OCEAN DRILLING PROGRAM

LEG 138 SCIENTIFIC PROSPECTUS

Eastern Equatorial Pacific

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This Scientific Prospectus is based on pre-cruise site-survey information and 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 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

The primary objective of ODP Leg 138 is to define the paleoceanographic evolution of the eastern equatorial Pacific during the last 12 million years. To address this objective two drilling transects across the complex oceanographic circulation system of the equatorial Pacific are planned. Four primary sites are planned along the easternmost transect, centered at 95°W, and five primary sites are planned along 110°W. To allow high-resolution paleoceanographic studies, all sites along the eastern transect will be double APC cored and those along the western transect will be triple APC cored.

Introduction

This leg represents the fifth expedition of the Ocean Drilling Program to examine the evolution of global climate change during the late Cenozoic through high-resolution studies of tropical ocean sediments. Previous legs have sampled the equatorial Atlantic (Leg 108), the Peru Current (Leg 112), the western tropical Indian Ocean (Leg 117), and the western equatorial Pacific (Leg 130).

Two north-south transects of advanced hydraulic piston cored (APC) holes are planned to obtain continuous, undisturbed sedimentary sections for studies of the late Cenozoic paleoceanography of the eastern equatorial Pacific Ocean. The planned sites will address the evolution of climate during the period when the Earth changed to a world dominated by extensive northern high-latitude glaciation. The focus of this study will be the eastern Pacific equatorial circulation system, a region responsible for over half of the world's primary productivity and a sensitive recorder of global climate change.

Regional Oceanographic Setting

The general geographic setting of Leg 138 is the eastern equatorial Pacific, from the Central and South American Coast to approximately 120°W. To place the size of this area into perspective, this small portion of the Pacific is about the same size as the entire equatorial Atlantic Ocean.

The surface circulation of this region is shown schematically in Figure 1. The westward flowing South Equatorial Current (SEC) is located south of about 5°N. This current, in part, is a continuation of the Peru Current, which brings waters from higher latitudes to the equator. The strength of the SEC reflects the southeast trade winds. North of about 10°N is the westward flowing North Equatorial Current (NEC), which is driven by the northeast trades. Between the NEC and SEC is the eastward flowing North Equatorial Countercurrent (NECC). This current brings low-nutrient tropical waters from the western Pacific into the eastern equatorial Pacific. These sets of surface currents have been described as being part of two gyre systems (Baumgartner and Christensen, 1985; Fig. 2) with the NEC and NECC forming an elongated subtropical cyclonic gyre north of the equator and the SEC being part of a southern hemisphere anticyclonic circulation cell.

As shown in Figure 2 the response of the equatorial current system to interannual climate events such as El Niño is asymmetric, with the northern gyre (the NEC and NECC) increasing in intensity while the southern elements (SEC) of the current system weaken. Such behavior has been predicted for the response of this current system to longer-term climate change such as interglacial/glacial cycles.

A feature of the area that is an important part of the regional biological productivity is the Costa Rica Dome. This region of extremely shallow thermocline is centered at about 8°N and 90°W and is bounded by the NECC to the south, the NEC to the north, and the northward flowing Costa Rica Coastal Current to the east. The Costa Rica Dome was originally proposed to reflect the cyclonic circulation of the eastern limb of the subtropical gyre shown in Figure 2. However the strength of the thermocline doming (the thermocline often is only 10 m below the sea surface) seems not to be correlated to the strength of the NECC but rather to the intensity of wind-stress curl (Hofmann et al., 1981). These authors suggest that the "dome" features are a consequence of atmospheric circulation of the Intertropical Convergence Zone and are found in other areas of the tropical ocean.

The eastern equatorial Pacific is a locus of a large part of the Earth's primary and new productivity in today's ocean (Chavez and Barber, 1987). Careful study of the eastern equatorial Pacific is required to define variability in the global budget of productivity or paleoproductivity. Clearly, the circulation system of the equatorial Pacific should be highly sensitive to climate change and associated changes in atmospheric circulation. The drilling transects will provide the necessary sedimentary records to document late Cenozoic circulation changes in this important oceanographic region.

Scientific Objectives

From complete, undisturbed cores, answers to the following questions can be expected:

1. How did the Pacific equatorial circulation evolve through the late Cenozoic as a response to increased global glaciation?

2. Are oceanographic changes hemispherically symmetrical or asymmetrical?

3. What was the nature of the circulation system during the late Miocene when open communication with the Atlantic occurred through the Panamanian seaway?

4. What was the nature of oceanographic variability during the late Miocene and Pliocene, and how does this compare to the Pleistocene (i.e., do the changing boundary conditions modify the sensitivity of the system)?

5. What was the nature of circulation during the Pliocene after the closure of Panama but before the onset of Pleistocene glaciation in the northern hemisphere?

6. How do oceanographic changes affect productivity in the equatorial Pacific surface waters?

The answers to these questions will provide important clues needed to understand the cause and nature of oceanographic and climatic variability. The last million years of the Earth's history are characterized by large changes in northern hemisphere ice cover. These

changes have been linked to changes in solar radiation--the Milankovitch Hypothesis. The identification of the oceans' and atmosphere's response is complicated by the presence of both large ice-volume changes and changing external (insolation) forcing. Examination of the ocean system at times before the existence of major northern hemisphere ice sheets (question 5) provides the means for determining the effects of external forcing and changes in boundary conditions due to ice-volume changes. Comparison between the variability and nature of oceanographic conditions during the late Miocene and Pliocene (question 4) provides information on the sensitivity of the climate system to changes in major oceanic boundary conditions.

The study of the tropical climate systems in the Pacific, Indian, and Atlantic oceans will be critical to a global understanding of climate changes. The planned equatorial Pacific transects will provide an important late Cenozoic complement to transects drilled in the equatorial Atlantic, western equatorial Pacific, and the Indian Ocean monsoon region. Samples from the Pacific transects will ensure that comparisons can be made of the four tropical areas.

Systems Development

Two new data systems will be used for core characterization as part of shipboard sediment analysis. The first, a multi-channel color scanner, allows the collection of digital sediment color at centimeter sampling resolution. The color scanner spans the visible color spectrum and includes the infrared and ultraviolet bands, providing a more complete characterization of the multicolored aspect of the pelagic sediments expected to be recovered during this leg.

The second system is a digital sediment velocimeter which makes ultrasonic measurements of the speed of sound on split cores and digitally stores the waveforms for future processing. This system, originally tested on Leg 130, produces highly accurate measurements of sound speed in that part of the sediment column too shallow to log and provides a calibration of the log data in the deeper part of the section. In addition, the waveform data can be processed to produce estimates of sediment attenuation as a function of depth.

Ancillary Programs

At the request of the JGOFS (Joint Global Ocean Flux Study) steering committee, and with the endorsement of the JOIDES Planning Committee, detailed water-column sampling will be conducted on a non-interference basis during Leg 138. The measurements and samples include meteorology and ship positioning, CTD, O_2, fluorometry, optics, and water samples collected for analysis of nutrients (NO_3, NO_2, PO_4, $Si(OH)_4$, and NH_4), POC/PON, extracted chlorophyll, and phaeopigments. This program will be completed only if such operations do not interfere with drilling operations and if the appropriate equipment is available on the ship.

Drilling Strategy

Leg 138 is scheduled to depart Panama on 6 May 1990 after a 5-day port call and to arrive in San Diego on 5 July 1991. Two complementary north-south transects will be drilled across the complex equatorial current system (Fig. 3). The western transect (five primary sites centered at about 110°W) crosses the equatorial Pacific current system where it is fully developed and removed from influences of eastern boundary currents. As such it represents the easternmost (and highest productivity) end-member of an oceanwide study of equatorial sedimentation (Legs 85 and 130). The north-south transect adds a new dimension to the study of this current system and allows a detailed look at the development of the equatorial current system in response to global climatic change. The eastern transect (four primary sites centered around 95°W) is designed to look at the interaction of the equatorial current system with the Peru Current and the eastern boundary of the Pacific. This transect will provide insight into changes in coastal upwelling as well as the eastern boundary current system. Sedimentation rates are expected to be very high here, allowing for extremely high-resolution studies.

The sites were chosen to sample each of the major oceanographic features of the equatorial current system. All sites were surveyed during Leg 1 of the Venture expedition of the R/V *Thomas Washington* in the fall of 1989. Backtrack histories indicate that these sites would have remained within present water masses during the late Cenozoic, assuming that no major oceanographic changes occurred. These sites will provide a continuous record of the eastern tropical Pacific current system throughout the past 8-10 million years, with some sites extending back to 15 Ma.

Ideally, all of the sites will be drilled, in order to provide both east-west and north-south coverage. However, time constraints may preclude drilling all sites. The primary sites along the 95°W transect are EEQ-1, EEQ-2, EEQ-3, and EEQ-4. All EEQ sites will be double APC cored with XCB coring to basement as needed. The primary sites along the 110°W transect are WEQ-3, WEQ-4, WEQ- 5, WEQ-6, and WEQ-7. All WEQ sites will be triple APC cored with XCB coring to basement as needed. If time permits, the third APC hole at each site, presently scheduled to be drilled to 50 mbsf, may be deepened. Three alternate sites include EEQ-4A, EEQ-5, and WEQ-2. WEQ-2 is logistically the last site along the ship track and will be cored if time permits. Estimated drilling, logging, and transit times are presented in Tables 1 and 2.

Logging programs for all sites are outlined in Table 3. Where penetration depths are sufficient, geophysical (seismic-stratigraphic), geochemical, and formation microscanner tool strings will be used to log each site.

References

Baumgartner, T. and Christensen, N. (1985). Coupling of the Gulf of California to large-scale interannual climatic variability. *Journal of Marine Research,* **43**:825-848.

Chavez, F. P. and Barber, R. T. (1987). An estimate of new production in the equatorial Pacific. *Deep Sea Research,* **34**:1229-1243.

Hofmann, E. E., Busalacchi, A. J., and O'Brien, J. J., (1981). Wind generation of the Costa Rica Dome. *Science,* **214**:552-554.

Table 1. Leg 138 time estimates.

Site	Latitude Longitude	Water Depth (m)	Penetration (mbsf)	Drill* (days)	Log (days)	Total (days)	Transit (days)†
FIRST PRIORITY SITES:							
Panama							
							3.0
EEQ-2	7°55.3'N 90°28.9'W	3430	271	3.4	0.9	4.3	
							1.1
EEQ-1	9°34.9'N 94°35.3'W	3725	283	3.8	0.9	4.7	
							2.4
EEQ-3	0°12.1'N 95°19.2'W	3355	295	3.6	0.9	4.5	
							1.4
EEQ-4	3°05.8'S 90°49.6'W	3320	411	4.4	1.0	5.4	
							4.9
WEQ-5	2°59.7'S 110°28.9'W	3870	93	2.3	0.6	2.9	
							0.6
WEQ-6	0°06.2'N 110°30.3'W	3840	312	4.3	0.9	5.2	
							0.7
WEQ-4	2°45.5'N 110°34.3'W	3780	312	4.3	0.9	5.2	
							0.7
WEQ-3	5°19.6'N 110°04.6'W	3870	120	2.6	0.8	3.4	
							0.5
WEQ-7	7°12.7'N 109°45.1'W	3730	65	1.9	0.4	2.3	
							6.6
San Diego							
			Subtotals	**30.6**	**7.3**	**37.9**	**21.9**
			Total days at sea = 59.8				
SECONDARY SITES:							
WEQ-2	11°16.3'N 109°36.3'W	3520	27	1.4	0.3	1.7	
EEQ-4A	3°01.8'S 95°04.8'W	3520	181	2.7	0.8	3.5	
EEQ-5	5°36.2'N 94°12.2'W	3575	212	3.2	0.8	4.0	

* Triple APC all WEQ sites; Double APC all EEQ sites; XCB to basement where necessary.
† Transit time assumes average speed of 10 kt.

Table 2. Leg 138 transit distances/times.

Site	Latitude Longitude	Distance (nmi)	Transit (days)
Panama			
		725.1	3.0
EEQ-2	7°55.3'N 90°28.9'W		
		263.5	1.1
EEQ-1	9°34.9'N 94°35.3'W		
		564.9	2.4
EEQ-3	0°12.1'N 95°19.2'W		
		334.9	1.4
EEQ-4	3°05.8'S 90°49.6'W		
		1179.3	4.9
WEQ-5	2°59.7'S 110°28.9'W		
		149.5	0.6
WEQ-6	0°06.2'N 110°30.3'W		
		171.8	0.7
WEQ-4	2°45.5'N 110°34.3'W		
		157.1	0.7
WEQ-3	5°19.6'N 110°04.6'W		
		114.6	0.5
WEQ-7	7°12.7'N 109°45.1'W		
		1585.9	6.6
San Diego			
	Totals =	**5246.6**	**21.9**

Transit time assumes average speed of 10 kt.

Table 3. Logging time estimates.

Site	Position	Water Depth (m)	Penet. Depth (m)	Hole Prep (hr)	Geophys (hr)	Geochem (hr)	FMS (hr)	Rig Down (hr)	Total (hr)
WEQ-2	11°16.3°N 109°36.3°W	3520	27	2.0		4.5		1.5	8
WEQ-3	5°19.6°N 110°04.6°W	3870	120	4.1	4.8	5.3	3.8	1.5	19
WEQ-4	2°45.5°N 110°34.3°W	3780	312	4.4	5.6	6.4	4.2	1.5	22
WEQ-5	2°59.7°S 110°28.9°W	3870	93	4.0	4.7	5.1		1.5	15
WEQ-6	0°06.2°N 110°30.3°W	3840	312	4.4	5.6	6.4	4.2	1.5	22
WEQ-7	7°12.7°N 109°45.1°W	3730	65	3.6		4.4		1.5	9
EEQ-1	9°34.9°N 94°35.3°W	3725	283	4.3	5.4	6.2	4.1	1.5	21
EEQ-2	7°55.3°N 90°28.9°W	3430	271	4.3	5.2	5.9	3.9	1.5	21
EEQ-3	0°12.1°N 95°19.2°W	3355	295	4.3	5.2	6.0	3.9	1.5	21
EEQ-4	3°05.8°S 90°49.6°W	3320	411	4.5	5.7	6.7	4.2	1.5	23
EEQ-4A	3°01.8°S 95°04.8°W	3520	181	4.2	4.9	5.4	3.7	1.5	20
EEQ-5	5°36.2°N 94°12.2°W	3575	212	4.2	5.0	5.6	3.8	1.5	20

**Assumes no side-entry sub needed.

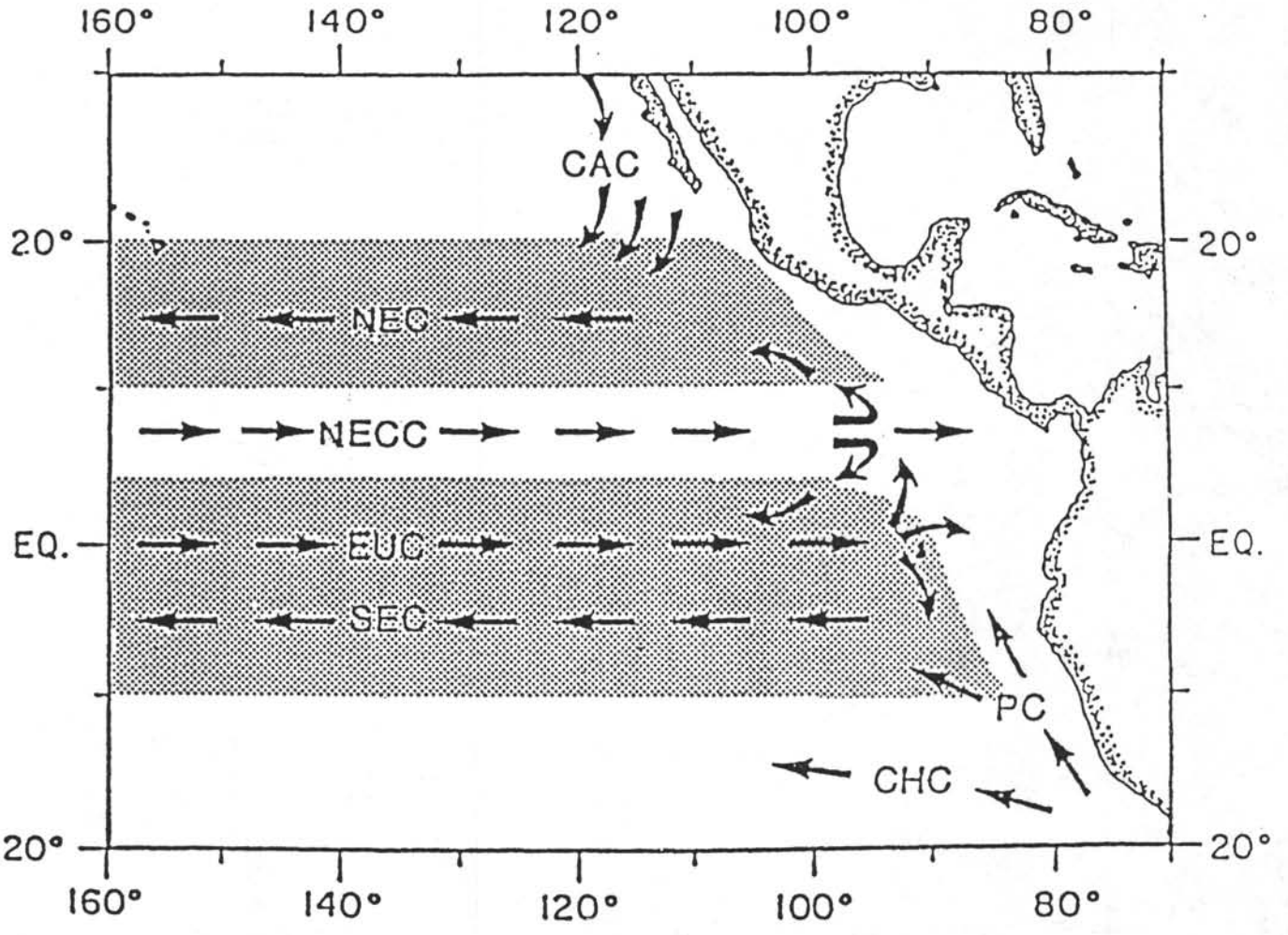


Figure 1. General circulation of the equatorial Pacific. CAC: California Current. NEC: North Equatorial Current. NECC: North Equatorial Countercurrent. EUC: Equatorial Undercurrent. SEC: South Equatorial Current. PC: Peru Current. CHC: Chile Current.

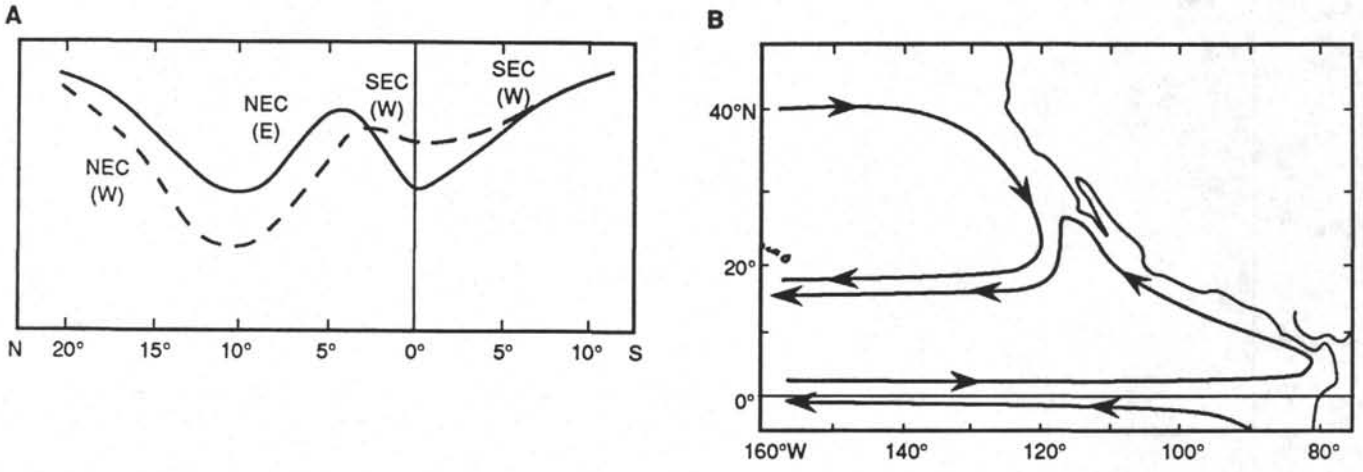


Figure 2. A: Schematic section of dynamic topography from 20°N to 10°S in the central Pacific showing location of convergences (ridges) and divergences (troughs) in relation to the current systems and the direction of flow (east-west). The solid line indicates topographic configuration during weakened eastward flow in the NECC and strong westward flow in the SEC (Anti-El Nino conditions). The dashed line shows change in topography associated with strengthened eastward flow in the NECC and weakened westward flow in the SEC (El Nino conditions).

B: Schematic diagram of expanded and intensified north equatorial cyclonic gyre circulation in relation to contracted anticyclonic North Pacific and South Pacific gyres inferred to exist during El Nino episodes.

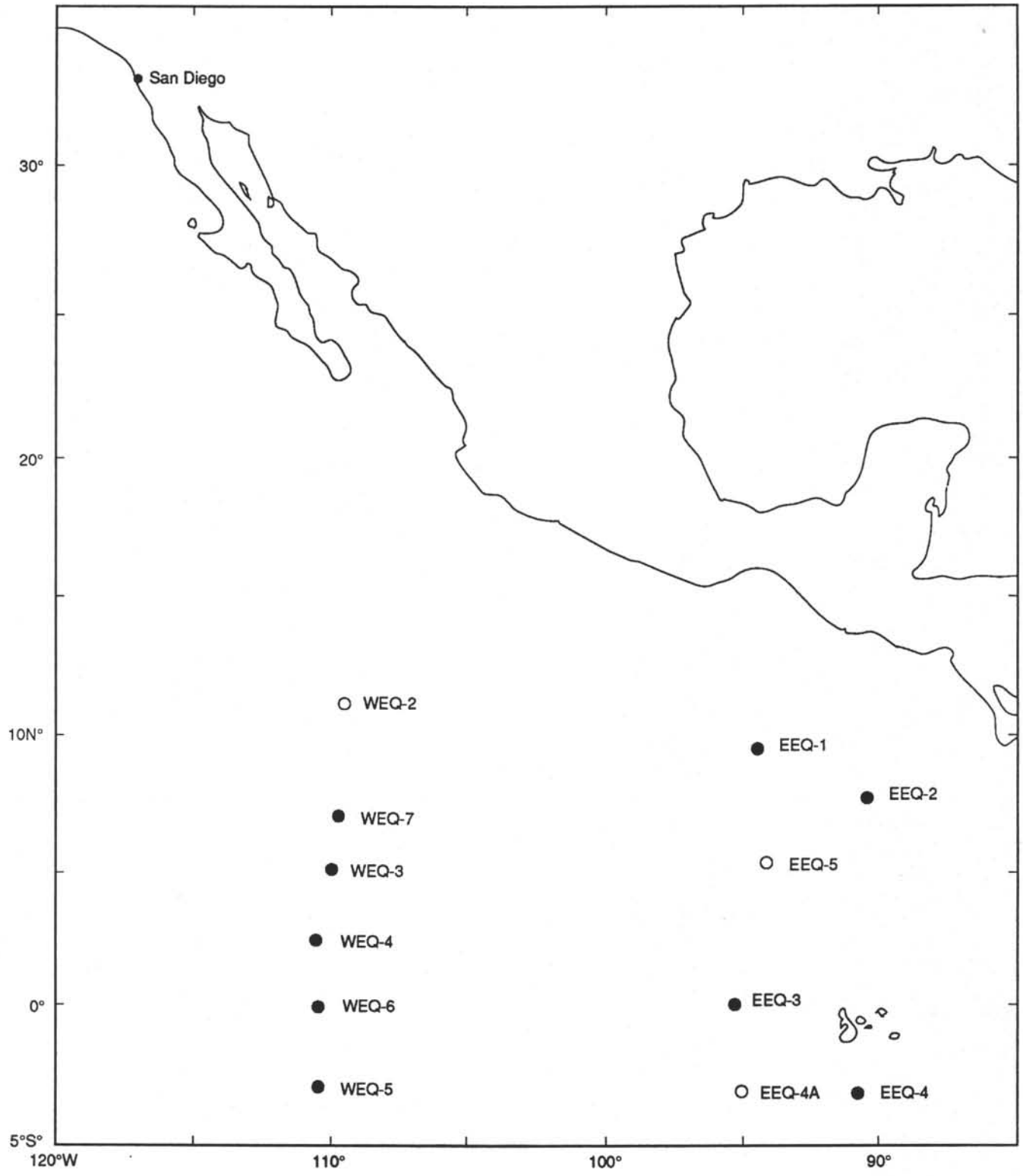


Figure 3. Proposed Leg 138 drilling sites surveyed by the R/V *Thomas Washington,* Venture Leg 1. Solid circles: priority 1 sites; open circles: priority 2 sites.

SITE: **WEQ-2** PRIORITY: 2

POSITION: 11° 16.3'N, 109° 36.3'W

WATER DEPTH: 3520 m (SB)

SEISMIC RECORD: R/V *Washington* station #4, 0605Z 03 Sept. 1989

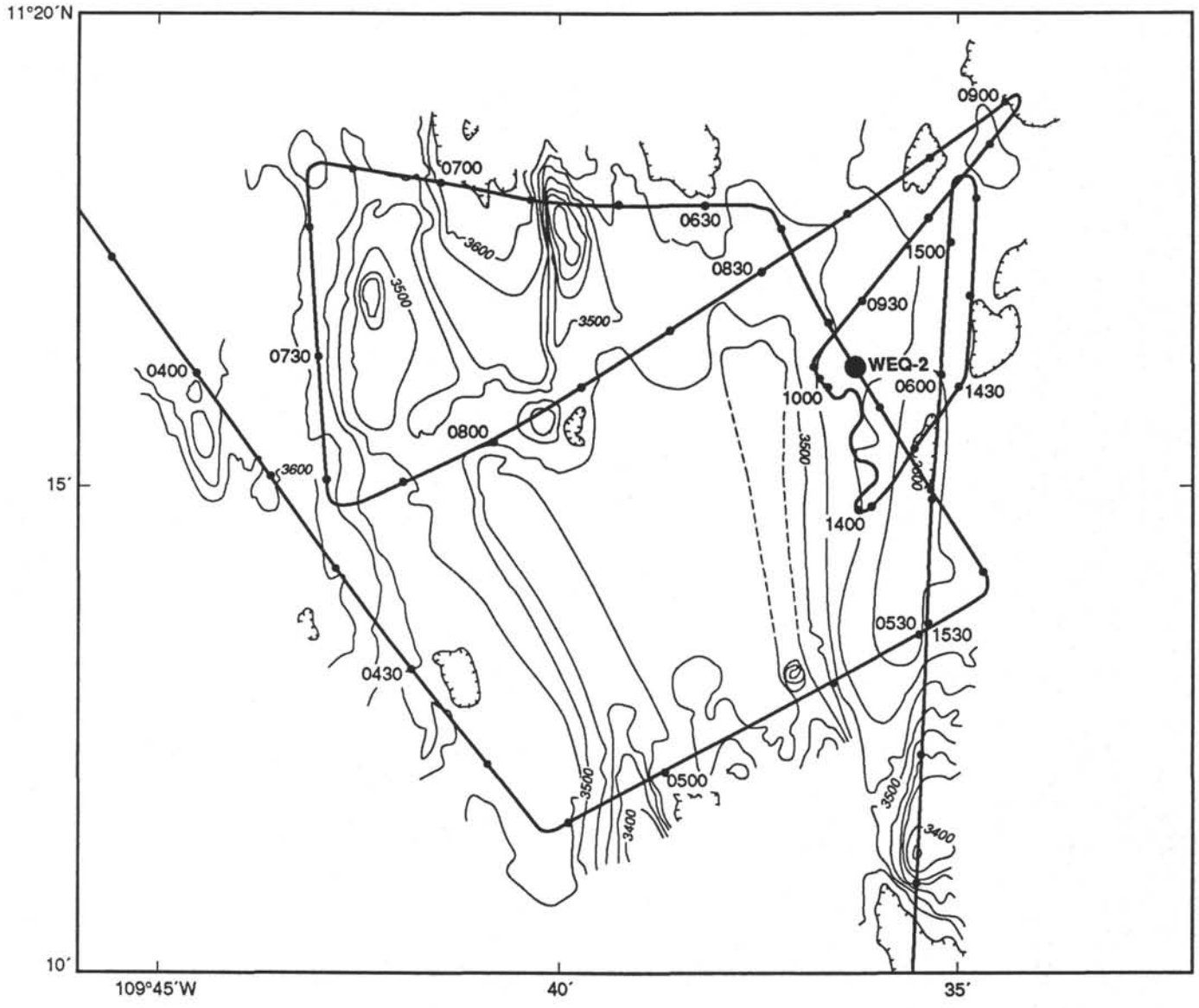
SEDIMENT RECORD: VNTR01-01 PC SEDIMENT THICKNESS: 27 m

PROPOSED DRILLING PROGRAM: Triple APC coring, with XCB coring to basement as needed.

LOGGING: Geochemical combination tool string.

OBJECTIVES: Proposed drill site WEQ-2, beneath the westward flowing North Equatorial Current, is located in a thinly sedimented region on crust ~9 Ma. The primary site is situated on top of a broad, very gently sloping north-south-trending local high just north of the Clipperton Fracture Zone. The thin pelagic drape in this region varies in thickness from about 20 to 40 m and is ~27 m thick at the proposed site. There are no major topographic features in the survey area. Given the thin sediment cover in this area, a careful 3.5-kHz survey will be necessary before final beacon deployment.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Pelagic calcareous ooze.


11°20′N
15′
10′
109°45′W
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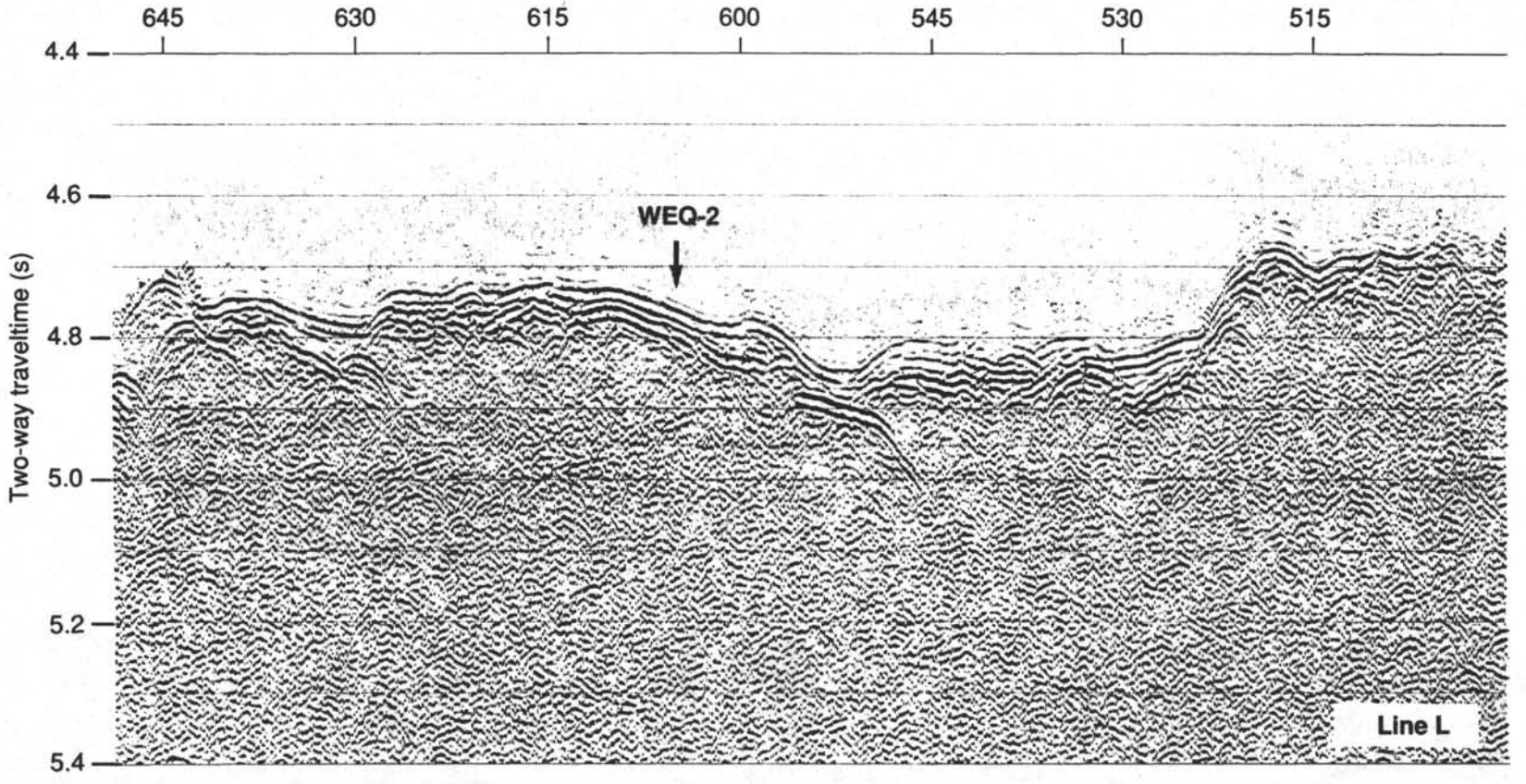
1530
WEQ-2
3600
3500
3400


645
630
615
600
545
530
515
4.4
4.6
4.8
5.0
5.2
5.4
Two-way traveltime (s)
WEQ-2
Line L

SITE: **WEQ-3** PRIORITY: 1

POSITION: 5° 19.6'N, 110° 4.6'W

WATER DEPTH: 3870 m (SB)

SEISMIC RECORD: R/V *Washington* station 5a, 0933Z 06 Sept. 1989

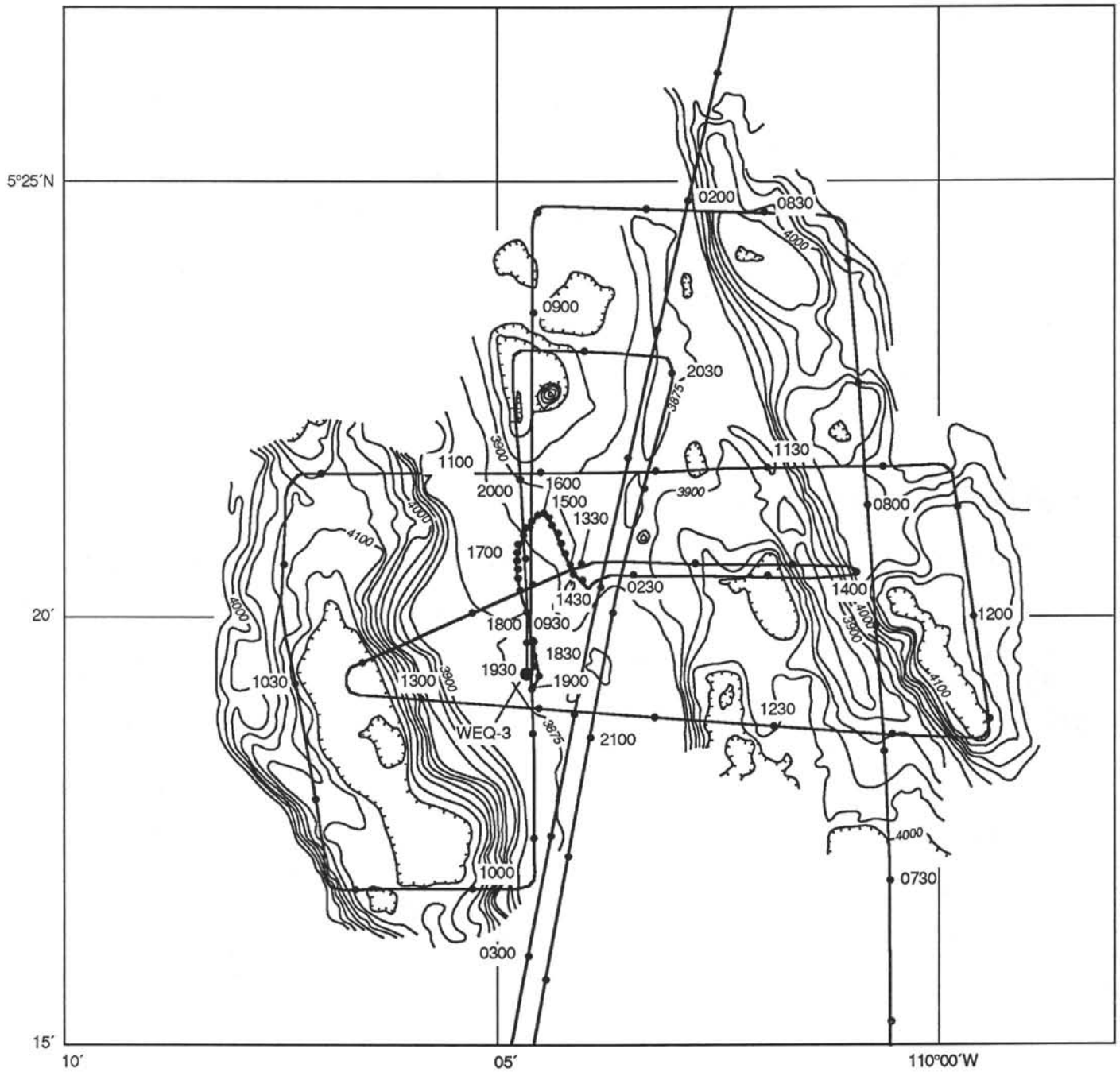
SEDIMENT RECORD: VNTRO1-04 PC SEDIMENT THICKNESS: 120 m

PROPOSED DRILLING PROGRAM: Triple APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings, and the formation microscanner.

OBJECTIVES: WEQ-3, near the North Equatorial Countercurrent and South Equatorial Current boundary, is located on a northwest-southeast-trending topographic high with gentle basement and surface relief. The crust in this region is ~12.5 Ma. The pelagic sediment cover along the crest of the high is fairly continuous and ~120 m thick at the proposed site. Thicker accumulations of sediment are found in several troughs surrounding the high, but these troughs probably contain redeposited material and thus have been eliminated as potential drilling targets.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Pelagic calcareous ooze.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1000
0730
0300
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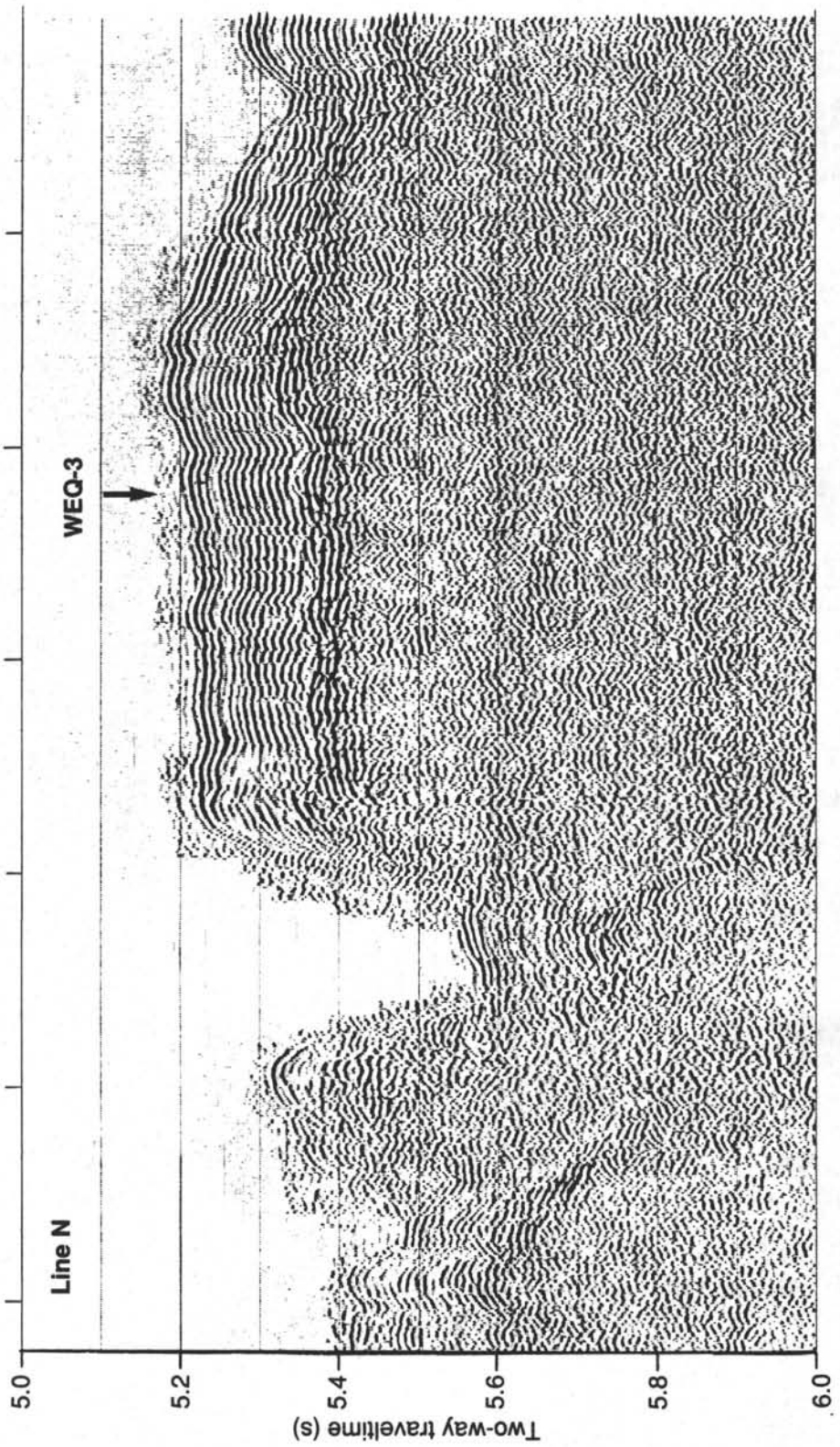
4100
3900
3875


Line N
WEQ-3
1030
1015
1000
945
930
915
5.0
5.2
5.4
5.6
5.8
6.0
Two-way traveltime (s)

SITE: **WEQ-4** PRIORITY: 1

POSITION: 2° 45.5'N, 110° 34.3'W

WATER DEPTH: 3780 m (SB)

SEISMIC RECORD: R/V *Washington* station 6

Primary site:	1733Z 07 Sept. 1989
Crossing:	1943Z 07 Sept. 1989

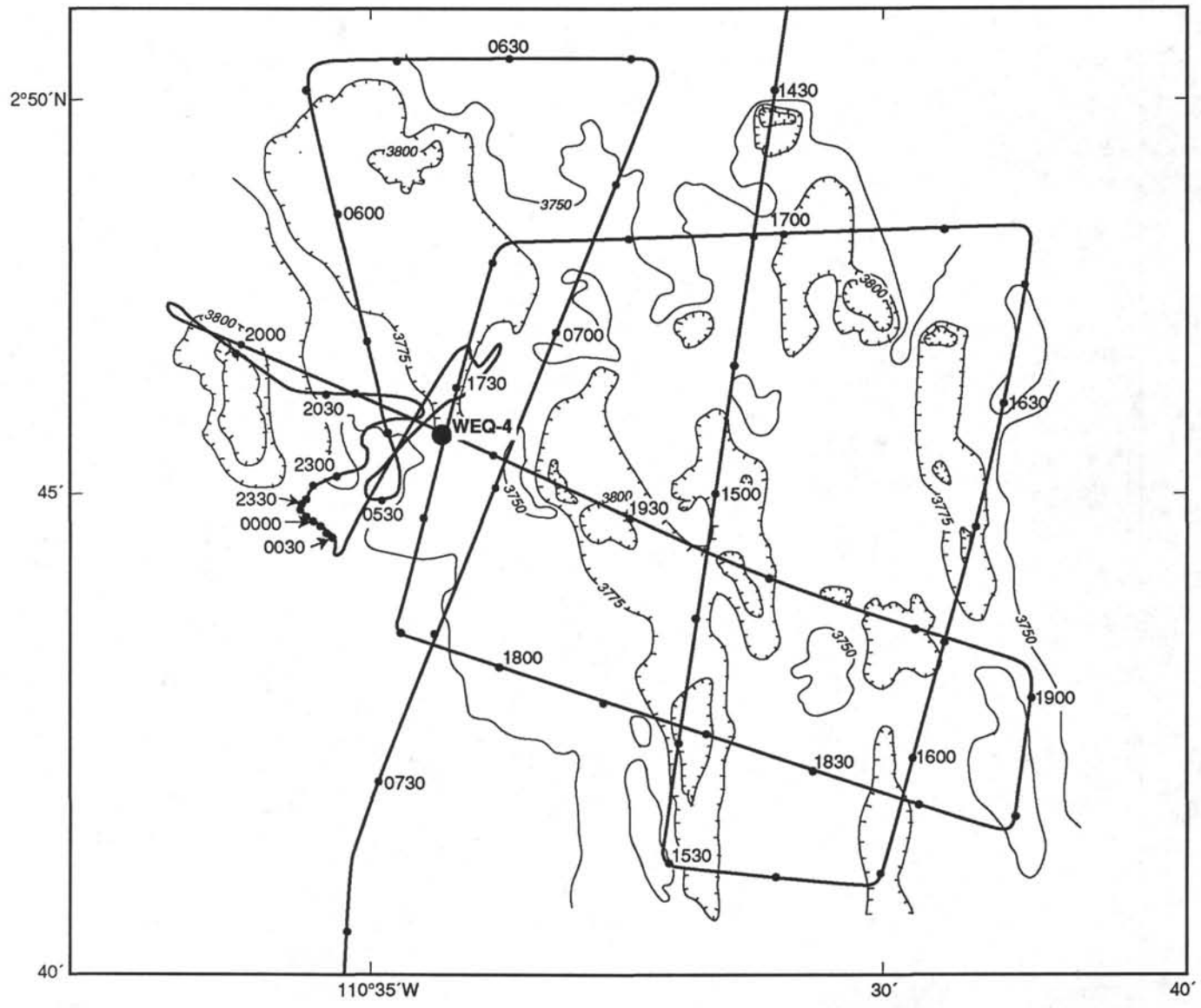
SEDIMENT RECORD: VNTR01-05 GC and VNTR01-06 PC SEDIMENT THICKNESS: 312 m

PROPOSED DRILLING PROGRAM: Triple APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings, and the formation microscanner.

OBJECTIVES: WEQ-4 is located beneath the South Equatorial Current on crust ~13 Ma. The proposed site is on a broad northwest-southeast-trending topographic high with somewhat complex basement relief. The complexity of the basement structure is mirrored (though in a subdued manner) in the surface relief. The proposed site, however, is in an area of relatively flat basement and thus relatively flat seafloor. The sediment column in this region has thickened considerably with respect to the sites farther north; the section at the proposed site is ~312 m thick. The numerous flat-lying reflectors draping over basement topography imply fairly undisturbed pelagic accumulation.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Pelagic calcareous ooze.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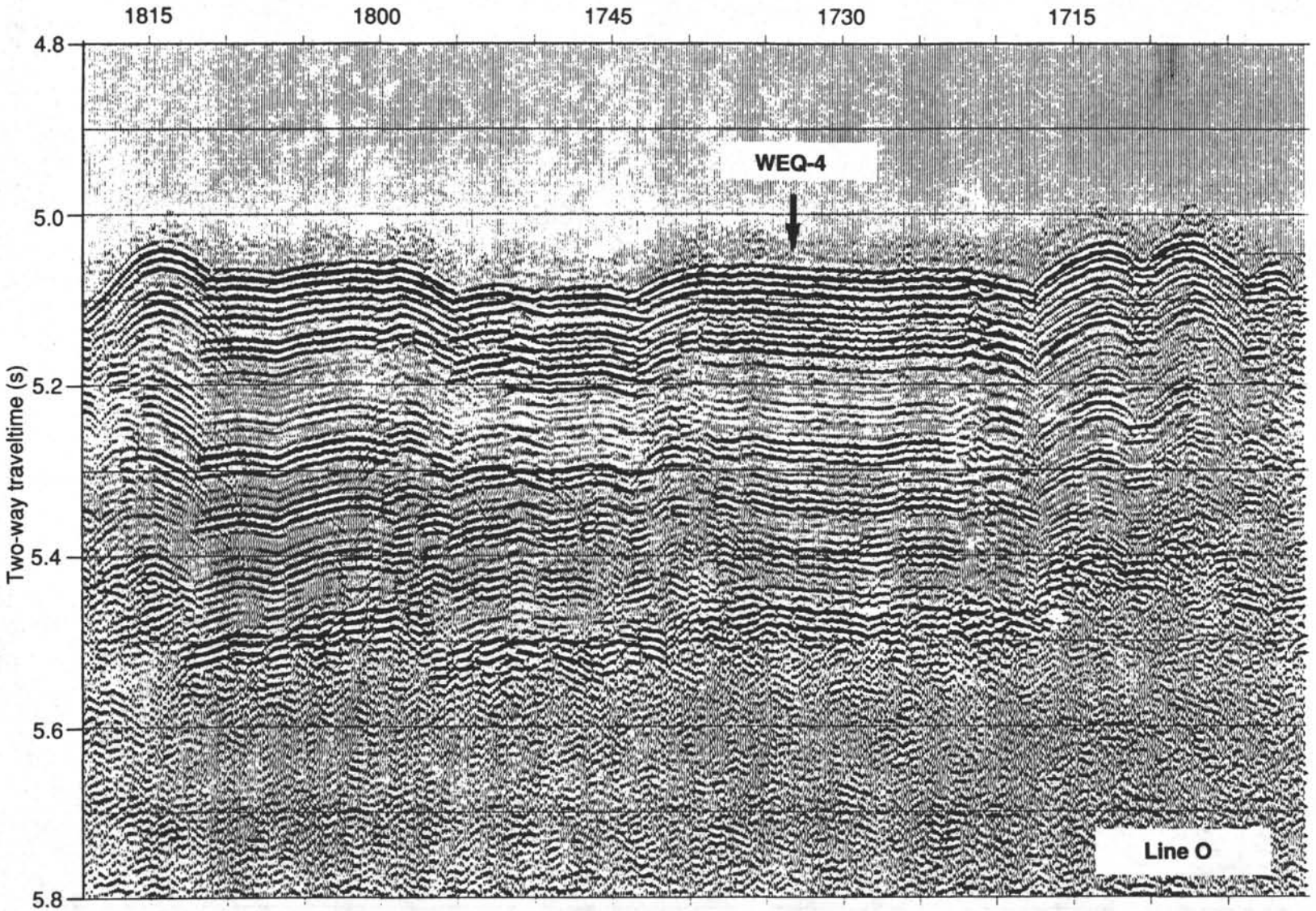

1815
1800
1745
1730
1715
4.8
5.0
5.2
5.4
5.6
5.8
Two-way traveltime (s)
WEQ-4
Line O

SITE: **WEQ-5** PRIORITY: 1

POSITION: 2° 59.7'S, 110° 28.9'W

WATER DEPTH: 3870 m (SB)

SEISMIC RECORD: R/V *Washington* station 7

Primary site:	1638Z 10 Sept. 1989
Crossing:	1741Z 10 Sept. 1989

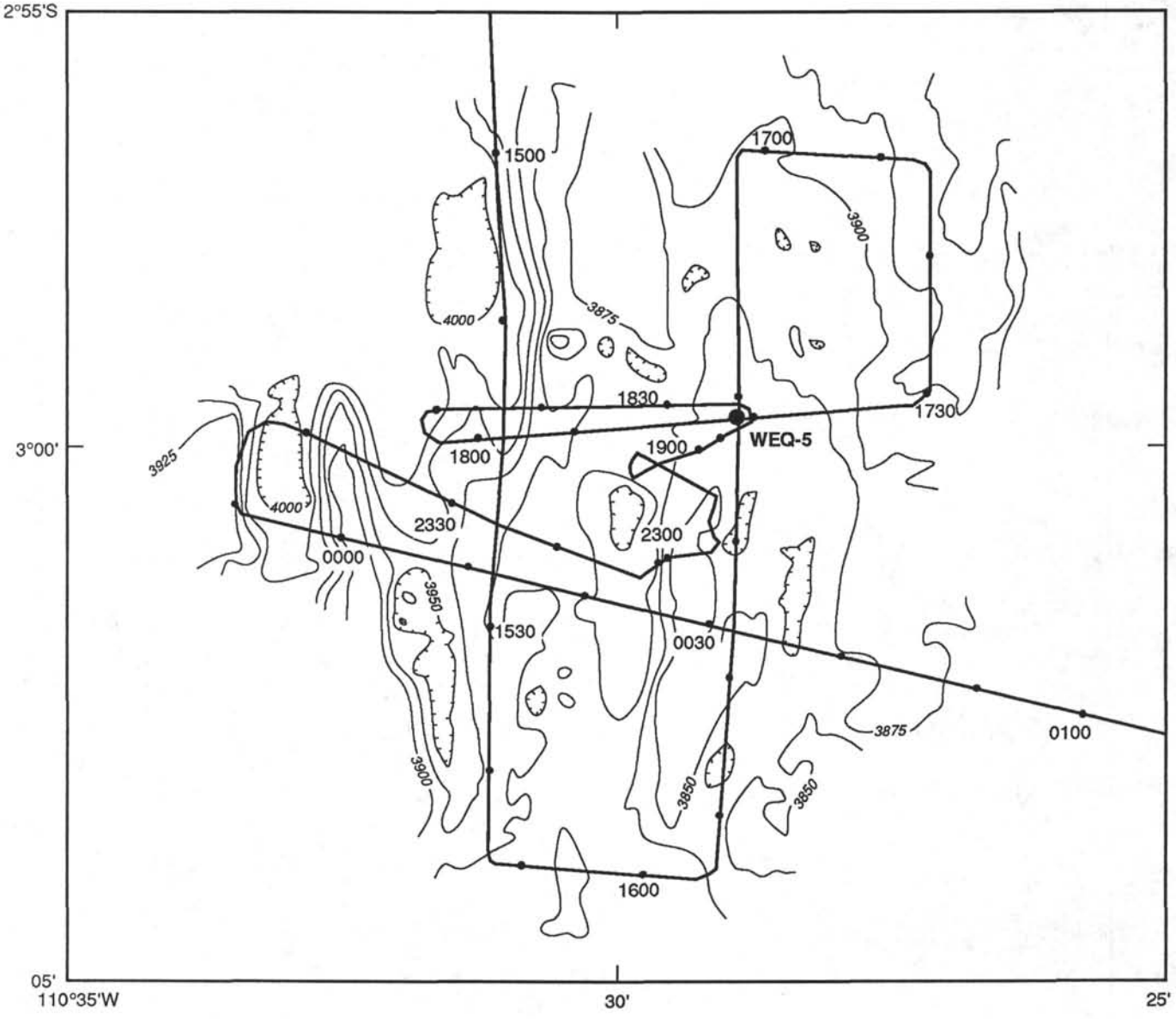
SEDIMENT RECORD: VNTR01-09 PC SEDIMENT THICKNESS: 93 m

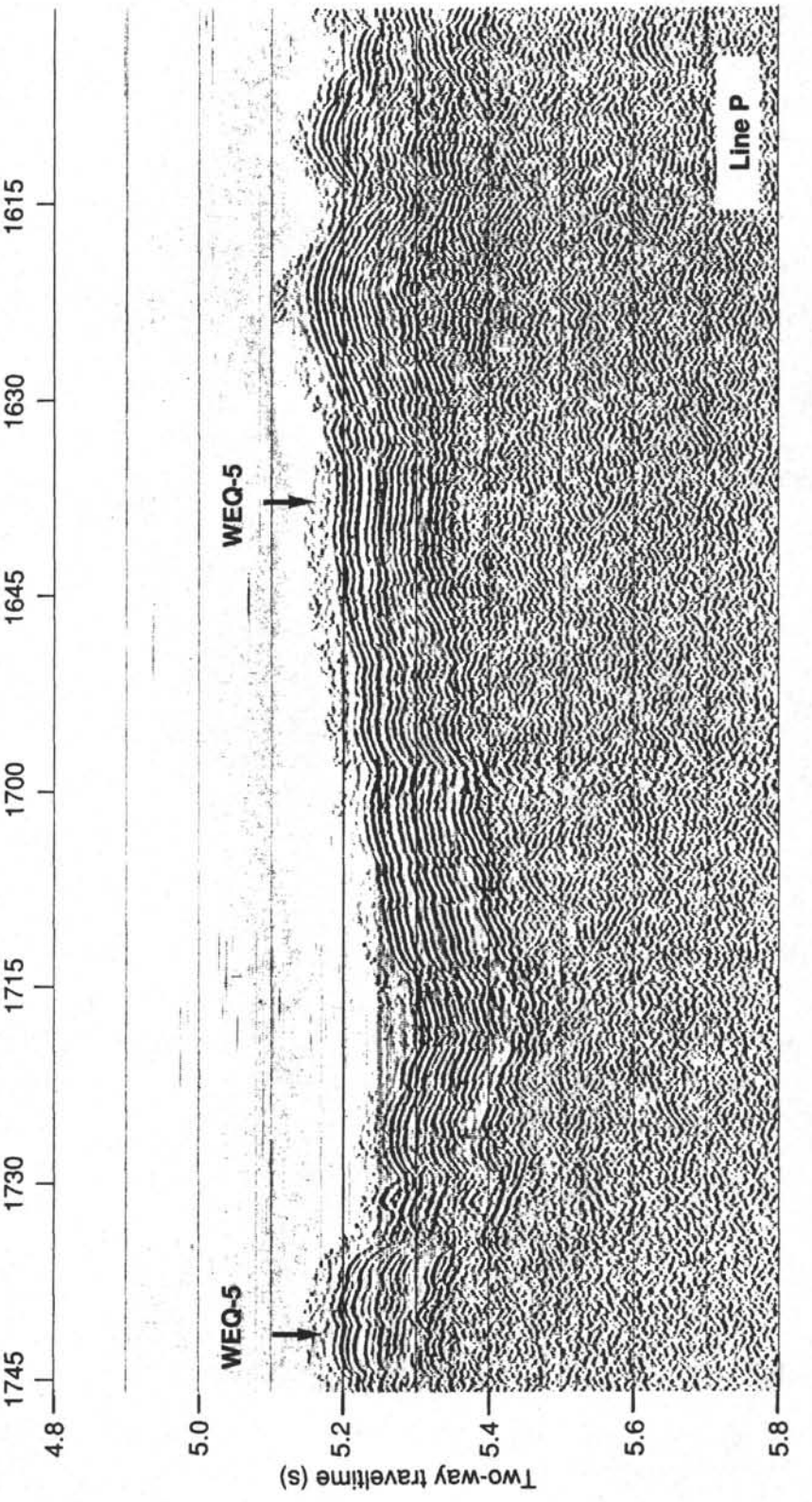
PROPOSED DRILLING PROGRAM: Triple APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings.

OBJECTIVES: WEQ-5 is located beneath the Southern Equatorial Current on crust ~10 Ma. The region displays a north-south topographic grain; the proposed site is located on the crest of a gentle topographic swell. To the west, both the surface and basement topography become rugged with a number of small peaks and troughs. The proposed drill site, however, is well removed from the area of rugged topography. The sediment cover here is much thinner than that at the sites farther north that lie beneath the equatorial divergence; the sediment thickness at the proposed site is ~93 m. Once again the seismic section in the vicinity of the proposed sites shows numerous, apparently undisturbed flat-lying reflectors, indicating pelagic depositional processes.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Pelagic calcareous ooze.


2°55'S
3°00'
05'
110°35'W
30'
25'
1500
1700
1730
1830
1800
1900
WEQ-5
2330
2300
0000
0030
1530
0100
1600
4000
3875
3900
3925
3950
3850


1745
1730
1715
1700
1645
1630
1615
4.8
5.0
5.2
5.4
5.6
5.8
Two-way traveltime (s)
WEQ-5
WEQ-5
Line P

SITE: **WEQ-6** PRIORITY: 1

POSITION: 0° 6.2'N, 110° 30.3'W

WATER DEPTH: 3840 m (SB)

SEISMIC RECORD: R/V *Washington* station 6, 0828Z 09 Sept 1989 (analog seismic only).

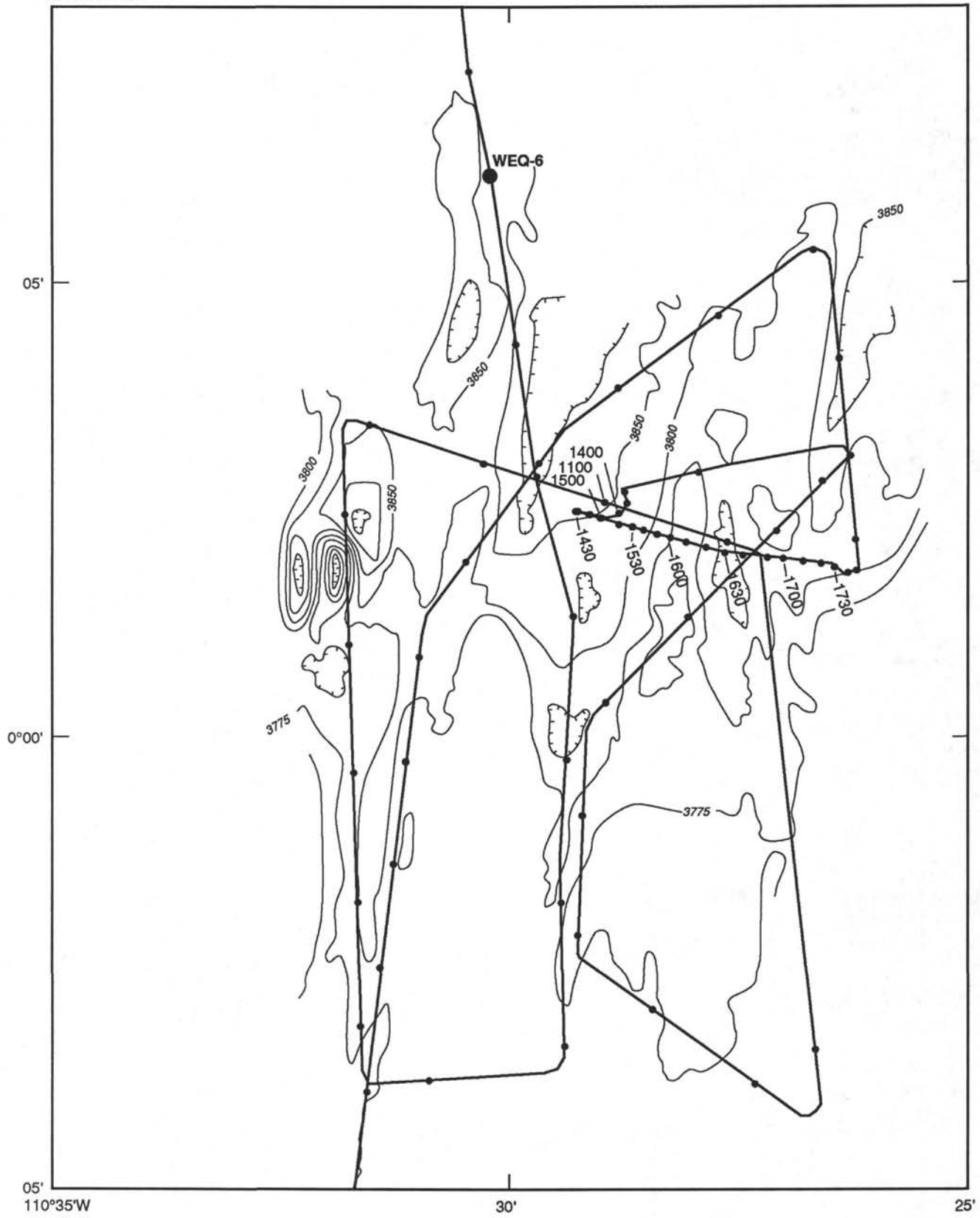
SEDIMENT RECORD: VNTR01-08 PC SEDIMENT THICKNESS: 312 m

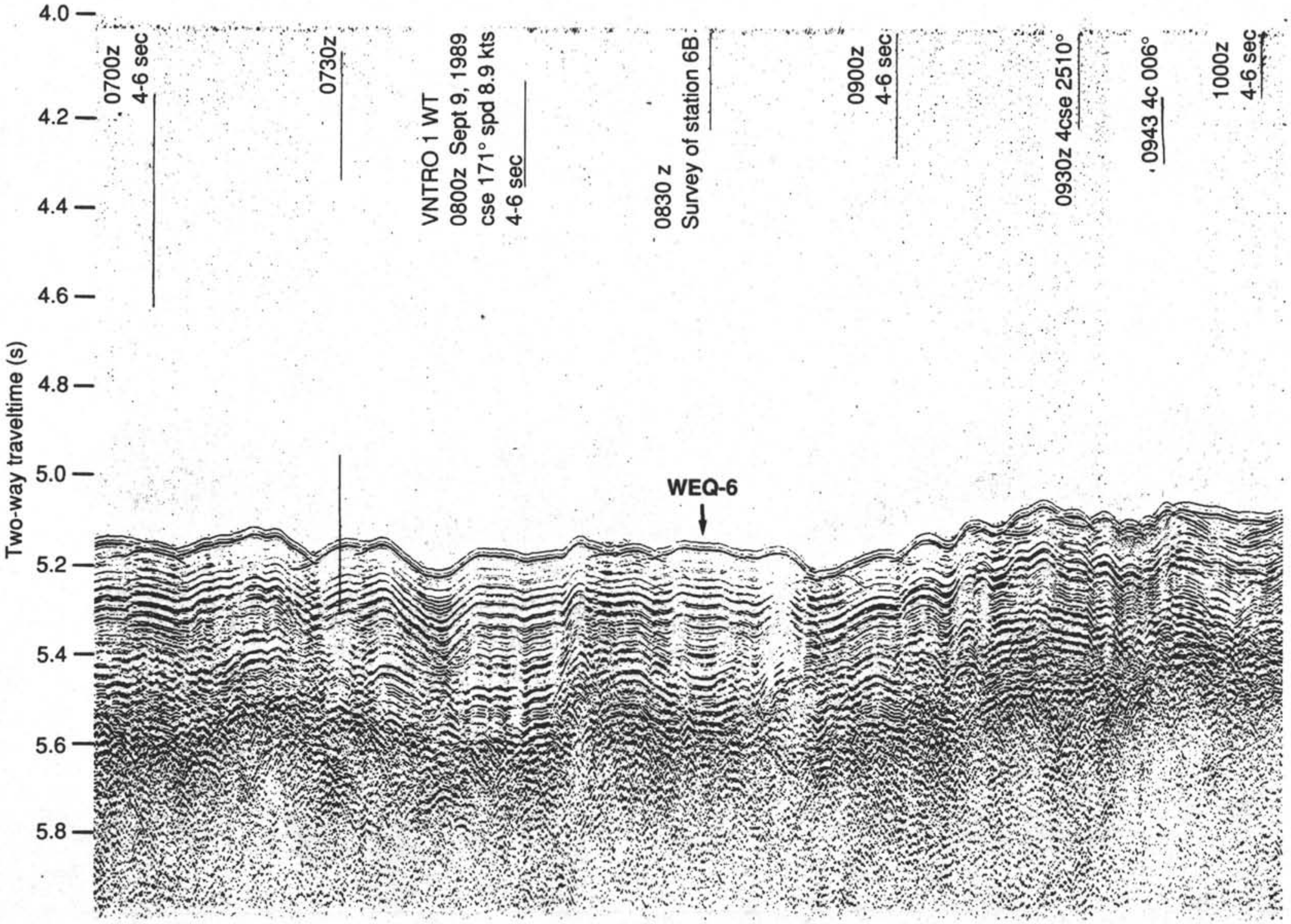
PROPOSED DRILLING PROGRAM: Triple APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings, and the formation microscanner.

OBJECTIVES: WEQ-6 is located beneath the present-day equatorial divergence zone on crust ~12.5 Ma. While surficial and basement topography are generally subdued in the center of the detailed survey area, both basement and surficial relief increase to the west and the southeast. A small basement peak rises ~300 m above the surrounding seafloor in the western extreme of the survey area; a well-developed moat around this basement high attests to the activity of bottom currents in the region. The thickest and least complex seismic section in the region is found shortly before the beginning of the detailed survey. Sediment thickness here is ~340 m, and the reflectors are relatively flat-lying and undisturbed. Smaller targets can be found within the detailed survey area, and the primary drill site is proposed where the section is ~312 m thick.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Pelagic calcareous ooze.


WEQ-6
3850
3850
3800
3800
3850
3850
3775
3775
1400
1100
1500
1430
1530
1600
1630
1700
1730
05'
0°00'
05'
110°35'W
30'
25'


Two-way traveltime (s)
4.0
4.2
4.4
4.6
4.8
5.0
5.2
5.4
5.6
5.8
0700z
4-6 sec
0730z
VNTRO 1 WT
0800z Sept 9, 1989
cse 171° spd 8.9 kts
4-6 sec
0830 z
Survey of station 6B
0900z
4-6 sec
0930z 4cse 2510°
0943 4c 006°
1000z
4-6 sec
WEQ-6

SITE: **WEQ-7** PRIORITY: 1

POSITION: 7° 12.7'N, 109° 45.1'W

WATER DEPTH: 3730 m (SB)

SEISMIC RECORD: R/V *Washington* station 5, 1238Z 05 Sept. 1989

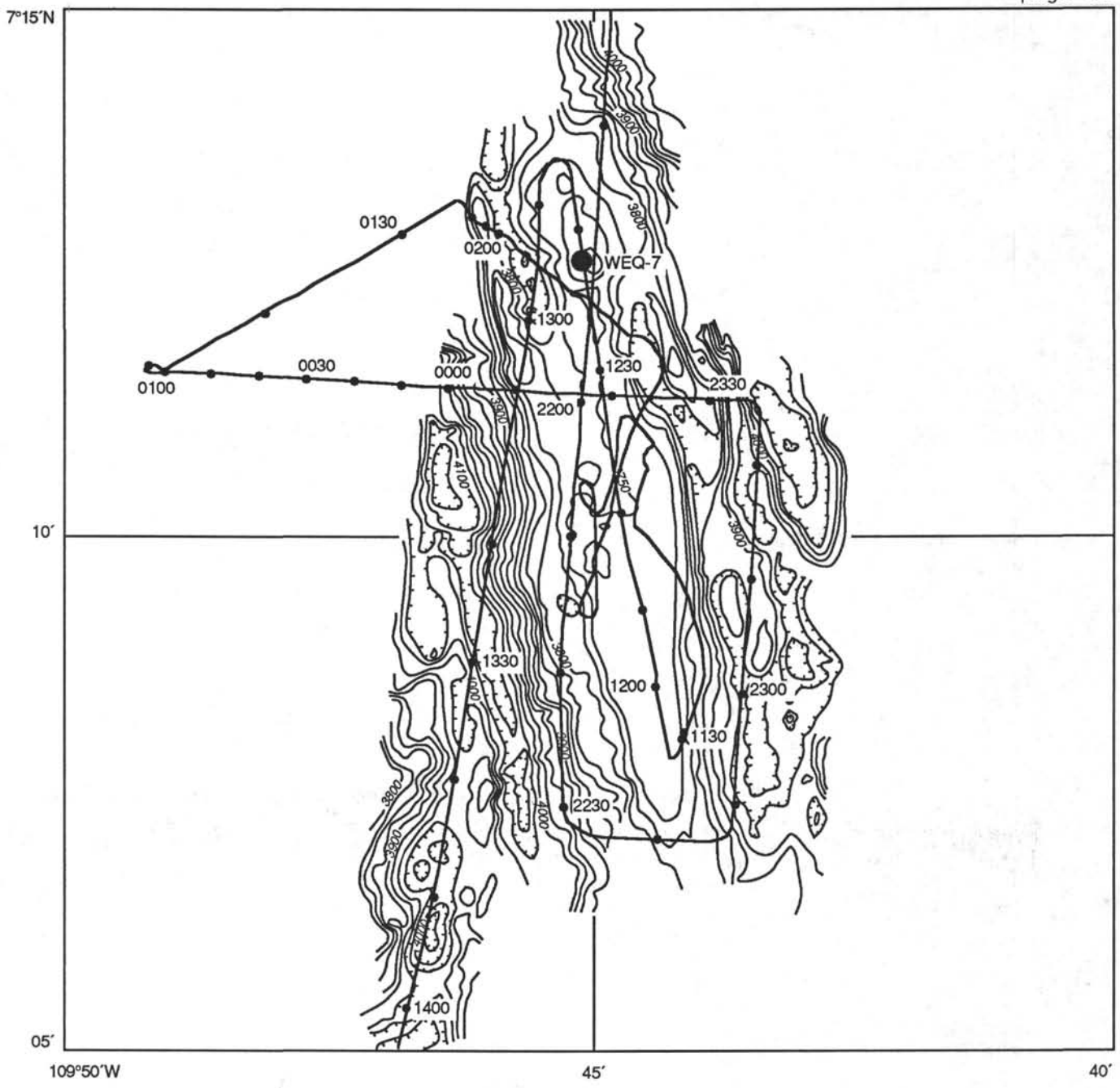
SEDIMENT RECORD: VNTR01-03 PC SEDIMENT THICKNESS: 65 m

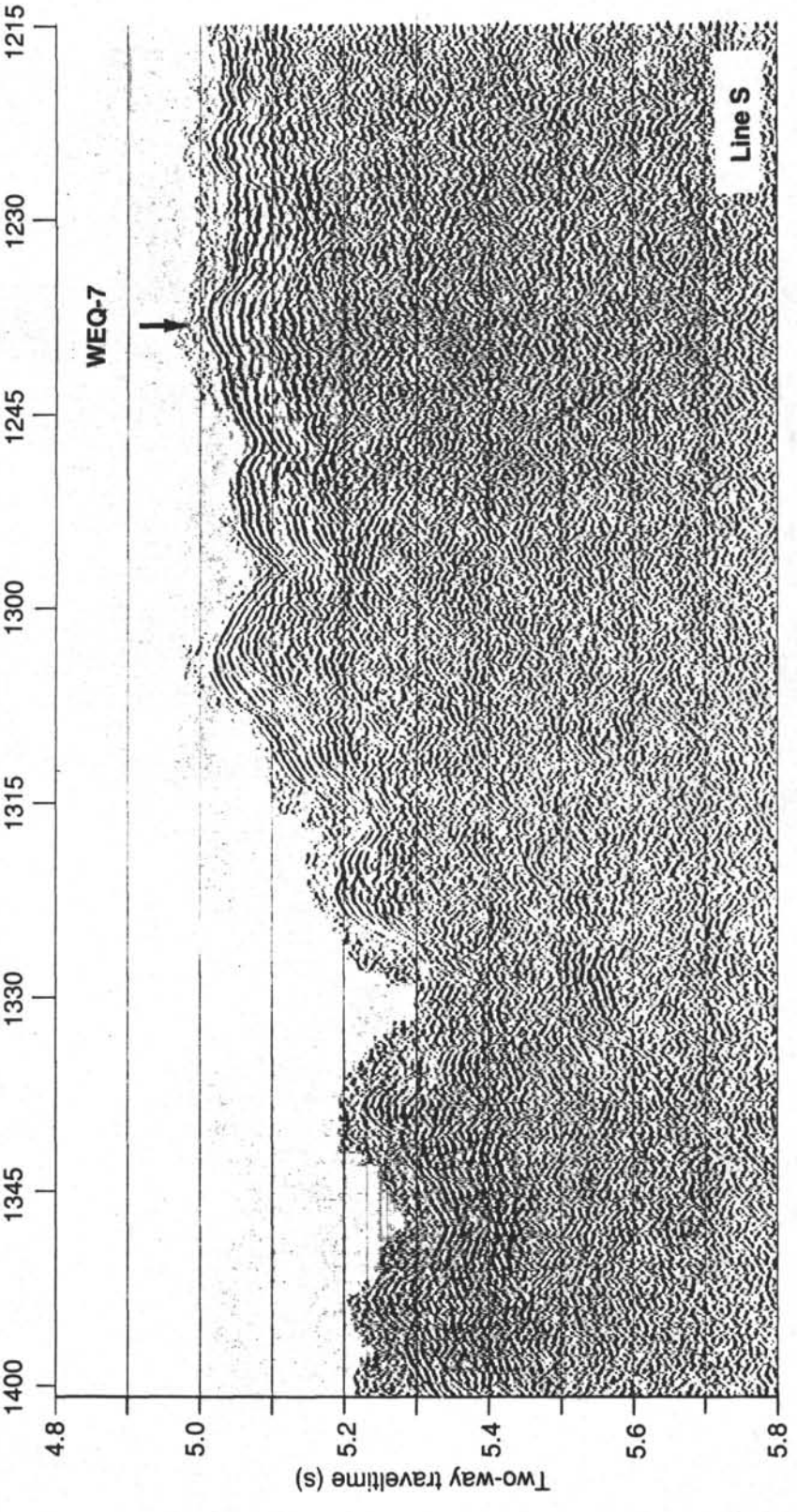
PROPOSED DRILLING PROGRAM: Triple APC coring, with XCB coring to basement as needed.

LOGGING: Geochemical combination tool string.

OBJECTIVES: WEQ-7, near the boundary between the North Equatorial Current and the North Equatorial Countercurrent, is located on the crest of a north-south-trending regional high. The crust in this area is ~13 Ma. The sediment cover in this region is variable, with sediment accumulating on local highs and in troughs and virtually no accumulation on the intervening slopes. This pattern of sediment distribution is probably typical of areas with low sedimentation rates and with topographically enhanced bottom-current activity. The primary site proposed is located within a small basement depression on top of a regional high and thus probably has been protected from bottom-current activity.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Pelagic calcareous ooze.


7°15′N
10′
05′
109°50′W
45′
40′
WEQ-7
0100
0130
0200
0030
0000
1300
1230
2330
2200
1330
1200
2300
1130
2230
1400
3900
4000
4100
3800
3700


Line S
WEQ-7
1400
1345
1330
1315
1300
1245
1230
1215
4.8
5.0
5.2
5.4
5.6
5.8
Two-way traveltime (s)

SITE: **EEQ-1** PRIORITY: 1

POSITION: 9° 34.9'N, 94° 35.3'W

WATER DEPTH: 3725 m (SB)

SEISMIC RECORD: R/V *Washington* station 15

Primary site:	2059Z 28 Sept. 1989
Crossing :	2249Z 28 Sept. 1989

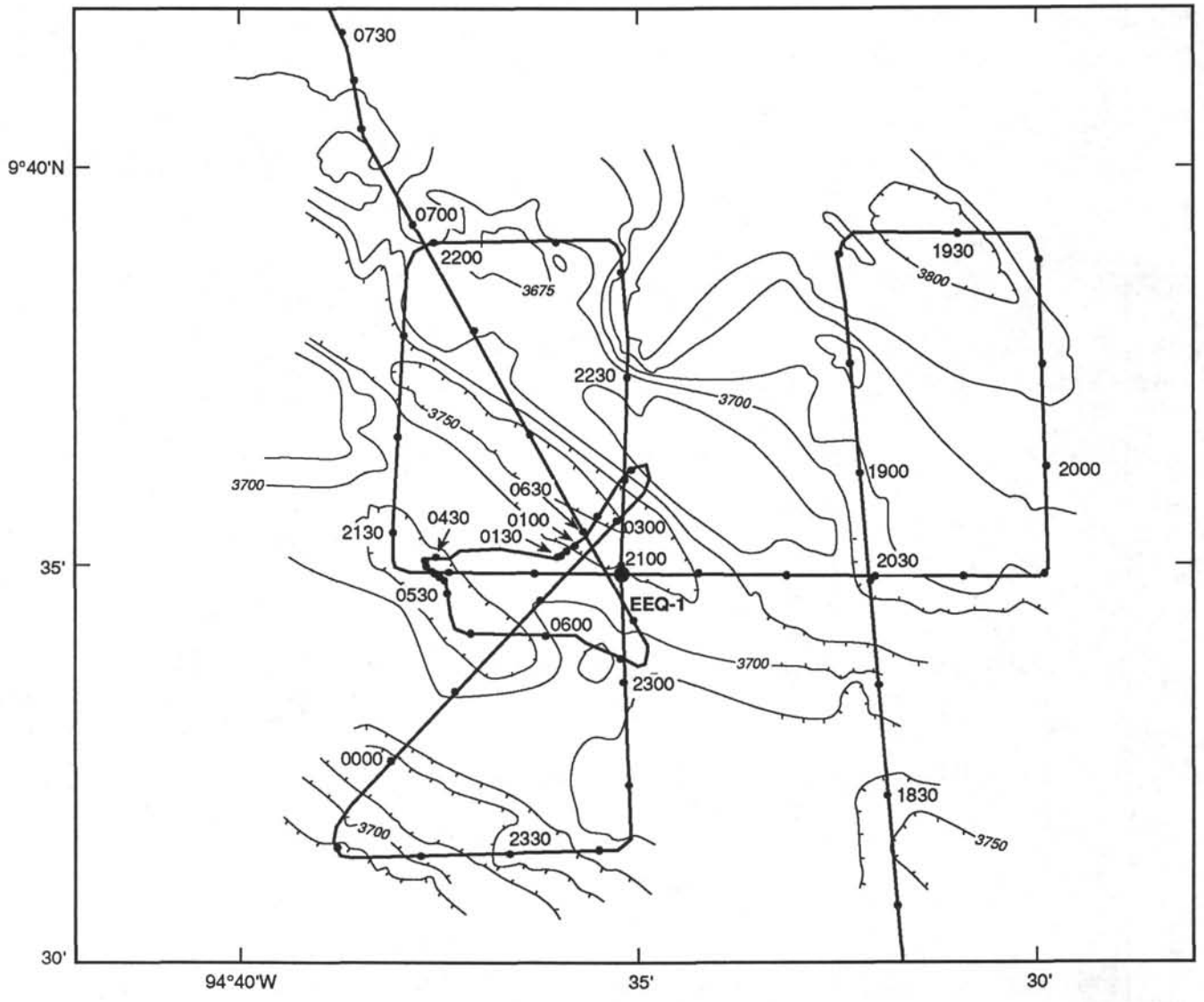
SEDIMENT RECORD: VNTR01-21 PC SEDIMENT THICKNESS: 283 m

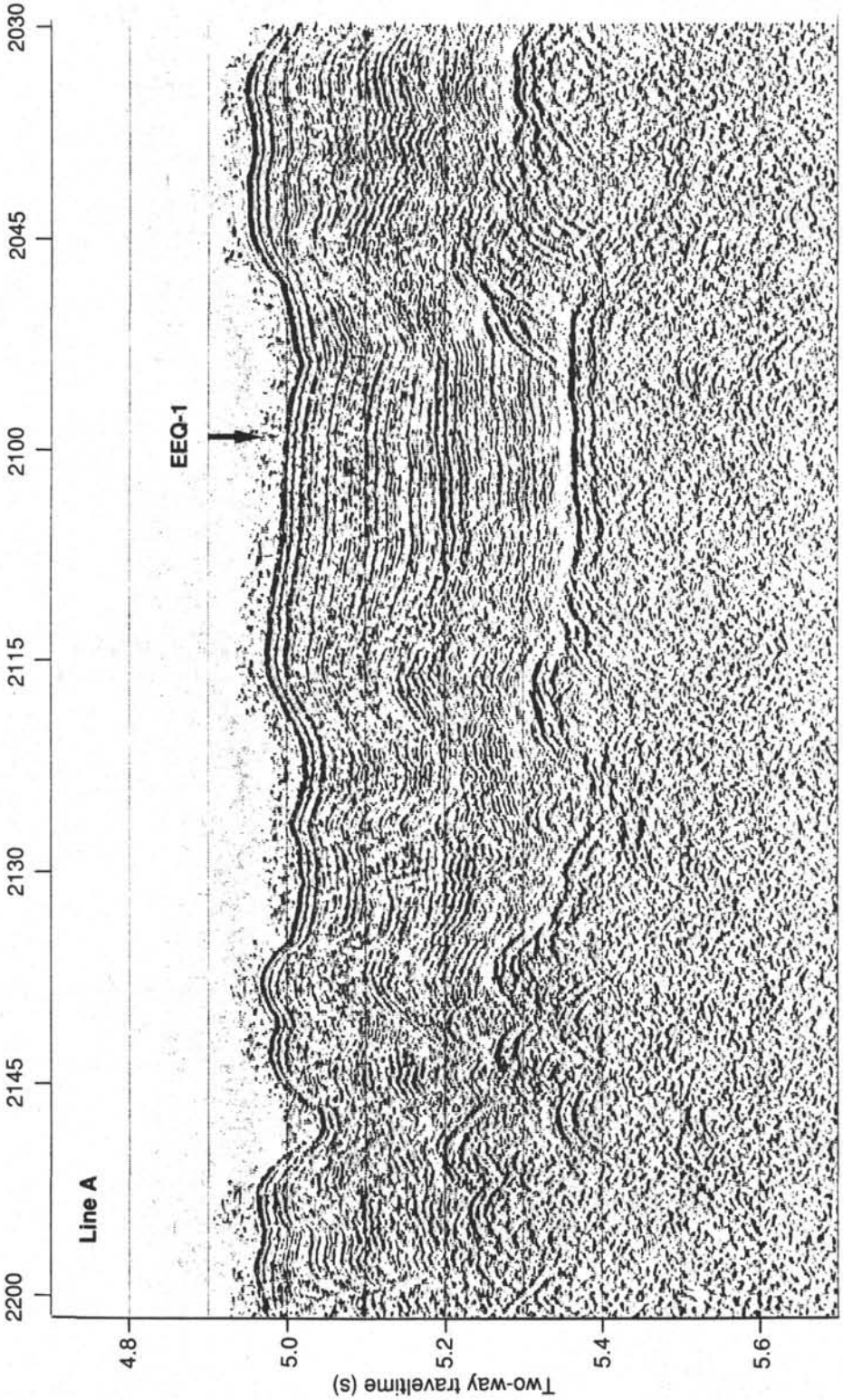
PROPOSED DRILLING PROGRAM: Double APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings, and the formation microscanner.

OBJECTIVES: EEQ-1, the northernmost proposed drilling site in the 95°W transect, is situated beneath the North Equatorial Current. It rests on 15-million-year-old crust that was generated at the East Pacific Rise. The surficial relief in the area is moderate (50-100 m), though there is a pronounced northwest-southeast trend. While basement relief is also moderate, the basement surface is quite rough, resulting in scattering and lack of coherency in the seismic reflection profile. The proposed site is located in a small region where the basement reflector becomes quite smooth and the overlying sediment section shows continuous and relatively undisturbed seismic reflections.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Fossiliferous clay.


0730
0700
2200
3675
2230
3700
3750
3700
0630
0430
0100
0130
0300
2130
2100
2030
1930
3800
1900
2000
0530
EEQ-1
0600
3700
2300
0000
3700
2330
1830
3750
9°40'N
35'
30'
94°40'W
35'
30'


Line A
EEQ-1
2200
2145
2130
2115
2100
2045
2030
4.8
5.0
5.2
5.4
5.6
Two-way traveltime (s)

SITE: **EEQ-2** PRIORITY: 1

POSITION: 7° 55.3'N, 90° 28.9'W

WATER DEPTH: 3430 m (SB)

SEISMIC RECORD: R/V *Washington* station 13

Primary site:	0655Z 25 Sept. 1989
Secondary site:	0842Z 25 Sept. 1989

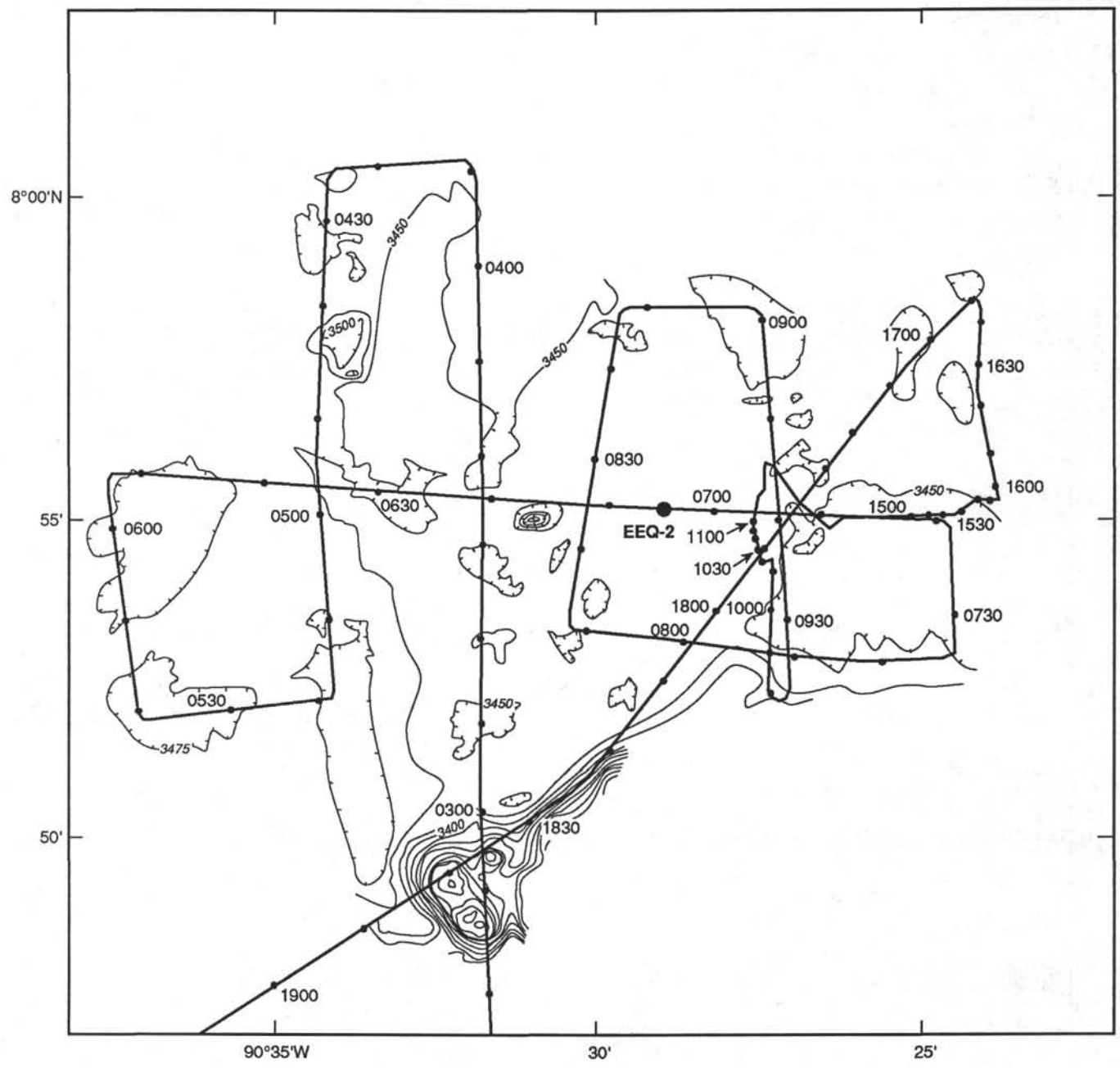
SEDIMENT RECORD: VNTR01-19 PC SEDIMENT THICKNESS: 271 m

PROPOSED DRILLING PROGRAM: Double APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings, and the formation microscanner.

OBJECTIVES: EEQ-2 is located beneath the physical oceanographic feature known as the Costa Rica Dome, a shoaling of the thermocline caused by the deflection of the North Equatorial Countercurrent by the Central American landmass. The combination of this deflection and local curl of the wind stress gives this region some of the highest open-ocean productivity in the world's oceans. EEQ-2 is on the Cocos Plate, located on crust generated at the East Pacific Rise ~18 Ma. Upon entering the survey area for EEQ-2, a small (~300-400 m above the surrounding seafloor) seamount was crossed. Aside from this seamount, the surficial topography in the detailed survey area is minimal (25-30 m) with no trend or lineation discernable. Regionally the topography trends northwest-southeast. An area north and west of the seamount was originally surveyed but this region (except for a small target) shows complex basement topography as well as thinning and loss of the upper part of the section. To the east the basement flattens, and a thick and reasonably undisturbed sedimentary section has accumulated.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Foraminifer-bearing siliceous clay.


8°00'N
55'
50'
90°35'W
30'
25'
0430
3450
0400
3500
3450
0900
1700
1630
0830
0700
3450
1600
0630
0500
0600
EEQ-2
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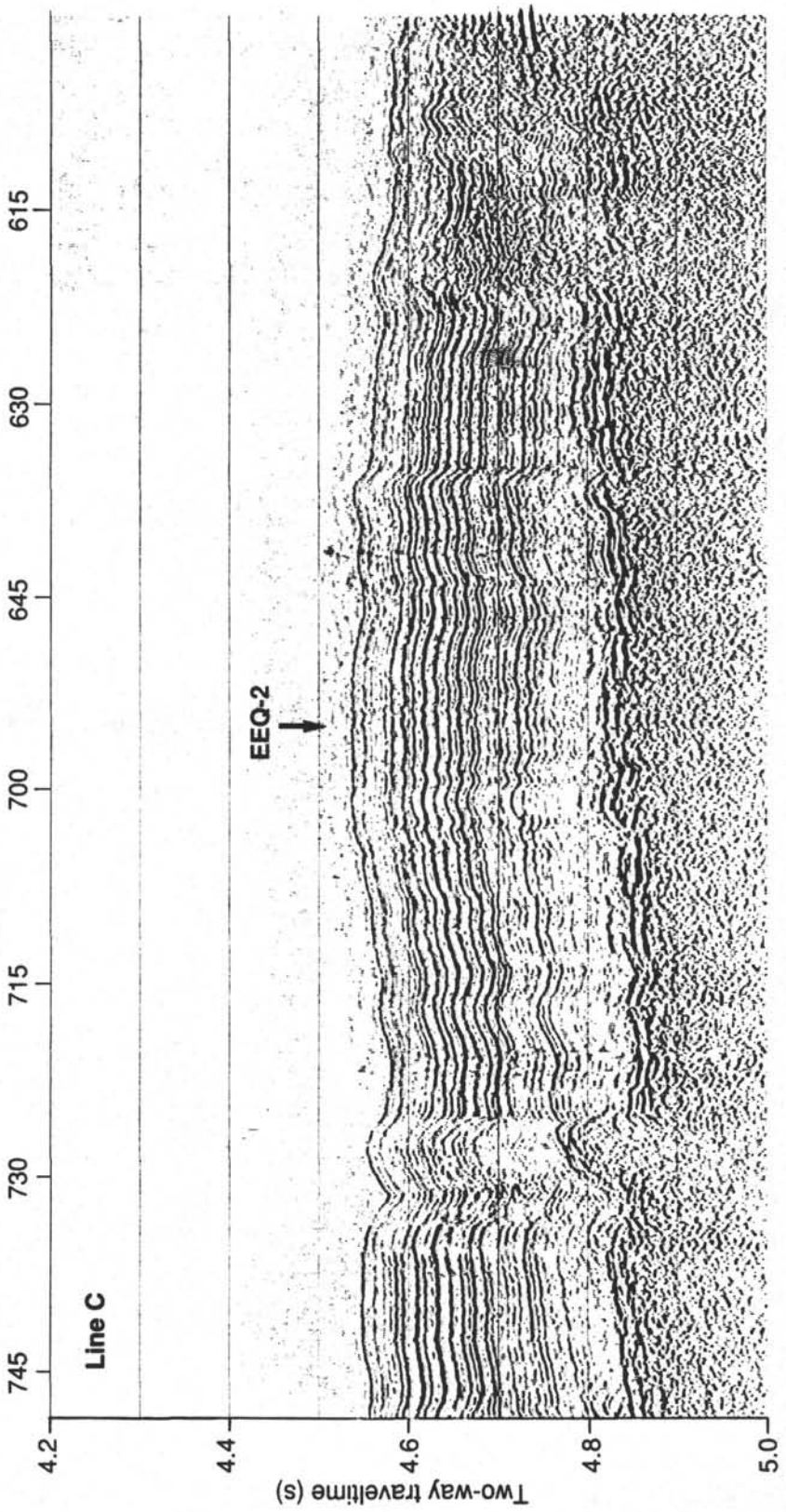
0800
0530
3450
3475
0300
3400
1830
1900


Line C
EEQ-2
745
730
715
700
645
630
615
4.2
4.4
4.6
4.8
5.0
Two-way traveltime (s)

SITE: **EEQ-3** PRIORITY: 1

POSITION: 0° 12.1'N, 95° 19.2'W

WATER DEPTH: 3355 m (SB)

SEISMIC RECORD: R/V *Washington* station 11

Primary site:	0854Z 16 Sept. 1989
Crossing:	0534Z 16 Sept. 1989

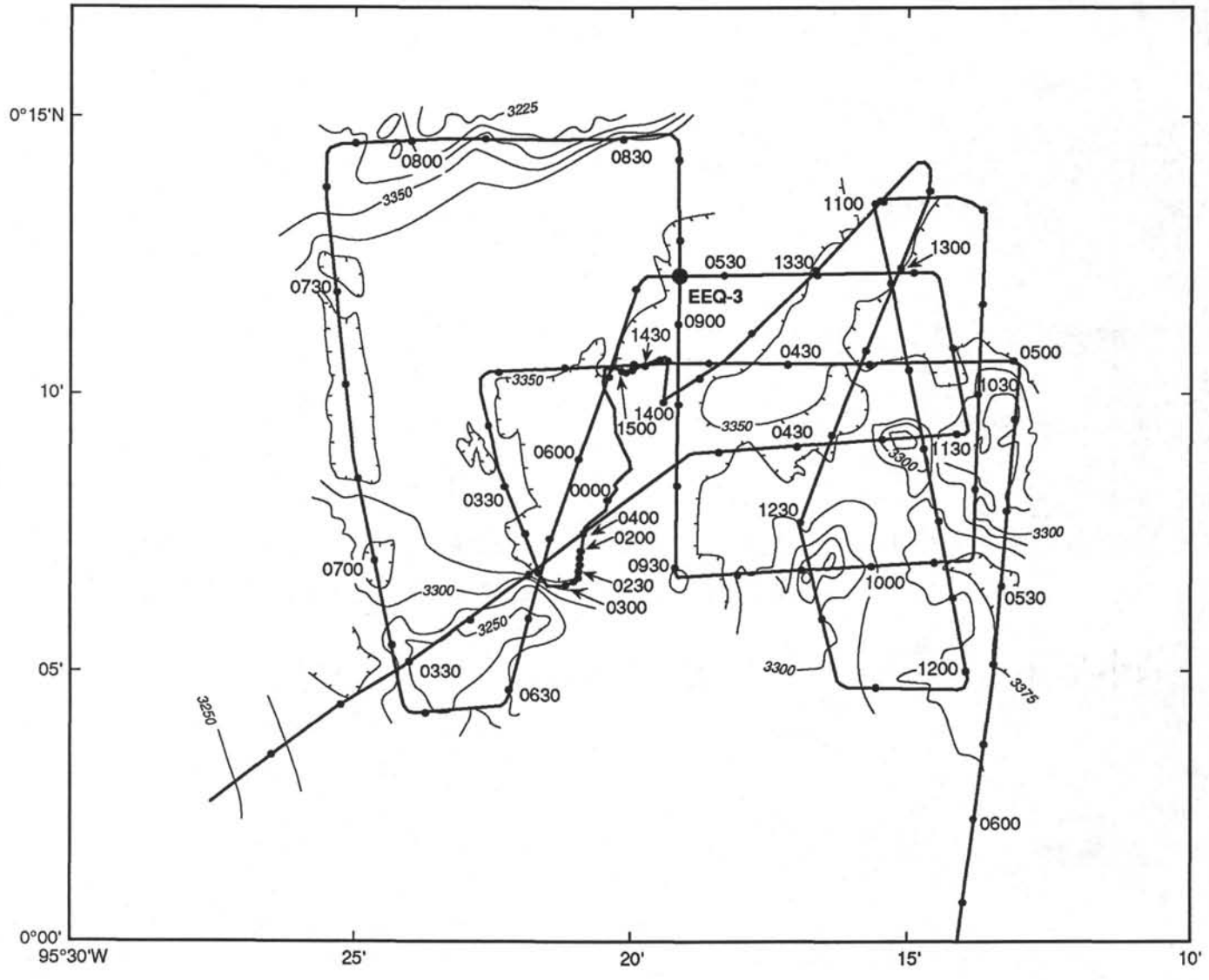
SEDIMENT RECORD: VNTR01-11 PC SEDIMENT THICKNESS: 295 m

PROPOSED DRILLING PROGRAM: Double APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings, and the formation microscanner.

OBJECTIVES: EEQ-3, west of the Galapagos Islands, lies beneath a region of interaction between the shallow Equatorial Undercurrent (EUC) and the South Equatorial Current. The crust at EEQ-3 lies within the transition zone between crust generated at the east-west-trending Galapagos Spreading Center and crust generated at the north-south-trending East Pacific Rise. The topography in the survey area trends northeast-southwest, and the crustal age is estimated to be 8 Ma. Both the northwest and southeast quadrants of the survey area are characterized by relatively rough basement overlain by undulating surface topography and a complex seismic reflector pattern. In the center of the survey area is a northeast-southwest-trending trough-like feature that is underlain by relatively smooth basement and is filled with flat-lying sediments. The seafloor in the areas of rough basement is 20-50 m shallower than that above the smooth basement. The sediment thickness over smooth basement is, however, slightly greater than that over the areas of rough basement (0.45 seconds below seafloor (sbsf) over smooth basement, 0.43-0.44 sbsf over rough basement). There are numerous acceptable drilling targets within the region of flat-lying seismic reflectors; the primary site is chosen where several crossing lines demonstrate the three-dimensional continuity of the seismic horizons.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Pelagic calcareous ooze.


0°15'N
10'
05'
0°00'
95°30'W
25'
20'
15'
10'
EEQ-3
0800
0830
0730
0530
1330
1100
1300
0900
1430
0430
0500
1030
1400
1500
0600
0000
0330
0400
0200
0700
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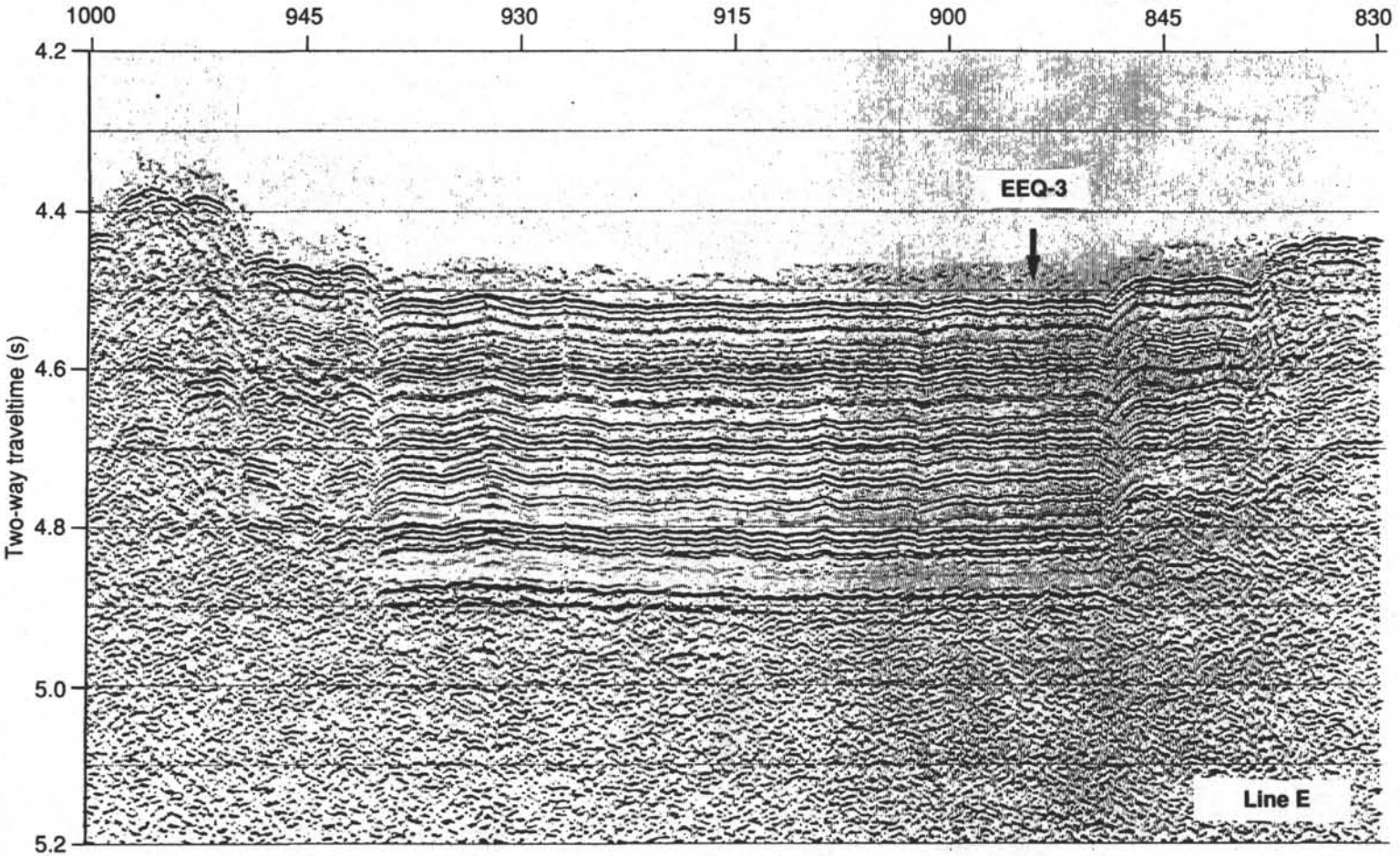
1200
0600
3225
3350
3300
3250
3375


1000
945
930
915
900
845
830
4.2
4.4
4.6
4.8
5.0
5.2
Two-way traveltime (s)
EEQ-3
Line E

SITE: **EEQ-4** PRIORITY: 1

POSITION: 3° 05.8'S, 90° 49.6'W

WATER DEPTH: 3320 m (SB)

SEISMIC RECORD: R/V *Washington* station 10

Primary site:	2136Z 19 Sept. 1989
Crossing:	0015Z 20 Sept. 1989

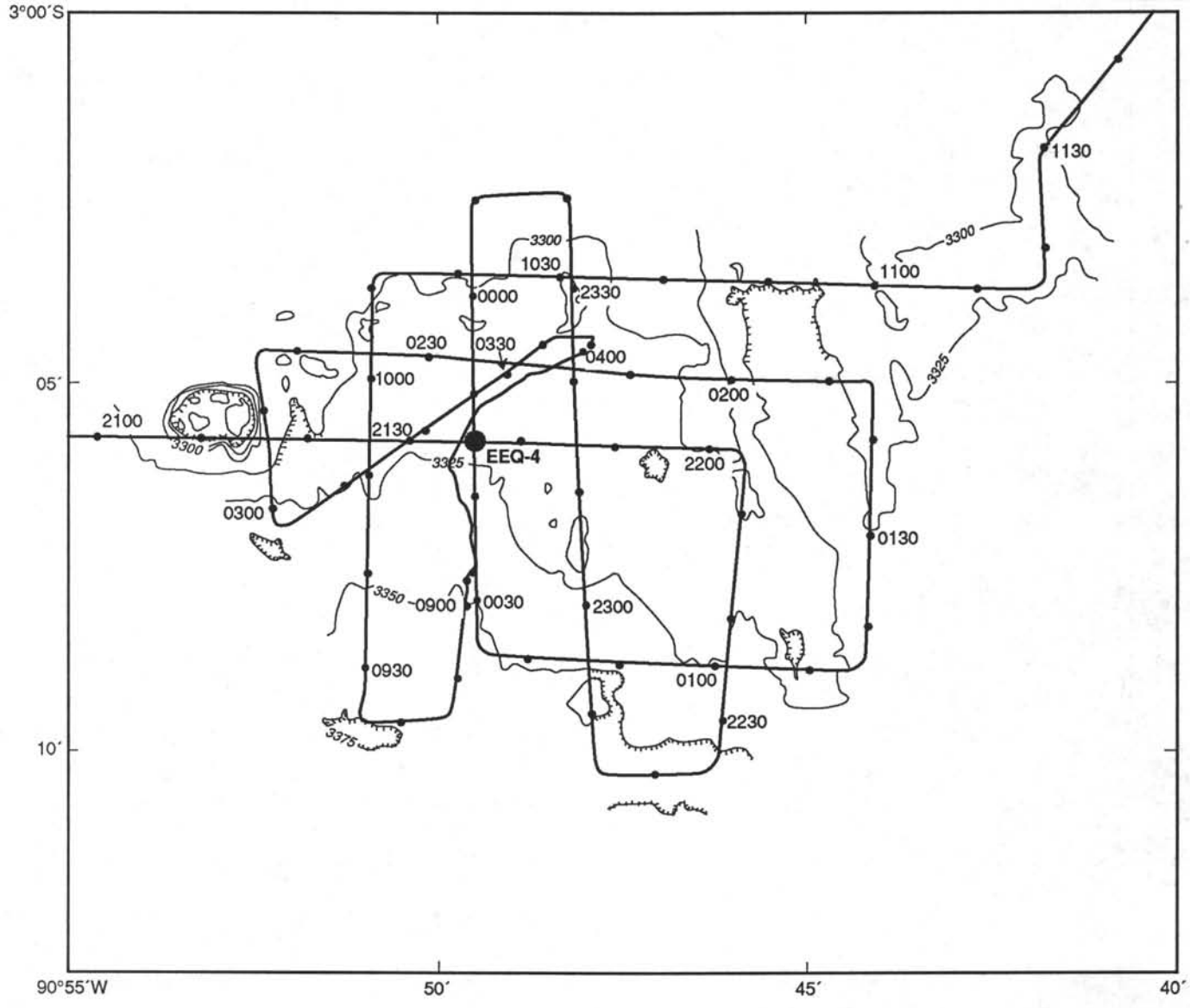
SEDIMENT RECORD: VNTR01-13 PC SEDIMENT THICKNESS: 411 m

PROPOSED DRILLING PROGRAM: Double APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings, and the formation microscanner.

OBJECTIVES: This second site surveyed within the region of interaction between the South Equatorial Current and the Peru Current is also located on crust that may have originated at either the Galapagos Spreading Center or the East Pacific Rise. Both the surficial and basement topography of the detailed survey area are remarkably flat (~25 m of relief) and a clear lineation trend is not discernable. Crustal age is estimated to be ~15 Ma. Several kilometers to the east of the survey area both the basement and the seafloor are rather rugged; SeaBeam data imply that this structure is lineated north-south, but with a single line it is difficult to be conclusive. The easternmost extent of the region of rough basement and surficial topography is seen at the western edge of the detailed survey area. West of the region of rugged basement, the survey area is characterized by an extremely thick and flat-lying accumulation of undisturbed sediments.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Pelagic calcareous ooze.


3°00´S
05´
10´
90°55´W
50´
45´
40´
EEQ-4
1130
1100
1030
0000
2330
0230
0330
0400
1000
0200
2100
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0300
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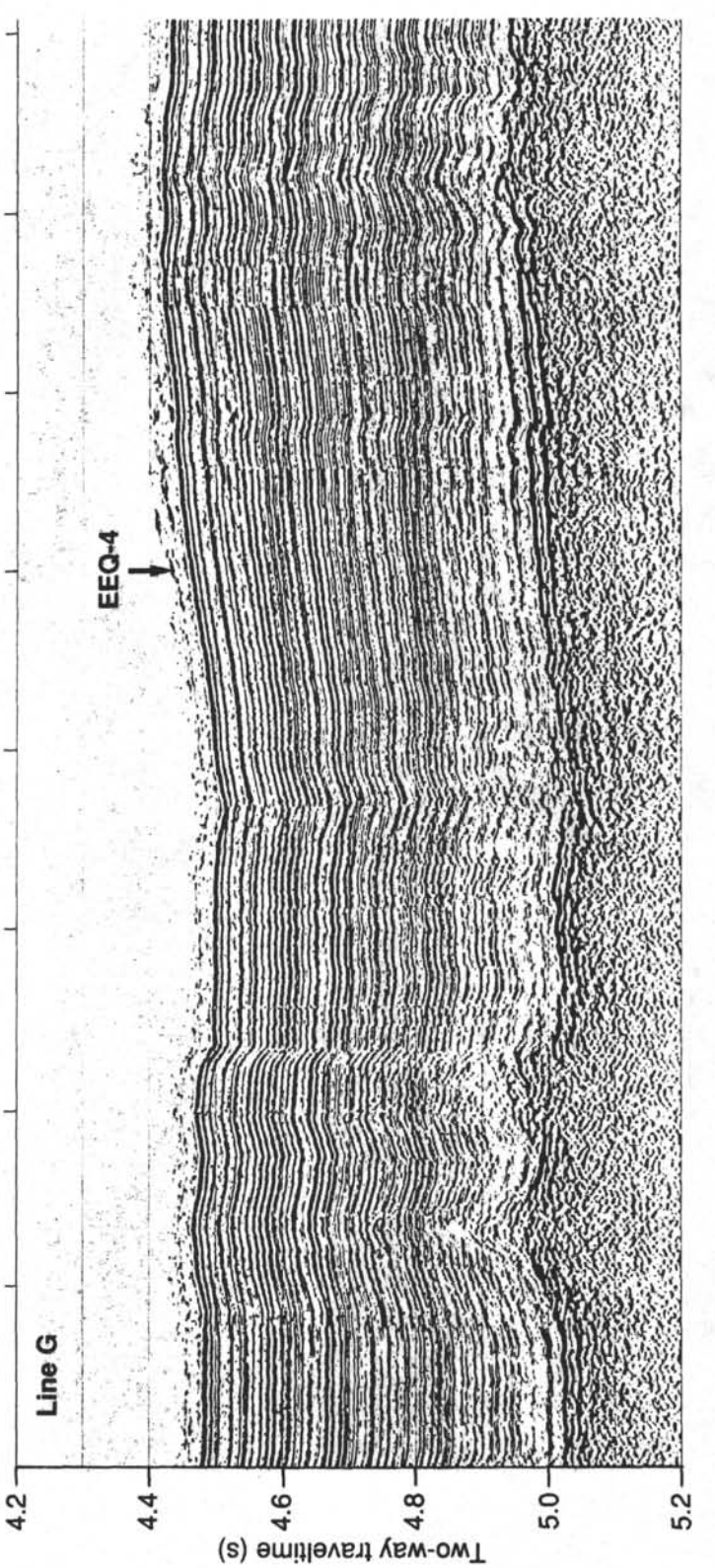
0930
0100
2230
3300
3325
3350
3375


Line G
EEQ-4
115
100
045
030
015
0000
2345
2330
4.2
4.4
4.6
4.8
5.0
5.2
Two-way traveltime (s)

SITE: **EEQ-4A** PRIORITY: 2

POSITION: 3° 01.8'S 95° 04.8'W

WATER DEPTH: 3520 m (SB)

SEISMIC RECORD: R/V *Washington* station 9

Primary site:	0625Z 18 Sept. 1989
Crossing:	0848Z 18 Sept. 1989

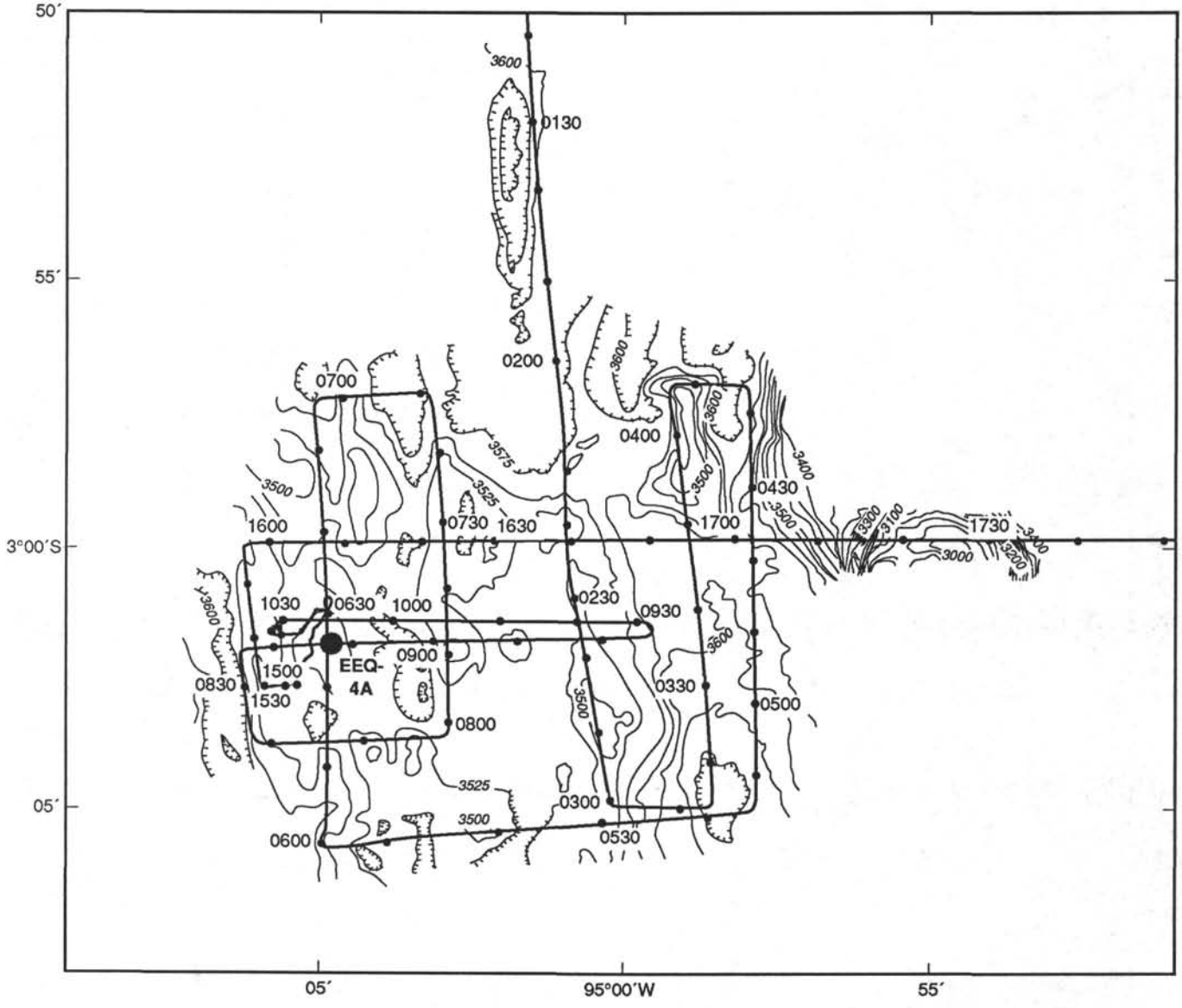
SEDIMENT RECORD: VNTR01-12 PC SEDIMENT THICKNESS: 181 m

PROPOSED DRILLING PROGRAM: Double APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings, and the formation microscanner.

OBJECTIVES: EEQ-4A is located in a region influenced by the interaction of the South Equatorial Current and the Peru Current. The crust on which the site is located is near the transition zone between crust generated at the Galapagos Spreading Center and crust generated by the East Pacific Rise, though the north-south trend of both basement and surficial topography implies an East Pacific Rise origin. Crustal age is estimated to be 9.5 Ma. A large (more than 1200 m above average seafloor depth) seamount is found about 45 km west of the detailed survey area, and a smaller (~300 m above surrounding seafloor) seamount is located ~13 km east of the primary site. While both of these seamounts have accumulated thickened ponds of sediment around their bases, the proposed drill site is located on a local topographic high that appears to be removed from the influence of ponding or topographically enhanced currents.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Pelagic calcareous ooze.


50′
55′
3°00′S
05′
05′
95°00′W
55′
3600
0130
0200
0700
3575
3525
3500
0400
3400
0430
1600
0730
1630
1700
1730
3300
3100
3000
3200
1030
0630
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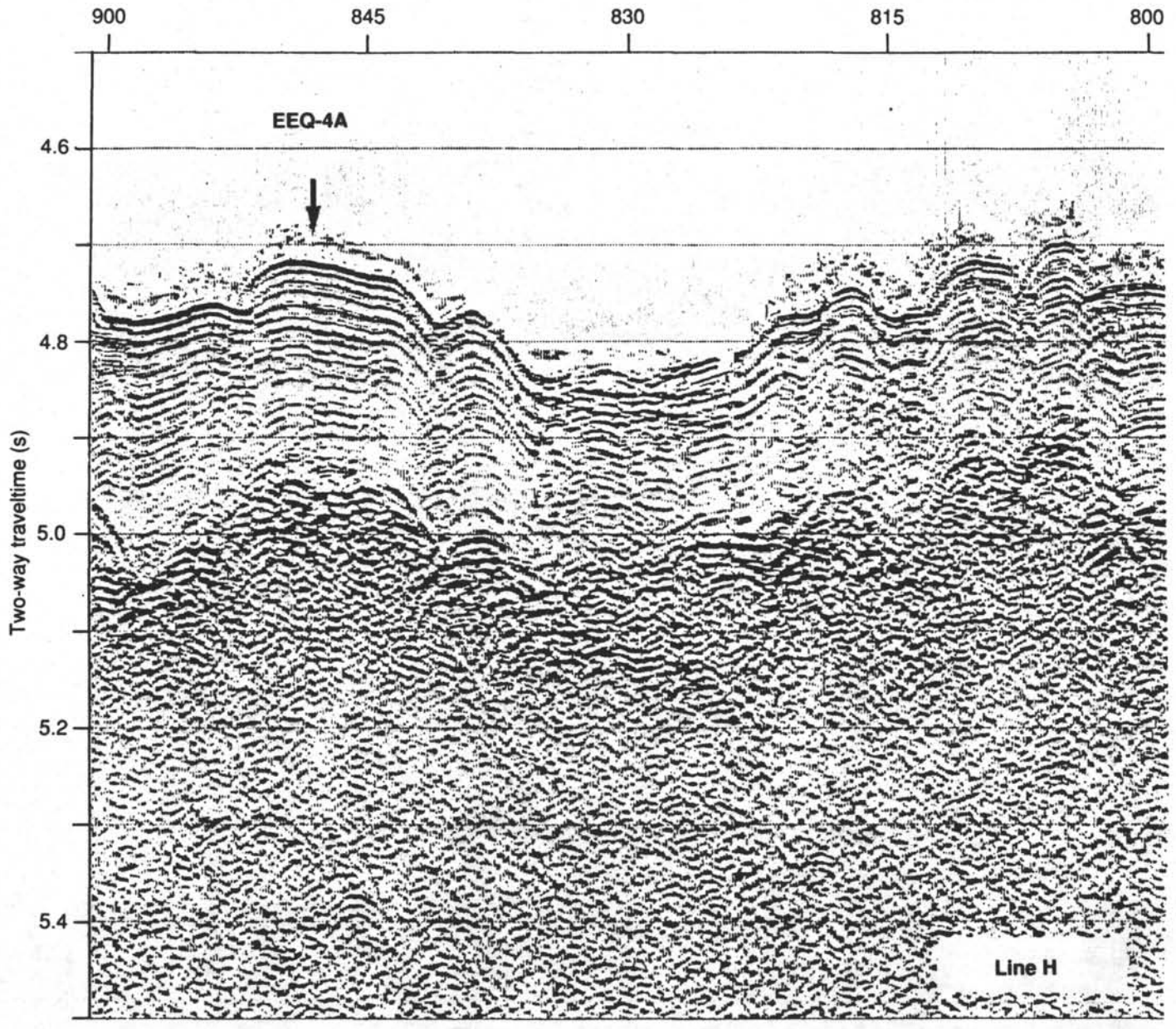
1530
0800
0330
0500
0300
0530
0600


900
845
830
815
800
EEQ-4A
4.6
4.8
5.0
5.2
5.4
Two-way traveltime (s)
Line H

SITE: **EEQ-5** PRIORITY: 2

POSITION: 5° 36.2'N 94° 12.2'W

WATER DEPTH: 3575 m (SB)

SEISMIC RECORD: R/V *Washington* station 14, 0746Z 27 Sept. 1989

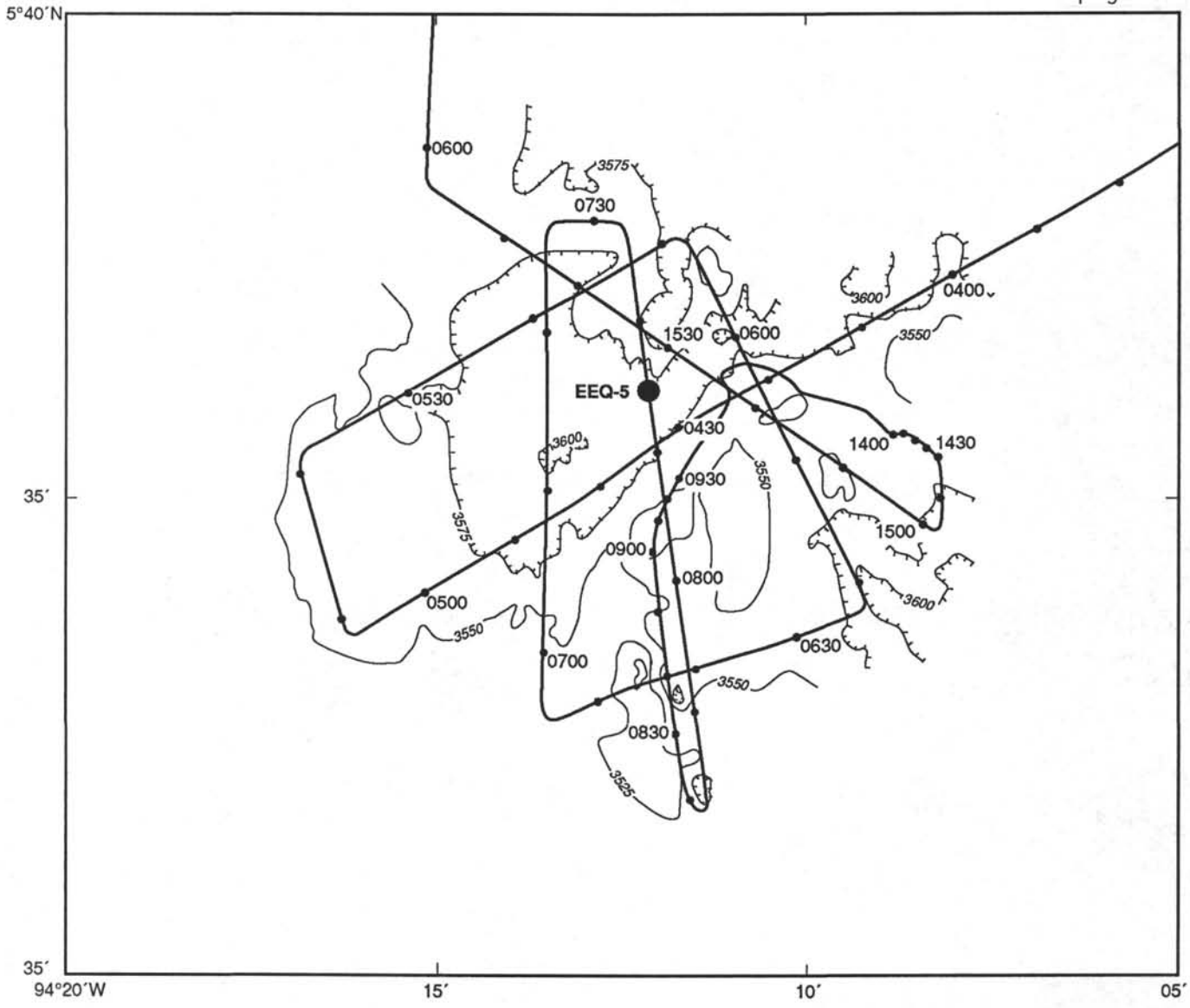
SEDIMENT RECORD: VNTR01- 20 PC SEDIMENT THICKNESS: 212 m

PROPOSED DRILLING PROGRAM: Double APC coring, with XCB coring to basement as needed.

LOGGING: Geophysical and geochemical combination tool strings, and the formation microscanner.

OBJECTIVES: EEQ-5, beneath the eastward flowing North Equatorial Countercurrent, is located on the Cocos Plate on crust ~10 Ma. The local surficial relief is slight (25-30 m), and while there is no strong lineation to the topography, an overall northwest-southeast trend can be seen. "Acoustic basement" in the detailed survey area is remarkably smooth, though some indication can be found of a rougher surface beneath the deepest coherent reflectors. The sediment column in the survey area is generally flat-lying and appears to be undisturbed. In some places the smooth basal reflectors are offset, and the sediment column is displaced, mirroring the basement topography.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Fossiliferous clay.


5°40′N
35′
35′
94°20′W
15′
10′
05′
EEQ-5
0600
0730
0530
0500
0700
0830
0900
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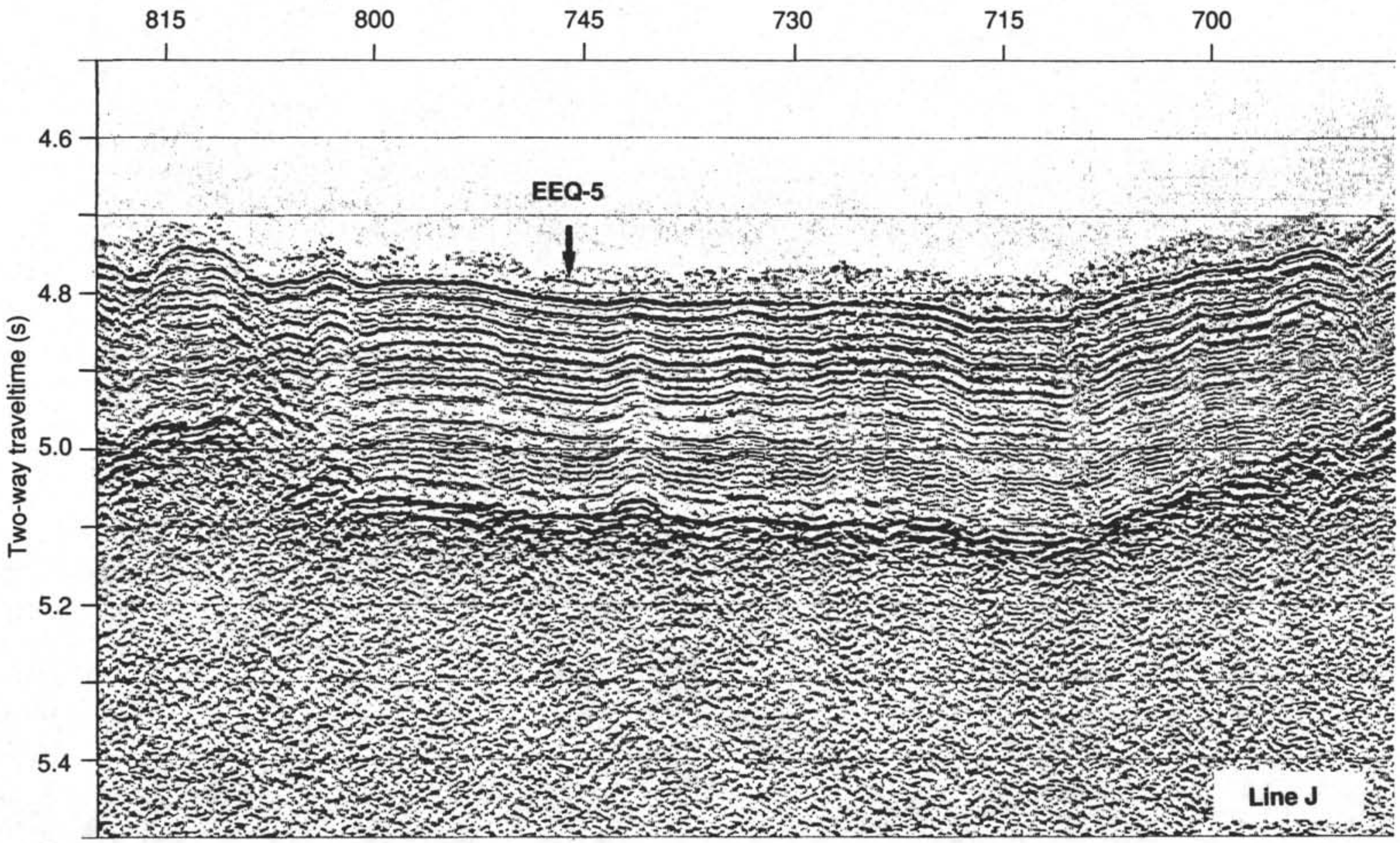
0430
1530
0600
0400
1400
1430
1500
0630
3575
3600
3550
3525


815
800
745
730
715
700
4.6
4.8
5.0
5.2
5.4
Two-way traveltime (s)
EEQ-5
Line J

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