OCEAN DRILLING PROGRAM

LEG 130 SCIENTIFIC PROSPECTUS

ONTONG JAVA PLATEAU

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INTRODUCTION

One of the more intriguing results of recent central equatorial Pacific drilling is the identification of a series of seismic reflection horizons that are synchronous over a large area of the central equatorial Pacific seafloor (Table 1). These events appear to correlate with major reorganizations of the oceanic circulation system that are the result of fundamental tectonic, climatic, and oceanographic processes (e.g., the initiation of northern hemisphere glaciation, the closing of the Tethys, ice buildup in Antarctica, the opening of the Drake Passage, etc.; Mayer et al., 1985, 1986). Even more intriguing is the apparent correlation of these seismic events with basin-wide hiatuses (Keller and Barron, 1983) and possibly with the "sea-level" events seen in continental-margin sections (Vail et al., 1977).

The specific response of the central equatorial sediment system to these major paleoceanographic events is the increased dissolution of calcium carbonate. The seismic horizons are the direct result of impedance contrasts caused by this carbonate dissolution, as are many of the widespread hiatuses. While discrete periods of increased carbonate dissolution create events that are extremely useful from a seismic or stratigraphic perspective, the complete removal or severe compression of the section that results from this dissolution makes the detailed evaluation of paleoceanographic indicators at these critical times virtually impossible. Thus, while we have clear evidence for a series of global paleoceanographic events, the nature of their expression in the central equatorial Pacific (as dissolution events) precludes the examination of many of the key parameters (e.g., isotopes, faunal changes, chemical tracers, etc.) that can provide the basis for understanding the nature of paleoceanographic change.

In order to obtain a detailed stratigraphic record across these critical intervals as well as to provide critically needed insight into the nature of vertical oceanic gradients and their linkage to climatic parameters, we propose a drilling program that takes advantage of the unique geological characteristics of the Ontong Java Plateau to address these issues directly.

In addition to these Neogene objectives, we propose to address a number of key questions relating to the origin of the plateau and to its pre-Neogene paleoceanographic history. Recovery of the Cretaceous-Paleogene sedimentary section on the Ontong Java Plateau is important because it records the early history of the plateau. In addition, the Ontong Java Plateau is one of the few locales in the Pacific where it is possible to recover a southern-hemisphere, mid-latitude, intraoceanic carbonate record. The Neogene and pre-Neogene objectives have different requirements in regard to site selection because the thickest Neogene sediments occur on the edges of the Ontong Java Plateau where older sequences are usually missing or incomplete (DSDP Sites 288, 289, and 586; Figs. 1 and 2).

The crust of the Ontong Java Plateau is of continental dimensions. Deep drilling into the basement on this plateau may help settle the oceanic vs. continental crust controversy for this plateau. Radiometric dating of and paleomagnetic data from the basement samples also would help answer important questions regarding the age of the plateau and its migrational history.

GEOLOGIC SETTING

The Ontong Java Plateau (Fig. 1) is a broad, elevated area in the western equatorial Pacific, with its shallowest regions above 2000 m and its flanks reaching depths in excess of 4500 m (over a lateral distance of less than 700 km). With an area of 1.5 million km^2, it is the largest of the "classic" Pacific plateaus. The Ontong Java Plateau has a crustal thickness on the order of 40 km and yet is in isostatic equilibrium. While crustal seismic velocities are in the range of oceanic crust (Hussong et al., 1979), the makeup of the plateau is still controversial, with a persistent minority (e.g., Nur and Ben-Avraham, 1978) arguing that it is continental in origin (like Rockall Bank). The central part of the plateau is surmounted by several atolls and is underlain by more than 1 km of flat-lying, well-stratified Mesozoic and Cenozoic sediments (Kroenke,1972).

Four DSDP sites (rotary-drilled Sites 64, 288, and 289, and piston-cored Site 586; Figs. 1-4) have been drilled on the plateau . The most continuous deep sampling of the plateau was at Site 289 (Leg 30) near the crest of the Ontong Java Plateau in a water depth of 2206 m. Site 289 (Fig. 3) terminated at 1271 mbsf in pre-early Aptian tholeiitic basalt with vitric tuff directly overlying the basalt. Above the tuff are 1260 m of Campanian to Pleistocene biogenous sediments; from 1262 to 969 mbsf are Lower Cretaceous to upper Eocene radiolarian-bearing limestones, nannofossil-foraminifer chalks, and nodular cherts; and from 969 mbsf to the seafloor are upper Eocene to Pleistocene nannofossil-foraminifer chalks and oozes. Sediment recovery was 56% at this site. A number of unconformities were found in the oldest part of the section, but from the lower Oligocene to Recent, the section is continuous, with diverse and well-preserved microfossils indicating deposition above the calcite compensation depth, or CCD (Andrews, Packham, et al., 1975).

Site 586 (Fig. 4), a piston-cored site located very close to Site 289, was aimed at providing a high-resolution record of the upper part of the section. Coring was quite successful at this task, recovering 300 m of well-preserved Neogene nannofossil chalks and oozes. The first chalks appeared at about 260 mbsf, and coring was stopped in sediments of late Miocene age (foraminifer Zone N16). Sedimentation rates were variable, ranging from 13 to 40 m/m.y., with most of the section having accumulated at the higher end of the range. One of the most surprising results of this site was the discovery of evidence for the nearly ubiquitous mechanical transport of the recovered materials. Despite this sedimentological evidence, the biostratigraphy of the section is nearly continuous (Moberly, Schlanger, et al., 1986).

Based on these drilling results and on tectonic reconstructions of the area (e.g., Kroenke et al., 1986), a provisional history of the plateau can be put together. The plateau probably began to form about 160 Ma along a west-northwest-aligned ridge. Pelagic sediments were deposited on the plateau as it formed; a shift from Austral to Tethyan assemblages at about 100 Ma (Site 289) reflects the northward movement of the plateau. The bathymetric relationships extant on the plateau today appear to have remained constant throughout its history (Resig et al., 1976). In late Oligocene to early Miocene time the southwestern part of the plateau encountered the North Solomon subduction zone, resulting in the intrusion of dikes and sills into the region. Subduction ended in the early Miocene (about 22 Ma) when the convergent boundary shifted. Subduction resumed south of the Solomon Islands region in the late Miocene, forming the San Cristobal Trench. During this episode, overthrusting, uplift, and folding of the oceanic crust resulted in the emplacement of ophiolites on the islands of Malaita and Santa Isabel (Fig. 1). This overthrusting is probably still occurring.

NEOGENE DEPTH TRANSECT

SCIENTIFIC OBJECTIVES

The major objective of the Neogene portion of Leg 130 is to drill four sites on a depth transect from the top to the slope of the Ontong Java Plateau to collect a series of continuous sedimentary sequences. The study of sediments from this transect will produce:

1. High-resolution stratigraphic records across intervals of major paleoceanographic changes (Table 1) by evaluating variations of primary paleoceanographic indicators (isotopes, carbonate, biota).
2. A detailed record of vertical oceanic gradients and their linkages to climatic parameters and bottom-water properties.
3. A detailed sedimentary record to better understand the nature and role of carbonate dissolution in the deep sea and to attempt to quantify amounts of dissolution (CO_2 problem).
4. A high-resolution sedimentary record completing a global network of equatorial depth transects in order to better understand basin-basin fractionation and biotic evolution as well as part of a comparison with marginal transects for basin-shelf fractionation.
5. A sedimentary record to understand the origin of seismic events on oceanic plateaus and to compare them with seismic horizons in oceanic basins.

The accumulation of pelagic carbonate sediments in open-ocean environments is primarily dependent on the rate of production and dissolution of foraminifers and calcareous nannoplankton. Productivity is determined by the availability of nutrients which, in turn, depends on the rate of supply of these elements from continental runoff and ocean circulation (e.g., vertical mixing, upwelling). In general, the rate of dissolution of calcium carbonate sediment is a function of the degree of calcite saturation in sea water at the sediment/water interface. Averaged globally, the degree of calcite saturation varies in order to balance the total carbonate budget by setting the appropriate rate of dissolution. The oceanic circulation, and the underlying causes for its development and change, are therefore a key factor among the dissolution-related parameters.

Several aspects of the Ontong Java Plateau's history make the plateau ideally suited for the detailed paleoceanographic studies proposed. First and foremost is the remarkable combination of bathymetry and geographic location. Straddling the equator, the plateau is presently, and has been for a good part of its history, located in a region characterized by the relatively high production of biogenous sediments. More importantly, the bathymetry of the plateau has resulted in the accumulation of a thick pile of sediments that has not been subjected to pervasive dissolution and, in close juxtaposition, in the accumulation of sediments that are exposed to increasingly deeper and more corrosive waters. A series of equatorial drill sites that runs from the top of the plateau to near its base would traverse nearly 2000 m of depth range in a relatively small geographic area (sampling sediments exposed to both upper and lower deep waters). The sediments sampled would have been produced in the same surface-water conditions and thus in the same pelagic rain. This depth interval (~2200-4200 m) is precisely the depth range in which changes in dissolution gradients are most pronounced (Berger and Johnson, 1976; Berger and Mayer, 1978). Thus the combination of bathymetry and geography eliminates many of the variables normally associated with pelagic sedimentation (i.e., productivity and latitudinal gradients) and creates a nearly ideal natural laboratory for evaluating the vertical distribution of a range of oceanic parameters.

It would be easy to justify such an experiment even for just the modern ocean. The collection of a series of surficial samples that would provide the modern distribution of sediment properties as a function of depth and relate them to modern watermass distributions and ocean chemistry would be extremely useful (this has, at least in part, been done with box cores, e.g., Berger et al., 1987). Another unique aspect of the Ontong Java Plateau, however, allows this same experiment to be carried out for a large portion of the Cenozoic. Unlike many other Pacific plateaus which appear to have at some point in their history been at or above sea level, the Ontong Java Plateau seems to have remained fairly constant in its depth throughout its 100-million-year history (Andrews, Packham, et al., 1976; Hughes and Turner, 1977). The reason that this immensely thick crust has remained at a constant depth for such a period of time is unclear; the answer to this question may be an interesting byproduct of Ontong Java Plateau drilling.

Whatever its cause, this relative stability suggests that any given site on the plateau should have a fairly constant paleobathymetry and that most of the plateau has remained above the CCD for at least 30 million years. Given these factors, a depth transect of continuously cored drill sites will allow a relatively simple construction of the time and depth history of oceanic variability in the Western Pacific basin. It will be possible to establish not only the dissolution history of a given site but also, more importantly, the history of dissolution gradients through time, which has important implications for the history of atmospheric CO_2 (Berger and Spitzy, 1988). Similarly, time series of gradients in all measurable oceanographic parameters (isotopes, carbonate, tracers, e.g., Cd) and biological gradients (benthic foraminifers) can be determined. The result will be a multidimensional picture of the response of ocean chemistry and watermass structure to climatic and tectonic forcing.

A careful selection of sites with no obvious evidence of current activity will allow control for all variables and for assessing the effect of dissolution on the primary sediments. The Ontong Java Plateau depth transect would therefore become a natural laboratory and complement other equatorial depth transects (Atlantic, Indian, and Eastern Pacific Oceans) to give a global scale to paleoceanographic research.

PALEOGENE-CRETACEOUS SEQUENCES AND BASEMENT

Major hiatuses were encountered in Upper Cretaceous-Paleogene sediments at DSDP Sites 289 and 288 (Fig. 2). Yet many of the unconformities at Site 288 do not correlate with those at Site 289 (or the shallower, spot-cored Site 64), implying that they record local events of limited areal extent (Andrews, Packham, et al., 1975). (Note that Site 288 is situated on the sloping southern flank of the Ontong Java Plateau and Site 289 is near the head of a large submarine canyon, as shown in Figure 1.) Drilling at other locations atop the plateau therefore is highly likely both to recover some of the key sections either missing or poorly preserved in the earlier holes, and to permit differentiation of regional or watermass-controlled unconformities from those which are local or tectonic and/or current-controlled. The Cretaceous-Paleogene section is of importance because it records the early history of the plateau and provides a reference for southern hemisphere paleoceanography.

SEDIMENTOLOGICAL OBJECTIVES

Drilling and sampling Cretaceous and Paleogene sediments on the Ontong Java Plateau will allow us to:

1. Fill critical gaps in Cretaceous biostratigraphy and paleo-biogeography.
2. Estimate the original basement depth of the plateau and subsequent bathymetric change (from benthic foraminifers).
3. Determine the nature and extent of Cretaceous anoxic events in the South Pacific to increase understanding of mechanisms leading to the deposition of ocean-wide, carbon-rich sediments.
4. Recover a well-preserved Cretaceous/Tertiary boundary in order to gain insight into the causes of mass extinctions.

The Ontong Java Plateau is one of the few locales in the Pacific where it is possible to recover a southern hemisphere, intraoceanic, biostratigraphic record preserved in Mesozoic carbonates. Because the Ontong Java Plateau migrated equatorward from southern mid-latitudes (Hammond et al., 1975), Cretaceous microfossil assemblages reflect a change from Austral to Tethyan provincial affinities in mid-Cretaceous time (Scheibnerova, 1974). With better resolution of this interval than is possible to derive from Sites 288 or 289, a boundary point for the Austral realm in the Pacific can be established.

Drilling on the Ontong Java Plateau can provide an important southern hemisphere, mid-latitude, intraoceanic, Pacific counterpart to the Shatsky Rise work. Significantly, previous drilling on the Ontong Java Plateau recovered no black shales or carbon-rich sediments. They may have been associated with the several missing Cretaceous intervals at Sites 288 and 289; alternatively, such sediments were never deposited on the Ontong Java Plateau because it was in an oceanic setting where the conditions of low O_2 and high productivity needed for formation of organic-carbon-rich sediments did not exist. Circulation-induced isolation from terrigenous organic-carbon inputs (e.g., Arthur et al., 1985) also could have been important. Establishing whether or not Cretaceous carbon-rich sediments are present on the Ontong Java Plateau can give a substantially broader perspective to Shatsky Rise drilling, and may in fact be needed to substantiate conclusions drawn from work there. The Cretaceous cherts which severely impeded earlier drilling on the Shatsky Rise appear not to be a problem on the Ontong Java Plateau.

LITHOSPHERE OBJECTIVES

Drilling into basement on the Ontong Java Plateau will allow us to:

1. Determine the nature of the crust on the Ontong Java Plateau to help settle the oceanic versus continental crust controversy as well as establish the lithology, petrogenesis and sources of Ontong Java Plateau crustal material.

2. Determine basement age and paleolatitudes of the Ontong Java Plateau in order to better understand the origin of the plateau.

3. Compare the basement composition of the Ontong Java Plateau to that of the extensive "mid-Cretaceous" volcanic events of the Pacific in order to gain insight into the origin of both features.

None of the old, intraoceanic Pacific plateaus (Ontong Java, Manihiki, Shatsky, Hess, Magellan) are well understood, and the Ontong Java Plateau is an end-member of this group. The crust of the high plateau is of truly continental proportions (~40 km thick on the main high plateau; e.g., Hussong et al., 1979). Even on the edges of the Ontong Java Plateau the crust is still well within the continental range (~30 km, for instance, near the island of Malaita ; e.g., Nixon and Boyd, 1979; Kroenke, 1972, and unpub. data). If there is continental crust on any of the large Pacific intraoceanic plateaus, the Ontong Java Plateau, with by far the thickest crust, would seem one of the most favorable places to find it. A deep basement hole on the main high plateau would go far toward settling this issue.

Age information on a deep basement hole can be obtained from radiometric dating, possibly from microfossils in sedimentary layers interbedded with igneous rocks, and the M-series magnetic-polarity record (Fig. 5). In conjunction with age dating, paleomagnetic measurement of basement rocks will provide important insights on the paleolatitudes of the Ontong Java Plateau during the period of crustal formation. Existing data from the sedimentary records at Sites 289 and 288 indicate a substantial migration of the Ontong Java Plateau from higher southern latitudes to its present equatorial location (Hammond et al., 1975). New results from a deep basement section would reveal the earlier migrational history of the plateau, knowledge of which is essential for testing the currently debated hypothesis that the Ontong Java Plateau formed above a ridge-centered Louisville hotspot (e.g., Mahoney, 1987; Gordon, R., and Henderson, L., 1987, pers. comm.).

Unlike other Pacific plateaus, part of the Ontong Java Plateau basement and sedimentary section can be studied on land, on the islands of Malaita and Santa Isabel. There, samples larger than drill-core diameter can be obtained, and local field relations can help guide interpretation of drill-hole data elsewhere on the plateau. Evidence that the Cretaceous crustal basement on these islands indeed forms part of the Ontong Java Plateau is strong and includes the thick crust (~30 km) in the vicinity, the continuity of seismic reflectors with those on the main Ontong Java Plateau, and the remarkably similar stratigraphy on Malaita and at Sites 289 and 288 (e.g., Kroenke et al., 1986).

GEOPHYSICAL SURVEYS AND SITE LOCATIONS

NEOGENE TRANSECT

Detailed site surveys (Fig. 6) were conducted on the Ontong Java Plateau to determine optimal locations for sites on the depth transect (Fig. 7). For each survey area (depth interval) a preliminary bathymetric chart (hand-contoured from Sea Beam data) and seismic section are shown (see site summaries at the end of this prospectus for detailed bathymetry, survey tracklines, and seismic profiles of each proposed site). Criteria used to select the proposed sites include the avoidance of those sites showing evidence of modern or past erosion (i.e., hyperbolae or channel structures), displacement or disruption in the sediment column, major faulting, and seismic anomalies. Also included as "hazards" are strongly reverberant layers that commonly occur mid-section in water depths greater than 3000 m. These features, which have the seismic appearance of the chert found near the bottom of Site 289 (reflector G; Fig. 8), may be related to basement complexities, tectonic disruption, igneous intrusion, erosion and early chertification, or some combination of these. The sedimentary cover on the plateau thins from approximately 1200 m in thickness at 2200 m water depth to less than 450 m at 4300 m water depth (averaging about 100 m loss in thickness for every 200 m of water depth). Preference was given to those sites that showed relatively expanded sections and where the quality of the seismic images was high.

Using results from DSDP Legs 30 and 89, it is possible to assign approximate ages to some of the major reflectors (Figs. 8 and 9). Eight reflectors were chosen for tracing, the deepest two representing chert and basaltic basement, respectively, at Site 289.

OJP-1 DASHER SURVEY 2600-2800 m

Using Site 586/289 (at 2200 m) as an upper-plateau reference point, the traverse from Site 586/289 to the Dasher region is quite straightforward (Fig. 10). The "layer-cake" seismic stratigraphy of the upper plateau remains virtually constant; individual reflectors can actually be traced the 139 km between the sites. There is virtually no reduction in the thickness of the section between the sites except for possibly in the deepest part of the section. Bathymetry in the region shows a fairly gentle but steady increase in depth from about 2500 m in the southwest quadrant to 2860 m in the northeast. A channel-like feature is found in the northern part of the survey area. Hazards in the region consist mostly of evidence for surface erosion.

PRANCER SURVEY 3040-3180 m

The fairly continuous stratigraphy of the upper plateau continues on from Dasher down to the 2850-m contour. At this point there is a 150-m scarp-like drop in bathymetry. Concomitant with this bathymetric drop is a loss of about 0.2 s in the seismic section. Reflectors are difficult to trace at this point, but it appears that most of the loss is in the upper part of the section (although all marker reflectors are still present; Fig. 10). A short distance beyond this bathymetric drop, mid-section reverberations (MSR's) are evident. This continues between the 3000- and 3500-m contours along with extremely rugged surficial topography and much surface erosion. The Prancer region appears to be a small window with no MSRs and only minor (though ubiquitous) surface erosion.

The Prancer area is gently sloping to the southeast, with a large, deep depression in the northeast section. Hazards included faulting and surface erosion. The regional seismic correlation indicates that the section has thinned by almost 30% between 2600 and 3050 m and that most of the thinning has taken place between ~8 and 20 Ma (reflectors B-D) and in the very deepest part of the section.

OJP-2 VIXEN SURVEY 3100-3300 m

The surface topography in the Vixen area is more complex than that of the preceding areas. A zone of rough topography associated with MSR and possibly basement roughness is found in the southeast section of the survey area. Hazards include numerous MSRs in the western part of the survey area, surface erosion in the south, and faulting in the northeast. The seismic section is similar to that found at Prancer (though of better quality here), with the section appearing to be slightly thinner from 0 to 8.0 Ma and somewhat expanded between 8 and 20 Ma (Fig. 10). The section may be deeper here than at Prancer.

OJP-4 DANCER SURVEY 3400-3600 m

The bathymetry in the Dancer area is relatively flat, with several regions of very rugged topography (northeast and southwest) that appear to be related to basement features. Hazards in the area include numerous MSRs, rough basement, and numerous small faults. The small faults do not appear to disrupt the seismic stratigraphy, though. At this depth the section is 60% of that at Site 586/289 (Fig. 10). The upper two marker reflectors (A and B) can no longer be traced with any confidence. This does not necessarily mean that part of the section is missing but may indicate only that the section is compressed to a point where the seismic character is now substantially different.

OJP-3 COMET SURVEY 4120-4200 m

Deeper than 4000 m, the sediment column on the Ontong Java Plateau thins substantially. Evidence for strong erosion is common. In the vicinity of this survey area, amidst a region of extremely complex structures (MSRs and basement(?) features), an enclosed basin containing a relatively thick sedimentary fill was found. The fill might represent redeposited material from the surrounding highs, but the seismic character of the fill appears to correlate with the section outside of the basin, indicating that it should be predominantly pelagic. The basin itself is very flat; rough topography can be found outside of the basin (in the northeast) associated with the apparent outcrop or near outcrop of basement(?) highs. OJP-3 was selected at the point of thickest fill.

At 4200 m the section is less than half that at 2200 m. Most of the thinning appears to have taken place above the C reflector (14 Ma). This is consistent with the record of equatorial carbonate stratigraphy, which shows a major change in the nature of carbonate chemistry in the Pacific near the middle/late Miocene boundary (Mayer et al., 1985, 1986). Prior to this boundary, carbonate values generally remained high, even in the deep Pacific, but after this time major fluctuations in carbonate content began.

OJP-6 (Alternate to **OJP-3**)

This site lies on a gentle slope, just above 4000 m. The sediment thickness is about 17% less than that of the next shallowest site (OJP-4) and 10% greater than that of the deepest site (OJP-3). It is proposed as an alternate to OJP-3 because its well-behaved reflection stratigraphy suggests that a good pelagic record will be found. This cannot be expected at OJP-3 with equally high confidence.

PRE-NEOGENE

OJP-5

The site of a deep basement hole can be very flexible, subject only to the following provisos: it should be (1) located on the main high plateau; (2) distant from Sites 289 and 288, so as to avoid the local hiatuses in the sedimentary sections at those sites; and (3) in a region of relatively smooth basement and sedimentary topography, distant from complicating features such as plateau seamounts, structural complexities, and canyons, so as to maximize the chances of recovering little-disturbed sediment and basement sections. Also, to best evaluate the proposed north-south age progression across the Ontong Java Plateau (Fig. 5), the deep hole should be situated away from the postulated isochron passing through Site 289. Many locations on the high plateau meet these criteria, and the location chosen for OJP-5 is shown in Figure 7.

DRILLING STRATEGY

Leg 130 will drill the proposed sites in the order shown in Table 2, completing the Neogene objectives at proposed sites OJP-4, OJP-3 (or OJP-6), OJP-2, and OJP-1 before addressing Paleogene and basement objectives at OJP-5. The cruise is scheduled to depart from Guam on January 24, 1990, and return to Guam on March 27, 1990 (Table 3).

NEOGENE

The objective of the Neogene portion of Leg 130 is to collect a series of sedimentary sequences in order to produce high-resolution records of isotopes, carbonate, and biota to better evaluate vertical oceanic chemical gradients and bottom-water processes, the nature and role of carbonate dissolution in the deep sea, basin-basin and basin-shelf fractionation, and the origin of seismic events on oceanic plateaus. To address these topics, Leg 130 will drill a depth transect of five sites (Fig. 7) within a water depth range of 2600 to ~4000 m. The strategy is to drill until uppermost Oligocene sediments are reached at three of these sites (OJP-1, -2, and -3). These three sites will be triple APC'd: two to refusal (250 mbsf?) and one to 50 mbsf. In addition, OJP-1 and -2 will be deepened with a single XCB hole to the depth (age) objective.

OJP-4 will also be triple APC'd: two to refusal (250 mbsf?) and one to 50 mbsf. In addition, OJP-4 will be deepened with an XCB hole to refusal and then by RCB until 790 mbsf (or approximately 10 m into basement to reach its Paleogene and basement objectives; see discussion below). The fifth site (OJP-5) will be a reentry hole drilled to basement; this will be only one APC hole, owing to time constraints (see discussion below). Two standard Schlumberger logging runs will be conducted at OJP-1, -2, and -4.

PRE-NEOGENE OBJECTIVES

The Paleogene and Upper Cretaceous sedimentological objectives of Leg 130 are to fill critical gaps in Cretaceous biostratigraphy and paleo-biogeography, determine the extent of Cretaceous anoxic events, recover a well-preserved Cretaceous/Tertiary boundary, and determine bathymetric changes on the Ontong Java Plateau.

The continental vs. oceanic origin of the Ontong Java Plateau also needs to be resolved. In order to determine the nature of the crust, basement age, and migrational history of the Ontong Java Plateau, as well as the pre-Neogene sedimentological objectives discussed above, one single-bit RCB hole (OJP-4) coring into Mesozoic sediments and penetrating 10 m into basement, and one reentry hole (OJP-5) coring into Mesozoic sediments and penetrating 50 m into basement, are planned. OJP-4 will be deepened with an RCB to 790 mbsf (or about 10 m into basement) after the XCB refusal point has been reached (see Neogene drilling objectives); no more than 11.2 days will be spent at this site to ensure adequate time to complete all Neogene objectives at proposed sites OJP-1, -2, and -3. OJP-5 will consist of a single APC/XCB hole drilled until refusal (600 mbsf?). A reentry cone will then be set and drilling will continue with an RCB toward a target depth of 1400 mbsf (50 m into basement). Any time savings made up during the cruise from faster than expected transits, drilling rates, etc., will be applied to deepening OJP-5 to depths greater than 1400 mbsf. Two standard Schlumberger logging runs will be conducted at OJP-4 and -5. A formation microscanner/BHTV run also will be conducted at OJP-5.

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Table 1. Seismic reflectors of the central equatorial Pacific, their age, sedimentary causes, and associated events.

Reflector	Approximate Age (Ma)	Primary Cause of Reflector	Geochemical Events	Hiatus	Paleoceanographic Events
Green	3.0-3.5	Carbonate minimum	Benthic ^{18}O enrichment. $CaCO_3$ dissolution		N. Hemisphere glaciation? N. Atlantic erosion. Closing of Panama Isthmus.
Brown	6.5-7.5	Carbonate minimum	Chron 6 ^{13}C depletion	NH6	Climatic deterioration.
Purple	8.5-9.5	Extreme carbonate minimum	Benthic ^{18}O enrichment. Mid-chron 10 $CaCO_3$ dissolution event	NH5 NH4?	Major N. Atlantic erosion. Increase of siliceous deposition in Pacific. Major cooling. Major drop in sea level.
Red	13.5-14.5	Carbonate minimum	15c $CaCO_3$ dissolution event. Benthic ^{18}O enrichment	NH3?	Ice buildup in Antarctica. Intensification of Antarctic Bottom Water.
Lavender	16.5-17.5	Carbonate minimum	16g $CaCO_3$ dissolution event. Chron 16 ^{13}C enrichment	NH1b	Closing of Tethys. Norwegian sea spillover. Intensified Pacific upwelling.
Yellow-Orange	20.5-22.5	Diagenesis		NH1a?	Opening of Drake Passage.

Table 2. Leg 130 drill sites

Site #	Latitude Longitude	Water Depth (m)	Penetration (m) sed	bsmt	Time Estimate (days) Drill	Log	Total
OJP-4	02°26.0'N 160°32.7'E	3400	780	10	9.7	1.5	11.2
OJP-3	01°06.3'N 162°35.7'E	4200	250	---	4.4	---	4.4
OJP-2	01°13.5'N 160°31.8'E	3200	500	---	5.6	1.5	7.1
OJP-1	00°19.2'N 159°21.9'E	2600	600	---	5.6	1.4	7.0
OJP-5	03°34'N 156°36'E	2820	1350	50	17.7	3.6	21.3
Alternate Sites:							
OJP-1a	00°19.2'N 159°21.9'E	2600	600	---	5.6	1.4	7.0
OJP-3a	01°06.3'N 162°35.7'E	4200	250	---	4.4	---	4.4
OJP-4a	02°26.0'N 160°33.3'E	3400	250	10	1.5	---	1.5
OJP-4b	02°26.0'N 160°32.7'E	3400	780	10	9.7	1.5	11.2
OJP-5a	03°34'N 156°36'E	2820	1350	50	17.7	3.6	21.3
OJP-6	00°59.0'N 161°35.8'E	3920	250	---	4.2	---	4.2

Drilling Plan:

OJP-1	Double APC to 250 mbsf, Third APC to 50 mbsf, XCB to 600 mbsf
OJP-2	Double APC to 250 mbsf, Third APC to 50 mbsf, XCB to 500 mbsf
OJP-3	Double APC to 250 mbsf, Third APC to 50 mbsf
OJP-4	Double APC to 250 mbsf, Third APC to 50 mbsf, XCB to 500 mbsf, RCB to 790 mbsf
OJP-4a	Wash to 250 mbsf, RCB to 260 mbsf
OJP-5	APC to 220 mbsf, XCB to 600 mbsf, Set reentry cone and RCB to 1400 mbsf
OJP-6	Double APC to 250 mbsf, Third APC to 50 mbsf

Logging Plan: 2 Schlumberger runs at OJP-1, 2, 4, 5 and FMS/(BHTV ?) at OJP-5

Table 3. Leg 130 Tentative Drilling Schedule

	Date	Time on Site (days)	Transit time* (days)
Leg 130 departs Guam at 1200 hr on 24 January 1990			
Transit from Guam to OJP-4			4.7 (4.7)†
AR OJP-4	29 JAN	11.2(15.9)	
LV OJP-4	09 FEB		
Transit to OJP-3			0.6(16.5)
AR OJP-3	09 FEB	4.4(20.9)	
LV OJP-3	14 FEB		
Transit to OJP-2			0.5(21.4)
AR OJP-2	14 FEB	7.1(28.5)	
LV OJP-2	22 FEB		
Transit to OJP-1			0.4(28.9)
AR OJP-1	22 FEB	7.0(35.9)	
LV OJP-1	01 MAR		
Transit to OJP-5			1.0(36.9)
AR OJP-5	02 MAR	21.3(58.2)	
LV OJP-5	23 MAR		
Transit to Guam			3.8(62.0)
Arrive Guam	27 MAR		

* Transit time assumes a ship speed of 10 knots.
† Cumulative days at sea in parentheses.

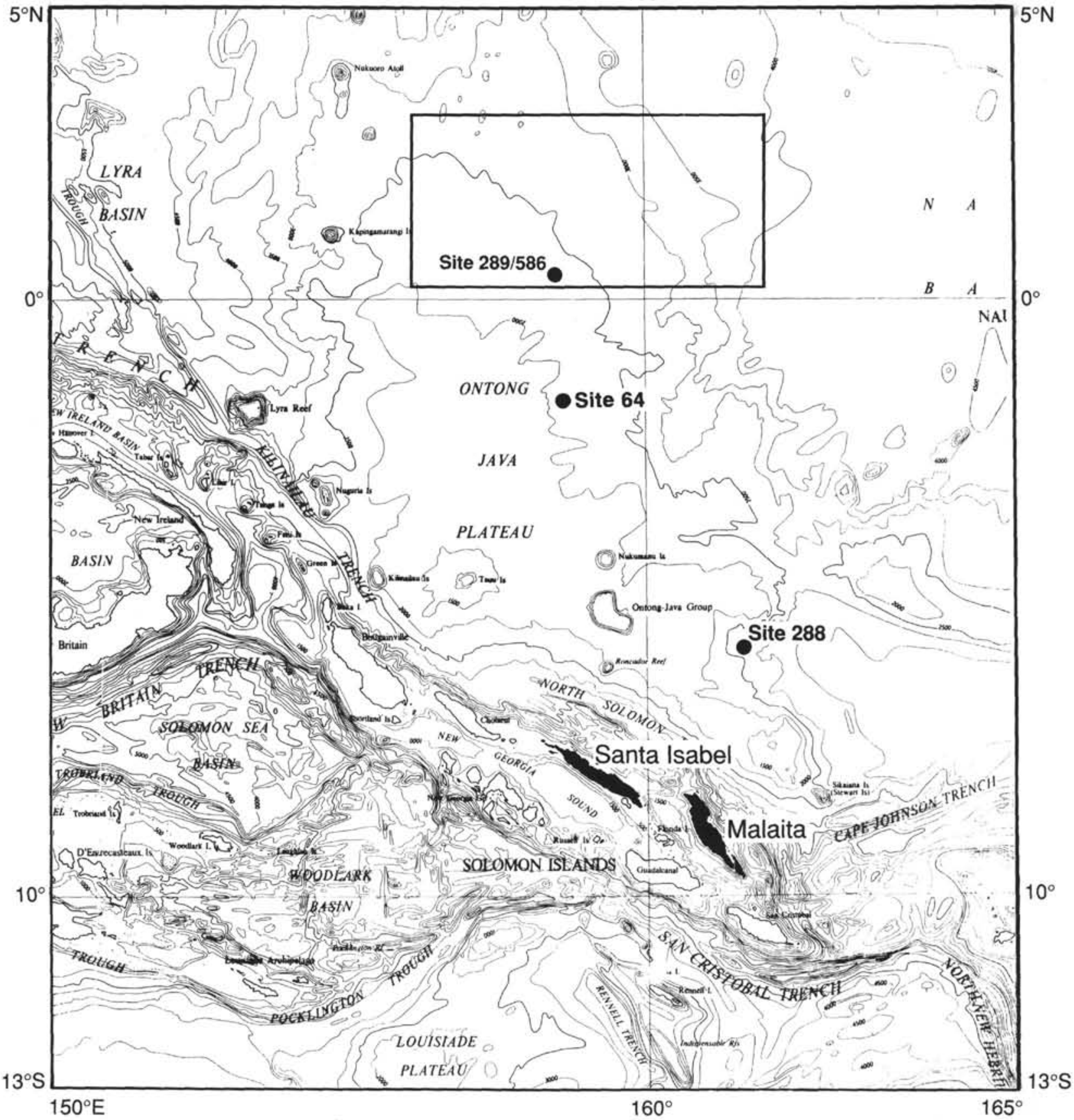


Figure 1. Bathymetry in meters of the southwestern part of the Ontong Java Plateau, showing the location DSDP Sites 64, 288, and 289 (and 586) and the location of Malaita and Santa Isabel. Box shows location of Leg 130 drilling.

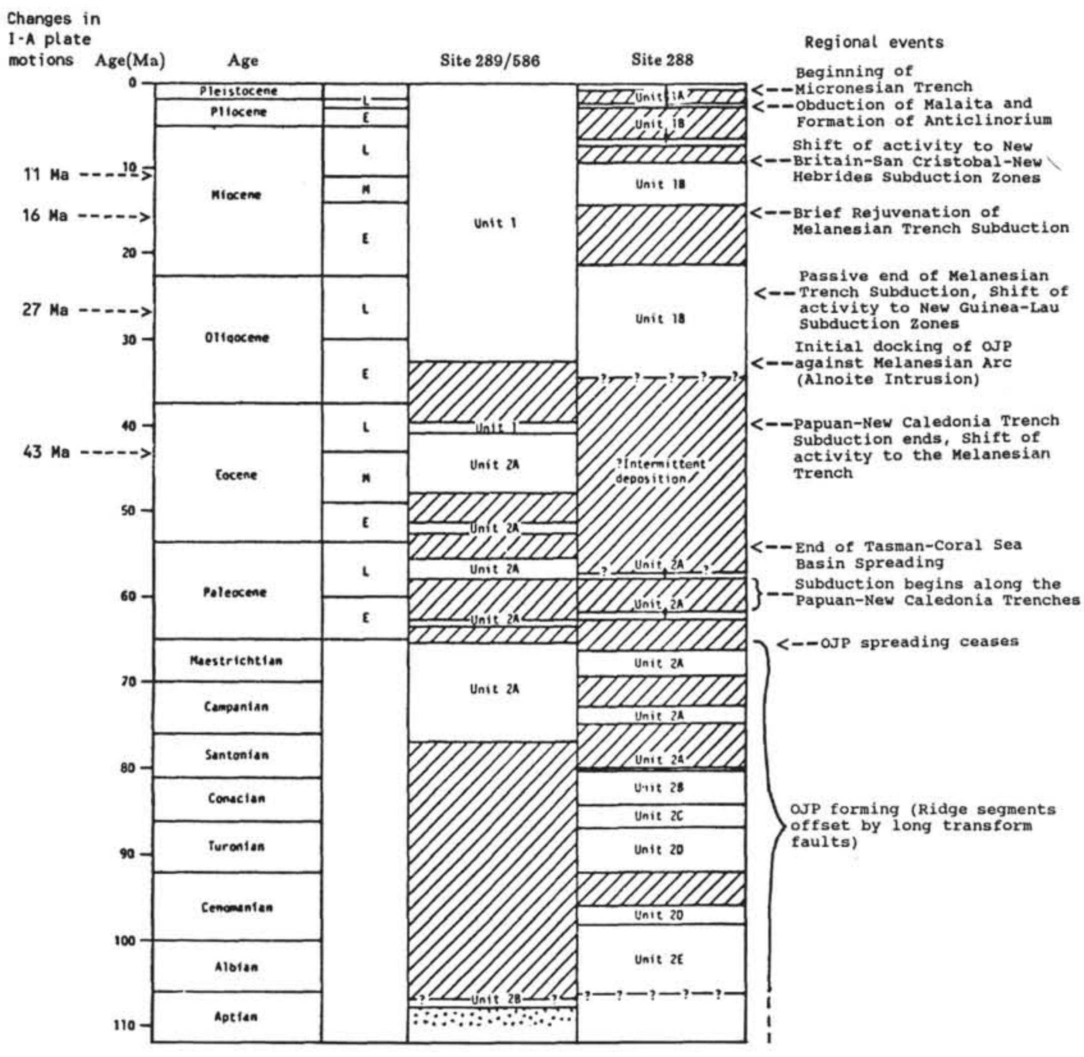


Figure 2. Lacunae at Ontong Java Plateau (OJP) DSDP sites vs. regional tectonic events (after Andrews, Packham, et al., 1975; Kroenke, 1984). Hachured areas indicate intervals of no recovery.

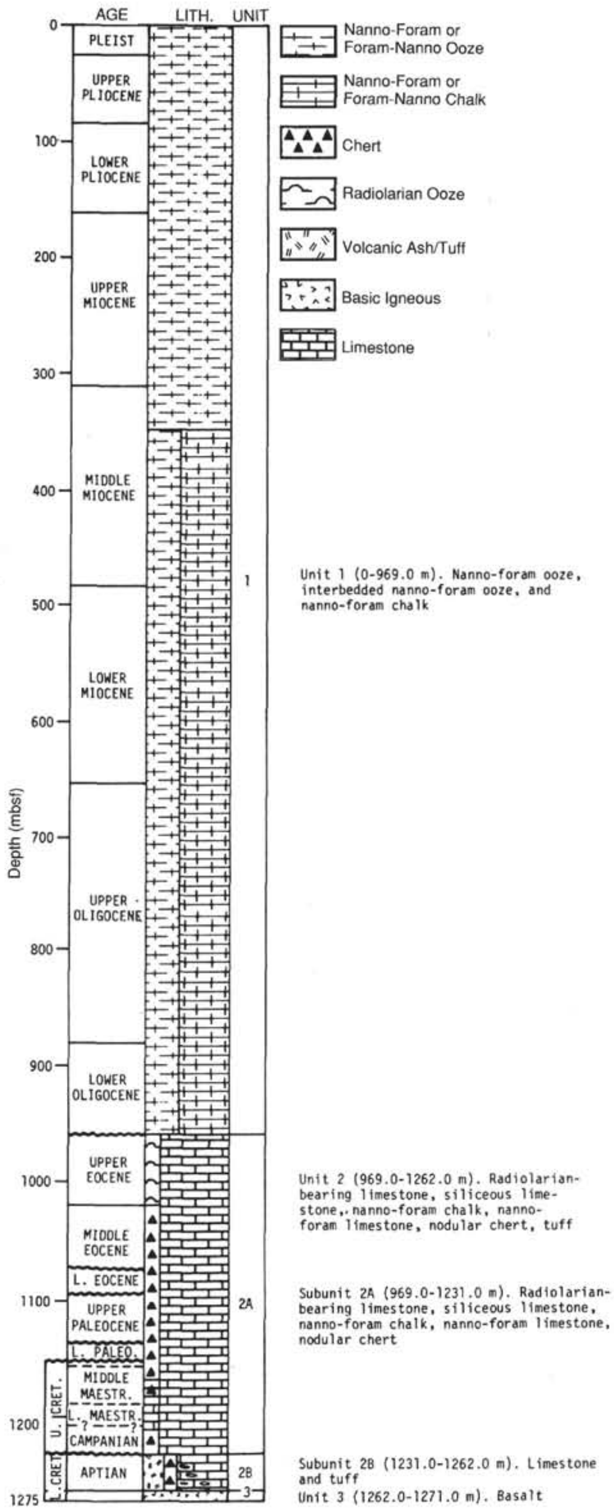


Figure 3. Site 289 stratigraphic column (from Andrews, Packham, et al., 1975).

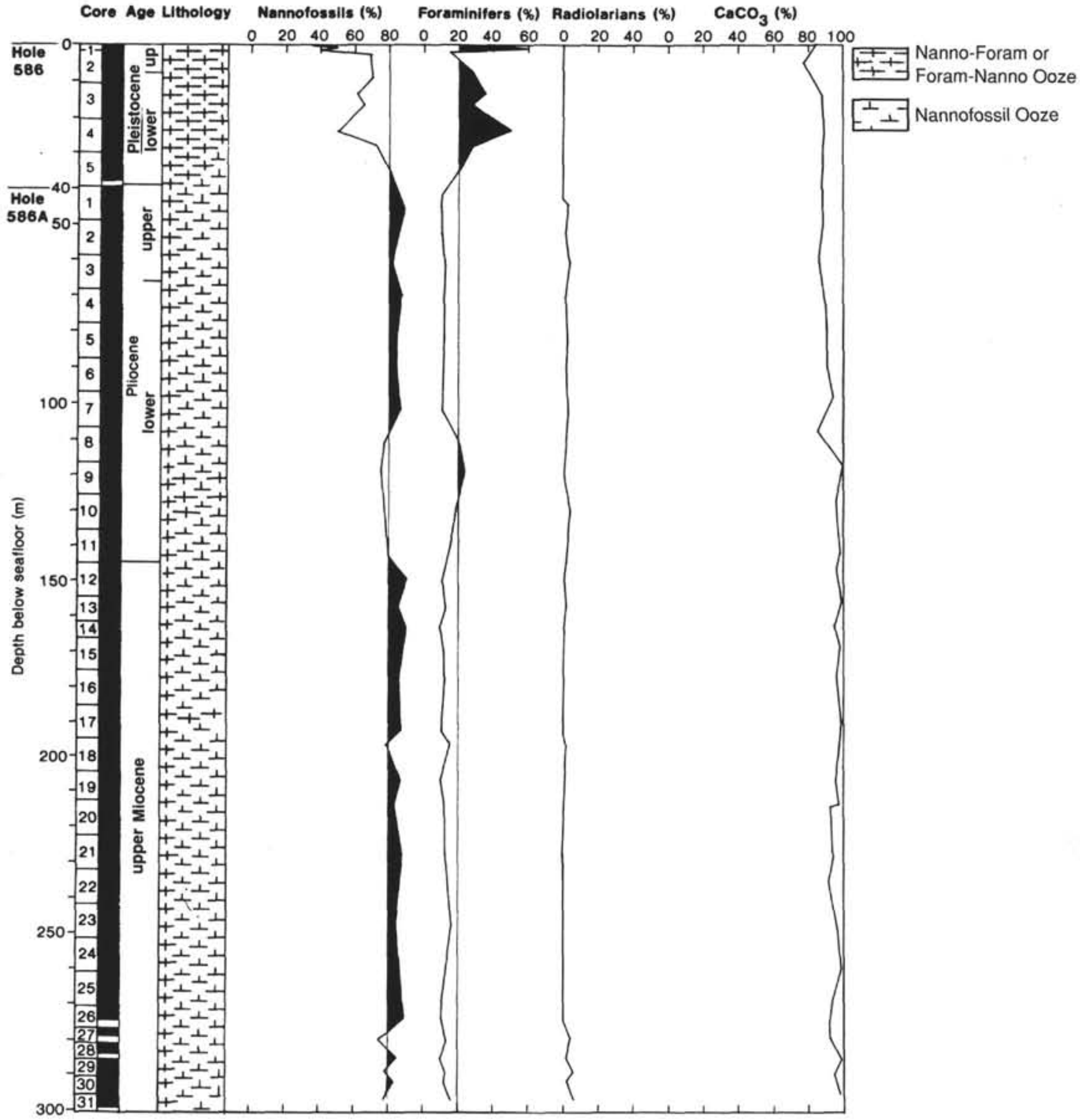


Figure 4. Site 586 stratigraphic column (from Moberly, Schlanger, et al., 1986).

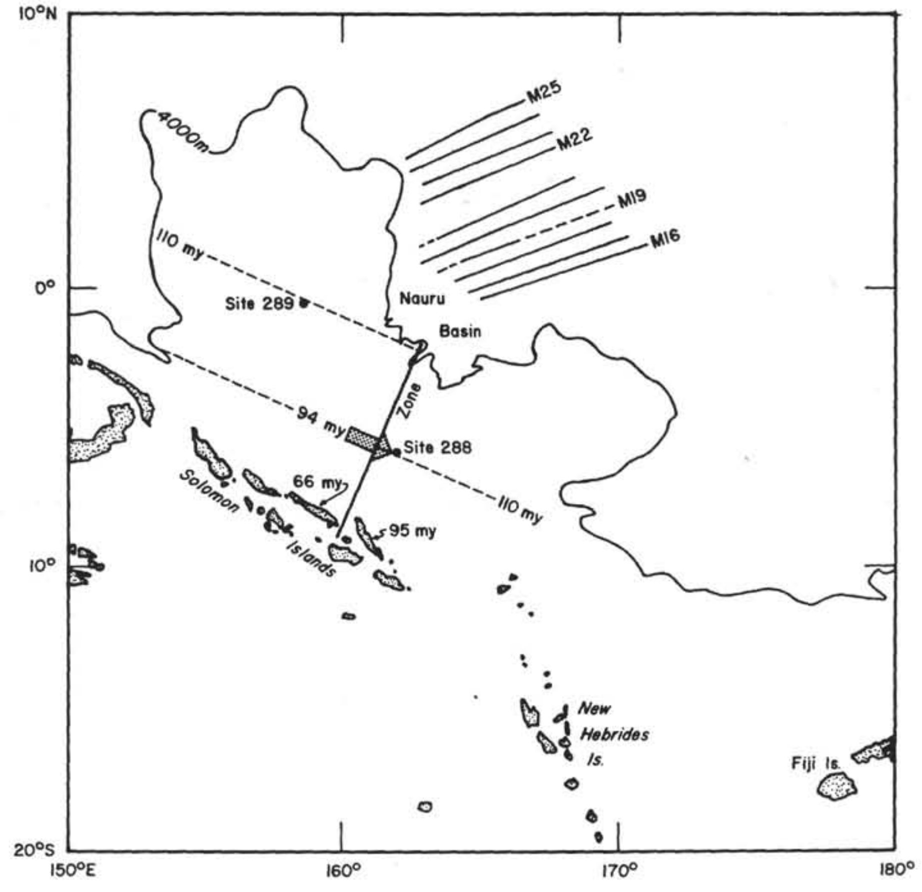


Figure 5. Crustal age determinations from DSDP drill sites on the Ontong Java Plateau and radiometric data in the Solomon Islands suggest an age progression across the region consistent with crustal generation patterns in the Lyra and Nauru basins. On the basis of these dates the plateau crust would have formed at a half rate of about 2 cm/yr (from Hussong et al., 1979).

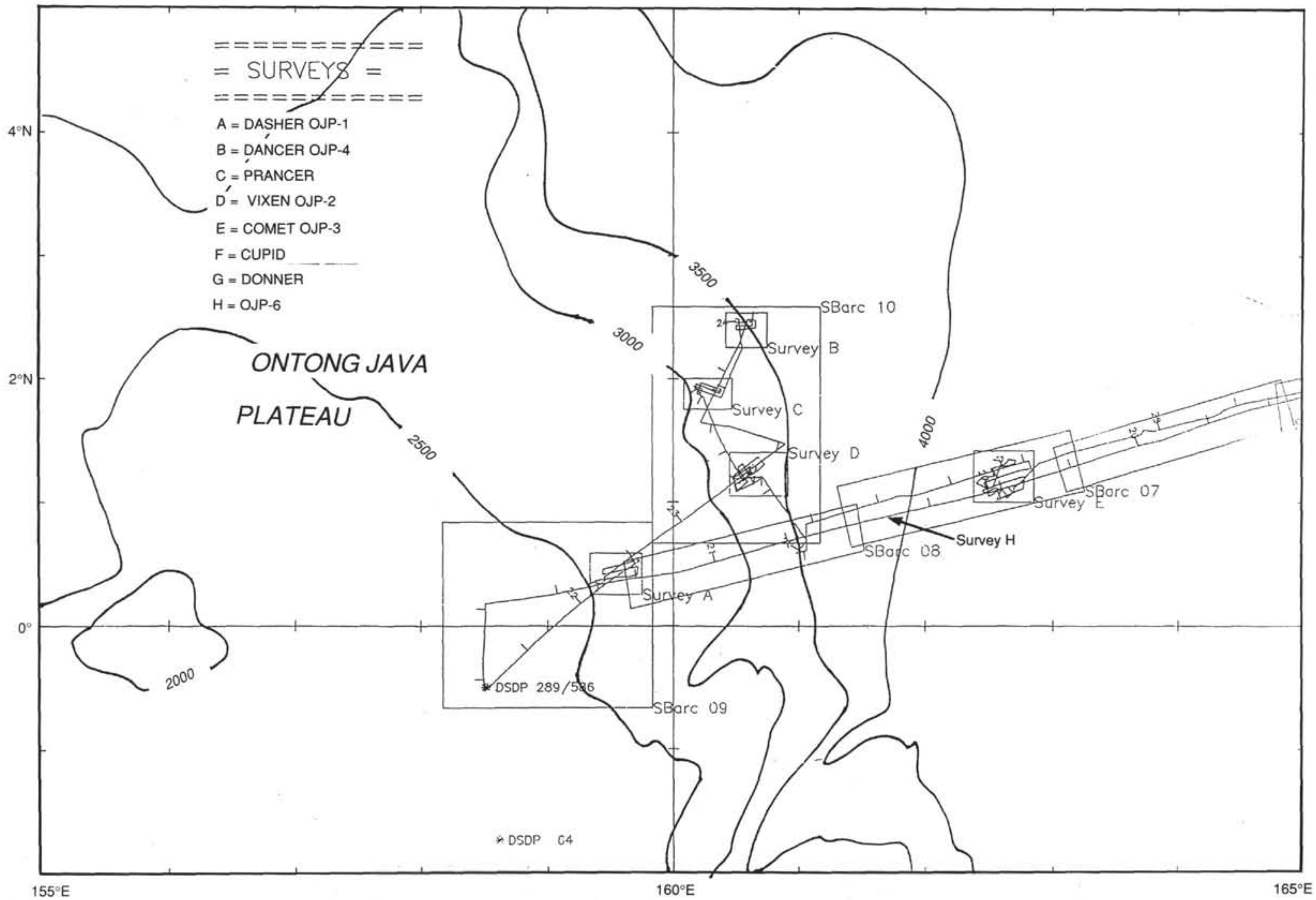


Figure 6. Detail of *R/V Thomas Washington* Roundabout 11 cruise track on the Ontong Java Plateau. Bathymetry in meters.

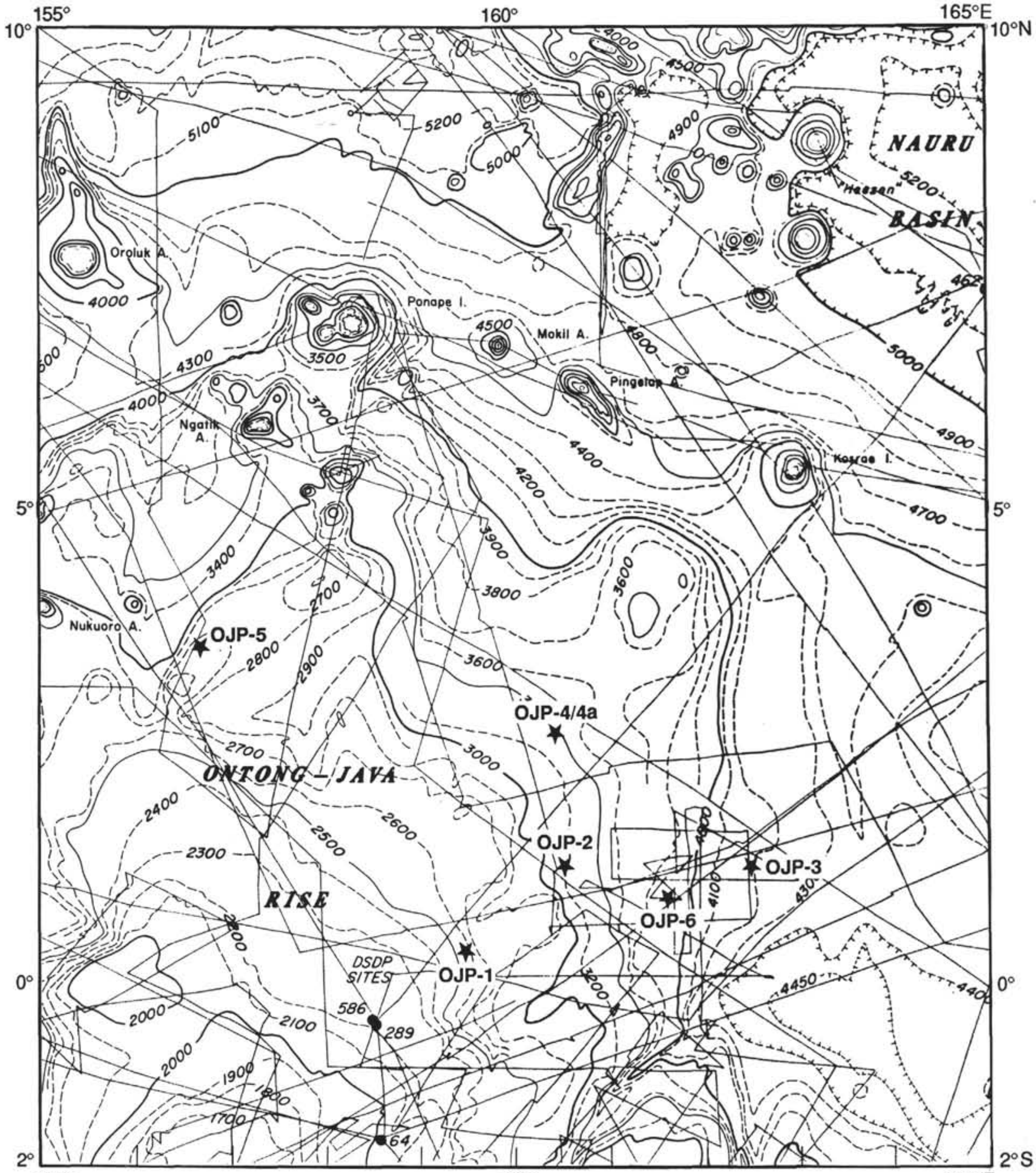


Figure 7. Bathymetric map showing the location of proposed Leg 130 sites. Bathymetry in meters.

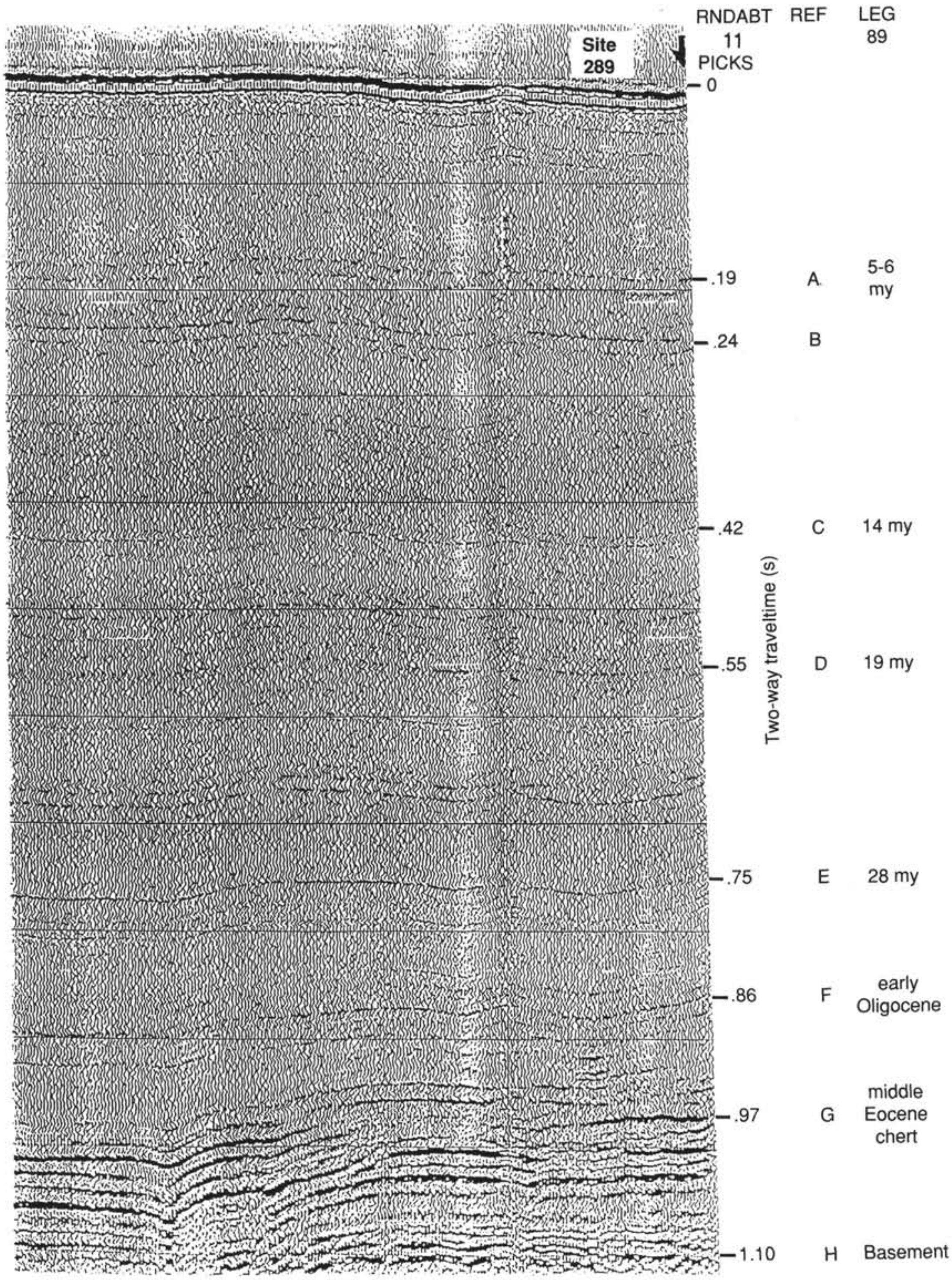


Figure 8. Roundabout 11 water-gun profile over Site 289/586. Interpretation based on Site 586 results.

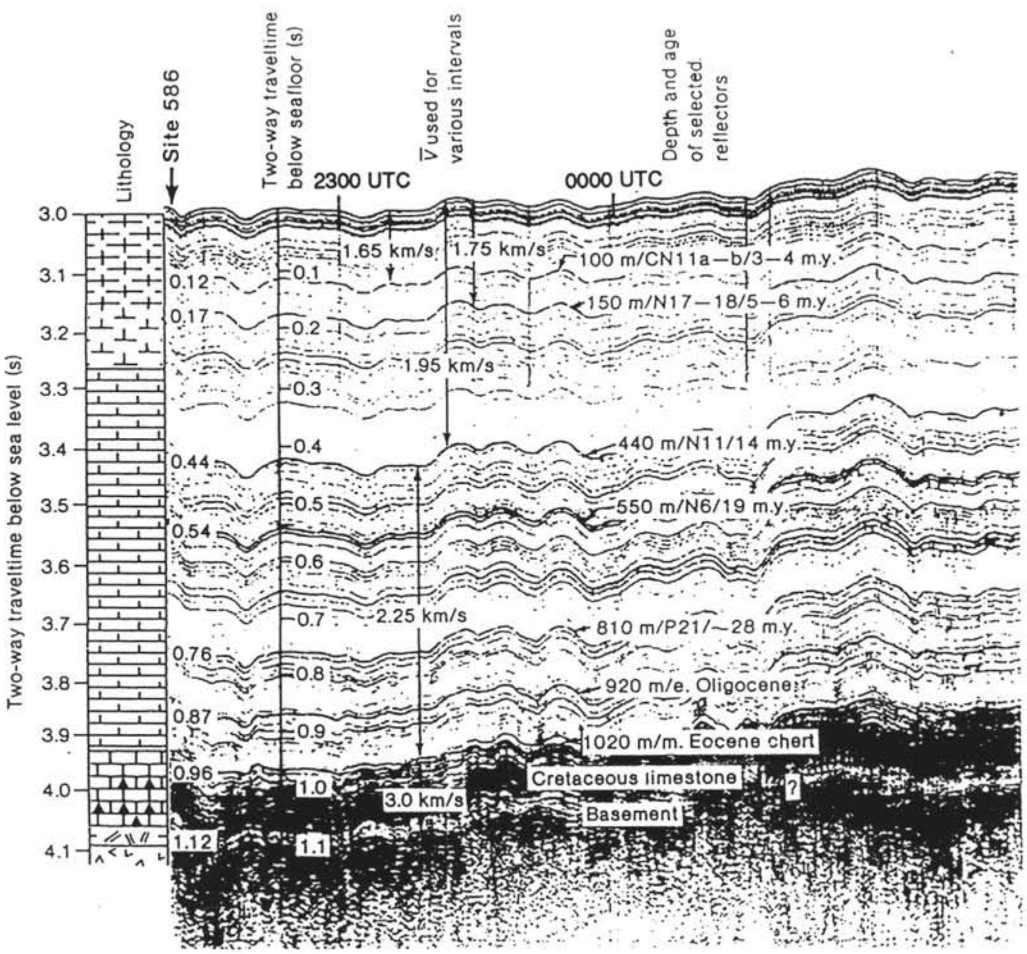


Figure 9. Interpretation of Leg 89 seismic profile over Site 586 (from Moberly, Schlanger, et al., 1986). Survey speed was 7 kt.

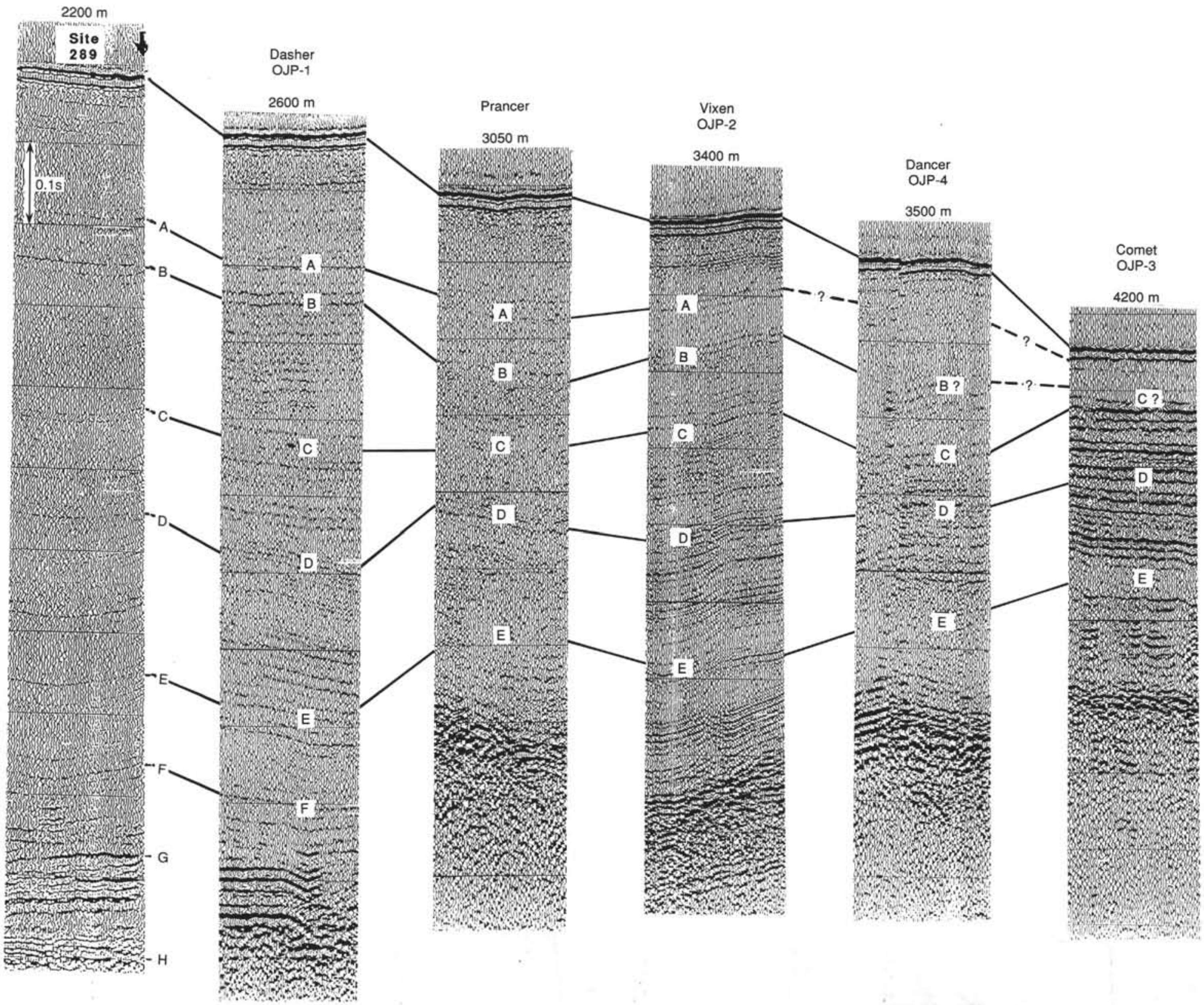


Figure 10. Relationships of seismic sections and marker reflectors down the Ontong Java Plateau. Horizontal lines within each section represent 0.1 s of two-way traveltime.

SITE OJP-1 PRIORITY 1

POSITION: 00°19.2'N
159°21.9'E

WATER DEPTH: 2600 m SEDIMENT THICKNESS: 1240 m

PROPOSED DRILLING PROGRAM: Double APC to 250 mbsf; Third APC to 50 mbsf; XCB to 600 mbsf.

SEISMIC RECORD: ROUNDABOUT cruise 11 "Dasher " survey at 0608Z on 21 December.

LOGGING: 2 standard Schlumberger runs.

OBJECTIVES: Fourth site to be drilled in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk.

SITE OJP-1a PRIORITY 1 (alternate to OJP-1)

POSITION: 00°19.8'N
159°24.6'E

WATER DEPTH: 2600 m SEDIMENT THICKNESS: 1240 m

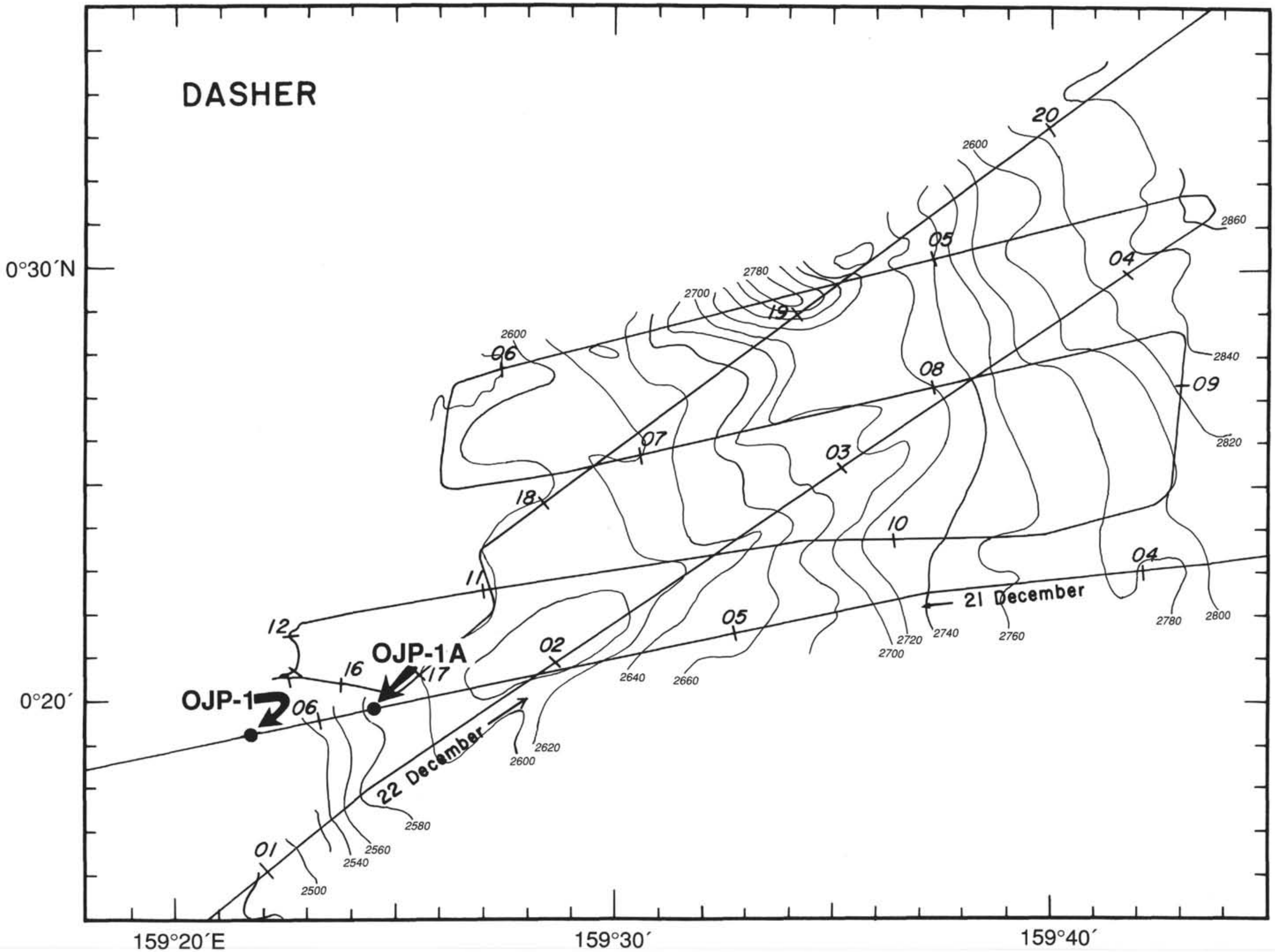
PROPOSED DRILLING PROGRAM: Double APC to 250 mbsf; Third APC to 50 mbsf; XCB to 600 mbsf.

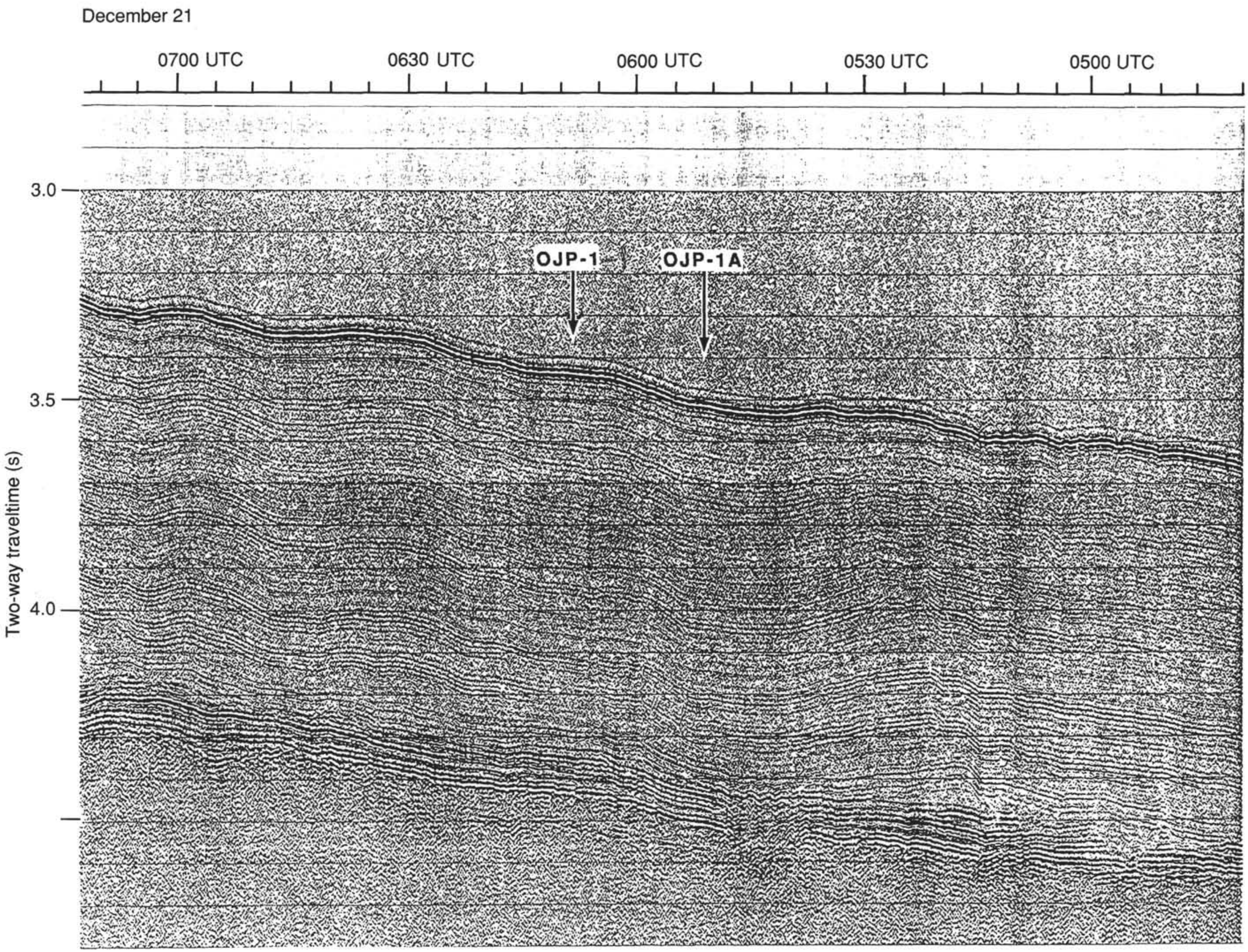
SEISMIC RECORD: ROUNDABOUT cruise 11 "Dasher " survey at 0551Z on 21 December.

LOGGING: 2 standard Schlumberger runs.

OBJECTIVES: Fourth site to be drilled in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk.


DASHER
OJP-1
OJP-1A
21 December
22 December
0°30′N
0°20′
159°20′E
159°30′
159°40′
2500
2540
2560
2580
2600
2620
2640
2660
2700
2720
2740
2760
2780
2800
2820
2840
2860


December 21
0700 UTC
0630 UTC
0600 UTC
0530 UTC
0500 UTC
OJP-1
OJP-1A
3.0
3.5
4.0
Two-way traveltime (s)

SITE OJP-2 PRIORITY 1

POSITION: 01°13.5'N
160°31.8'E

WATER DEPTH: 3200 m SEDIMENT THICKNESS: 930 m

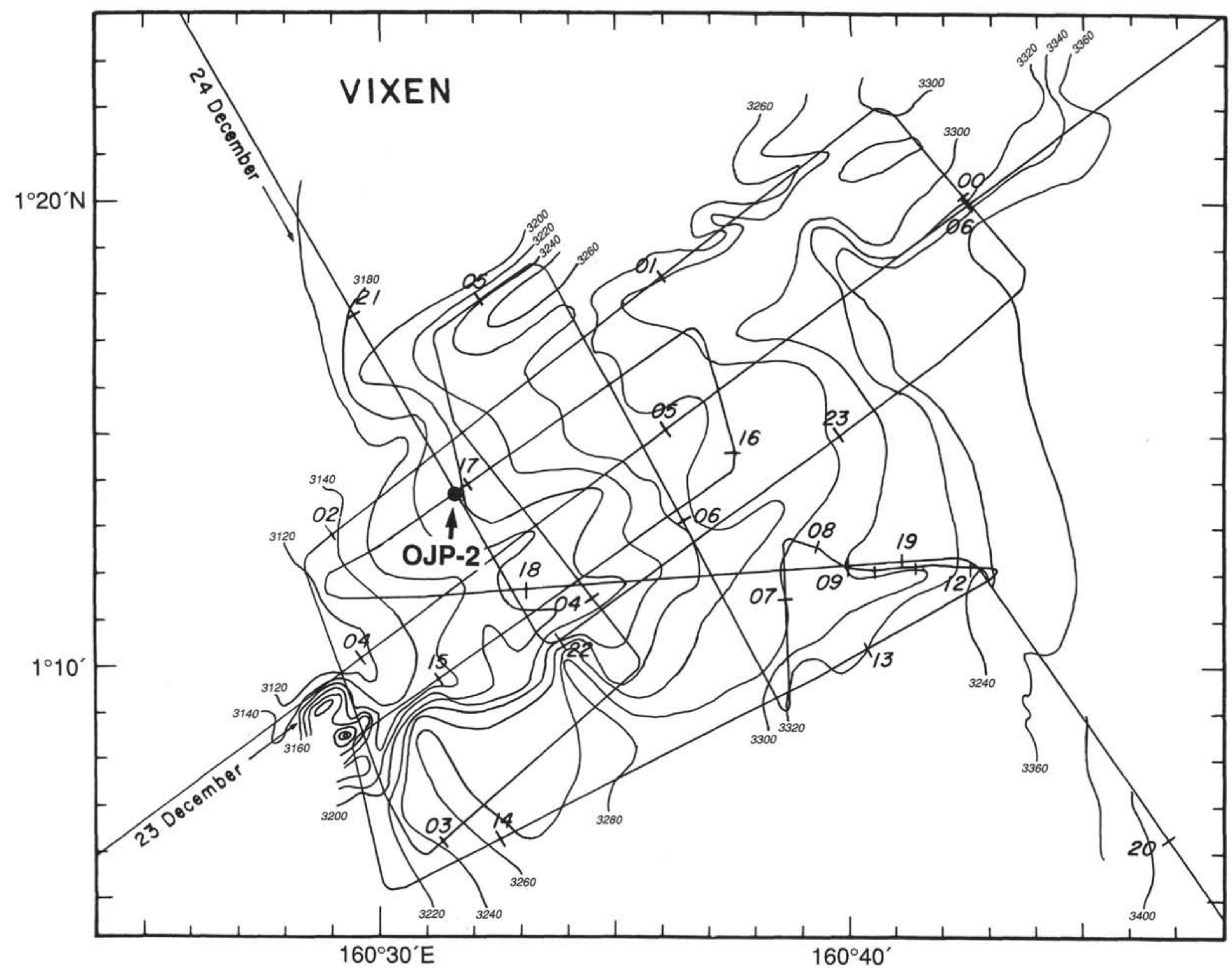
PROPOSED DRILLING PROGRAM: Double APC to 250 mbsf; Third APC to 50 mbsf; XCB to 500 mbsf.

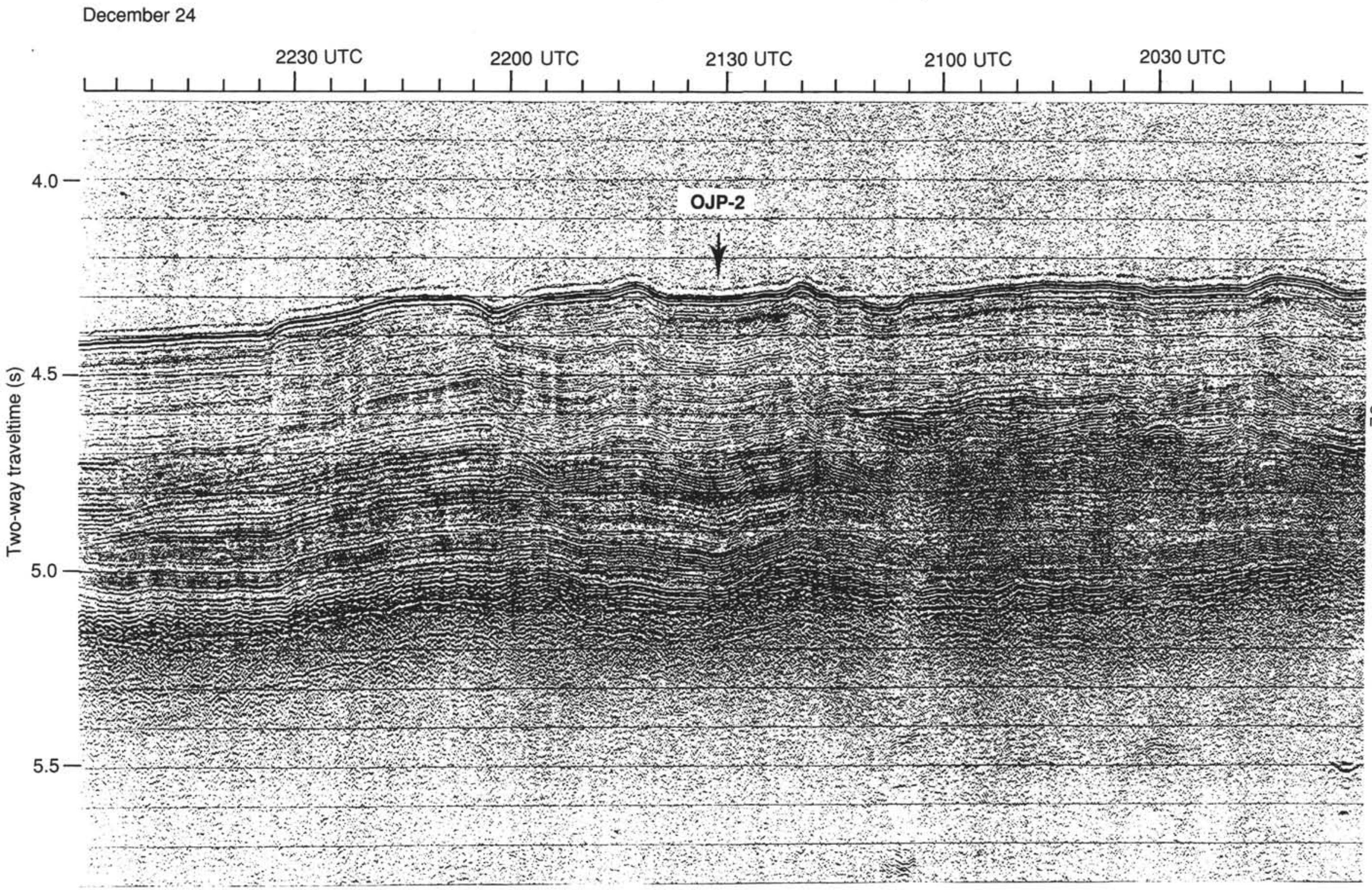
SEISMIC RECORD: ROUNDABOUT cruise 11 "Vixen " survey at 2131Z on 24 December and 1704Z on 25 December.

LOGGING: 2 standard Schlumberger runs.

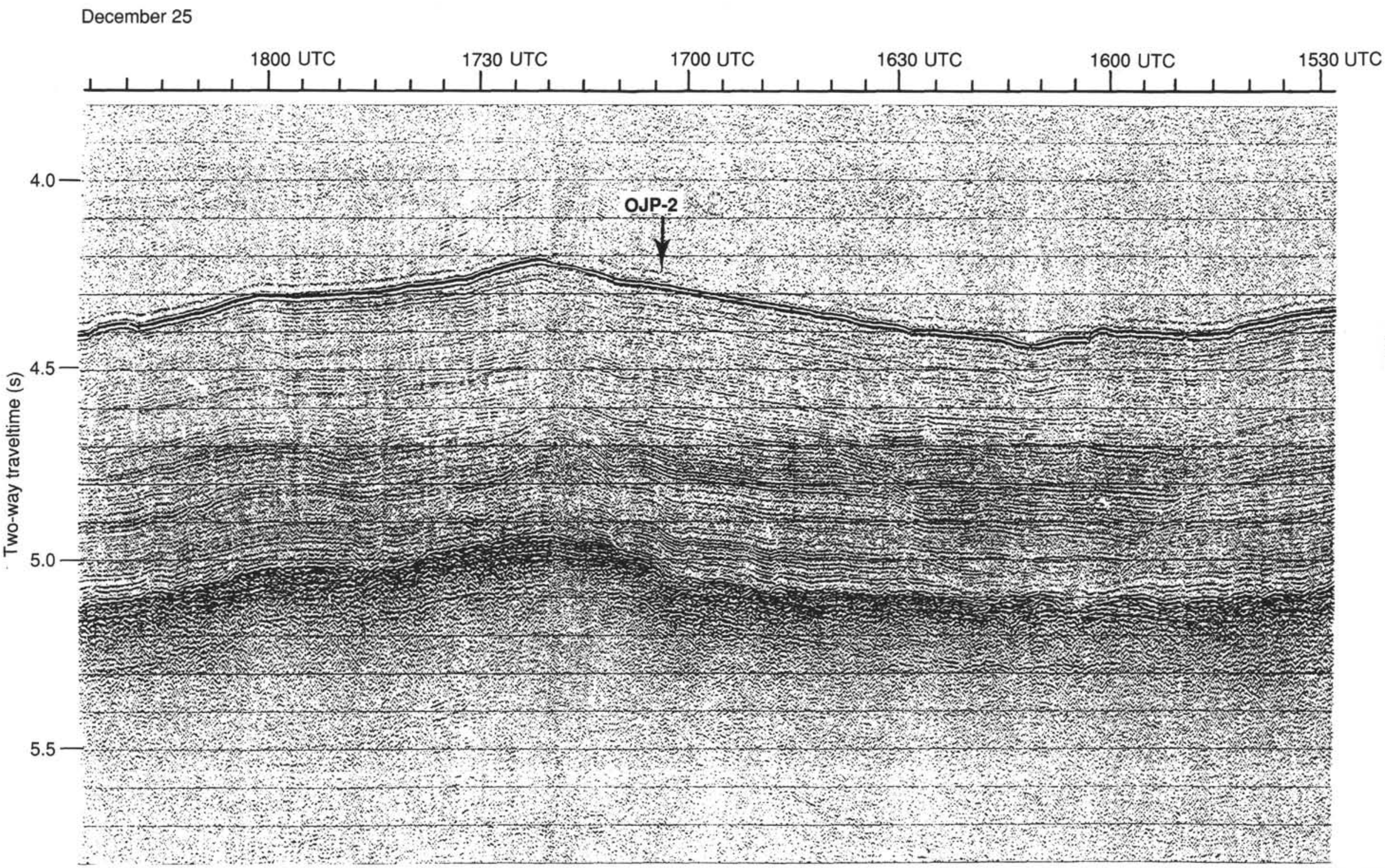
OBJECTIVES: Third site to be drilled in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk.


VIXEN
24 December
23 December
OJP-2
1°20′N
1°10′
160°30′E
160°40′
3120
3140
3160
3180
3200
3220
3240
3260
3280
3300
3320
3340
3360
3400



December 24
2230 UTC
2200 UTC
2130 UTC
2100 UTC
2030 UTC
OJP-2
Two-way traveltime (s)
4.0
4.5
5.0
5.5


December 25
1800 UTC
1730 UTC
1700 UTC
1630 UTC
1600 UTC
1530 UTC
OJP-2
4.0
4.5
5.0
5.5
Two-way traveltime (s)

SITE OJP-3 PRIORITY 1

POSITION: 01°06.3'N
162°35.7'E

WATER DEPTH: 4200 m SEDIMENT THICKNESS: 625 m

PROPOSED DRILLING PROGRAM: Double APC to 250 mbsf; Third APC to 50 mbsf.

SEISMIC RECORD: ROUNDABOUT cruise 11 "COMET" survey, at 0803Z on 20 December.

LOGGING: None.

OBJECTIVES: Second site to be drilled in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk.

SITE OJP-3a PRIORITY 1 (alternate to OJP-3)

POSITION: 01°09.7'N
162°45.9'E

WATER DEPTH: 4200 m SEDIMENT THICKNESS: 625 m

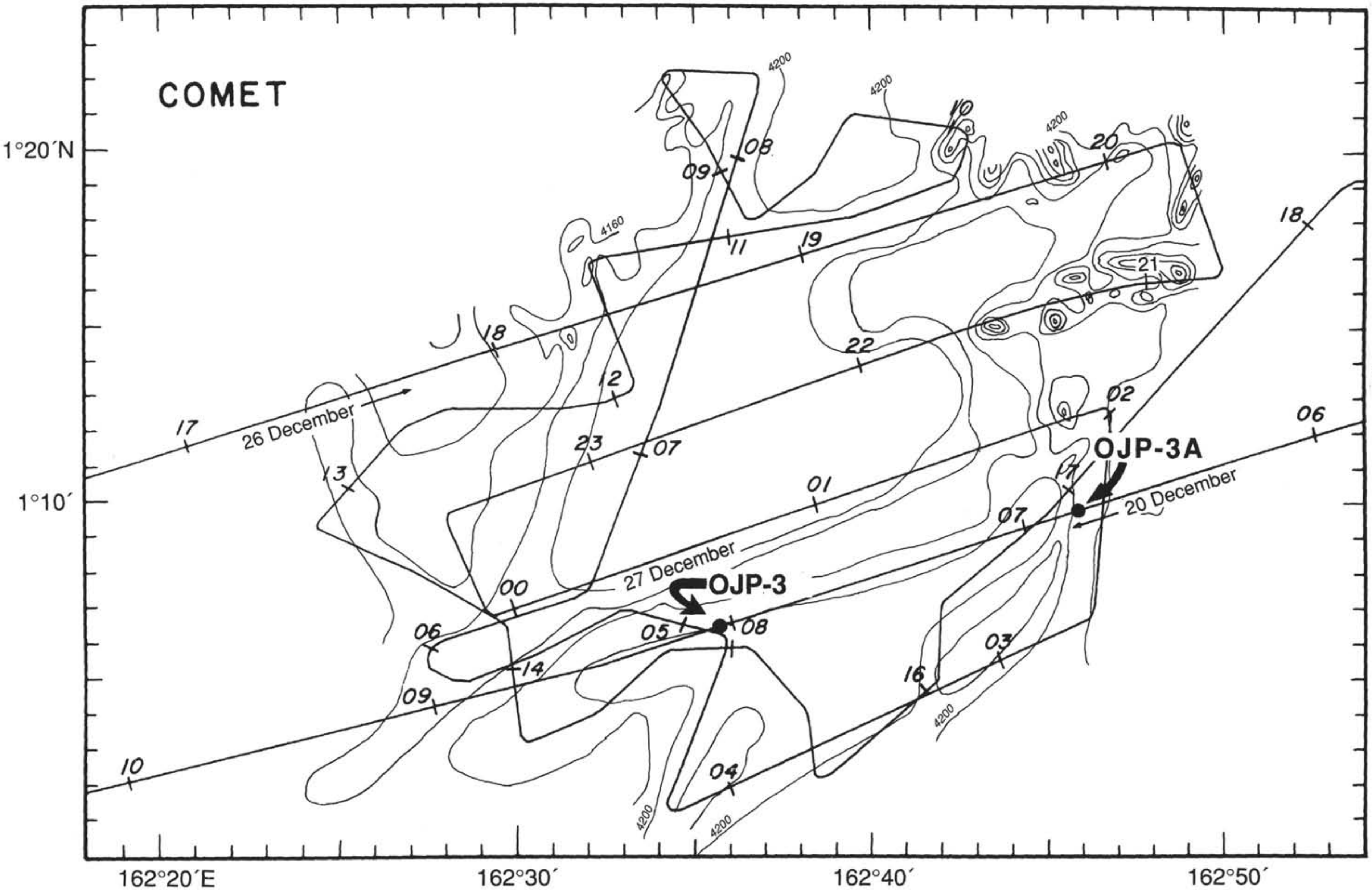
PROPOSED DRILLING PROGRAM: Double APC to 250 mbsf; Third APC to 50 mbsf; Approved by Safety Panel to 5.95-s reflector.

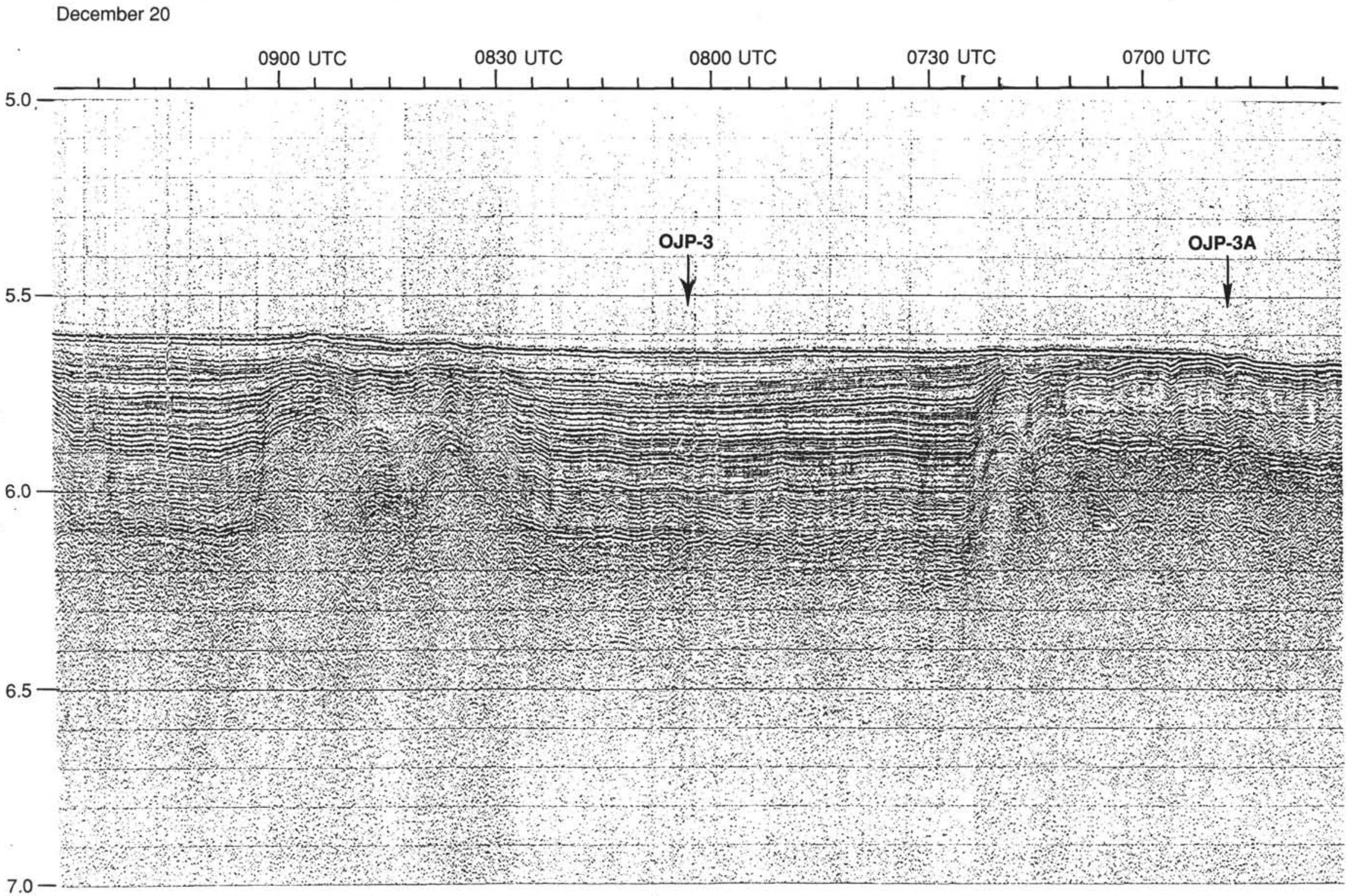
SEISMIC RECORD: ROUNDABOUT cruise 11 "COMET" survey, at 0648Z on 20 December.

LOGGING: None.

OBJECTIVES: Second site to be drilled in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk.


COMET
1°20′N
1°10′
162°20′E
162°30′
162°40′
162°50′
26 December
27 December
20 December
OJP-3
OJP-3A
4200
4160


December 20
0900 UTC
0830 UTC
0800 UTC
0730 UTC
0700 UTC
5.0
5.5
6.0
6.5
7.0
OJP-3
OJP-3A

SITE OJP-4 PRIORITY 1

POSITION: 02°26.0'N
160°32.7'E

WATER DEPTH: 3400 m SEDIMENT THICKNESS: 780 m

PROPOSED DRILLING PROGRAM: Double APC to 250 mbsf; Third APC to 50 mbsf; XCB to 500 mbsf; RCB to 790 mbsf.

SEISMIC RECORD: ROUNDABOUT cruise 11 "DANCER" survey, at 2207Z on 23 December (near 0040Z on 24 December).

LOGGING: 2 standard Schlumberger runs.

OBJECTIVES: a) First site to be drilled in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system. b) Recover Paleogene and Cretaceous sediments and basement rock to determine pre-Neogene paleoceanography and origin of the OJP.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk/ limestone, chert and basalt.

SITE OJP-4a PRIORITY 2

POSITION: 02°26.0'N
160°33.3'E

WATER DEPTH: 3400 m SEDIMENT THICKNESS: 250 m

PROPOSED DRILLING PROGRAM: Wash to 250 mbsf; RCB to 260 mbsf.

SEISMIC RECORD: ROUNDABOUT cruise 11 "DANCER" survey, at 2213Z on 23 December (near 0040Z on 24 December).

LOGGING: None.

OBJECTIVES: Determine nature and composition of "basement" high at this location.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Basalt?

SITE OJP-4b PRIORITY 1 (alternate to OJP-4)

POSITION: 02°26.0'N
160°32.0'E

WATER DEPTH: 3400 m SEDIMENT THICKNESS: 780 m

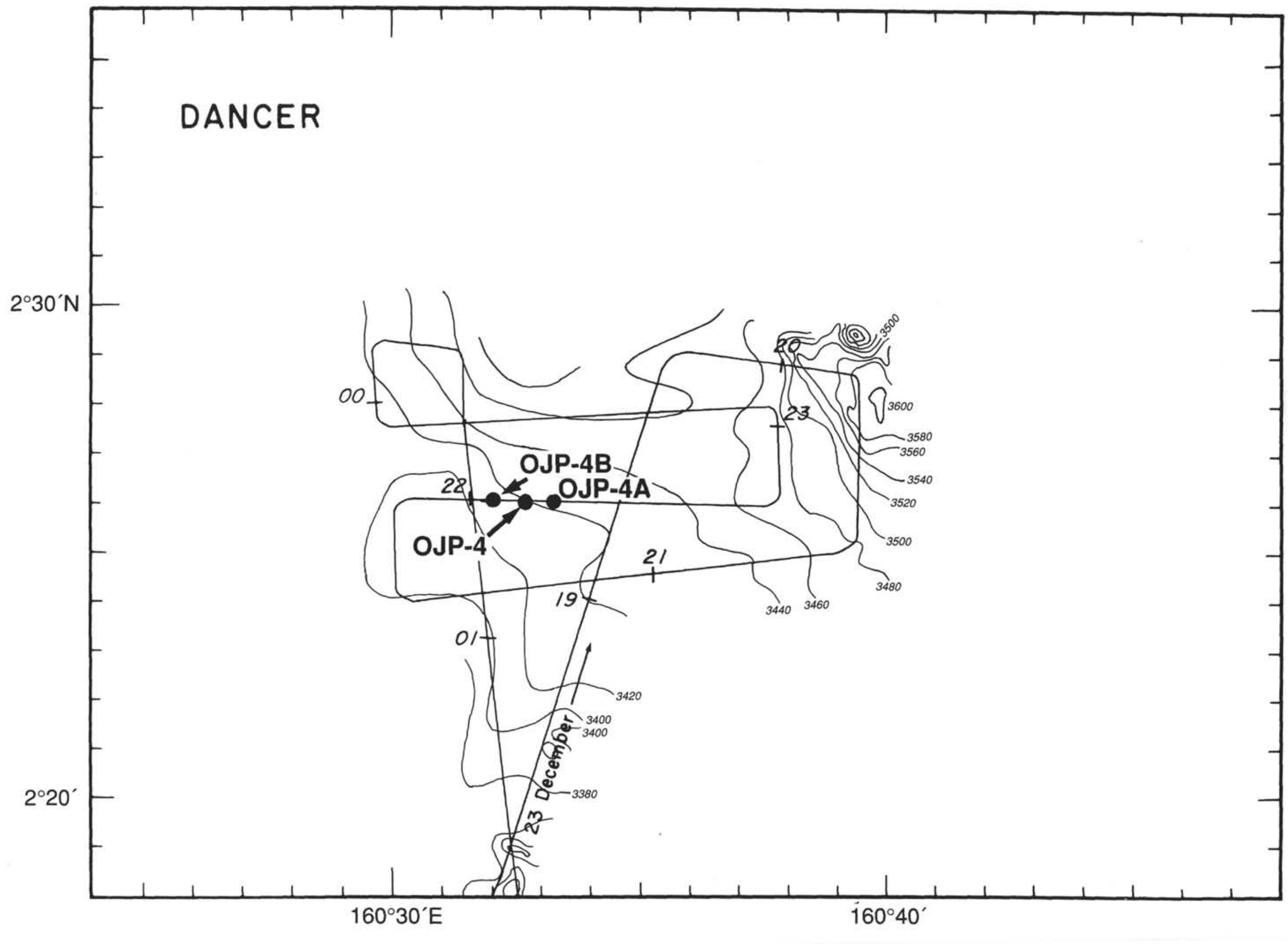
PROPOSED DRILLING PROGRAM: Double APC to 250 mbsf; Third APC to 50 mbsf; XCB to 500 mbsf; RCB to 790 mbsf.

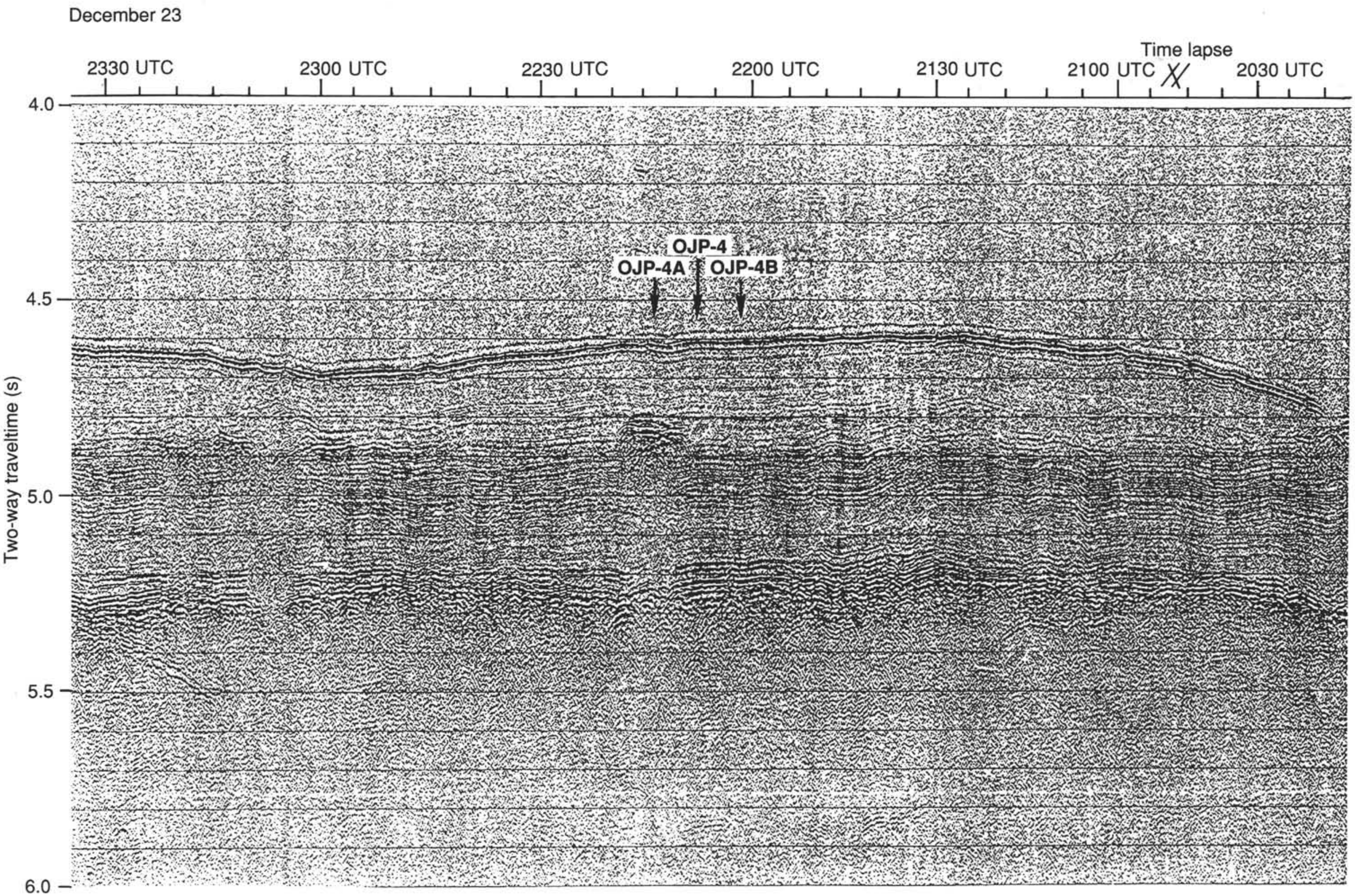
SEISMIC RECORD: ROUNDABOUT cruise 11 "DANCER" survey, at 2202Z on 23 December (near 0040Z on 24 December).

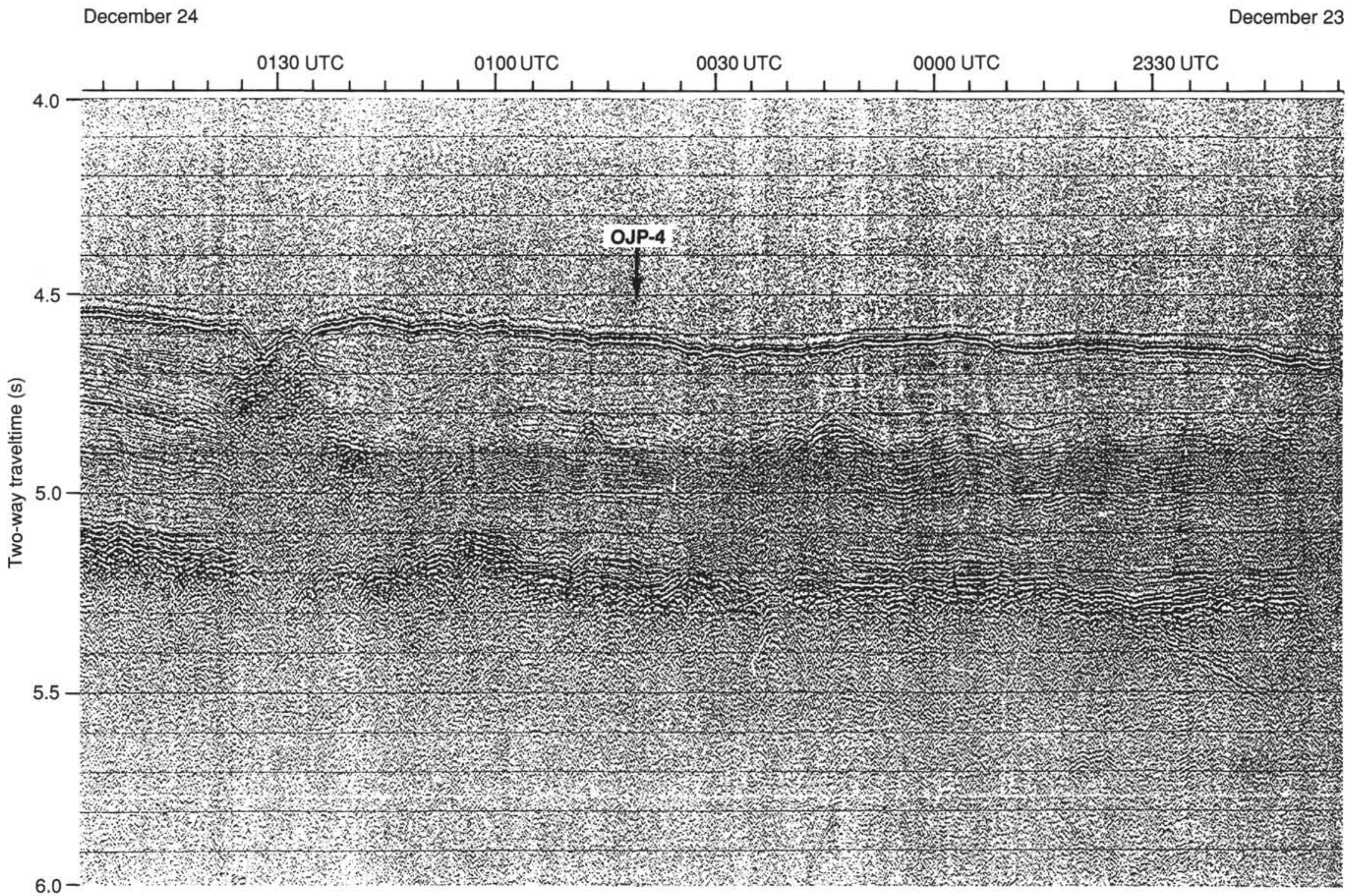
LOGGING: 2 standard Schlumberger runs.

OBJECTIVES: a) First site to be drilled in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system. b) Recover Paleogene and Cretaceous sediments and basement rock to determine pre-Neogene paleoceanography and origin of the OJP.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk/ limestone, chert and basalt.


DANCER
OJP-4B
OJP-4A
OJP-4
2°30′N
2°20′
160°30′E
160°40′
23 December
00
01
19
20
21
22
23
3380
3400
3400
3420
3440
3460
3480
3500
3500
3520
3540
3560
3580
3600


December 23
2330 UTC
2300 UTC
2230 UTC
2200 UTC
2130 UTC
2100 UTC
Time lapse
2030 UTC
OJP-4
OJP-4A
OJP-4B
4.0
4.5
5.0
5.5
6.0
Two-way traveltime (s)


December 24
December 23
0130 UTC
0100 UTC
0030 UTC
0000 UTC
2330 UTC
OJP-4
4.0
4.5
5.0
5.5
6.0
Two-way traveltime (s)

SITE OJP-5 PRIORITY 1

POSITION: 03°34'N
156°36'E

WATER DEPTH: 2820 m SEDIMENT THICKNESS: 1350 m (?)

PROPOSED DRILLING PROGRAM: APC to 220 mbsf; XCB to 600 mbsf; set reentry cone and RCB to 1400 mbsf (50 m into basement).

SEISMIC RECORD: R/V WASHINGTON "Eurydice" cruise 9 at 0320Z on 11 April.

LOGGING: 2 standard Schlumberger runs plus FMS or BHTV.

OBJECTIVES: a) Last site to be drilled in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system. b) Recover Paleogene and Cretaceous sediments and basement rock to determine pre-Neogene paleoceanography and origin of the OJP.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk / limestone, chert and basalt.

SITE OJP-5a PRIORITY 1 (alternate to OJP-5)

POSITION: 03°34'N
156°36'E

WATER DEPTH: 2820 m SEDIMENT THICKNESS: 1350 m (?)

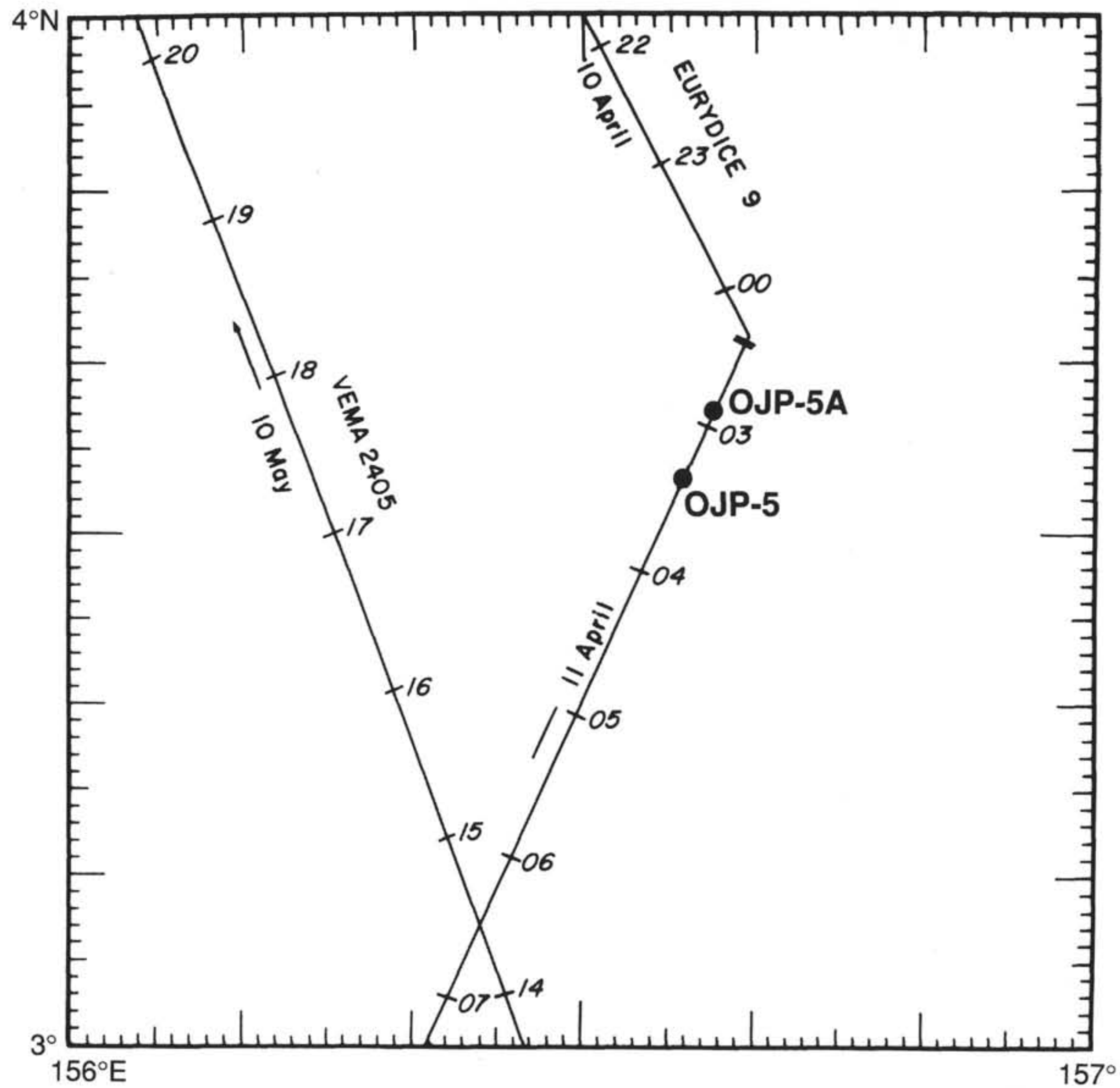
PROPOSED DRILLING PROGRAM: APC to 220 mbsf; XCB to 600 mbsf; set reentry cone and RCB to 1400 mbsf (50 m into basement).

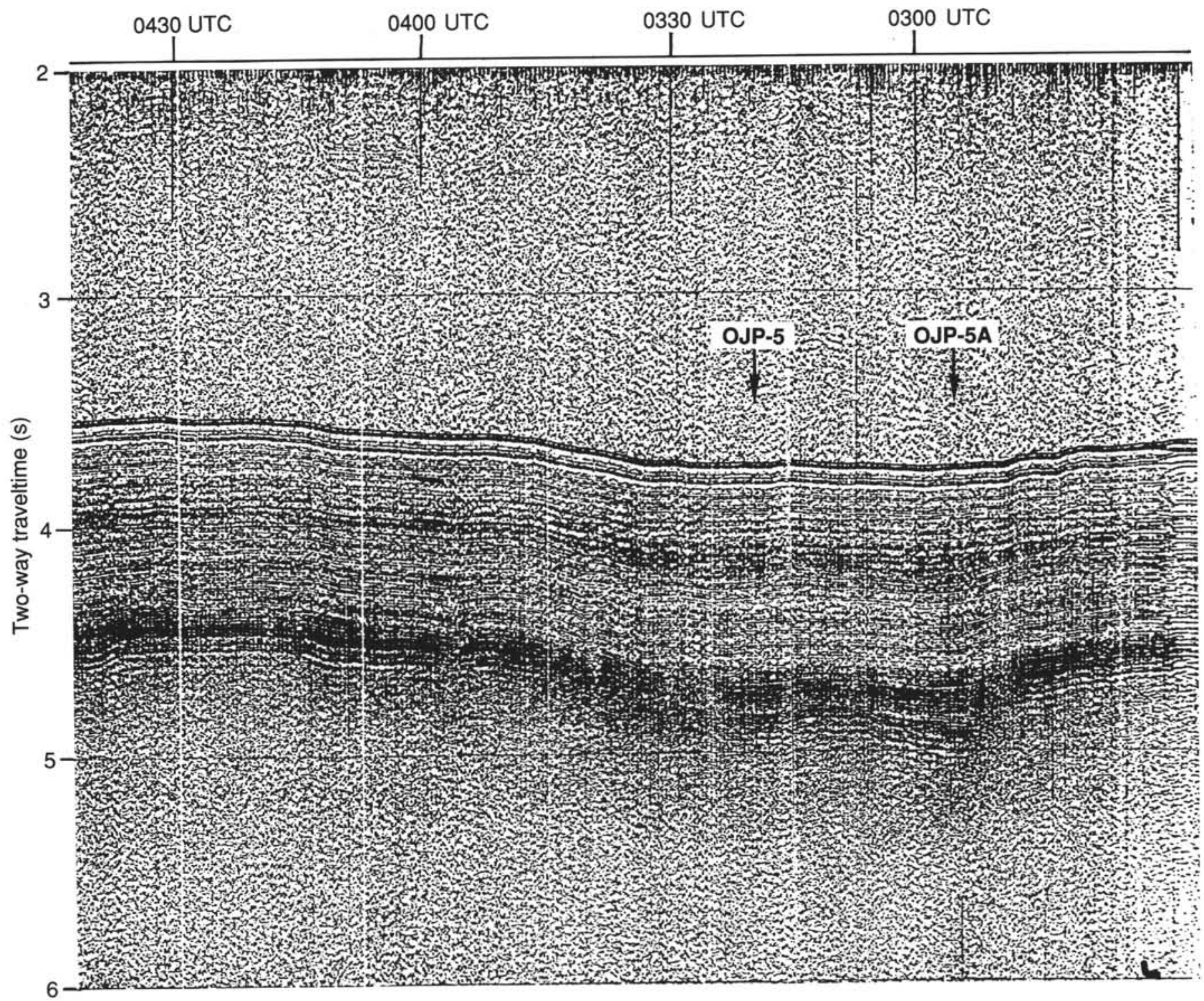
SEISMIC RECORD: R/V WASHINGTON "Eurydice" cruise 9 at 0255Z on 11 April.

LOGGING: 2 standard Schlumberger runs plus FMS or BHTV.

OBJECTIVES: a) Last site to be drilled in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system. b) Recover Paleogene and Cretaceous sediments and basement rock to determine pre-Neogene paleoceanography and origin of the OJP.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk / limestone, chert and basalt.


4°N
3°
156°E
157°
20
19
18
17
16
15
14
10 May
VEMA 2405
22
23
00
03
04
05
06
07
10 April
EURYDICE 9
11 April
OJP-5A
OJP-5


0430 UTC
0400 UTC
0330 UTC
0300 UTC
2
3
4
5
6
Two-way traveltime (s)
OJP-5
OJP-5A

SITE OJP-6 PRIORITY 1 (alternate to OJP-3)

POSITION: 00°59'N
161°35.8'E

WATER DEPTH: 3920 SEDIMENT THICKNESS: 500 m

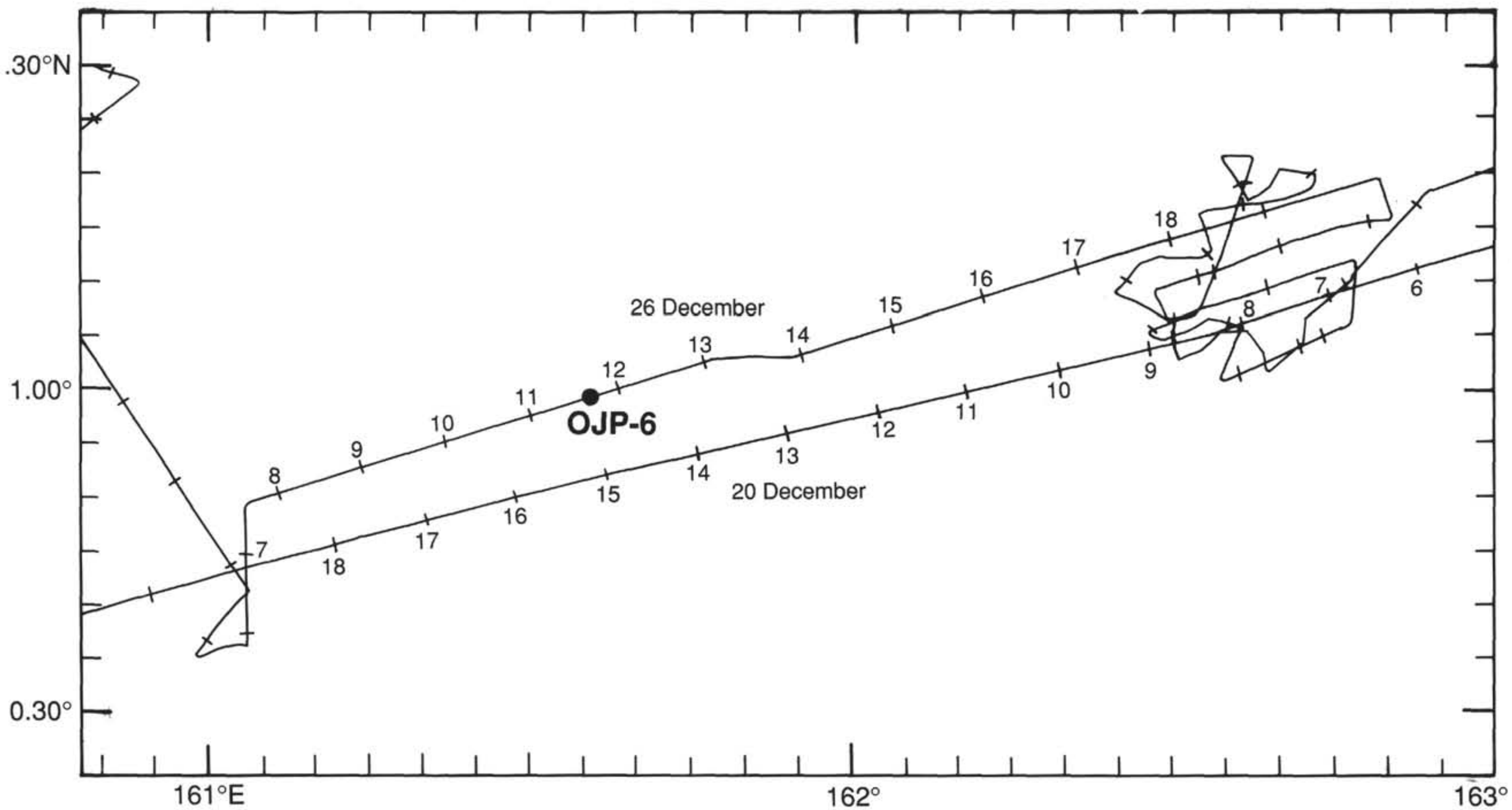
PROPOSED DRILLING PROGRAM: Double APC to 250 mbsf; Third APC to 50 mbsf.

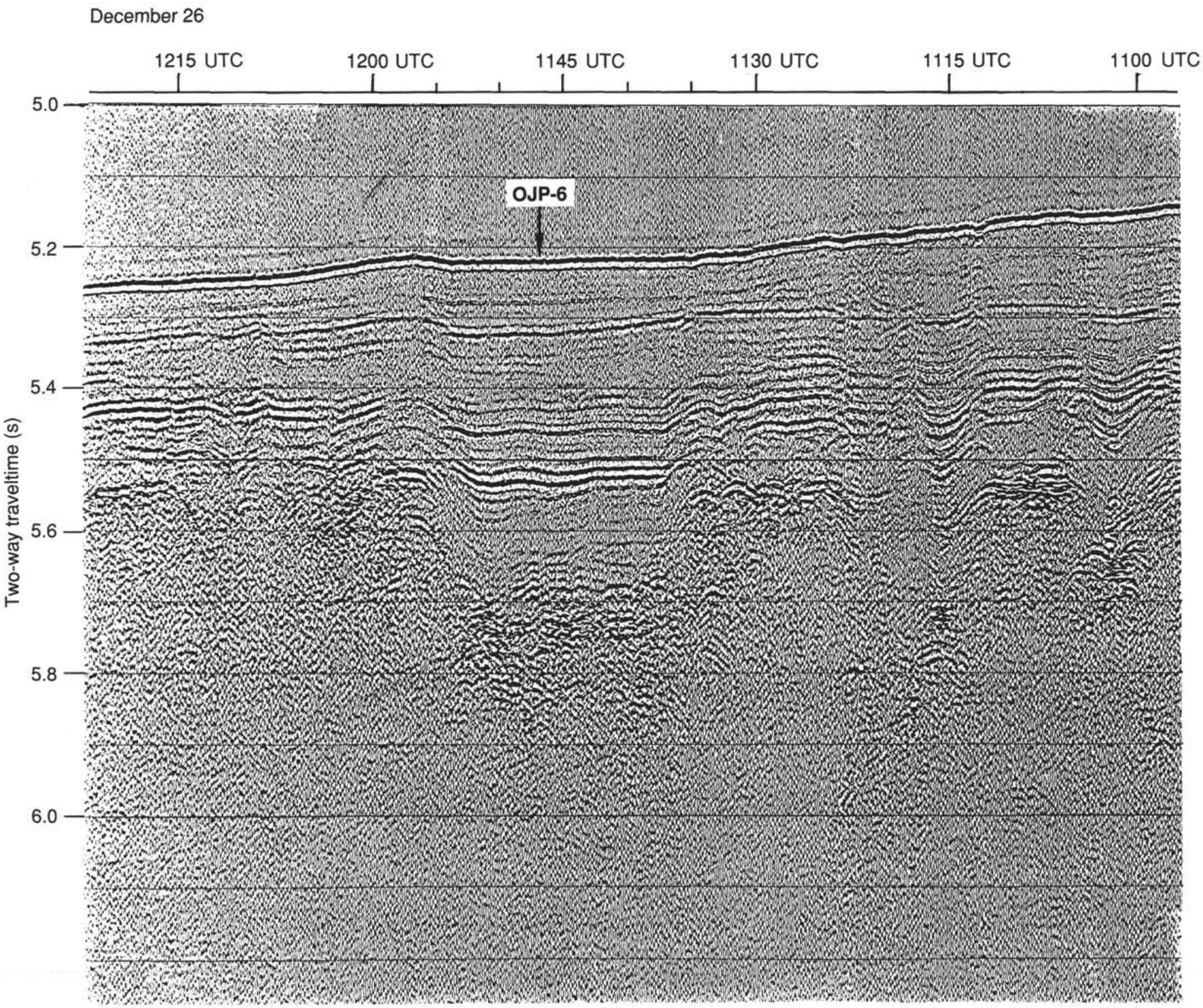
SEISMIC RECORD: ROUNDABOUT cruise 11, at 1145Z, 26 December.

LOGGING: None.

OBJECTIVES: Alternate second site in Neogene transect to obtain a high-resolution sediment record for dissolution and biostratigraphic studies of the Neogene and Quaternary carbonate system.

NATURE OF SEDIMENT/ROCKS ANTICIPATED: Calcareous ooze and chalk.


.30°N
1.00°
0.30°
161°E
162°
163°
26 December
20 December
OJP-6
8
9
10
11
12
13
14
15
16
17
18
7
6


December 26
1215 UTC
1200 UTC
1145 UTC
1130 UTC
1115 UTC
1100 UTC
OJP-6
5.0
5.2
5.4
5.6
5.8
6.0
Two-way traveltime (s)

SCIENTIFIC PARTICIPANTS

OCEAN DRILLING PROGRAM LEG 130

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