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1. BACKGROUND AND INTRODUCTION[1]

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INTRODUCTION

Leg 123 of the Ocean Drilling Program (ODP) was undertaken in the northeast Indian Ocean, off the northwestern margin of Australia. This margin forms one of the oldest continent/ocean boundaries on Earth (approximately 160 Ma, Middle to Late Jurassic) and is comparable in age to the conjugate margins of eastern North America and northwestern Africa. In the early Mesozoic, the Australian margin was part of a continental rift zone on eastern Gondwana, the common name for the supercontinent that united the southern landmasses from Permian to Early Cretaceous time (Fig. 1). To the north of Gondwana lay the Tethys Sea, which, in his 1893 address to the Geological Society of London, the geologist E. Suess described as follows (Suess, 1893): "...a great ocean which once stretched across part of Eurasia. The folded and crumpled deposits of this ocean stand forth to heaven in Tibet, the Himalayas, and the Alps. This ocean we designate by the name 'Tethys,' after the sister and consort of Oceanus. The latest successor of the Tethys Sea is the present Mediterranean...." The geological transition from Tethys into the modern Indian Ocean commenced with Late Jurassic to Early Cretaceous rifting along the north- and west-facing margins of Australia, leading to the formation of the Argo and Gascoyne Abyssal plains (Figs. 2 and 3).

It is not clear how the incipient Argo Ocean connected to Tethys; paleogeographic reconstructions diverge on the symmetry of the initial oceanic graben that became the Argo Abyssal Plain. The reason for this is simply that the matching half of the Mesozoic Argo Ocean was lost during the massive reorganization of Southeast Asia in post-Mesozoic time. Audley-Charles (1989) showed a Jurassic Argo rift graben delimited by continental blocks; Australia with Timor and New Guinea laid along the southern margin; and a speculative continental sliver with parts of Burma, Malaya, and the Indonesian Archipelago that formed the northern side of the Jurassic rift graben. Reconstructions by Sengor (1987) and Bernoulli and Lemoine (1980) avoided concise paleogeographic rift models for the initiation of the Late Jurassic to Early Cretaceous Indian Ocean in the Argo and Gascoyne areas.

As a result of the difficulties encountered in reconstructing the Mesozoic paleogeography of the northwestern Australian margin, deep-marine water exchange and surface circulation patterns from Tethys to the early Argo Ocean are speculative. Deep-marine benthic foraminiferal assemblages in Jurassic to Cretaceous sediments of Deep Sea Drilling Project (DSDP) Site 261 in the Argo Abyssal Plain (see below) compare to coeval assemblages in the Atlantic Ocean; this points to open-ocean connections with Tethys and the early Atlantic (Gradstein, 1983). We do know that paleomagnetic reconstructions show a dramatically shifting polar-wander path for the Australian Plate: the northwestern margin rotated from about 30°S in Jurassic time to about 45°S in the Early Cretaceous and greater than 50°S in the Late Cretaceous (Table 1). Rifting between Antarctica and southern Australia was initiated during the Cenozoic (Fig. 2) and resulted in the steady northward drift of Australia to its present position near 16°S. Consequently, the northwestern margin of Australia has moved out of, and back into, the carbonate (reef) depositional belt since Jurassic time.

In mid-Tertiary time, Australia collided with the Sunda Arc to the north (Fig. 2). This led to the cessation of circum-equatorial surface circulation and resulted in a stronger influx of cold Antarctic water. Steadily lowering global sea level, punctuated by relatively large and more sudden declines of sea level in the Oligocene and Miocene, caused shelf progradation and submarine erosion and canyon cutting, leading to increased continental margin-derived sedimentation over the Argo Abyssal Plain.

ODP Legs 122 and 123 represent a combined study of the northwestern margin of Australia. Leg 123 investigated the outboard area of the Exmouth Plateau in the Argo and Gascoyne Abyssal plains, whereas the continental margin was drilled at five sites during Leg 122 (Leg 122 Shipboard Scientific Party, 1989). The geographic positions of the two drill sites designated for Leg 123 are indicated in Figure 3. Site 765 is in a water depth of 5.7 km over volcanic basement, postulated as of late Oxfordian age on the basis of magnetic lineations. The site is approximately 75 km north of the Argo-Exmouth ocean/continent boundary (Fig. 4). Site 766 is in a water depth of 4.5 km, at the foot of an escarpment on the western Exmouth Plateau. Sediment thicknesses for Sites 765 and 766 are estimated at 950 and 550 m, respectively. A schematic outline of the regional stratigraphy along three oceanward transects that closely intersect the Leg 123 abyssal sites is given below. Details on the seismostratigraphy, lithostratigraphy, and chronostratigraphy near the sites may be found in the Sites 765 and 766 chapters (this volume).

Scientific Objectives

The scientific objectives of Leg 122 were principally related to the post-Permian rifting of the Exmouth Plateau. Those of Leg 123 addressed the final stages of rifting and the formation of volcanic basement and early oceanic sediments in the adjacent Argo and Gascoyne Abyssal plains. The following specific objectives were proposed for Leg 123:

1. To compare the sedimentation, tectonic events, and seismic stratigraphic sequences of the Argo and Gascoyne Abyssal plains with those on the northwestern Australian continental margin and correlative geological settings in the North and South Atlantic oceans.
2. To improve the Mesozoic, and particularly the Late Jurassic to Early Cretaceous, magneto-biostratigraphy and the geological time scale for mid- (paleo) latitudes.
3. To determine the nature of magmas associated with final stages of rifting at a continental margin and the formation of the earliest Indian Ocean crust.

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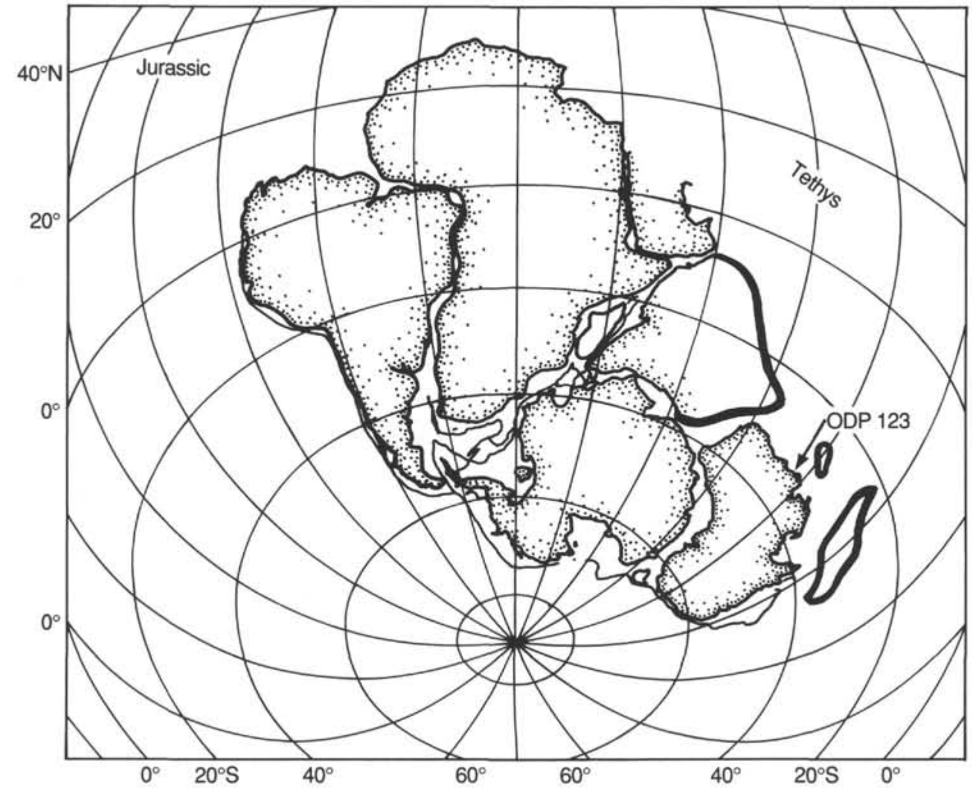

Figure 1. Reconstruction of Gondwana for Jurassic time (>160 Ma; after Scotese and van der Voo, 1982).

4. To provide a "geochemical reference site" in sediments and oceanic basement for use in global mass-balance models.

5. To undertake a unique set of logging experiments in an 1150-m section of sediments and oceanic crust, involving vertical seismic profiling, permeability testing in oceanic crust, hydro-fracture experiments for stress analysis, and determination of the regional stress pattern of the eastern Indian Ocean.

Regional Geology at Site 765

The Argo Abyssal Plain is an extremely flat, about 5.7 km deep, abyssal plain located north of the Exmouth Plateau and west of the Scott Plateau (Fig. 3). On the north it is bounded by the Java Trench. It is underlain by the oldest oceanic crust known in the Indian Ocean; this crust, since the Cenozoic, has slowly been consumed by the convergence of Australia and the Sunda Arc. Together with the Exmouth Plateau, the Argo Abyssal Plain represents a passive margin that was starved of sediment because of a dry climatic regime and the low relief of northwestern Australia. The result was a thin, approximately 2500-m sequence of syn- and post-rift sediments, which at Site 765 at the southernmost limit of the Argo Abyssal Plain, is condensed into a 1000-m section. The sedimentary history of the margin is thus amenable to stratigraphic analysis by deep ocean drilling. An additional advantage of the relatively thin sedimentary sequence is the potential for drilling basement lithologies that were emplaced in Jurassic time and now provide the substratum to the abyssal sedimentary sequence.

In the Argo Abyssal Plain, marine magnetic surveys (Larson, 1975; Heirtzler et al., 1978; Veevers et al., 1985; Fullerton et al., 1989) clearly show that the basement is volcanic; these studies delineated the location of marine magnetic anomalies, generally trending N70°E (Fig. 4). Using the Hawaiian and Keathley marine magnetic anomaly sequences (from the Pacific and the Atlantic oceans, respectively) and the accepted Late Jurassic age of basal sediments at DSDP Site 261, the presence of M25 to M16 marine magnetic lineations and isochrons is indicated (Fig. 4). The paleomagnetic reversal time scale of Ogg (1989) suggests that at Site 765 basement may be of late Oxfordian age. Site 765 is less than 75 km from a prominent positive magnetic anomaly that lies along the continent/ocean boundary (COB of Veevers et al., 1985).

Seismic surveys also indicate that the basement is volcanic. The multichannel seismic expression of the strata over the site is shown in a portion of the Australian Bureau of Mines multifold site survey Line 56-23 (Fig. 5). Site 765 spans 1 s of two-way traveltime penetration of relatively soft sediments (approximately 900 m). Flat-lying sedimentary reflectors contrast with the characteristic hyperbolic reflectance of basement. The site itself is situated over a smooth basement surface that contrasts with the rougher, block-faulted terrain on either side.

DSDP Site 261 (Veevers, Heirtzler, et al., 1974), drilled during DSDP Leg 27, is located approximately 320 km to the north of Site 765 (Figs. 3 and 4). Its lithologic succession was used to predict lithologies drilled at Site 765. Recovery of sediments at this site was, on average, less than 23%. The age of the section is ambiguous because of imprecise magnetostratigraphy and an incomplete biostratigraphic record; a controversial site biostratigraphy gives basal sediment ages of Valanginian to Oxfordian/Kimmeridgian (see below). Magnetostratigraphic lineation interpretations place DSDP Site 261 at M23, in the late Kimmeridgian. Tholeiitic basalts drilled at the base of this hole are typical mid-ocean ridge basalts, but are overlain by a sill of more evolved iron-titanium basalt (Robinson and Whitford, 1974).

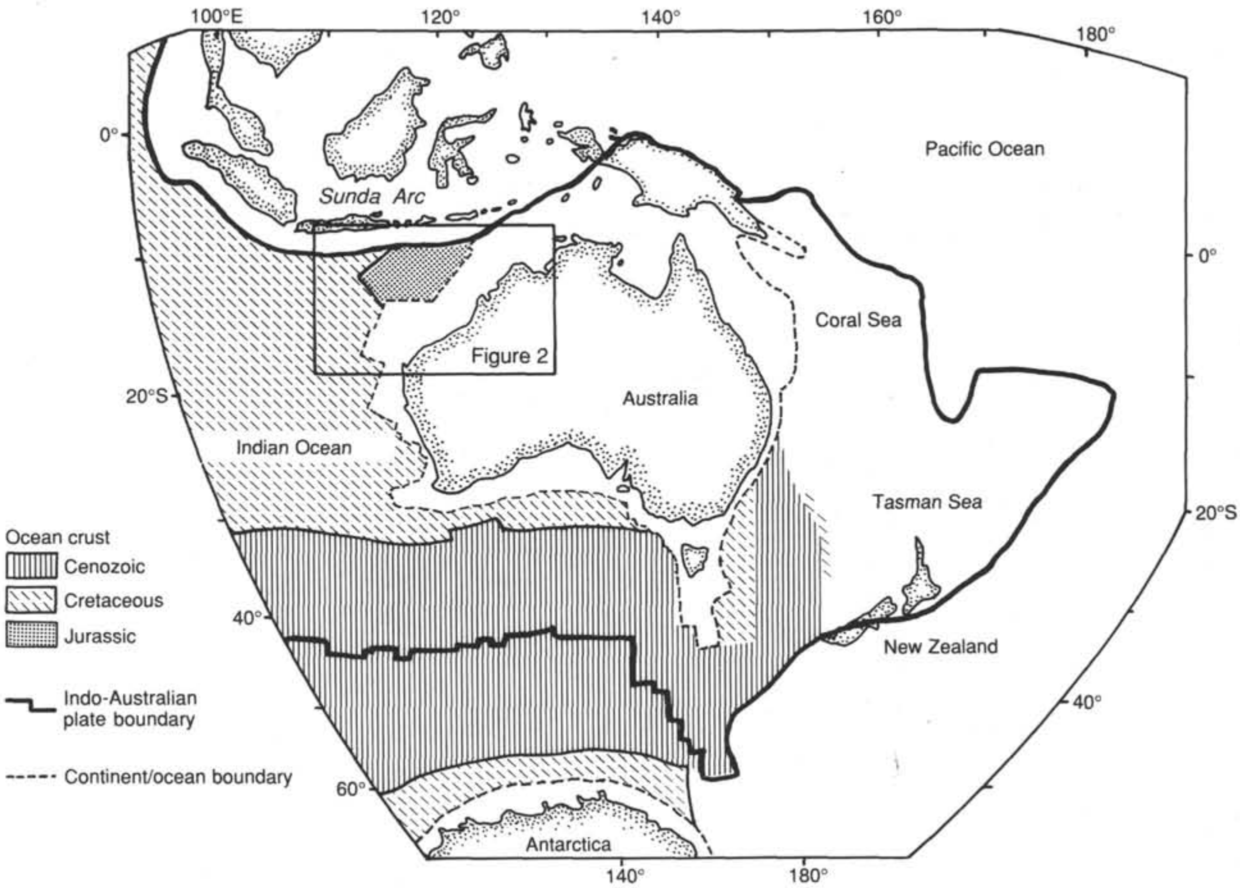

Figure 2. Map showing plate tectonics of Australia and neighboring continents and oceans.

Regional Geology at Site 766

Site 766 is located on the western limit of the Exmouth Plateau, at the foot of the continental slope, leading to the Gascoyne Abyssal Plain (Fig. 3). The seafloor represents an erosional surface that may expose strata as old as Cretaceous. On seismic Line 55-3E (Fig. 6), the sedimentary section is less than 0.5 s (500–700 m) of two-way traveltime. This section overlies a faulted basement, which may represent the top of volcanics intermediate between oceanic and continental basement. The overlying 500- to 700-m-thick sedimentary sequence was interpreted as including Triassic to Jurassic pre- and syn-rift strata, overlain by deep-marine, post-rift Cretaceous and Paleogene sediments. However, the post-rift sequence appears to overlie directly oceanic basement. Seafloor spreading in the Gascoyne region is constrained by the Hauterivian to Barremian age of sediments overlying tholeiitic basalt at DSDP Site 260 and the difficult identification of the M-sequence lineations (Fullerton et al., 1989; Fig. 4). Seafloor spreading is thought to have started in M10 time at the Valanginian/Hauterivian boundary, with a spreading jump seaward between M5 and M4 time (late Hauterivian) (Fig. 4). Backtracking calculations, assuming a Valanginian age for basement at Site 766, predict bathyal (900 m water depth) sediments on basement. Both Sites 765 and 766, with relatively thin sedimentary covers, represent prime sites for studies of biostratigraphy and magnetostratigraphy, subsidence history, and basement formation and rifting in a passive margin.

Stratigraphic Cross Sections

To place the geology of the Argo and Gascoyne Abyssal plains in a regional framework, we have included three east-to-west schematic cross sections from the Australian continental margin toward the abyssal plains (Fig. 7). These sections are based on seismic data and stratigraphic interpretations from exploratory wells and dredges (von Stackelberg et al., 1980; von Rad and Exon, 1982; Bradshaw et al., 1988). The main features of the geological development of the plateaus are as follows. The sediments beneath Exmouth Plateau (cross section A-A' in Fig. 7) were deposited in an extension of the Carnarvon Basin (Fig. 3) that formed a north-facing Tethyan embayment in Gondwana and received detrital sediments from the south and the east until Early Cretaceous time. In the central plateau region, at least 3000 m of mainly paralic and shallow-marine detrital sediments, derived from the south and east, covered the Triassic to Jurassic block-faulted surface. About 200 m of shallow marine sediments was deposited in the middle Cretaceous, followed by 500 to 1000 m of Upper Cretaceous to Cenozoic pelagic carbonate sediments. The Exmouth Plateau Arch and landward Kangaroo Syncline probably warped to their present form during the Miocene, by which time the central plateau had subsided to bathyal depth (cross section A-A' in Figs. 3 and 7).

The northern Exmouth Plateau experienced a Cretaceous to Cenozoic evolution similar to that of the central plateau (cross section B-B' in Fig. 7). However, a sequence of 1- to 3-km-thick probable Triassic to Lower Jurassic shelf carbonates were deposited north of the "North Exmouth hingeline," during a time when the central Exmouth Plateau was being eroded (e.g., on the Wombat Plateau, drilled during Leg 122; see cross section B-B' in Fig. 7). The available data indicate that in Jurassic time breakup occurred along the northeastern rim of Gondwana and quickly led to formation of an abyssal oceanic graben north of

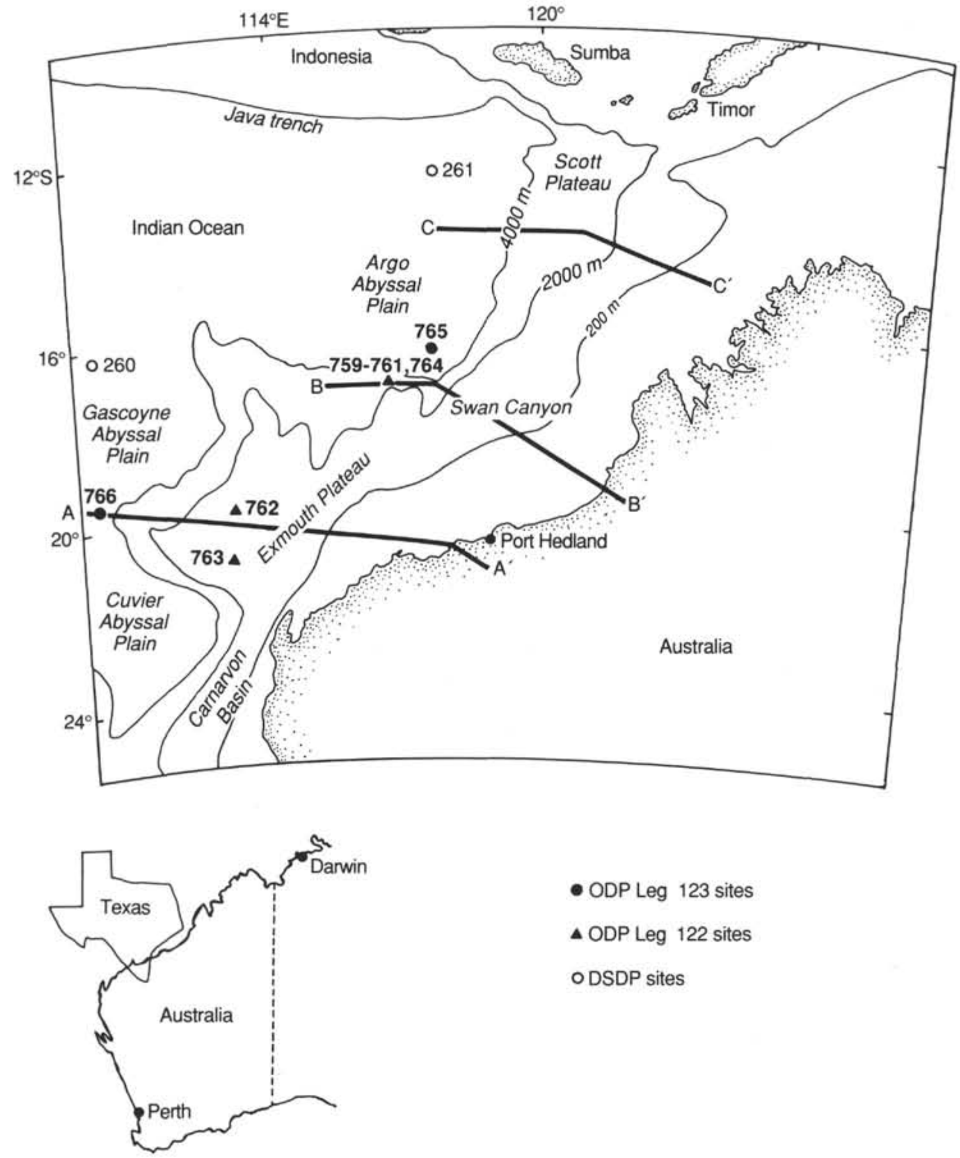

Figure 3. Geography of northwestern Australia and location of ODP sites drilled during Leg 122 (closed triangles) and Leg 123 (closed circles). The transects A-A', B-B', and C-C' refer to the geological cross sections in Figure 7.

the Exmouth Plateau: the present Argo Abyssal Plain. This was followed in the Early Cretaceous by separation of Australia and India, when seafloor spreading was initiated in the present Gascoyne and Cuvier Abyssal plains, to the west of these plateaus.

In the Cretaceous, over 500 m of calcareous claystone accumulated in these sediment-starved, deep-ocean basins (cross section C-C' in Fig. 7), presumably derived from the southeast. Since then, more than 400 m of zeolitic clay, siliceous clay, and calcareous ooze turbidites has been deposited in these oceanic basins. Backtrack curves for DSDP Sites 260 and 261 indicate initial mid-ocean ridge depths near 2500 m, close to the world average. Cooling of normal ocean crust, therefore, can account for most of today's ocean depths along the northwestern Australian margin.

The Jurassic to Cretaceous Time Scale

Modern geological time scales make use of several methods to construct relative and linear scales that link successive geological events. The first step is to weld biostratigraphic zonations to a common chronostratigraphic scale using different fossil groups. Ideally, the same sections that yield fossil biozonations should be used to erect a geomagnetic reversal stratigraphy and to arrive at an integrated magneto-, bio-, and chronostratigraphy. The next step is to expand the relative chronostratigraphic scale along the linear time axis and to create a geological time scale measured in Ma (10^6 yr) units. Several methods exist to convert the relative stratigraphic framework to one that is on a linear scale (Gradstein, 1985). The optimum method requires detailed inter-relation of sedimentary and marine magnetic (lineation) reversals and multiple biostratigraphy with many stratigraphically meaningful, radiometric measurements.

A Late Jurassic to Early Cretaceous bio-magnetostratigraphy that can be applied to lower-southern and higher-northern latitudes is still undeveloped. M-sequence magnetic reversals have been correlated with ammonite, calpionellid, nannofossil, dinoflagellate, radiolarian, and foraminiferal events or zonations in

Table 1. Estimated paleolatitudes for Site 765, Argo Abyssal Plain.

Age (Ma)	Time period (approx.)	Paleolatitudes, Site 765 Argo Abyssal Plain	
0	Present	16°S	Rapid rate of northward
10	middle/late Miocene	24°S	drift during late
21	early Miocene	26°S	Tertiary
37	early Oligocene	38°S	
44	middle/late Eocene	40°S	
57	late Paleocene	41°S	
66	K/T boundary	40°S	
82	Campanian/Santonian	53°S	"Hairpin" in path
95	Cenomanian/Albian	44°S	
108	middle Aptian	44°S	90° clockwise rotation
118	middle Aptian	45°S	with no latitude
128	Barremian/Hauterivian	47°S	change
160	Oxfordian	32°S	"Hairpin" in path to
200	Early Jurassic	31°S	low latitudes
240	early Triassic	60°S	Permian glaciation

These data are based on the apparent polar wander path for Australia. This path is derived from a suite of paleomagnetic results from radiometrically dated Mesozoic intrusives and Cenozoic laterite soil horizons. A smooth curve of constant continental drift and direction is assumed between each paleomagnetic pole. Uncertainties (95% confidence levels) in these paleolatitude estimates range from about 5° for the Late Cretaceous and Triassic-Early Jurassic to 13° for Late Jurassic-Early Cretaceous. Corresponding time periods for absolute ages are derived from the Leg 123 bio-chronostratigraphic time scale (see "Explanatory Notes" chapter, this volume). Paleolatitudes are derived from data of Embleton (1981) and Embleton and McElhinny (1982) and summarized by Embleton (1984) and by Johnson and Veevers (1984).

sedimentary sections, particularly at and near the Jurassic/Cretaceous boundary (Ogg and Lowrie, 1986). These studies have been undertaken only in the Tethyan-Atlantic realm, and have never been successfully conducted on middle- to higher-latitude fossil assemblages of the southern or northern regions. Figure 8 shows the few ocean drilling sites that have penetrated Upper Jurassic to Lower Cretaceous sediments and basement, thus allowing a minimum age estimate for M-sequence marine magnetic anomalies based on the age of the immediately overlying sediment. At the time of this writing, more than 765 sites have been drilled in the world oceans and along the continental margins, but only seven sites actually have been cored successfully to Jurassic or Earliest Cretaceous oceanic basement. DSDP Site 261 in the Argo Abyssal Plain is the only site that links southern-(paleo) latitude fossil assemblages to one of the oldest M-sequence isochrons, but here, sediment recovery was poor and as a result its basal biostratigraphic record is controversial for age control. Nannofossil, foraminifer, radiolarian, and dinoflagellate records from Site 261 point to an Earliest Cretaceous age for the basal sediments. An exception is the reported presence in the basal ("ridge crest") sample of several, poorly preserved specimens of the nannofossil *Stephanolithion bigoti* (Proto Decima, 1974) that in the Atlantic region is indicative of Oxfordian to lower Tithonian strata.

Site 765, on the oldest marine magnetic anomaly in the Argo Abyssal Plain, was expected to furnish important new stratigraphic data. These data should help to relate the older M-sequence magnetic reversals in the sediments and on the ocean floor to radiolarian, nannofossil, dinoflagellate, and foraminifer events in middle latitudes. A preliminary overview of regional and more-global biostratigraphy linked to magnetostratigraphy is shown in the "Introduction" section of the Site 765 chapter (this volume).

An important aspect of stratigraphy is the question of rhythmic sedimentation. Rhythmic couplets often characterize the early phase of post-rift sedimentation in Mesozoic Atlantic Ocean basins. These laminations result from a variety of sedimentary phenomena and may be due to combined changes in surface productivity, influx of organic matter, and intensity of bottom circulation that control episodic oxygen depletion at the sediment/water interface. Some studies (e.g., Schwarzacher, 1987; Ogg et al., 1987) suggest a global significance of the rhythmicity, possibly driven by climate, with a periodicity comparable to that of Milankovitch-type cycles. From DSDP Site 261 in the northern Argo Abyssal Plain scientists recovered only a few, partially filled cores. However, indications are that some carbonate banding exists. Sediments recovered during Leg 123 may allow us to determine, first, if such patterns exist, and second, if their periodicity records a fine-scaled geochronology.

The Initiation of Volcanic Basement

Site 765 is located within 25 to 75 km of the Australian continental margin on the oldest oceanic crust in the Indian Ocean. Magmatism was widespread in the northwestern Australian passive margin during rifting. Tholeiitic and alkalic rocks of various ages have been dredged from the Wombat, Scott, and Wallaby plateaus (von Stackleberg et al., 1980; von Rad and Exon, 1982). These authors cited potassium/argon (K/Ar) ages of 213 to 192 m.y. for felsic volcanic rocks of alkalic lineage that underlie a Lower Jurassic carbonate sequence on the Wombat Plateau. On the Scott Plateau, alkaline to subalkaline basalts give ages of 128 to 132 m.y., and in the Wallaby Plateau, tholeiitic basalts have been dated at 83 to 89 m.y. Evidently, the northwestern Australian margin underwent several stages of volcanism associated with a protracted rifting history. For the mafic rocks the samples were altered and the dates may reflect minimum ages. Early Cretaceous dates for the Scott Plateau apparently contradict the paleomagnetic information, which indicates that the onset of the formation of ocean crust was in Late Jurassic time.

Site 766 is located at the base of a fault scarp that marks the westerly limit of the Exmouth Plateau. Seismic velocities (Falvey and Williamson, 1986) are intermediate to those of oceanic basement and the Triassic-Jurassic sediments of the Exmouth Plateau. This crust is interpreted as (1) rift-related intermediate volcanics, (2) a composite of volcanics and sediment, or (3) Paleozoic sedimentary basement.

The evolution of magmatism associated with rifting of passive margins is difficult to evaluate, as the volcanic and extrusive rocks, which are associated with the earliest phases of rifting, are generally buried at depths that are not amenable to deep drilling. Volcanics that have been sampled in rifted passive margins are characteristically alkalic, but are often closely associated with tholeiitic basalts. Nonetheless, in the ancient geological record, where passive margin volcanic sequences have been identified, the mafic magmas are commonly rich in MgO and are picritic (e.g., Francis et al., 1983). Alkaline magmas are rare in the oceanic crust and, where present, are associated with hot spots and/or transforms. While MgO-rich glasses have been found in spreading centers, true picritic magmas are absent. Nonetheless, based on petrological and fluid-mechanic models, some authors (e.g., Elthon, 1979) argue that MgO-rich magmas are produced in the oceanic mantle but are not erupted in the ridge axes because of mixing in low-pressure magma chambers and/or between magma batches *en route* to the surface.

Site 765, located on the first "true" ocean crust produced in the Indian Ocean, and Site 766, which is located on one of the most outboard portions of the northwestern Australian continent, provide an ideal couplet for testing models of magmatism at a rifted continental margin.

Geochemical studies of Indian Ocean basement and volcanic oceanic islands indicate distinct characteristics relative to the Atlantic and Pacific oceans (Fig. 9). Site 765 should provide data about the geochemical character of basement in this area

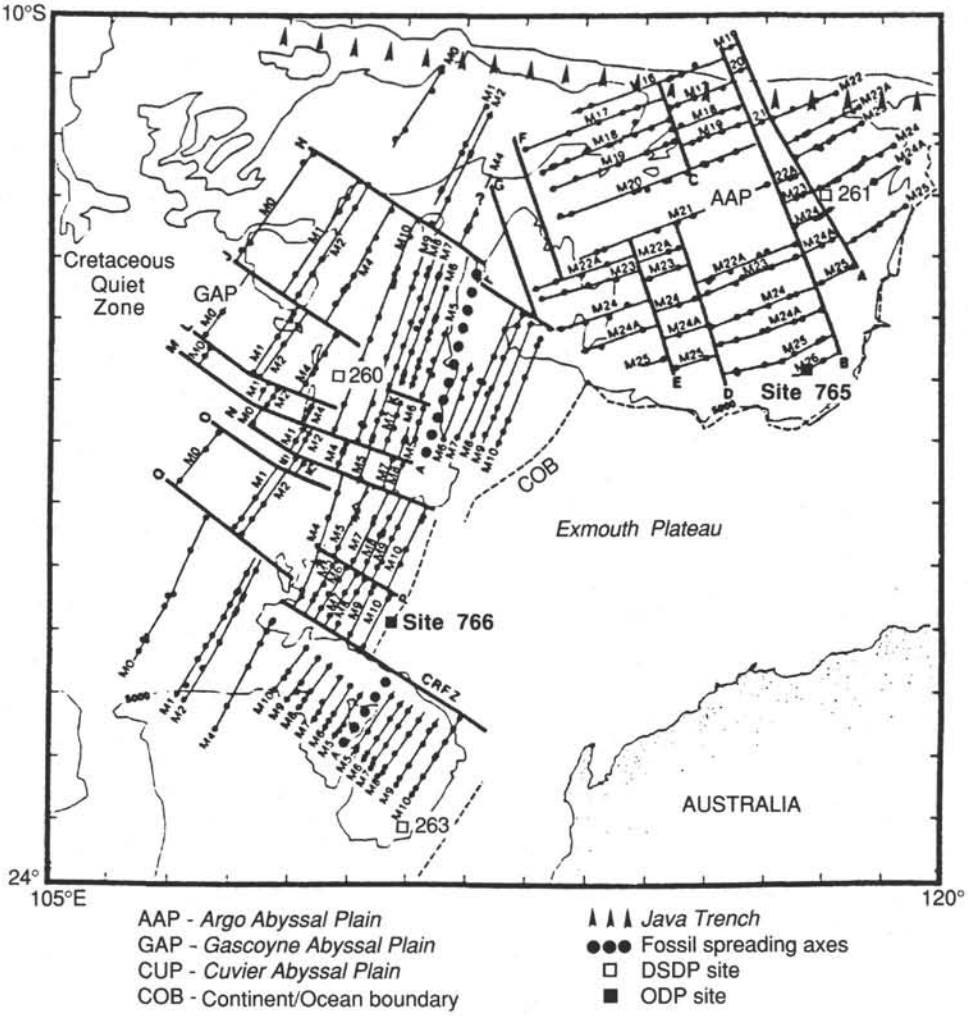

Figure 4. Geomagnetic isochrons and fracture zones overlain on the 500-m isobath. Dots indicate marine magnetic anomaly selections, and the dotted line represents the continent/ocean boundary (COB). CRFZ = Cape Range Fracture Zone; open squares = DSDP Sites 261, 260, and 263 (north-south). Modified from Fullerton et al. (1989).

of the Indian Ocean at the time of rifting. Comparison with data for the Ninetyeast Ridge and present ridge axes should also provide information concerning the longevity of the Indian Ocean mantle domains.

Geochemical Reference Site

Subduction zones are the primary sites of interaction between the Earth's crust and mantle. Some of the crustal material that is subducted reemerges in arc magmas and thus contributes to continental growth, while the remainder continues downward and introduces chemical heterogeneities into the mantle. Knowledge of these geochemical fluxes is essential for understanding how the Earth evolves. Simple mass-balance calculations indicate that only a small amount of subducted sediment is necessary to explain the chemistry of arc volcanics. This implies that a large proportion of the sediment and altered oceanic crust subducted potentially is taken into the deeper mantle. Because the chemical composition of marine sediment and altered oceanic crust may be substantially different from the composition of the mantle, incorporation of even small amounts of subducted material into the deep mantle might conceivably have a profound effect upon the geochemical evolution of the mantle. Thus, it is important to document the chemical characteristics of complete crustal sections oceanward of oceanic trenches. This can only be accomplished by studying deep-sea cores, such as those at Site 765.

In addition to its obvious applicability to problems specific to the Indonesian Arc, Site 765 provides an ideal reference section with which to investigate global problems of crustal recycling. Most crustal sections approaching trenches today consist primarily of pelagic sediment and basement of Cretaceous or greater age. Although in close proximity to the Australian margin, the Argo Abyssal Plain is sediment-starved and should comprise extensive sequences of pelagic sediment. The basement age is interpreted as Jurassic. Thus, the site is typical of those oceanic sections on Earth that are currently being subducted.

Based on lithostratigraphic observations from nearby DSDP Site 261, drilling at Site 765 was expected to penetrate a diverse sedimentary package of carbonate, siliceous ooze, pelagic clay, and in the youngest sediments, volcanic ash derived from the Indonesian Arc. This lithological diversity may translate into great chemical variability. Our approach for geochemical study of Site 765 is to establish a detailed chemical stratigraphy of the core that can be compared directly to the lithological variation in the same core. This will provide information about the rela-

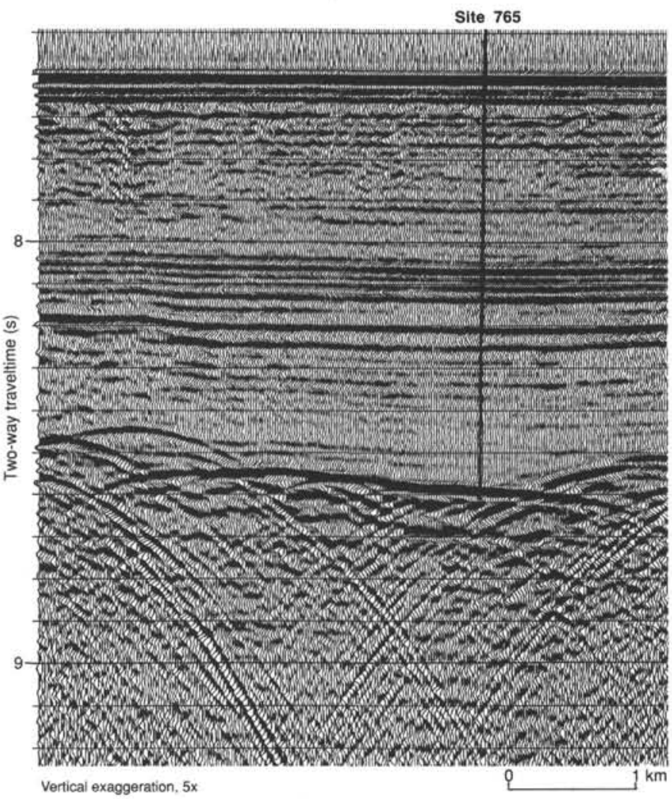

Figure 5. Segment of *Rig Seismic* Line 65/23C showing location of Site 765, Argo Abyssal Plain.

tionship between chemical and lithological processes and the ensuing rock composition. Such correlative trends may be extrapolated globally to deep-sea cores near other subduction zones.

Logging Deep-Ocean Sediments and Crust

Site 765 is one of the deepest oceanic drill holes ever logged and presents an ideal natural laboratory for both conventional logging tools and new, less-tested technology. During logging, we first executed the standard Schlumberger logs that involved the seismostratigraphic, geochemical, and litho-density tools to provide information concerning the porosity, resistivity, acoustical velocity, and composition of the radioactive elements of the section penetrated. Separate experiments investigated permeability and regional stress regimes using packer, hydro-fracture, and borehole-televiewer tools. In addition, scientists of Leg 123 conducted vertical seismic profiling and employed a new temperature probe that was attached to the seismostratigraphy and litho-density toolstring.

The hydro-fracture experiment was established to provide details of the state of stress of the Argo Abyssal Plain at about 1.2 km below the seafloor as it is "pinched" between the Sunda Arc and Australia. For the first time, vertical seismic profiling was attempted in the combined sediment and basement section. This allowed us to correlate accurately between the sediments cored and the regional seismostratigraphic trends and to image crustal reflectors below the site.

The Drilling Challenge

Site 765, located in 5725 m of water and drilled to a total depth below the mud line of more than 1150 m, represents one of the deepest holes ever attempted by ODP. This hole was drilled to recover effectively the Mesozoic sedimentary section, 250 m of underlying basalt, and to be stable enough to sustain up to two weeks of logging. Our operations plan involved a combined advanced piston core (APC) and extended-core barrel (XCB) through the sedimentary section until refusal. At that point, pipe was brought up to the drill floor and lowered again with the rotary core barrel (RCB) for coring to and into basement.

After coring of the sediment and shallow basement and standard Schlumberger logging runs, a reentry cone having 80 m of 16 3/4-in. conductor pipe was washed into the seafloor. Subsequently, a new hole was drilled below the cone to basement and cased with 11 3/4-in. pipe that was cemented in place. This operation made Site 765 the deepest hole cased in oceanic crust and represented another improvement in ODP/SEDCO drilling technology. At the finish of scientific operations in this area, Site 765 was stabilized for future deep-basement penetration and well-logging experiments.

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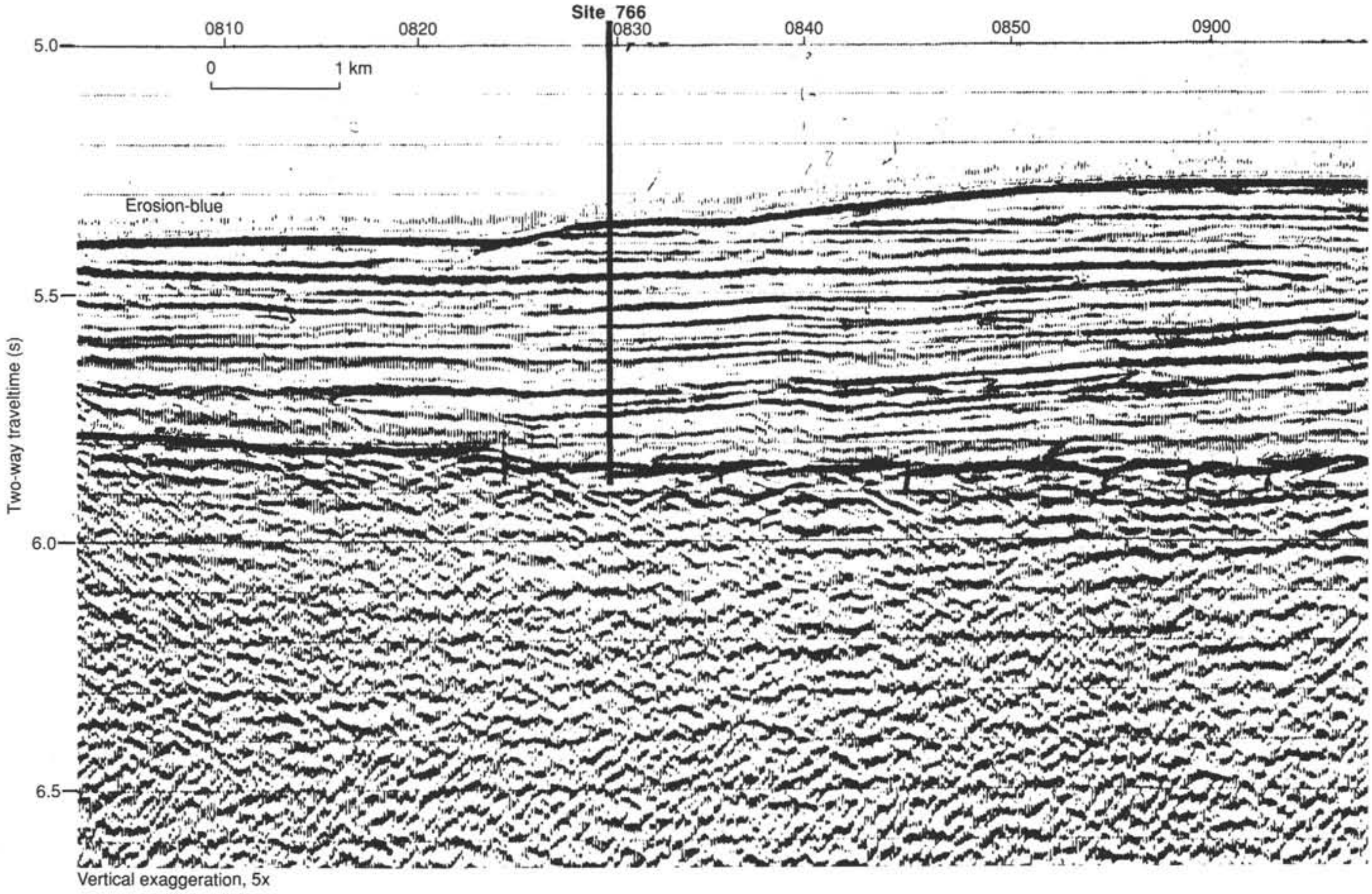

Figure 6. Segment of *Rig Seismic* Line 55/2 showing location of Site 766, Gascoyne Abyssal Plain.

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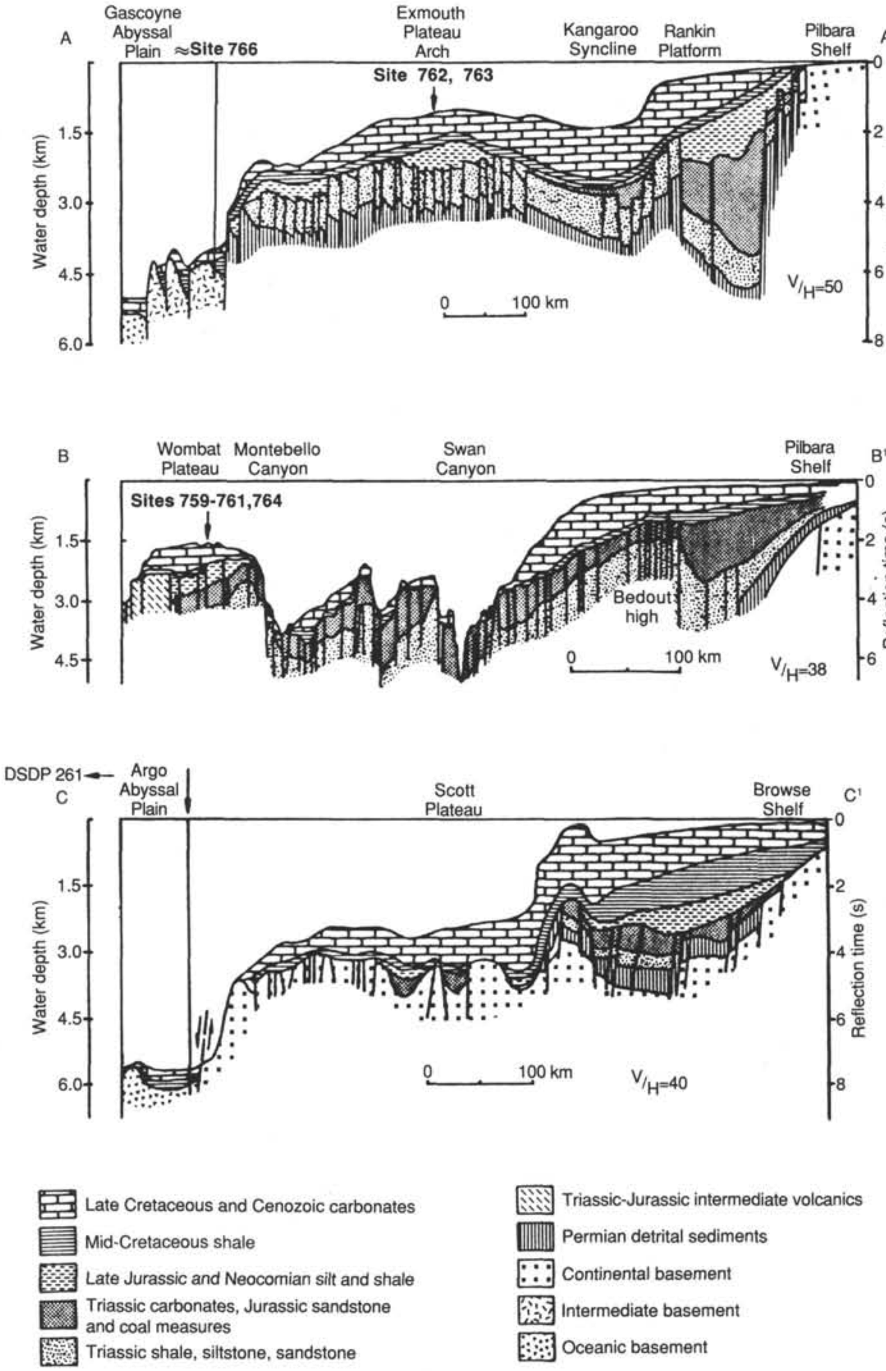

Figure 7. Schematic geological cross sections across the northwestern Australian margin and adjacent ocean basins showing the approximate locations of Leg 123, Argo Abyssal Plain, Site 766, and Gascoyne Abyssal Plain (after von Stackelberg et al., 1980; von Rad and Exon, 1982; and Bradshaw et al., 1988). Transect locations are shown on the geographic map (Fig. 3).

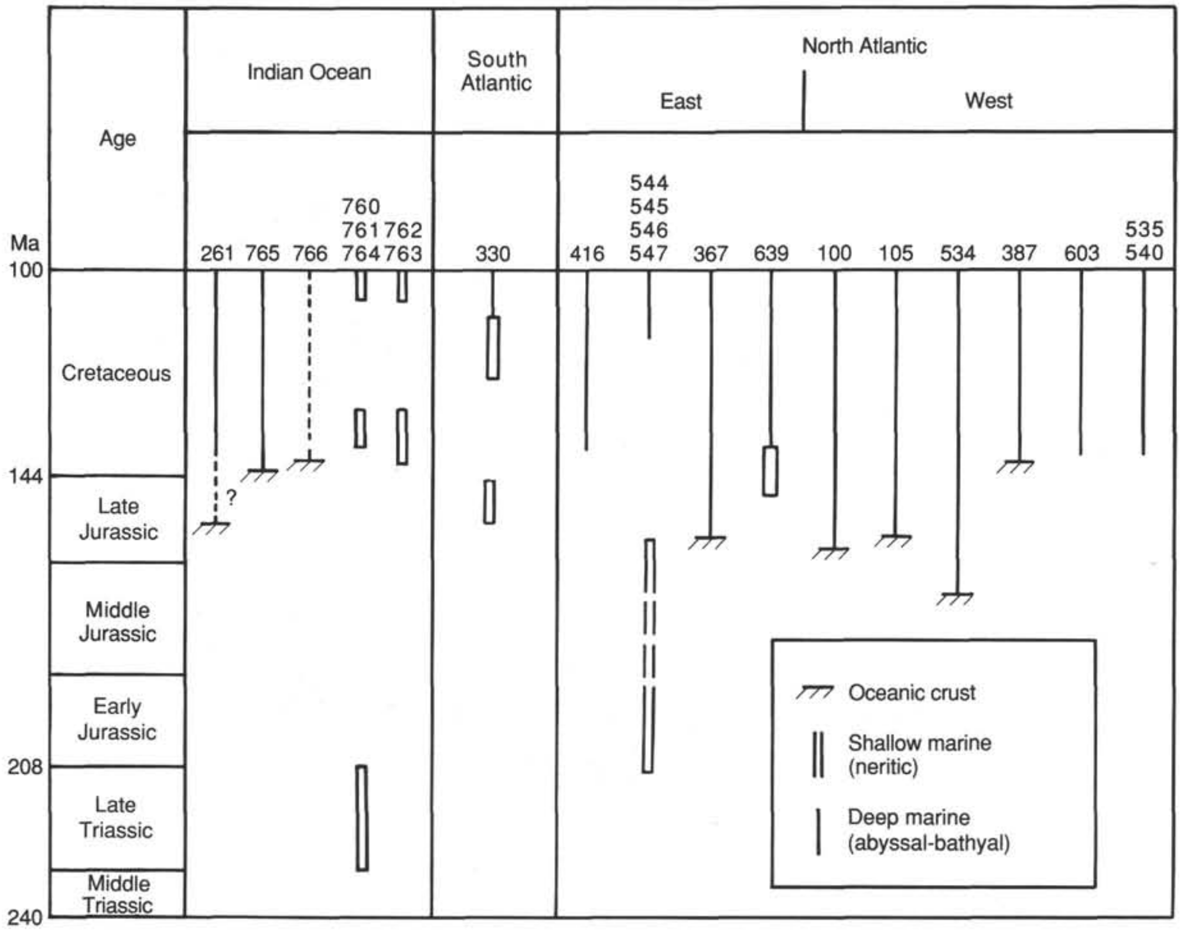

Figure 8. The quest for the oldest oceanic sediments in the world ocean basins; DSDP and ODP sites where Lower Cretaceous and older continental margin strata of neritic to abyssal water depth were cored. Only seven DSDP or ODP drill sites, of a total of more than 765, have been successfully cored for Upper Jurassic or Lowermost Cretaceous ocean basement and the oldest marine magnetic lineations. None succeeded in this objective in the Pacific Ocean.

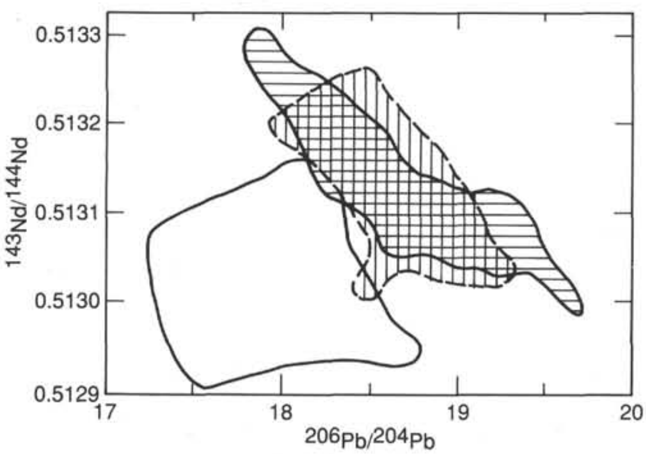

Figure 9. Isotopic composition of mid-ocean ridge basalts from the Indian, Atlantic, and Pacific oceans (after Ito et al., 1987). Indian Ocean, unshaded; Atlantic Ocean—horizontal hatching; Pacific Ocean—vertical hatching.