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1. INTRODUCTION[1]

Shipboard Scientific Party[2]

MAIN GOALS

The area drilled on the northeastern margin of the Ontong Java Plateau during Ocean Drilling Program (ODP) Leg 130 (Fig. 1) was chosen to provide a depth transect of carbonate deposition in the western equatorial Pacific. Our intent was to recover a complete record of Neogene, Paleogene, and Late Cretaceous ocean history along this transect, with the goal of achieving a detailed reconstruction of paleoceanography and paleoclimate in a well-constrained time frame. The unique geological setting of the plateau led to the accumulation and preservation of a thick cover of pelagic sediments, apparently undisturbed in many areas. Thus, this region appeared to be eminently suited for high-resolution studies of globally significant paleoceanographic signals. In addition, there was the expectation that paleoceanographic events could be traced in the physical properties of the sediment, and that a link to the seismic record would allow three-dimensional regional mapping as well as long-distance correlation. Last, but not least, the origin and tectonic history of the Ontong Java Plateau itself constituted an important objective of our studies.

ONTONG JAVA PLATEAU

The Ontong Java Plateau in the western equatorial Pacific is a broad mid-oceanic submarine plateau striking northwest and paralleling the Solomon Islands to the south (Fig. 1). Its name is taken from an exceptionally large atoll north of these islands. The plateau occupies an extensive area (1000 × 1500 km) and rises to unusually shallow depths in its central region (around 1700 m). The physiography along the margin is complex, with atolls or seamounts located near the western and southwestern edges (Kroenke, 1972).

Pelagic carbonate deposits of Mesozoic and Cenozoic age, well stratified and more than 1000 m thick, cover a large portion of the plateau. Although considerable evidence exists for disturbance, including mass wasting (Berger and Johnson, 1976), one can find many virtually undisturbed sections that display a layer-cake seismic stratigraphy (Fig. 2). The age and origin of these layers has long been a matter of investigation; the suggestion is that they reflect distinct paleoceanographic events (Mayer et al., 1986).

Previous drilling expeditions established the general stratigraphy of the sediment cover (Deep Sea Drilling Project [DSDP] Site 64: Winterer, Riedel, et al., 1971; DSDP Sites 288 and 289: Andrews, Packham, et al., 1975; DSDP Site 586: Moberly, Schlanger, et al., 1986; see Fig. 1), as well as the age of the oldest sediment overlying basalt (Aptian at Site 289). Wide-angle reflection and refraction measurements indicate a remarkably uniform sedimentary velocity structure within the sediment stack, with values ranging from 1.7 to 3.78 km/s over the entire plateau (Maynard et al., 1973). The sediments are carried by anomalously thick oceanic crust (Hussong et al., 1979) that appears to be more than 40 km thick near the center of the plateau. The thickness of the crust bears importantly on the apparent depth stability of the plateau, as seen in the carbonate record.

In addition to the broad, flat-lying, undeformed central part of the plateau, a variety of complex deformational styles that include faulting, folding, and diapiric intrusions are displayed mainly on its southwestern and southern margins (Fig. 3). Presumably, these reflect the collisional relationship of the plateau with the Solomon Island Arc, which also may be responsible for much of the sediment disturbance observed elsewhere.

Three of the DSDP sites mentioned (Sites 64, 288, and 289) were rotary drilled; Site 64 was spot cored and Sites 288 and 289 were continuously cored. Site 586, drilled adjacent to Site 289, was cored with the advanced hydraulic piston corer (APC) to 300 m below seafloor (mbsf), reaching the lowest upper Miocene. This site also was drilled ahead and logged to 623 mbsf (lower Miocene). The most continuous deep sampling of the section was at Site 289 (Leg 30) near the crest of the plateau in a water depth of 2206 m (Fig. 4). Drilling at Site 289 ended at 1271 mbsf in Aptian tholeiitic basalt (113 Ma; R. Duncan, pers. comm., 1990) 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. A number of unconformities were found in the older part of the section, but from the lower Oligocene to Holocene the section is continuous, with diverse and well-preserved microfossils (Andrews, Packham, et al., 1975).

Well-preserved nannofossil ooze was recovered from the upper 300 m of the section at Site 586, with the first chalky layers appearing at 260 m. This site provides a high-resolution Neogene record beginning about 11 Ma that can be compared in detail with our own records. Sedimentation rates at Site 586 vary between 13 and 39 m/m.y., suggesting considerable fluctuations in carbonate productivity or preservation, or both. The amount of reworking and redeposition that occurred at Site 586, however, is in doubt. As reported by the Leg 89 shipboard scientific party, evidence for substantial admixture of sediments from elsewhere was found throughout the section at Hole 586A (Moberly, Schlanger, et al., 1986). In contrast, as described by the Leg 90 shipboard scientific party, evidence for extensive reworking or turbidite layers was not found at Hole 586B, although numerous thin, foraminifer-rich zones ascribed to winnowing were observed in the upper 45 m of the section (Kennett, von der Borch, et al., 1986).

Based on previous drilling results and on tectonic reconstructions of the region (e.g., Kroenke, 1984; Kroenke et al., 1986), a provisional history of the plateau can be compiled. The Ontong Java Plateau apparently began to form before 113 Ma, probably along a west-northwest-aligned spreading 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. During its jour-

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[2] Shipboard Scientific Party is as given in the list of participants preceding the contents.

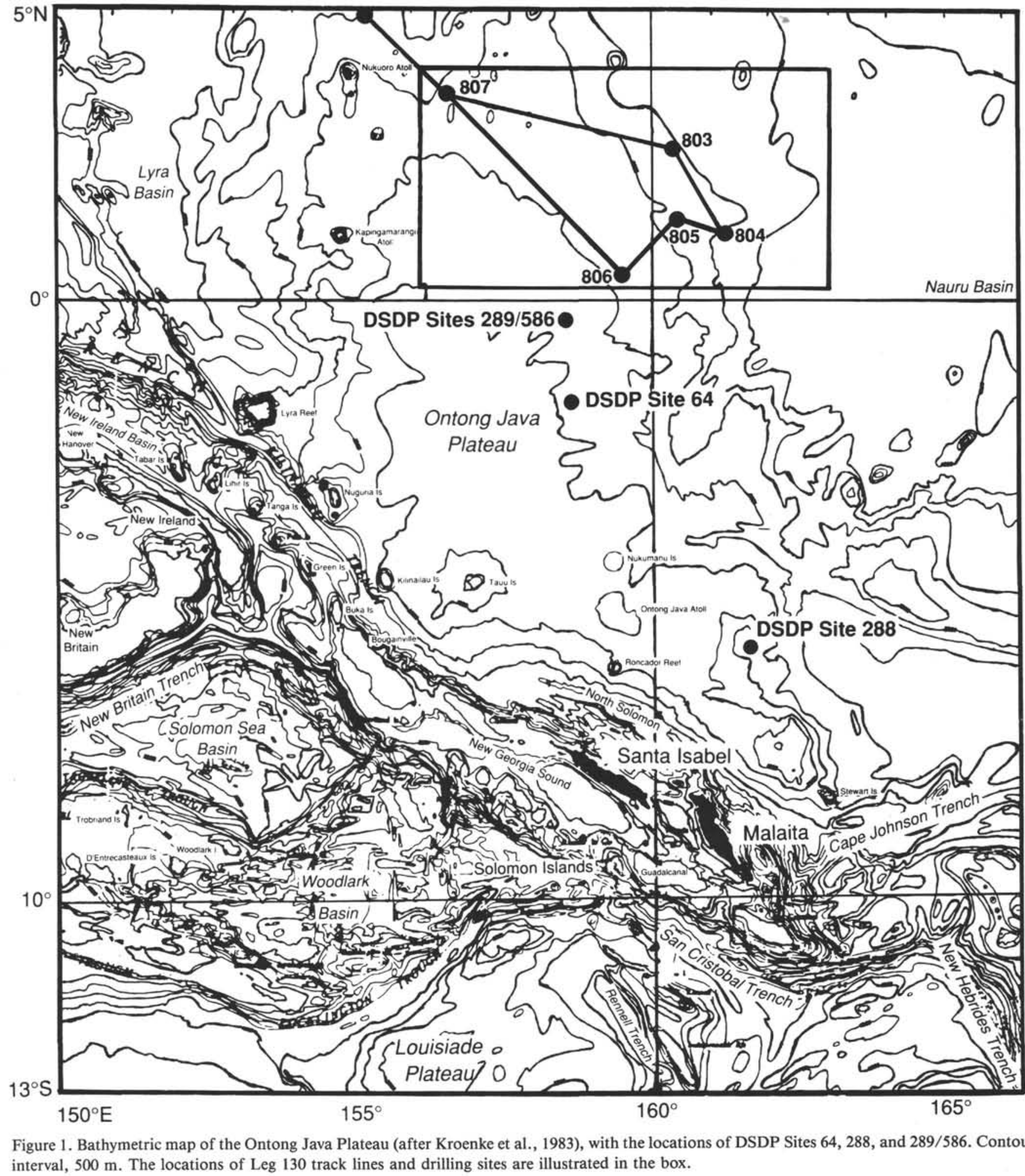

Figure 1. Bathymetric map of the Ontong Java Plateau (after Kroenke et al., 1983), with the locations of DSDP Sites 64, 288, and 289/586. Contour interval, 500 m. The locations of Leg 130 track lines and drilling sites are illustrated in the box.

ney, the plateau accumulated over 1000 m of pelagic sediment, much of which is ooze and chalk. The bathymetric relationships extant today appear to have remained constant throughout its history (Resig et al., 1976).

In late Oligocene time, the southwestern part of the plateau encountered the Outer Melanesian (North Solomon) subduction zone, resulting in an intrusion of dikes and sills along the outer trench rise (Roncador Homocline–Stewart Arch in Fig. 3). Collision of the plateau with the Outer Melanesian Arc (North Solomon Ridge in Fig. 3) ended subduction of the Pacific Plate beneath the arc. Subduction ceased in the latest Oligocene (ca. 25 Ma) when the convergent boundary shifted. Subduction resumed south of the Solomon Islands region in the late Miocene (ca. 10 Ma), forming the New Britain–San Cristobal Trench. Eastward subduction of the Indo-Australia Plate beneath the Pacific Plate brought about the subsequent collision of the Wood-

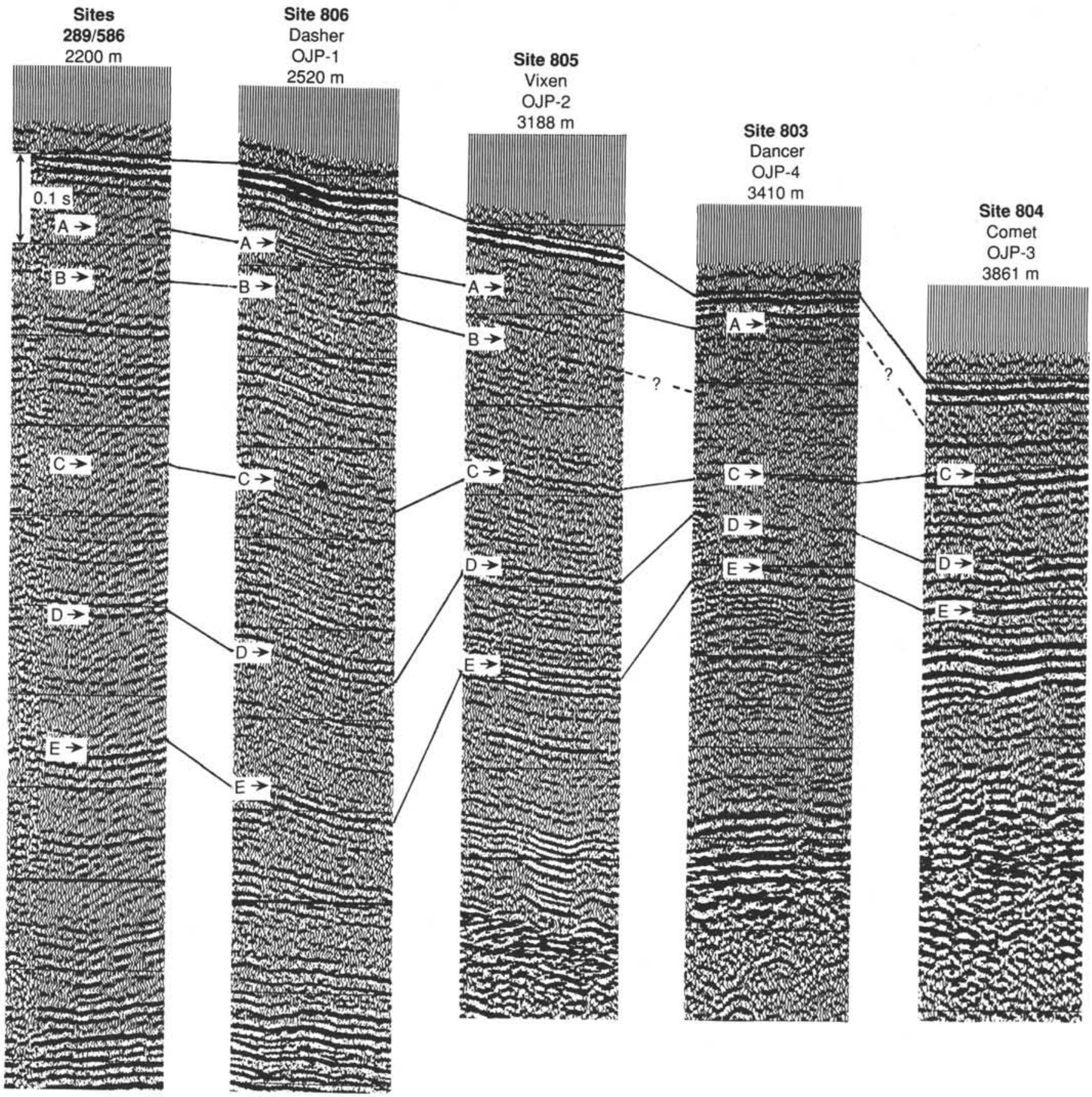

Figure 2. Relationships of seismic sections and marker reflectors on the northeastern flank of the Ontong Java Plateau (after Mayer et al., this volume). Horizontal lines within each section represent 0.1 s of two-way traveltime (twt). See text for discussion of acoustic reflectors (A, B, C, D, and E).

lark Spreading Ridge with the Solomon Islands Arc (ca. 4 Ma). That collision led to the elevation and folding of the southwestern margin of the Ontong Java Plateau, culminating in the formation of the Malaita Anticlinorium (Fig. 3), the overthrusting of the Solomon Arc by plateau oceanic crust, and the emplacement of ophiolites on the islands of Malaita and Santa Isabel (Fig. 1). This overthrusting probably is still occurring.

PALEOCEANOGRAPHIC BACKGROUND

The Ontong Java Plateau has long been a focal point for paleoceanographic studies for several reasons. First and foremost is its remarkable combination of geographic location and bathymetry. For a good part of its Neogene history, the plateau has been located close to the equator, a region characterized by unusually vigorous production of biogenic sediments. Rates of sediment supply to the seafloor are high, potentially providing an expanded sedimentary record. More important, the fact that the plateau rises well above the carbonate compensation depth (CCD), and did so for most of its history, has resulted in the accumulation of a thick pile of calcareous sediment little affected by dissolution. On the flanks of the plateau, however, similar sediments have been affected by dissolution. The contrast between these sections contains clues to the saturation history of the deep Pacific and, hence, to the global ocean carbon cycle.

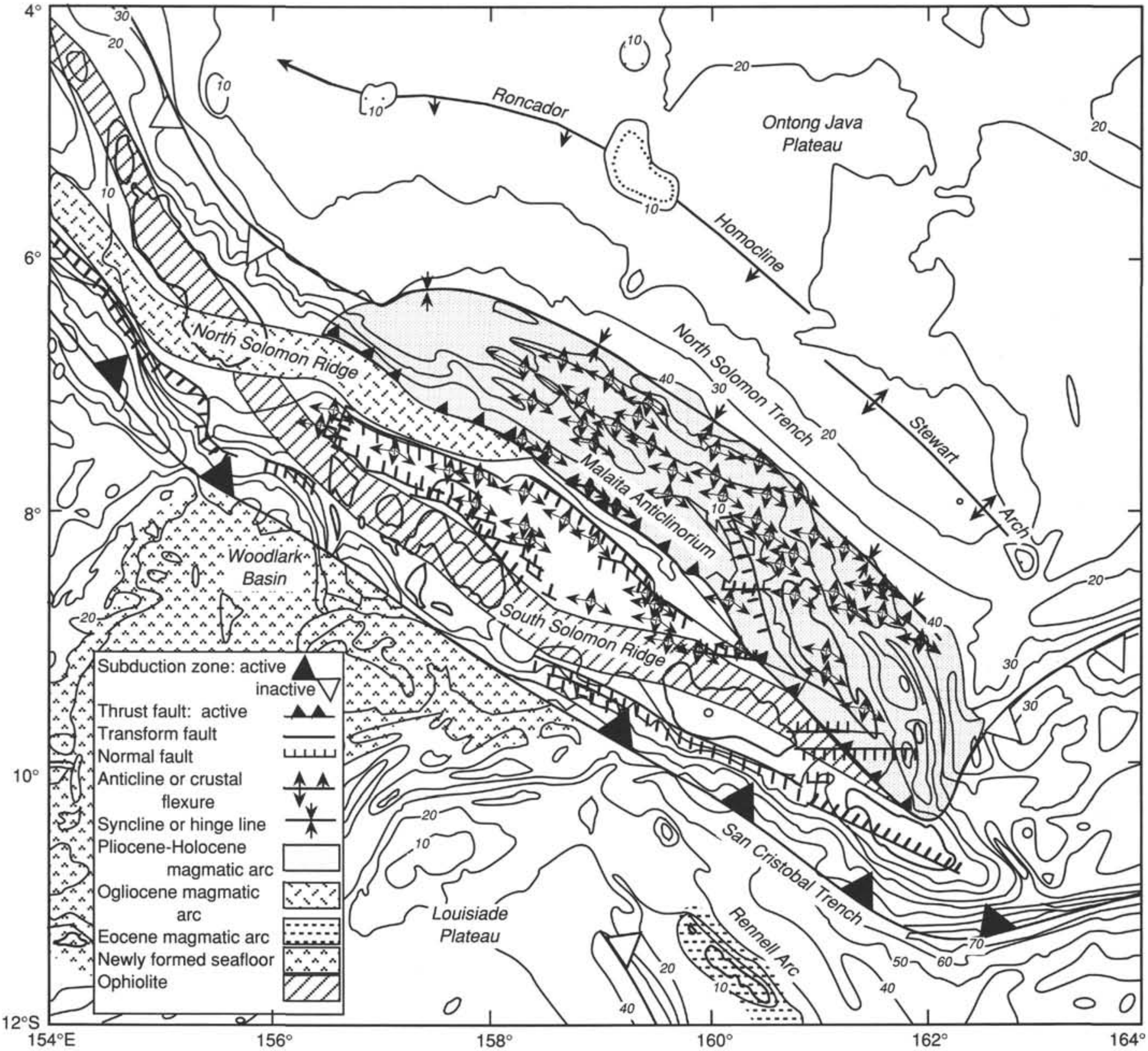

Figure 3. Structural elements of the Solomon Islands and the southwestern Ontong Java Plateau (after Kroenke, 1984; Kroenke et al., 1986).

The accumulation of pelagic carbonate sediments in open-ocean environments is primarily dependent on the rate of production and dissolution of foraminifers and calcareous nannofossils. Productivity is determined by the availability of nutrients, which, in turn, depends on the concentration of phosphate and nitrate in deep waters, and the rates of upward mixing to the photic zone. On a global scale, carbonate productivity controls carbonate dissolution through the requirement that carbonate supplied to the seafloor in excess of input to the ocean must be redissolved for recycling. Thus, a general increase in production also increases the overall dissolution rate. On a regional scale, high production results in increased carbonate deposition and a deepening of the CCD, as observed along the equator (Arrhenius, 1952; Berger and Winterer, 1974; van Andel et al., 1975). Therefore, increased production along the equator results in the increased accumulation of carbonate. Deposition rates for calcareous sediments on the Ontong Java Plateau, consequently, contain global and regional signals of ocean productivity.

NEOGENE OBJECTIVES

A major goal of Leg 130 was to drill four sites down the northeastern flank of the plateau (Fig. 5) to collect a series of continuous sedimentary sequences that would provide a depth transect of Neogene sediments. A series of equatorial drill sites from the top of the Ontong Java Plateau to near its base (Fig. 6) spans a depth range of 2000 m within a short distance. Most of the sediments sampled would have been produced under the same surface-water conditions and deposited from the same pelagic rain material. The depth interval bracketed by our sites (2500–3900 m) contains the depth range in which changes in dissolution gradients through time are most pronounced, with con-

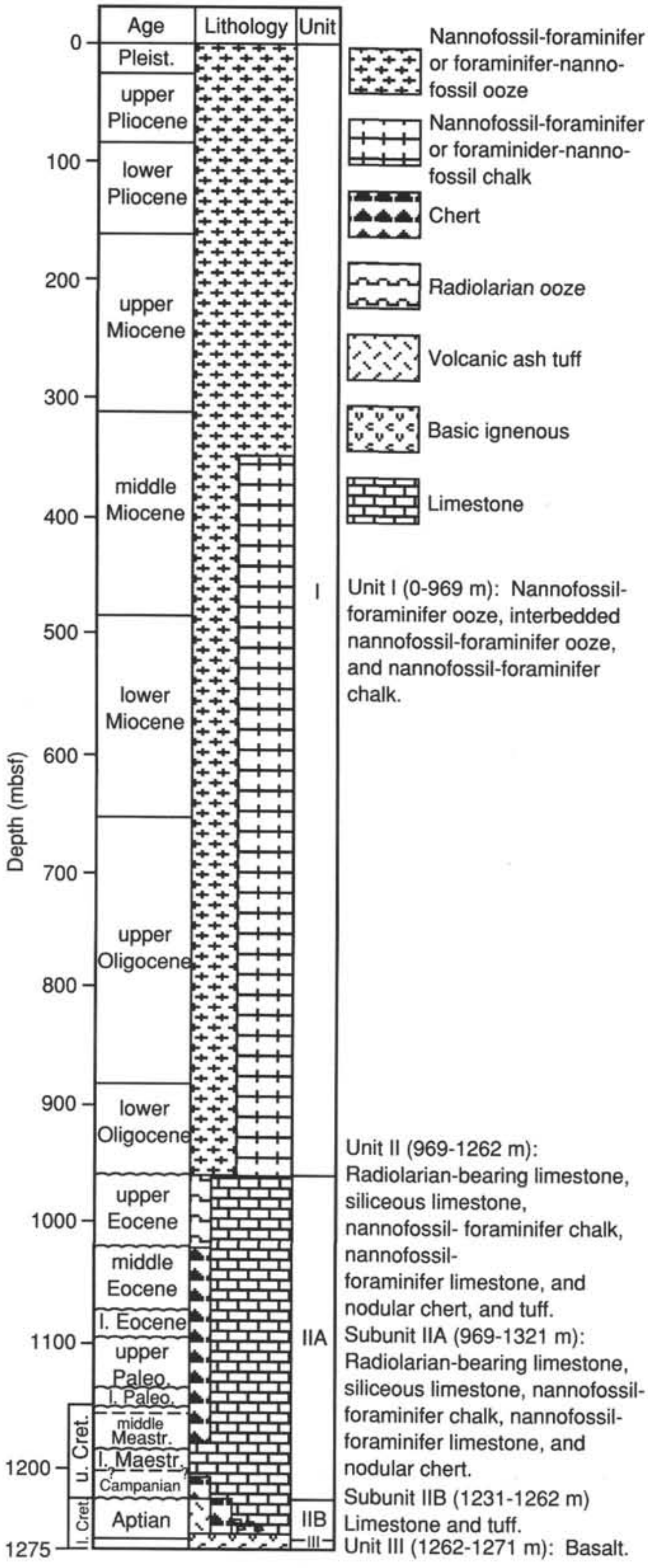

Figure 4. Site 289 stratigraphic column (from Andrews, Packham, et al., 1975).

siderable effects on physical properties and seismic reflectors (Berger and Johnson, 1976; Berger and Mayer, 1978; Mayer et al., 1986).

The favorable geographic and bathymetric characteristics of the Ontong Java Plateau eliminate many of the variables that may influence pelagic sedimentation (i.e., productivity and latitudinal gradients), thereby providing a nearly ideal natural laboratory for evaluating the vertical (depth) distribution of a variety of parameters of paleoceanographic significance.

Beside the patterns of sediment accumulation contained within these deposits, a large amount of information concerning the physical, chemical, paleontological, and sedimentological properties is also stored within them. The paleomagnetic record contains signals pertaining to the sedimentation of magnetic minerals and the history of the Earth's magnetic field. Other physical properties measurements reveal details about the diagenetic history. Stable isotope studies of foraminifer species permit the reconstruction of paleotemperature, strength of the thermocline and oxygen minimum, origin of deep waters, global ice volume, and other parameters important for ocean and climate history. Micropaleontological analyses provide additional paleoenvironmental data and allow high-resolution correlation between cores. The site reports and individual contributions present an introduction to these interpretations, but much remains to be extracted.

With regard to the Neogene objectives, the study of sediments drilled and cored along the depth transect was expected to yield the following:

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 links to climatic parameters and bottom-water properties;
3. a detailed sedimentary record that will provide a better understanding of the nature and role of carbonate dissolution in the deep sea and that will attempt to quantify amounts of dissolution (which is necessary to address the CO_2 problem and related questions);
4. a high-resolution sedimentary record necessary for the completion of a global network of equatorial depth transects that will yield a better understanding of basin-basin fractionation and biotic evolution as well as a pelagic standard for comparison with marginal transects to clarify basin-shelf fractionation; and
5. a sedimentary record that will contribute to our understanding of the origin of seismic reflectors on oceanic plateaus and that will enable us to make comparisons with seismic horizons in oceanic basins.

PRE-NEOGENE OBJECTIVES

The Cretaceous-Paleogene section also was important to us because of the intrinsic interest of unfamiliar ocean conditions outside of the range of the Neogene, and also because this record provides a reference for Southern Hemisphere paleoceanography and bears on the early history of the plateau itself. Major hiatuses were encountered in Upper Cretaceous-Paleogene sediments at DSDP Sites 288 and 289, which makes it unlikely that complete sequences are readily available. However, 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 represent local events of limited areal extent (Andrews, Packham, et al., 1975). Drilling at other locations on top of the plateau, therefore, may recover key sections missed at earlier sites. Such additional data may allow us to be able to differentiate

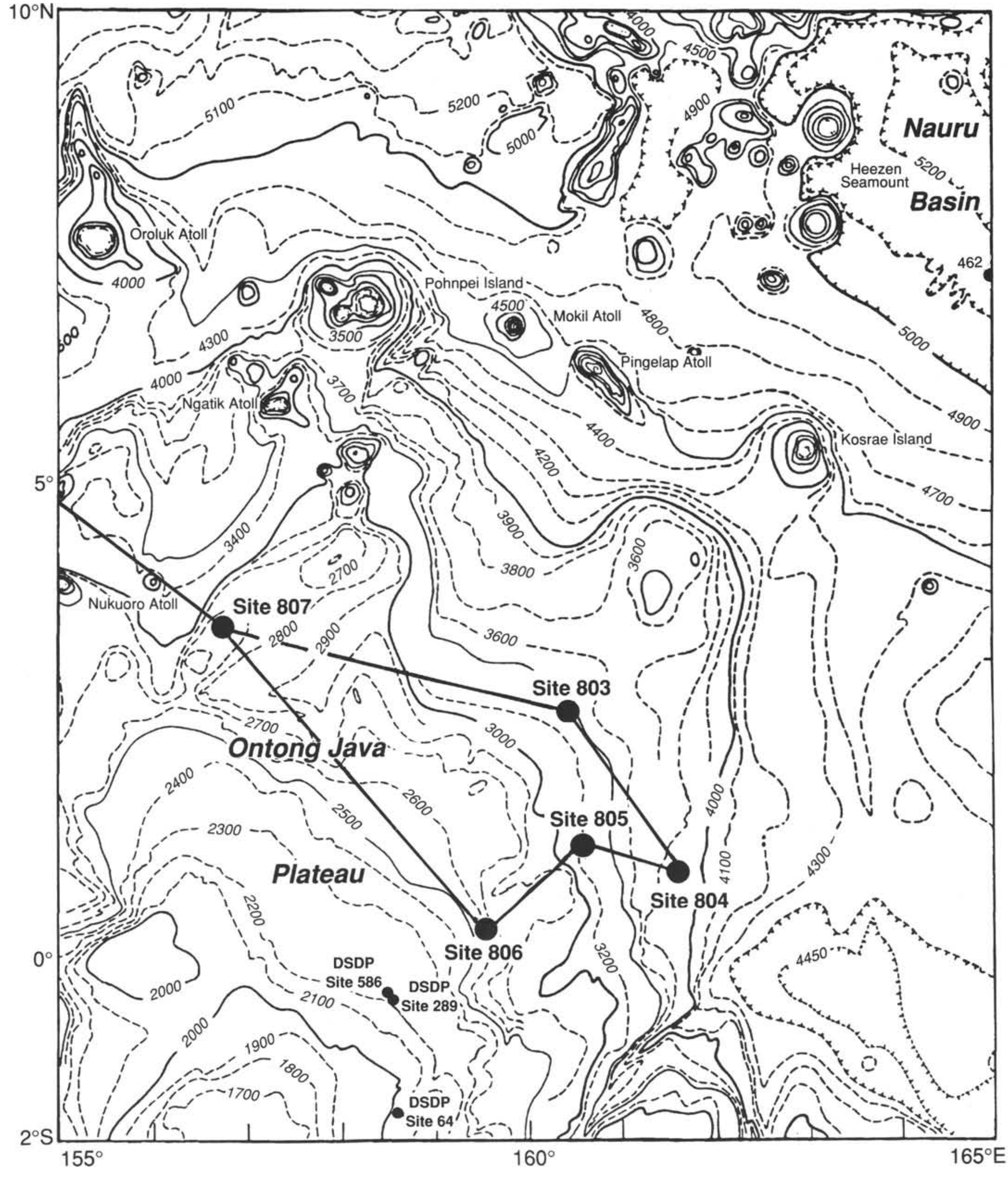

Figure 5. Bathymetric map (in meters) of the northwestern part of the Ontong Java Plateau (after Mammerickx and Smith, 1985). Locations of Leg 130 drill sites as well as sites drilled on DSDP Legs 7 (Site 64), 30 (Site 289), and 89 (Site 586) are provided for reference.

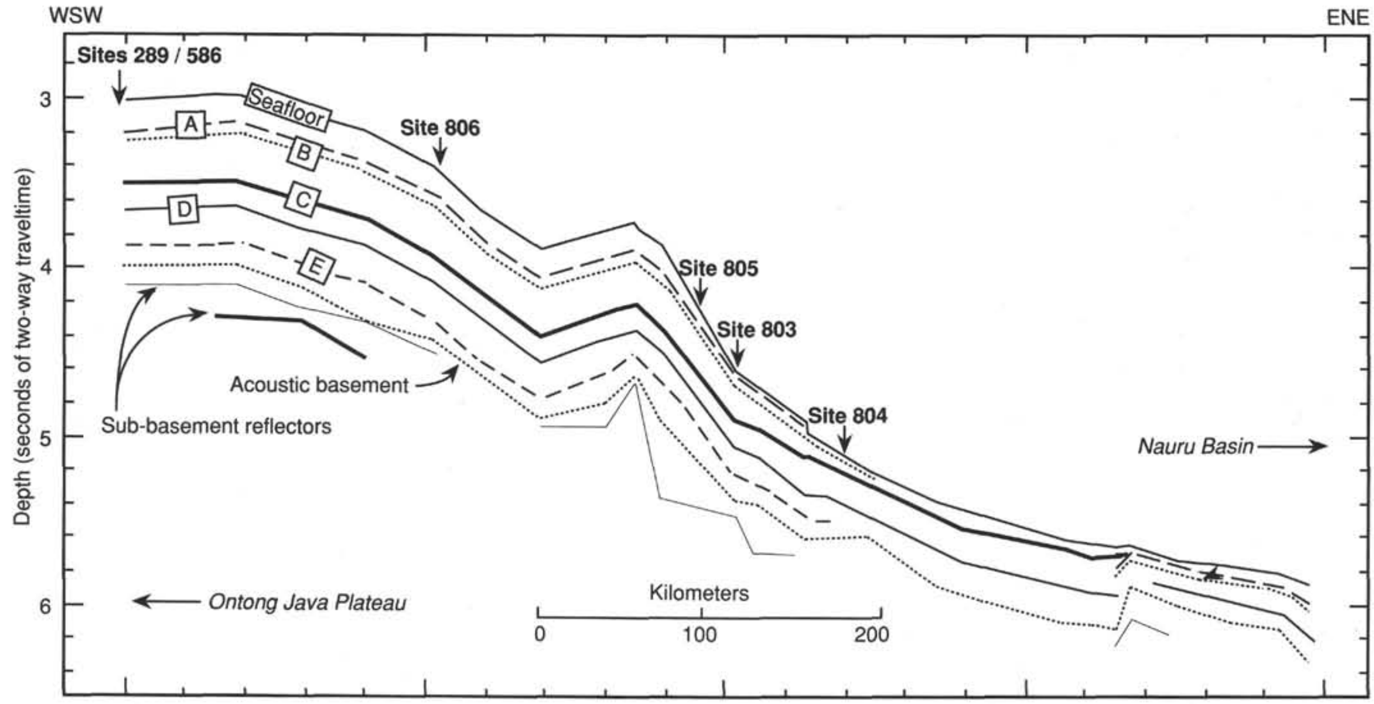

Figure 6. Generalized single-channel seismic (SCS) profile down the northeastern flank of the Ontong Java Plateau with the projected locations of Neogene transect Sites 803-806. See Mayer et al. (this volume) and seismic stratigraphy sections in each site report for discussions of acoustic reflectors labeled A-E in this figure.

Table 1. Events in the central equatorial Pacific, their age, sedimentary causes, and associated events.

Approximate age (Ma)	Geochemical events	Hiatus	Paleoceanographic events	Primary cause of relector
3.0-3.5	Benthic ^{18}O enrichment. $CaCO_3$ dissolution.		Closing of Panama Isthmus. North Hemisphere glaciation? North Atlantic erosion.	Carbonate miminum.
6.5-7.5	Chron 6 ^{13}C depletion	NH6	Increased isolation of Mediterranean Sea. Climatic deterioration.	Carbonate minimum.
8.5-9.5	Benthic ^{18}O enrichment. Mid-Chron 10 $CaCO_3$ dissolution event.	NH5 NH4?	Major North Atlantic erosion. Increase of siliceous deposition in Pacific. Major cooling. Major drop in sea level.	Extreme carbonate minimum.
13.5-14.5	15c $CaCO_3$ dissolution event. Benthic ^{18}O enrichment.	NH3?	Ice buildup in Antarctica. Intensification of Antarctic Bottom Water production.	Carbonate minimum.
16.5-17.5	16g $CaCO_3$ dissolution Chron 16 ^{13}C enrichment.	NH1b	Closing of Tethys. Norwegian Sea spillover. Intensified Pacific upwelling.	Carbonate minimum.
20.5-22.5		NH1a?	Opening of Drake Passage. Establishment of Circum-Atlantic Current and of a steep Southern Hemisphere thermal gradient.	Diagenesis.

Note: Source of data is from Theyer et al., 1989.

widespread (water-mass-controlled) unconformities from those produced locally by tectonic events or bottom currents.

With regard to Leg 130 objectives for Cretaceous and Paleogene sediments on the Ontong Java Plateau, our goals were as follows:

1. to fill critical gaps in Cretaceous biostratigraphy and paleobiogeography;

2. to estimate the original basement depth of the plateau and its subsequent bathymetric change from benthic foraminifers and, possibly, from the history of carbonate dissolution;

3. to investigate the record of Cretaceous anoxic events in the South Pacific and thereby increase understanding of the mechanisms that cause oceanwide deposition of organic-rich sediments; and

4. to recover a well-preserved Cretaceous/Tertiary boundary that might provide insights into the causes of mass extinctions.

We were aware that all but the first of these objectives would be difficult to achieve and that their realization would depend on circumstances of sediment recovery. Regarding paleobathymetry, the depth range of bathyal foraminifers is commonly quite broad, and the depth range of dissolution levels is poorly constrained in these older sequences. Successfully addressing the third and fourth objectives above is, to a large extent, a matter of luck; that is, the desired section of the proper age must be preserved in a sequence known to contain abundant hiatuses. Also, the appropriate section has to be in the recovered portion of the cored interval. Despite such odds, however, we did recover sediments appropriate to the purpose.

The Ontong Java Plateau is one of the few locales in the Pacific where it is possible to recover a fully pelagic biostratigraphic record from Mesozoic carbonates deposited in the Southern Hemisphere. Because the plateau migrated toward the equator 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 from Sites 288 or 289, a boundary point for the Austral realm in the Pacific can be established.

BASEMENT OBJECTIVES

Drilling into basement and recovering a substantial amount of basalt was the final item on our list of objectives. The origin of the old, oceanic Pacific plateaus (Ontong Java, Manihiki, Shatsky, Hess, Magellan) is poorly understood, and progress in this field on Ontong Java would be crucial. The Ontong Java Plateau has an unusually thick crust of truly continental proportions (~40 km thick on the main high plateau; e.g., Hussong et al., 1979). Even on the edges of the 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 unpubl. data, 1989). If there is continental crust on any of the large Pacific intraoceanic plateaus (as has been surmised by some), the Ontong Java Plateau, with by far the thickest crust, would seem to be one of the most favorable places to find it. A deep basement hole on the main high plateau (Fig. 5, Site 807) would go far toward settling this issue.

We drilled into basement on Ontong Java Plateau for the following reasons:

1. to determine the nature of the crust on the Ontong Java Plateau, that is, to establish the lithology, petrogenesis, and sources of Ontong Java Plateau crustal material;

2. to determine the age of the basement and paleolatitudes of the Ontong Java Plateau so that we can understand the origin and subsequent movement of the plateau better; and

3. to compare the basement composition of the Ontong Java Plateau with that of the extensive "mid-Cretaceous" volcanic events of the Pacific for insights into the origin of both features.

Age information on a deep basement hole can be obtained from radiometric dating (Ar-Ar), possibly from microfossils in sediments overlying the igneous rocks, and the M-series magnetic-polarity record. 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 288 and 289 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 and Henderson, pers. comm., 1987).

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