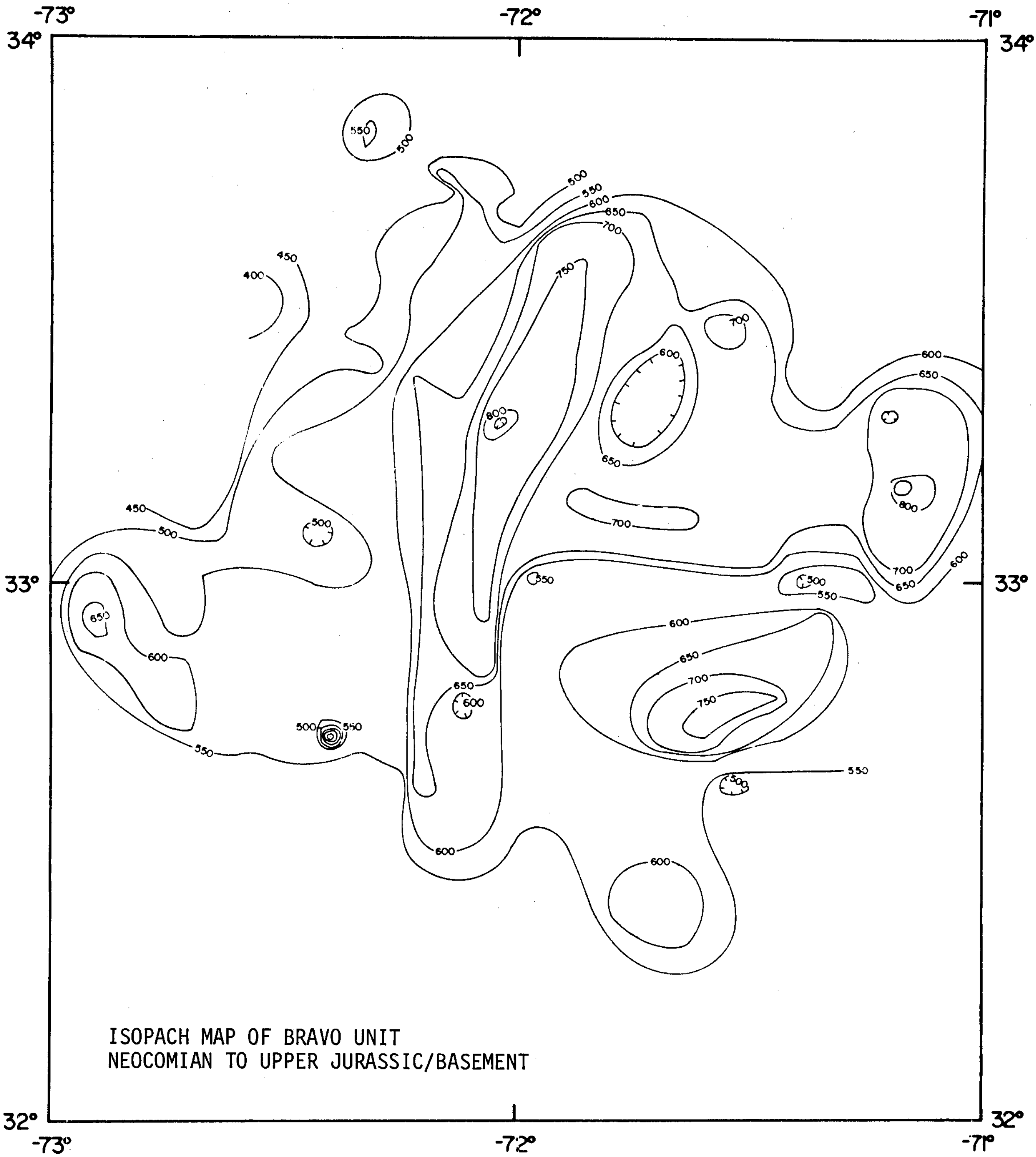


Figure 5 Thickness in meters of the Neocomian to the Upper Jurassic (or basement). A velocity of 2.5 km/sec was used for thickness calculations.

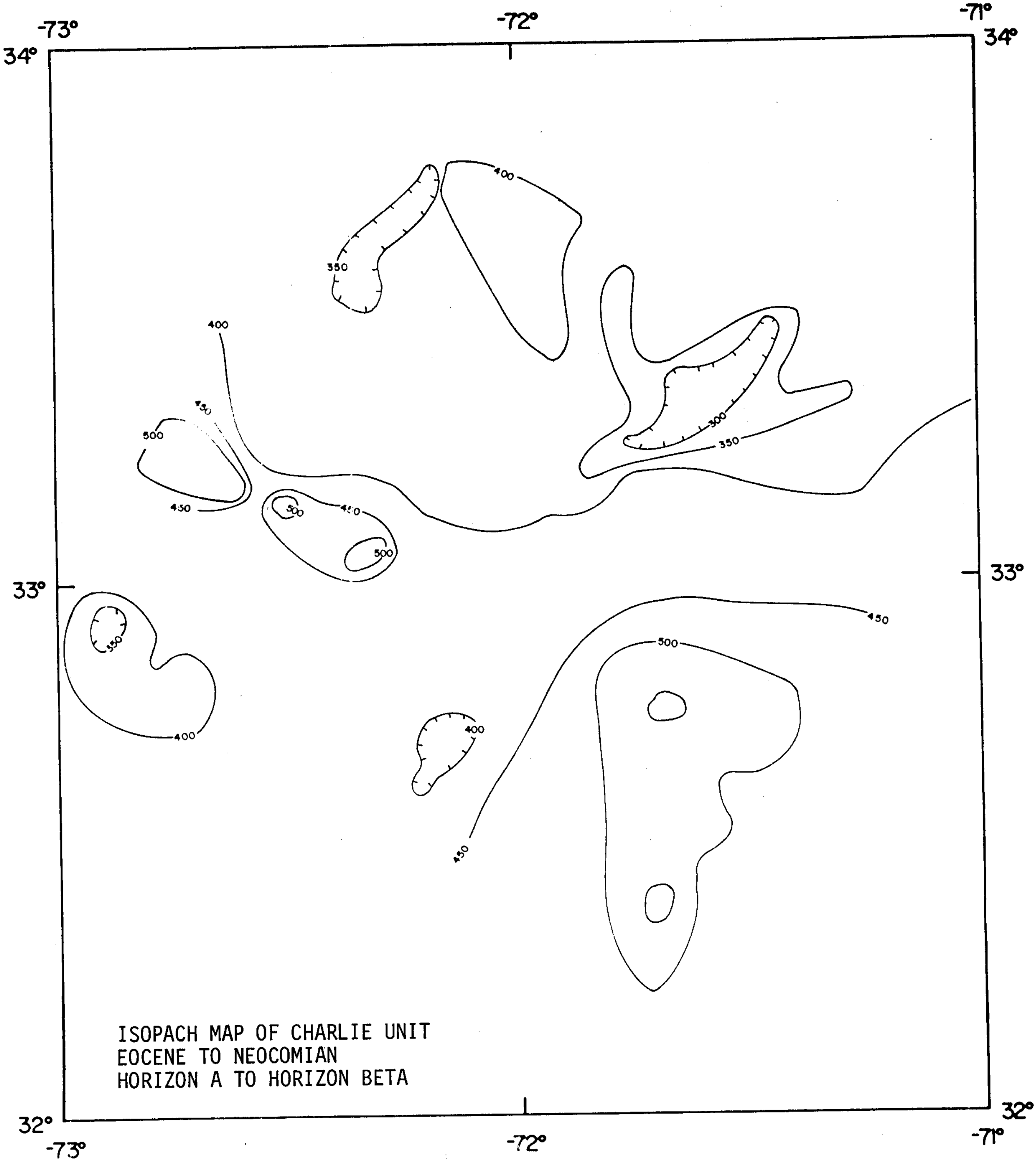


Figure 6 Generalized isopach map of Eocene to Neocomian sediments. A velocity of 2.2 km/sec was used to obtain the thickness in meters.

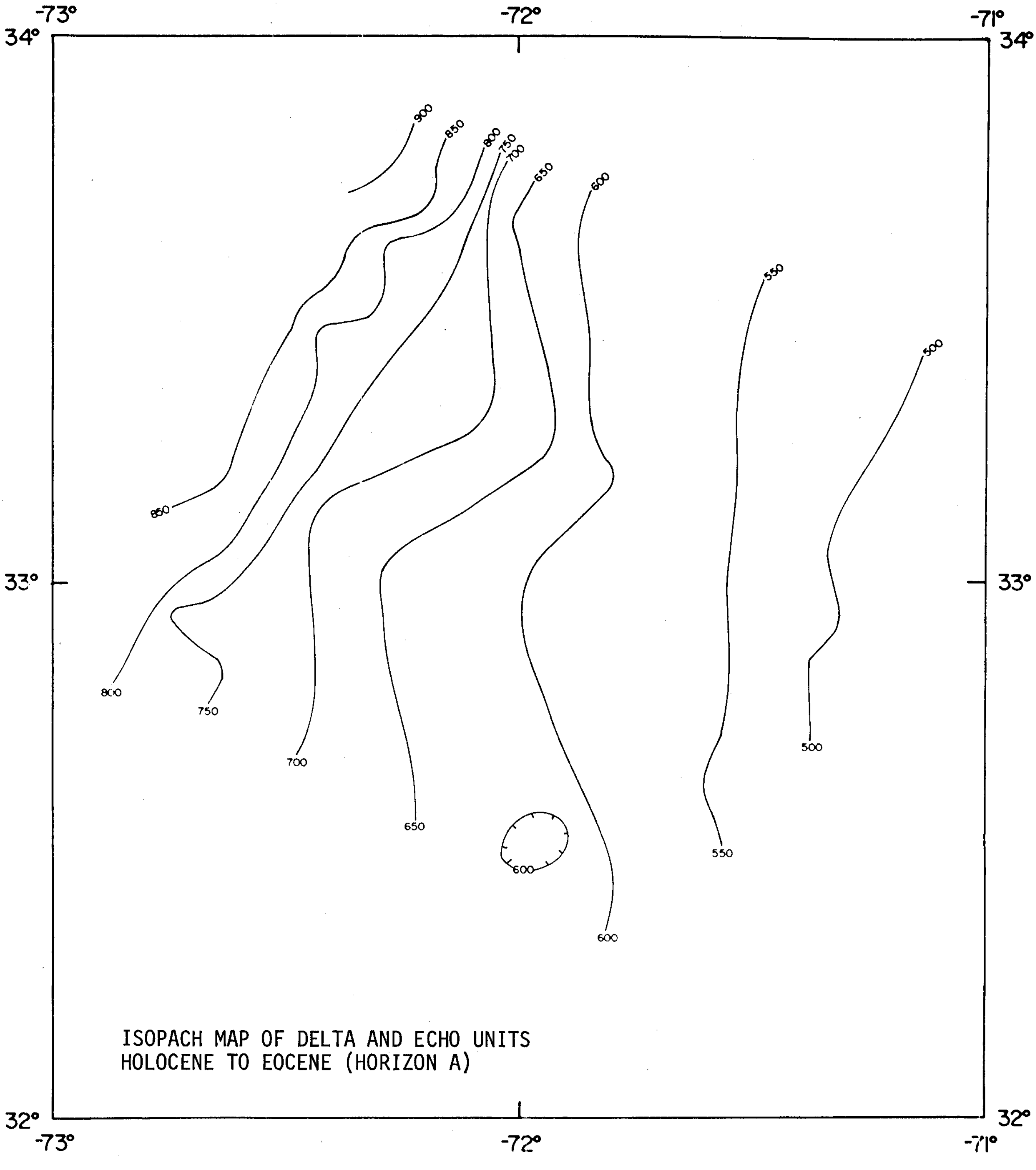


Figure 7 Sediment thickness from Holocene to Eocene in meters. Thickness calculations at 10 km spacings along track used 1.7 km/sec for the sediment velocity.

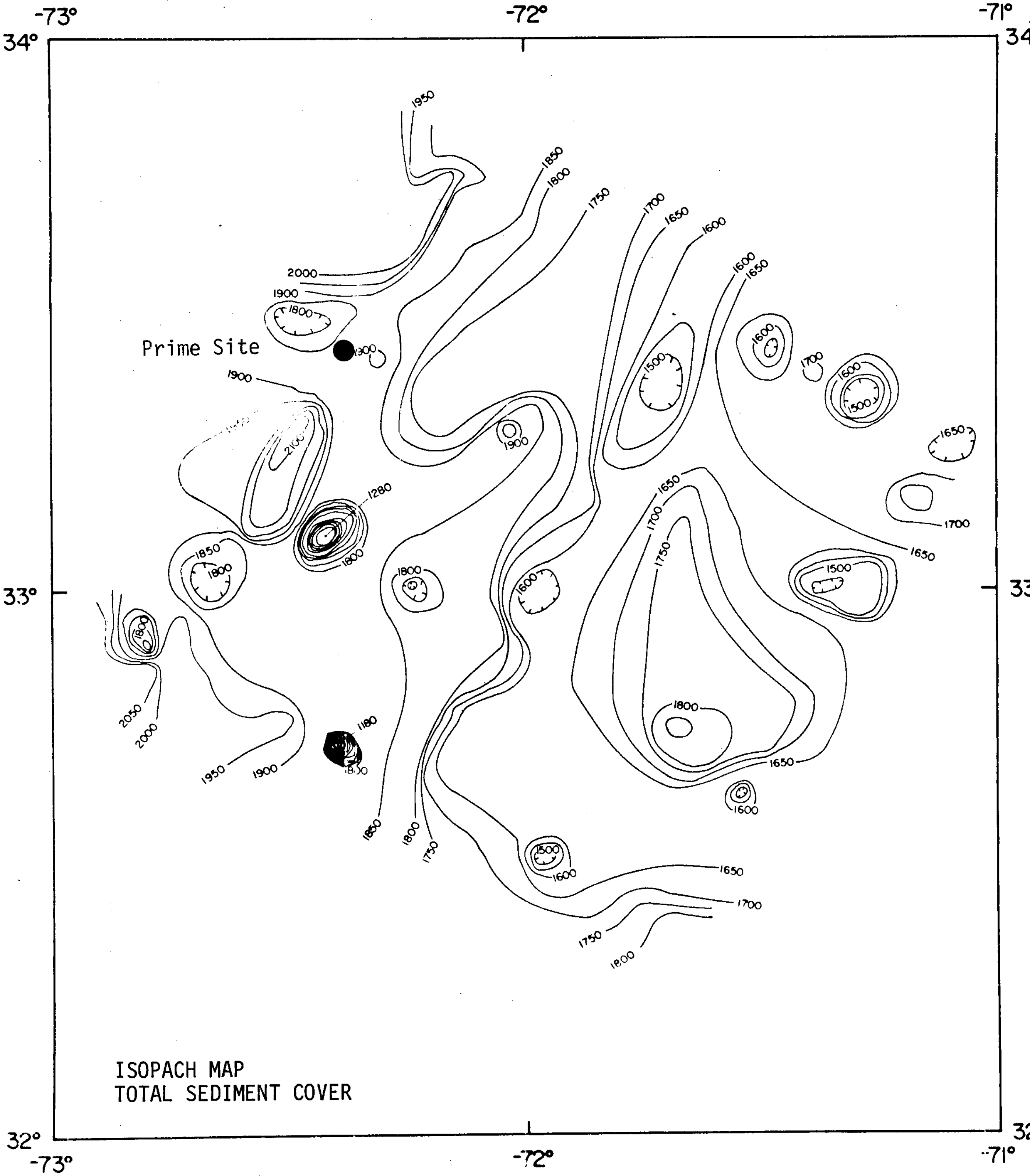
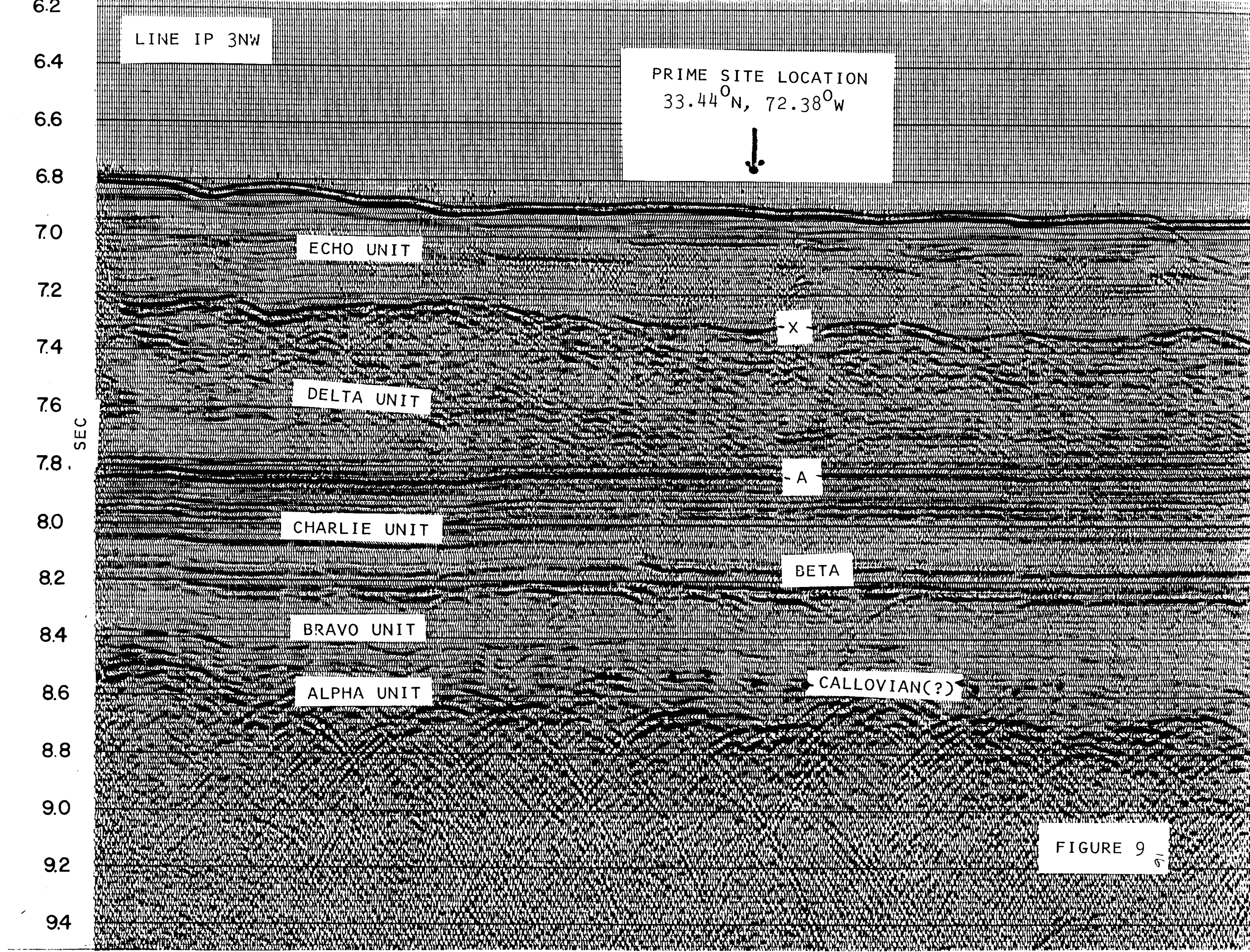


Figure 8 Generalized map showing total sediment thickness in the survey area. Data points were generally spaced at 10 km intervals along track. Additional points were added only where necessary to define extreme highs and lows. The contours are in meters. Velocity information was from CDP velocity analyses.



LINE IP 3NW
PRIME SITE LOCATION
33.44°N, 72.38°W
ECHO UNIT
-X-
DELTA UNIT
-A-
CHARLIE UNIT
BETA
BRAVO UNIT
CALLOVIAN(?)
ALPHA UNIT
SEC
6.2
6.4
6.6
6.8
7.0
7.2
7.4
7.6
7.8
8.0
8.2
8.4
8.6
8.8
9.0
9.2
9.4

FIGURE 9 16

I D A G R E E N C R U I S E R E P O R T

Cruise No. 15-1 & 2 Dates of Cruise 9 May 75 to 10 June 75

Members:	Crew		Scientific	
	Capt. Otis Murray		J. Watkins, CS	
	F. Cobb, Eng.	J. Mifsud, Asst. Eng.	K. Griffiths	R. Elliott
	R. Ash, A.B.	D. Patterson, O.S.	G. Barksdale	R. Cunningham
	R. Hundley, A.B.	G. Theisen, Cook	R. Buffler	G. Schuster
			T. Shipley	(U of Houston)
Project:			G. Putman	

Reason *(be specific)*:

REMARKS: Departed Galveston about 1410, 9 May 1975. IDA GREEN 15, Leg 1

10 May We hooked up the waste heat evaporator. The excess heat dissipated through the evaporator. It now keeps the port engine cool--which was running hot.

11 May Deployed single channel streamer to collect data on Sigsbee Scarp where it intersects the Mississippi Cone. Completed single channel work at 2200. Ship's air conditioning went out.

13 May Began single channel work in Straits of Florida about 0600. Ship's air conditioning working again after repairs. Gun #4 leaking badly. Data are so-so, probably because of relatively high speed.

15 May Put out long streamer. Repaired numerous leaks due to winding streamer too tightly on drum following last cruise. At 2200 began USGS lines in Southeast Georgia Embayment (24-fold; R. Buffler, project scientist). Severe reverberation observed on monitor. Continual problems with guns; we have been able to keep no more than 3 working. Loran-C working well.

18 May Continuing USGS work. Dropped one sonobuoy to test system which appears all right. Minor overhaul on compressors following completion of long north-south line.

19 May No. 1 depth transducer out. Difficult to maintain course in the Gulf Stream. Necessary to crab up 50°.

21 May Pulled streamer for repairs. Six of nine birds had ruptured diaphragms. Distal end running shallow and noisy as a result. A shark got two sections.

22 May Streamer repaired and out; inboard end still running slightly deep.

23 May Observed butte and mesa-type structures on Blake Plateau indicating resistant beds control erosion there as on land. Marked change in sea state upon entering the Gulf Stream. Water calm outside the Stream; 2-3'swells inside the Stream. Perceptible vibration in engines. More often than not, we lose Loran-C at dusk and dawn. Otherwise it appears to work well. Radio transmitter problems.

25 May Completed USGS work. Gear in at 2030.

26 May Arrived at Port Canaveral about 1030 CDT. Took on food, fuel, got radio repaired.

27 May	Departed Port Canaveral, Florida 1430. IDA GREEN 15, Leg 2
28 May	Began Blake Plateau bootleg line, 12-fold. After air conditioner in Lab out. Streamer running slightly shallow (20-25 ft.) on inboard side due to removal of additional lead.
30 May	Completed Blake Plateau line. Possible subbasement reflectors observed in parts of line. Interesting structure. Shipley and Buffler will work up data. Minor problems with DFS due to inadequate refrigeration in Lab.
31 May	0009--Began IPOD survey (24-fold). Tom Shipley, project scientist.
1 Jun	Leak in line leading from fresh water tank to cofferdam. Patched the leak but lost quite a bit of fresh water. Emergency water restrictions ordered for 2-3 days to allow evaporator to build up surplus. Welder required in Bermuda to make permanent repair.
3 Jun	IPOD shooting going smoothly. Began shooting NW-SE sonobuoy line.
5 Jun	Completed IPOD work at 1705 CDT. Began running 12-fold line from IPOD area to DSDP Hole 105. IPOD data looks good. Possible deep reflection $\lesssim 6.5$ seconds subbottom, i.e., all the way to bottom multiple.
6 Jun	Completed 12-fold line to DSDP Hole 105. Pulled streamer. All birds operational; no leaks. Deployed single channel streamer. c/c for Bermuda.
7 Jun	1000--Starboard flopper stopper failed. Vertical bolt at base of boom snapped. Anchor windlass motor failed. Pulled in flopper stoppers by hand. Pull all gear, continue to Bermuda.
8 Jun	0930--Arrived St. Georges, Bermuda.
10 Jun	I departed St. Georges. Water tank repaired, aft air conditioner installed, and flopper stopper repair underway. Departed 1330.

J. S. Watkins
Chief Scientist