OCEAN DRILLING PROGRAM

LEG 123 PRELIMINARY REPORT

ARGO ABYSSAL PLAIN/EXMOUTH PLATEAU

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INTRODUCTION

Leg 123 of the Ocean Drilling Program 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 (~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 Gondwanaland, 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 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, mirror-image half of the Mesozoic Argo ocean was lost during the massive reorganization of Southeast Asia in post-Mesozoic time. Audley-Charles (in press) shows a Jurassic Argo rift graben delimited by continental blocks. Australia with Timor and New Guinea lay along the southern margin, and a speculative continental sliver with parts of Burma, Malaya, and the Indonesian Archipelago formed the northern side of the Jurassic rift graben. Reconstructions by Sengor (1987) and Bernoulli and Lemoine (1980) avoid a concise paleogeographic rift model for the Late Jurassic to Early Cretaceous ocean in the Argo and Gascoyne areas that led to the modern Indian Ocean.

As a result of the difficulties in reconstructing 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 DSDP Site 261 in the Argo Abyssal Plain (see below) compare to coeval assemblages in the Atlantic; 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. Rifting between Antarctica and Southern Australia was initiated during the Cenozoic (Fig. 2), and resulted in a 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) deposition belt since Jurassic time.

In mid-Tertiary time, Australia and the Sunda Arc to the north collided to form the active subduction zone and the associated ocean floor trenches that rim Indonesia (Fig. 2). This collision led to the cessation of circum-equatorial surface circulation and resulted in a stronger influence of cold Antarctic water. Steadily lowering global sea level, punctuated by relatively large and more sudden drops of sea level in the Oligocene and Miocene, caused shelf progradation and more 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 transect, while the continental margin was drilled at five sites during Leg 122 (Shipboard Scientific Party, in press). The geographic positions of the two sites drilled during Leg 123 are indicated in Figure 3. Site 765 is in a water depth of 5721.4 m over volcanic basement in the southernmost sector of the Argo Abyssal Plain, approximately 50 km north of the Argo-Exmouth ocean/ continent boundary (Fig. 4). Site 766 is in a water depth of 3997.5 m, at the foot of an escarpment on the Western Exmouth Plateau. Here the seismic data are equivocal and indicate an intermediate, ocean/continent crust. Sediment thicknesses for Site 765 and Site 766 are 931.2 m and 466.7 m, respectively.

Objectives

The 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) Comparison of 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.

2) Improvements of 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 first Indian Ocean crust.

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 tests in oceanic crust and hydrofracture experiments for stress analysis and determination of the regional stress pattern of the Eastern Indian Ocean.

Regional Geology at ODP Site 765

Geological cross sections from the Exmouth and Wombat plateaus to the Argo Abyssal Plain are shown in Figures 3 and 5. The Argo Abyssal Plain is an extremely flat abyssal plain about 5.7 km deep, located north of the Exmouth Plateau and west of the Scott Plateau (Fig. 3). On the north it is limited 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 owing to 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 in 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 of 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., in press) clearly show that basement is volcanic; these studies have delineated the location of marine magnetic anomalies, generally trending N70°E (Fig. 4). Calibrations using the Hawaiian and Keathley marine magnetic anomaly sequences (from the Pacific and Atlantic oceans, respectively), and the accepted Late Jurassic age of basal sediments at DSDP Site 261, indicate the presence of M25 to M16 marine magnetic lineations and isochrons (Fig. 4). At ODP Site 765 basement is assigned to marine magnetic anomaly M26, implying a late Oxfordian age for basement (Ogg, in press). Site 765 is less than 50 km from a prominent positive magnetic anomaly that lies along the ocean/continent boundary (COB of Veevers et al., 1985).

Seismic surveys also indicate that the basement is volcanic. The multiple-channel seismic expression of the strata over the site is shown in a portion of the Australian Bureau of Mineral Resources (BMR) Rig Seismic Line 56/23C, (Fig. 6). Site 765 is at shotpoint 116.248, and spans 1 s 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 ODP Site 765 (Figs. 3 and 4); its lithologic succession was used to predict lithologies to be drilled at Site 765. Recovery of sediments at this site was, on average, less than 23%. The age of the section is ambiguous owing to imprecise magnetostratigraphy and an incomplete biostratigraphic record; a controversial site biostratigraphy gives basal sediment ages of Valanginian to Oxfordian/Kimmeridgian. 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 Fe-Ti basalt (Robinson and Whitford, 1974).

Regional Geology at ODP 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 (Figs. 3 and 4). BMR Rig Seismic Line 55 delineates the site (Fig. 7). The seafloor represents an erosional surface that may expose strata as old as Cretaceous. At Shotpoint 74.203 on Line 55-2, the sedimentary section is less than 0.5 s two-way traveltime (500-700 m), overlying a faulted basement, which may represent the top of volcanics intermediate between oceanic and continental basement. The overlying 500-700 m thick sedimentary sequence might include (?)Triassic to Jurassic pre- and syn-rift strata, overlain by deep marine, post-rift Cretaceous and Paleogene sediments. On the other hand the post-rift sequence might directly overlie 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 rather difficult identification of the M-sequence lineations (Fullerton et al., in press). Seafloor spreading is thought to have started in M10/M11 time at the Valanginian/Hauterivian boundary with a spreading jump seaward between M5 and M4 time (late Hauterivian). Using a Valanginian age for basement at Site 766 as input in an oceanic backtrack curve, one can predict bathyal (900 m water depth) sediments on basement.

Both Sites 765 and 766, with a relatively thin sedimentary cover, represent prime sites for studies of bio- and magnetostratigraphy, subsidence history, and basement formation and rifting in a passive margin.

SITE 765 (ARGO ABYSSAL PLAIN)

Site 765 is located at 15°58.541'S, 117°34.495'E. A geological cross section from the Exmouth Plateau to the Argo Abyssal Plain is shown in Figure 5 with the position of Site 765 marked. Figure 8A shows the stratigraphy of Site 765 with stratigraphic information based on multivariate analyses of smear-slide data for the sediments; lithology and geochemistry of the basement are also shown. An example of the results of potassium and uranium logging is displayed in support of our findings that stratigraphic fluctuations in these element ratios strengthen lithostratigraphic subdivision of the hole.

The major objectives of Site 765 were to (1) elucidate the paleoceanography, sedimentology, and magmatic processes related to rifting of the early Indian Ocean; (2) constrain the rift to drift tectonic history of one of Earth's oldest oceanic basins; (3) improve the late Mesozoic time scale, particularly with reference to the Southern Hemisphere; and (4) provide a geochemical reference section of old oceanic crust, incorporating the bulk composition of the sediments and basement, for use in geochemical and petrological global mass-balance models.

Operations at Site 765 are summarized in Figure 9. Holes 765A, 765B, and 765C continuously cored Cenozoic and Cretaceous fine-grained, abyssal sediments. Oceanic basement was reached at 931 mbsf in Hole 765C. Average sediment recovery was 68%. Hole 765D is located approximately 30 m from the other holes, and was drilled and cased through 924 m of sediments into volcanic basement. The hole was then continuously cored a further 259 m into remarkably fresh basalt. Average core recovery in Hole 765D was 31%. Both Holes 765C and 765D were extensively logged with sonic, lithodensity, and geochemical tools. Site 765 is the deepest cased drill hole in the oceans; with its reentry cone on the seafloor, it is in perfect shape for future scientific operations.

The Sedimentary Section at Site 765

Using combined nannofossil/foraminifer/radiolarian/dinoflagellate biostratigraphy, visual core descriptions assisted by multivariate analysis of smear slide data, and sedimentary paleomagnetics, seven successive stratigraphic units were distinguished. These are, from basement to the seafloor:

Unit VII: (931.2-892.9 mbsf; Berriasian-Valanginian). Brown-red silty claystone and reddish-brown to greenish claystone; the basal contact between claystone and basalt is marked by a few cm of basalt hyaloclastite altered to celadonite floating in a matrix of red claystone and white sparry calcite cement. Altered volcanic ash layers occur higher up in Units VII and VI.

Unit VI: (892.9-859.2 mbsf; late Valanginian-Hauterivian). Nanno chalk and varied minor lithologies.

Unit V: (859.2-724.1 mbsf; Barremian-Aptian). Varicolored and dark gray radiolarian and rhodochrosite claystone.

Unit IV: (724.1-591.7 mbsf; Aptian-Cenomanian). Siliciclastic and mixed lithology turbidites, nannochalk, calcareous claystone, and zeolitic clay.

Unit III: (591.7-474.1 mbsf; Turonian-early Miocene with stratigraphic hiatuses). Varicolored zeolitic clay, redeposited calcareous sediments, and dark claystones.

Unit II: (474.1-189.1 mbsf; Miocene). Calcareous turbidites with minor clay and a massive debris flow containing basaltic pebbles.

Unit I: (189.1-0 mbsf; late Pliocene to Pleistocene). Clayey calcareous turbidites, massive slumps and debris flows, and siliceous ooze.

In general, the upper half of the sedimentary section recovered at Site 765 is dominated by calcareous turbidites, funneled down canyons that cut the edge of the deep continental margin plateaus, while the lower half is dominated by hemipelagic clays and claystones.

Geochemical variations, determined by using major and trace elements, are significant and can be related to dilution of clay related elements by $CaCO_3$ and SiO_2. Nonetheless, a "bulk" geochemical composition of the sediments can be calculated and individual turbidites may be geochemically fingerprinted. The principal clay minerals in the sediments represent volcanic alteration products, with the onset of rapid sedimentation in the early Miocene showing a wide variety of volcanic minerals from different source regions along the margin. All sediments display evidence of deposition below the carbonate compensation depth (CCD), although the (~4 km deep) seafloor may have been above the CCD in late Valanginian-Hauterivian time, when nannofossil chalk was laid down; the same relationships are present in the Atlantic Ocean. Organic carbon content is low, as expected in abyssal sediments, with, as consistent with global trends, a rapid excursion to higher values near the Aptian/Albian boundary. Mesozoic microfossil assemblages are typical for middle latitudes, and except for radiolarians, are not endemic.

Physical Properties and Logging of Sediments

Physical properties of sediments, measured on board, reflect a downhole compaction curve interrupted by intervals of variable physical properties in the stratigraphically condensed units of the Upper Cretaceous and lower Tertiary; this variation matches a series of high reflectivity zones in the seismic record. Magnetic susceptibility tracks iron oxides and is high in the upper Pliocene and the middle Cretaceous metalliferous shale units.

Detailed petrophysical well-logging recorded over 1100 m of geochemical data, 750 m of lithoporosity data, and 750 m of sonic velocity data. Steady compaction trends in the Miocene agree with the trends observed from on-board physical measurements; asymmetry in the spectrometric log patterns using Th/U and U/K can be related to the presence of clay layers in the carbonate dominated graded sequences. The activated spectrometry record correlates with the X-ray-fluorescence (XRF) results in sedimentary samples in terms of Ca/Si.

Excellent regional bio-, litho-, and seismostratigraphic correlations to DSDP Site 261, 320 km to the north, suggest that the Late Jurassic age of the basal sediments over the Argo Abyssal Plain may have to be revised upward by 20 m.y. Early opening of the Indian Ocean may thus have been Early Cretaceous rather than Late Jurassic, with important consequences for the early evolution of the Indian Ocean and the destruction of Tethys.

The Volcanic Section at Site 765

Holes 765C and 765D penetrated 28 m and 271 m, respectively, into volcanic basement. Twenty-two volcanic units were distinguished, based on lithological and geochemical variations. The main lithologies recovered were pillow basalt (54%), massive basalt (28%), diabase (4%), autoclastic breccia (6%), and tectonically brecciated pillow basalt (8%).

Despite being one of the oldest sections of oceanic basement cored, i.e., lowermost Cretaceous, rock preservation is excellent. Fresh glass is present in pillow margins and within hyaloclastite breccia. Low temperature alteration has affected the entire volcanic section, which is veined with calcite, celadonite, smectite, Fe-oxyhydroxides, and rare zeolites; there is no lithological indication of gradation at the base of the hole into higher temperature alteration assemblages. Nonetheless, in spite of the low temperature alteration and associated geochemical fronts parallel to the veins, much of the basaltic section is only slightly altered.

Although geochemical data indicate that the lavas are typical but somewhat evolved mid-ocean ridge basalt (MORB) tholeiites, the phenocryst assemblage is atypical for MORB. The lavas are dominantly aphyric or sparsely phyric with rare samples having up to 10% phenocrysts. Plagioclase is the dominant phenocryst with clinopyroxene being the only mafic phenocryst in many lavas. Olivine, when observed, is highly altered and appears xenocrystic. In the upper 50 m of basalt, numerous xenocrysts of calcic plagioclase and clinopyroxene occur.

Preliminary shipboard XRF data indicate at least eight geochemical cycles, recognized by systematic trends in Zr, Y, Ti, Cr, and other elements; Zr ranges from 110 ppm in the most evolved magmas to 70 ppm in the more primitive magmas of each cycle. Distinct negative correlations between Zr and Al and Ca indicate control of magma evolution by plagioclase and clinopyroxene fractionation.

A series of basaltic pebbles from the Miocene sedimentary debris flow described above were also described petrographically, and a subset was analyzed by XRF. The majority of these samples are basaltic with two oceanic andesites. The basalts are olivine and plagioclase phyric and range geochemically from normal-MORB to enriched-MORB compositions. In terms of petrography and geochemistry these basalts are distinct from those drilled at Site 765. There, provenance is probably a series of basement highs at the mouth of the Swan submarine canyon on the Exmouth Plateau; this interpretation would indicate a change in magma composition during rifting of the margin.

Logging and Geophysics in Hole 765D

Hole 765D was cased in order to provide a stable site for coring, logging, and a series of geophysical experiments. Lithoporosity, sonic, and geochemical logs were run in the hole without any operational problems; the chemical log was also run through the casing in the sedimentary section, as was the sonic log, to investigate the integrity of the cement behind the casing. High sonic velocities show broad correlations with massive flow intervals and the diabase. Potassium anomalies can be correlated with brecciated zones containing smectite and celadonite.

A vertical seismic profile (VSP) experiment was attempted in basement. This met with little success, probably owing to weak signals at depths to basement of 7 km. The VSP recordings were continued through the casing in the sedimentary section, and seismic recordings were made despite a considerable amount of noise from the pipe.

Two televiewer runs were completed in the basement, and reported breakouts. Prior to splitting, complete basalt cores were mapped for fracture patterns for comparison with the televiewer results to be processed onshore. The single packer permeability experiment was partially successful, and indicated low permeability in this old oceanic crust. The double packer experiment, which was constructed to quantify the stress measurements, failed owing to a malfunction in the packer tools.

SITE 766 (FOOT OF THE EXMOUTH PLATEAU ESCARPMENT)

Site 766 is located at 19°55.985'S, 110°27.130'E. A geological cross section from the Exmouth Plateau to the deep continent/ocean margin at Site 766 is shown in Figure 5. Figure 8B shows the stratigraphy of Site 766 with stratigraphic information based on multivariate analyses of smear-slide data for the sediments; lithology and geochemistry of the basement are also shown. An example of the results of potassium and uranium logging is displayed in support of our findings that stratigraphic fluctuations in these element ratios strengthen lithostratigraphic subdivision of the hole.

The initial drilling program proposed for this site called for Advanced Piston Corer/Extended Core Barrel (APC/XCB) coring to refusal, Rotary Core Barrel (RCB) coring to what was interpreted as basement intermediate between continental and oceanic rocks, and physical and geochemical well logging. However, owing to time restrictions, a reduced program, which eliminated the APC/XCB coring was carried out.

The principal objective of drilling at Site 766 was to understand the tectonic, sedimentary, and magmatic evolution of the outermost edge of a passive margin. As a result of the extensive sediment cover at most passive margins, it is rarely possible to core the transition zone from continental to oceanic basement; the sediment starved nature of the northwestern Australian margin makes this objective attainable at Site 766.

The specific questions posed at Site 766 were: (1) What is the nature of "basement" transitional to continental and oceanic crust in a rifted passive margin? (2) What are the ages of the onset of rifting between Australia and India, and of earliest seafloor spreading in the Gascoyne and Cuvier abyssal plains? (3) How does the lithologic and seismostratigraphic sequence along the continental-margin to deep-ocean transect from Sites 762 and 763, drilled by ODP Leg 122 on the adjacent Exmouth Plateau, compare to that of ODP Site 766?

Total penetration was 527 mbsf and average core recovery was 66%, with the best recovery in the critical lower section. The base of the sedimentary section was placed at 466.7 mbsf, after which coring retrieved only igneous rock. However, the first igneous rocks were encountered at 458 mbsf. These rocks are interpreted as intrusive sheets (small sills) of igneous material, which are inter-layered with green-gray siltstones; below 466.7 mbsf two or more large igneous intrusions were encountered and cored for a total of 60 m.

The geological location of Site 766 places it within 10 km of marine magnetic anomaly M10, the 130 Ma isochron mapped along the Exmouth margin. The published oceanic spreading rate of 3.2 cm/yr predicts onset of seafloor spreading at 134 Ma in the M11 isochron of late Valanginian age. As a result, basal sediments and volcanics at Site 766 should also be of late Valanginian age. This age is exactly as determined by radiolarian/dinoflagellate/ nannofossil stratigraphy for the oldest sediments at Site 766. The basement at Site 766 must therefore have been rifted, buried by sediments, and intruded by tholeiitic magmas immediately prior to the formation of true oceanic crust at the continent/ocean boundary. Whether Triassic crust is preserved at Site 766, or the hypabyssal intrusives grade downward into larger intrusive bodies, remains unsolved. The stratigraphic results indicate that basement was reached.

Sedimentary Section

The sedimentary succession consists of 8 units and subunits. These are, from bottom to top:

Unit VIII: (458.0-304.2 mbsf; uppermost Valanginian through Hauterivian). Greenish gray to black sandstone and bioturbated siltstone, with glauconite, quartz, bioclasts, and altered volcaniclastics.

Unit VII: (304.2-239.4 mbsf; upper Hauterivian through Barremian). Dark greenish gray to black claystone.

Unit VI: (239.4-191.0 mbsf; Aptian through lower Albian). Tan to light green nannofossil chalk, zeolitic and clayey in upper portion, siliceous in the lower half.

Unit V: (191.0-136.5 mbsf; Albian through Cenomanian). Brown to tan, bioturbated chalk with zeolite and clay.

Unit IV: (136.5-114.8 mbsf; Turonian through lower Campanian). Zeolitic calcareous ooze and clay, banded in brownish colors.

Unit III: (114.8-82.8 mbsf; Campanian through lower Paleocene). Pink to pale brown nannofossil ooze, with graded beds.

Unit II: (82.8-8.0 mbsf; Paleocene through lower Eocene and middle Pliocene). pale brown to white nannofossil ooze.

Unit I: (8.0 mbsf-seafloor; lower Pleistocene). Pink nannofossil ooze.

We interpret the Hauterivian to Barremian sand, silt, and clay sequence as a distal part of a submarine fan, which on seismic profiles can be seen to thicken toward the continental margin. Hydrocarbon levels are extremely low. The Aptian to Barremian boundary represents a marked change in sedimentation, from hemipelagic, gravity and traction deposition of largely terrigenous and shallow marine sediment with abundant plant spores, to pelagic, hemipelagic and lesser gravity deposition of calcareous material (largely nannofossils). The peak occurrence of zeolites coincides with the Cenomanian to Turonian boundary. Restored sedimentation rates of approximately 1.5 cm/1000 yr for the Hauterivian through Aptian sequence change to rates below 0.65 cm/1000 yr for the remainder of the section. This rapid change in sedimentation rate in the Aptian agrees with that at Site 765 on the Argo Abyssal Plain and appears to be a global trend. Subsidence and sedimentation analysis indicates that the site originated near 800 m water depth, with rapid early subsidence that declined from 20 to 4 cm/1000 yr in the Early Cretaceous, and much lower rates beyond, to its present water depth at 4 km. The site was always above the CCD.

Igneous Rocks

The first igneous rock, interpreted as an intrusive sheet, was encountered at 458 mbsf. This was followed by an 8-m interlayered sequence of 1- to 1.5-m thick intrusions and dark green to dark gray siltstone. Coring from 467.7 to 527 mbsf recovered a thick diabase intrusion; recovery in the intrusion was 100%.

Only one definitive intrusive contact was preserved in the sequence. This contact is inclined at 30° and is chilled against sediments which have been baked to within 5-10 cm from the contact. No hyaloclastite breccia was drilled, and all the igneous bodies display a symmetric gradational increase in grain size from base to center and top to center. All of these observations indicate that these igneous bodies are intrusions.

The base of the large diabase was not encountered and by the end of drilling a total of 60 m had been recovered. The diabase contains gabbroic segregations which are inclined at 60-80° relative to the drill core. In addition, cooling fractures are oriented in the same plane as the gabbroic segregation in all but the last two cores; both of these lines of evidence indicate that this intrusion may be flat in the lowermost cores recovered (i.e., a sill) and grade upward into a dike with a dip of up to 60°.

Geochemical data demonstrate that the intrusions are iron-rich tholeiites of MORB affinity. Some differences are observed between the different intrusions, which can be explained by fractional crystallization, indicating that the intrusions may be cogenetic.

The intrusions are slightly to moderately altered by low temperature processes. The veins and vesicles are filled with calcite, smectite and zeolite; pyrite occurs with smectite and zeolite.

Physical properties, including bulk density and porosity, display similar average values as the igneous rocks at Site 765; the only difference is that at Site 766 the values fluctuate much less, which supports the interpretation of a single massive intrusive below 467 mbsf.

Logging in Hole 766A

Three petrophysical logging runs were completed at Site 766. The drill pipe was set at 260 mbsf (below the upper sequence of pelagic clays and oozes). Seismostratigraphic and porosity logs were run below this depth; both logging tools could not be lowered below a ledge immediately above the volcanics (approximately 445 mbsf). The Lower Cretaceous sands and siltstones were successfully logged between 445 and 245 mbsf.

The geochemical log, run through the drill pipe, was completed with drill pipe within 10 m of the base of the hole (approximately 515 mbsf). This log clearly delineates the sediment/intrusion contacts between 450 and 470 mbsf. Noteworthy on the logs are (1) an increase of thorium at 14 mbsf that appears to be associated with the hiatus between Eocene and Pliocene; (2) a similar enrichment in a 3-m zone above the K/T boundary, which suggests a hiatus, as observed also on the plot of the Site 766 burial history; (3) anoxic bottom conditions in the Hauterivian as deduced from the thorium/uranium ratio, which agrees with the observation of many pyrite concretions in the sediment; and (4) petrophysical trends in the Hauterivian to Aptian section, which may identify proposed sea level fluctuations.

HIGHLIGHTS

The most surprising stratigraphic information at Site 765 was the lack of any Jurassic sediments. Detailed radiolarian, nannofossil, and dinoflagellate stratigraphy of the red-brown claystones recovered at the base of the sedimentary section dates the basement as late Berriasian to earliest Valanginian age (~140 Ma). This is at least 20 m.y. younger than predicted for Site 765. Detailed first order bio-, litho-, and seismo-stratigraphic correlation of Site 765 to DSDP Site 261 (Fig. 1), where so-called Jurassic basal sediments calibrated Jurassic opening of the Indian Ocean, indicates that both sites may be of Early Cretaceous age. The Cretaceous opening of the Indian Ocean has important consequences for plate tectonic evolution in the Southern Hemisphere, and the demise of Tethys.

The first of a series of geochemical reference sites was drilled at Site 765. Bulk geochemical analysis will be used to evaluate recycling of oceanic crust and sediment in subduction zones. Knowledge of the composition of the crust being subducted will be used to constrain models of magma genesis in volcanic arcs and also constrain global mass balance calculations related to sediment recycling in the mantle.

The revised timing of the initial rifting of the early Indian Ocean at Site 765 requires reappraisal of the rift to drift history of the northwestern Australian margin. Assuming a comparable age for Sites 765 and DSDP Site 261, and a slightly (5-10 m.y.) younger opening age for the Gascoyne and Cuvier abyssal plains, any north-south spreading in the Argo must have involved rapid ridge jumps to result in the predominant east-west spreading direction in the Gascoyne Abyssal Plain.

Few oceanic sites, and none in the Southern Hemisphere, exist that directly relate the M-series of geomagnetic reversals in the sediments with multiple biostratigraphy. Sites 765 and 766 yield a detailed reversal scale for M13 to M0, Valanginian to Aptian, which together with the detailed microfossil record and potential radiometric dates on the fresh basaltic basement and volcanic ash in the sediments, will strengthen understanding of the Mesozoic time scale.

Turbidite sedimentation dominated the sedimentary history of Site 765. The lowermost sediments of Site 765 comprise reddish-brown calcareous claystones derived from the old continental margin. These are overlain by red and green claystones with subordinate radiolarite layers, and are succeeded by Upper Cretaceous and lower Paleogene clays with subordinate carbonate turbidites (Fig. 8A). Nearby Swan Canyon was probably cut into the margin at the end of Oligocene time (approx. 25 Ma), and became an active conduit for turbidites in the Miocene.

270 m of basalt lava flows and pillow lavas was cored in Hole 765D (Fig. 8A). Despite their Early Cretaceous age, these lavas preserve fresh glass and are in perfect condition for laboratory studies to delineate Indian Ocean mantle reservoirs. They are fractionated relative to modern mid-Indian Ocean ridge basalts. However, their higher CaO and lower Na_2O, Zr, and Nb may reflect higher percentages of mantle melting.

For the first time in the history of ODP and DSDP a comprehensive suite of bulk sediment and clay fraction XRF analyses were completed on board. These analyses were complemented by a full suite of geochemical logs for K, U, Th, Ca, Si, and Al run in basement and in the sediments through the steel casing in Hole 765D (see examples in Fig. 8A). The bulk elemental sediment composition is variable on the scale of a meter. However, most of the variability is a result of simple mixing between three end members: biogenic calcium carbonate, biogenic silica, and an alumino-silicate component. Most of the geochemical variation can be explained in terms of mixing of a single terrigenous component and volcanogenic clays.

Pore waters in the lower sediments at Site 765 display unusually low salinity and sharp chloride gradients. These are related to fresh water addition. No other pelagic basins are known to have such low salinity pore waters, and their source remains problematic.

The deep hole at Site 765 provided an ideal location for detailed well logging and experimental geophysics projects. In addition to over 1100 m of geochemical data (mentioned above), 750 m of lithoporosity data and 750 m of sonic velocity data were recorded. These log patterns have been used to refine our understanding of the turbiditic sequences, particularly in the thick Miocene sediment unit that flowed out of submarine canyons on the Exmouth Plateau.

Two extremely successful televiewer runs were made in addition to a single packer permeability experiment. The orientation of stress induced breakouts suggests that this section of the Indian Plate is experiencing north-south compression.

At 460 mbsf in Hole 766A a sequence of interlayered small sills and sediments was encountered. This was replaced at 467 mbsf by a thick, inclined diabase intrusion; after 50 m of drilling, the base of this intrusion was not encountered. Geochemical analyses show the intrusions to be iron-rich tholeiites, and comparable to the basalts drilled at Site 765. Whether these intrusions grade into "true" oceanic basement, or whether Site 766 is underlain by an extensive sediment-volcanic complex, is unknown at present.

The green sands and siltstones at the base of Site 766 do not show continuity with the upper Barrow Delta sediments on the Exmouth Plateau, and indicate a local source perhaps on the edge of the plateau.

Paleomagnetic data from both the sediments and basalts of Sites 765 and 766 suggest that the paleolatitude of northwestern Australia was at about 30°-35°S, or 10° farther north in Cretaceous time than previously assumed. There is a good comparison of Sites 765 and 766 Cretaceous microflora and microfauna with those typically found in the mid-latitudes of the Northern Hemisphere. Nonetheless, some microfossil groups show local taxa, not known elsewhere, which suggest relative isolation of the early Indian Ocean water masses from global circulation patterns.

ODP Leg 123 was the last leg of highly successful drilling operations with JOIDES Resolution in the Indian Ocean. Site 765 is now the deepest cased site in the oceans and, with its reentry cone on the seafloor, is in perfect shape for future ocean drilling or related scientific investigations.

REFERENCES

Audley-Charles, M. G., in press. Evolution of the southern margin of Tethys (North Australian Region) from Early Permian to Late Cretaceous. In Tethys and Gondwana. Geol. Soc. London Spec. Publ.

Bernoulli, D., and Lemoine, M., 1980. Birth and early evolution of the Tethys: the overall situation. Mem. B.G.R.M., Coll. C5-26th I.G.C., Paris, 115:168-179.

Bradshaw, M. T., Yeates, A. N., Beynon, R. M., Brakel, A. T., Langford, R. P., Totterdell, J. M., and Yeung, M., 1988. Paleogeographic evolution of the northwest shelf region. In Purcell, P. G., and Purcell, R. R. (Eds.), The Northwest Shelf of Australia: Perth (Petrol. Expl. Soc. Australia Symp.), 29-59.

Fullerton, L. G., Sager, W. W., and Handschumacher, D. W., in press. Late Jurassic--Early Cretaceous Evolution of the eastern Indian Ocean adjacent to Northwest Australia. J. Geophys. Res.

Gradstein, F. M., 1983. Paleoecology and stratigraphy of Jurassic abyssal foraminifera in the Blake Bahama Basin, Deep Sea Drilling Project Site 534. In Sheridan, R. E., Gradstein, F. M., et al., Init. Repts. DSDP, 76: Washington (U.S. Govt. Printing Office), 537-559.

Heirtzler, J. R., Cameron, P., Cook, P. J., Powell, T., Roeser, H. A., Sukardi, S., and Veevers, J. J., 1978. The Argo Abyssal Plain. Earth Planet. Sci. Lett., 41:21-31.

Kent, D. V., Dia, O., and Sougy, J.M.A., 1984. Paleomagnetism of Lower-Middle Devonian and Upper Proterozoic-Cambrian(?) rocks from Mejeria (Mauritania, West Africa). In Van der Voo, R., Scotese, C. R., and Bonhommet, N. (Eds.), Plate Reconstruction from Paleozoic Paleomagnetism. Washington (Am. Geophys. Un.), Geodynamics Ser., 12:99-115.

Larson, R. L., 1975. Late Jurassic sea floor spreading in the eastern Indian Ocean. Geology, 3:69-71.

Ogg, J. G., in press. The Jurassic magnetic polarity time scale. In Westermann, G.E.G. (Ed.), Circum-Pacific Jurassic. Elsevier.

Robinson, P. T., and Whitford, D. J., 1974. Basalts from the Indian Ocean, DSDP Leg 27. In Veevers, J. J., Heirtzler, J. R., et al., Init. Repts. DSDP, 27: Washington (U.S. Govt. Printing Office), 551-559.

Sengor, A. M., 1987. Tectonics of Tethysides: orogenic collage development in a collisional setting. Ann. Rev. Earth Planet. Sci., 15:213-244.

Shipboard Scientific Party, in press. From Gondwana to Australia: rifting, paleoenvironment and sea level. Nature.

Suess, E., 1893. Are great ocean depths permanent? Natural Sci., 1:180-187.

Veevers, J. J., Tayton, J. W., and Johnson, B. D., 1985. Prominent magnetic anomaly along the continent-ocean boundary between the northwestern margin of Australia (Exmouth and Scott Plateaus) and the Argo Abyssal Plain. Earth Planet. Sci. Lett., 72:415-426.

Veevers, J. J., Heirtzler, J. R., et al., 1974. Init. Repts. DSDP, 27: Washington (U.S. Govt. Printing Office).

von Rad, U., and Exon, N. F., 1982. Mesozoic-Cenozoic sedimentary and volcanic evolution of the starved passive continental margin off northwest Australia. In Watkins, J. S., and Drake, C. L. (Eds.), Studies in Continental Margin Geology, Am. Assoc. Pet. Geol. Mem., 34:253-281.

von Stackelberg, U., Exon, N. F., von Rad, U., Quilty, P., Shafik, S., Beiersdorf, H., Seibertz, E., and Veevers, J. J., 1980. Geology of the Exmouth and Wallaby Plateaus off northwest Australia: sampling of seismic sequences. Bur. Miner. Resources J. Austral. Geol. Geophys., 5:113-140.

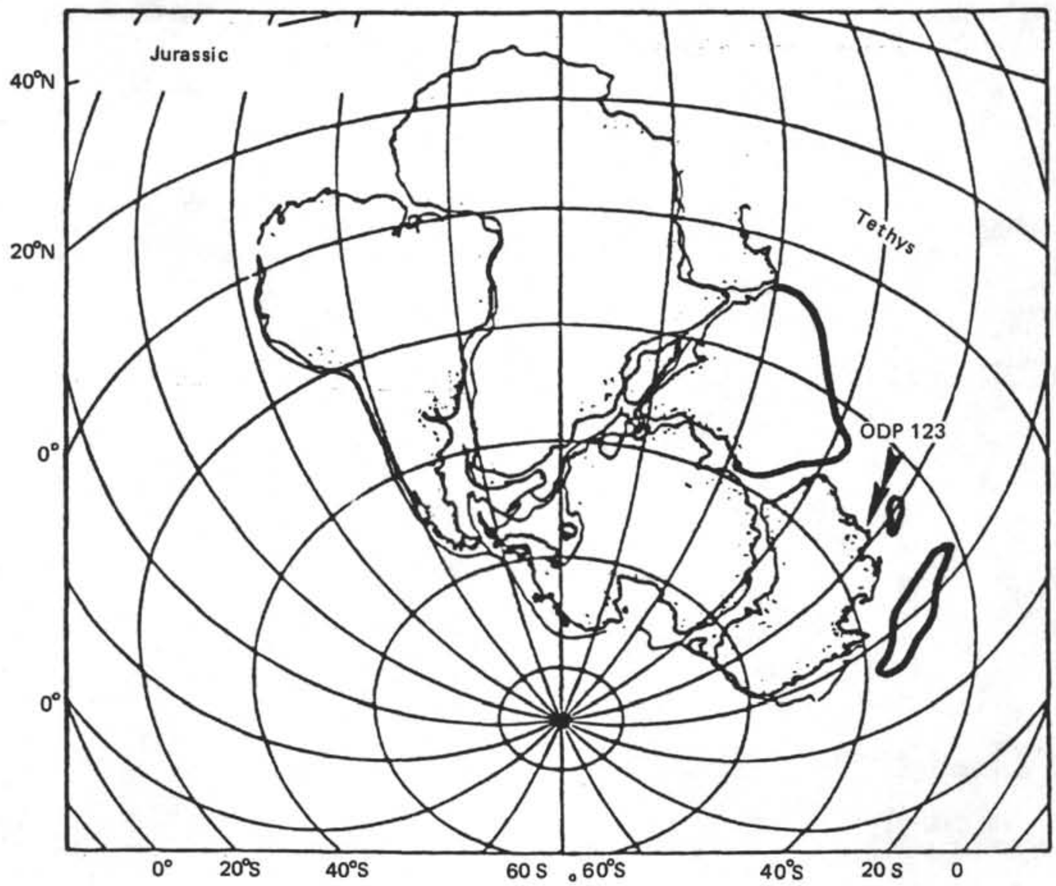


Figure 1. Gondwanaland reconstruction for Jurassic time (>160 Ma; after Kent et al., 1984). Box shows area of Leg 123 operations.

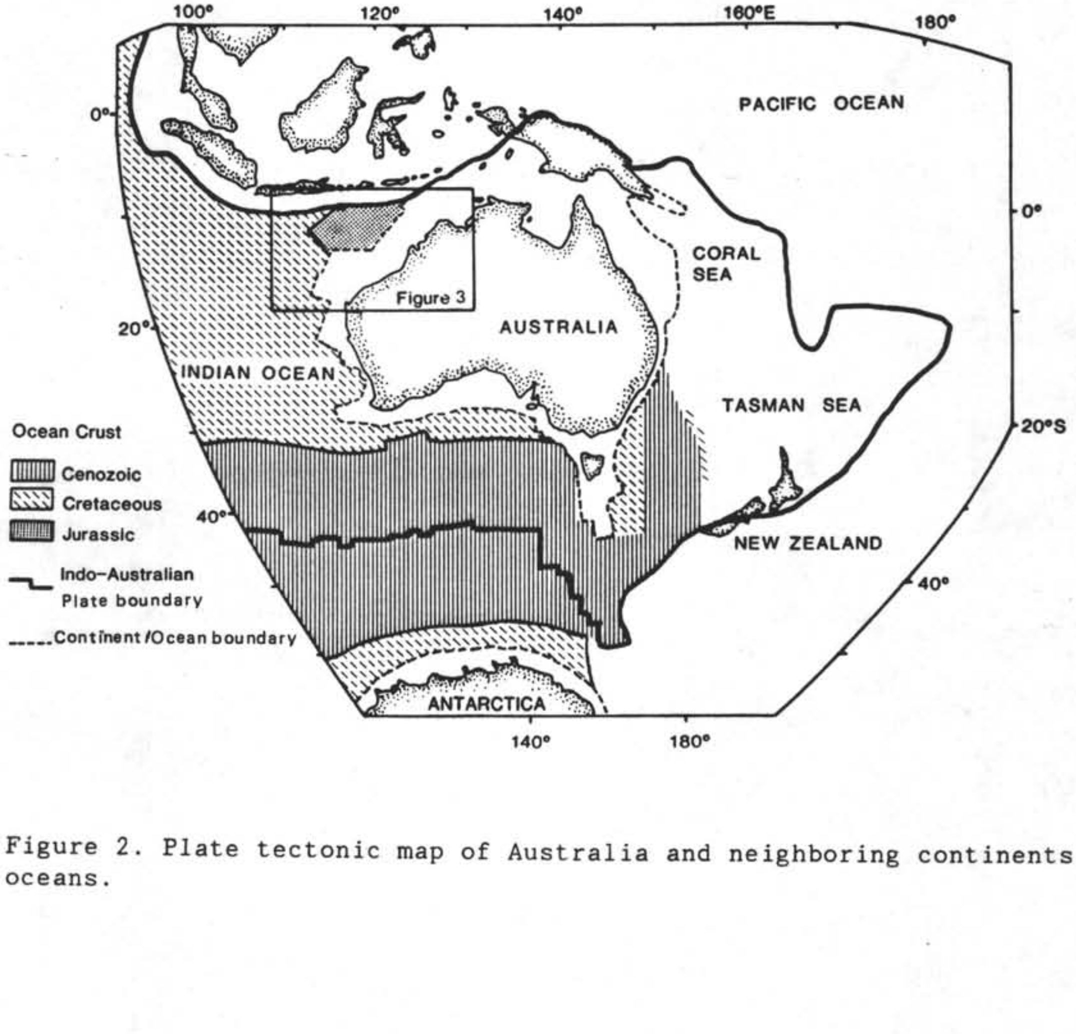


Figure 2. Plate tectonic map of Australia and neighboring continents and oceans.

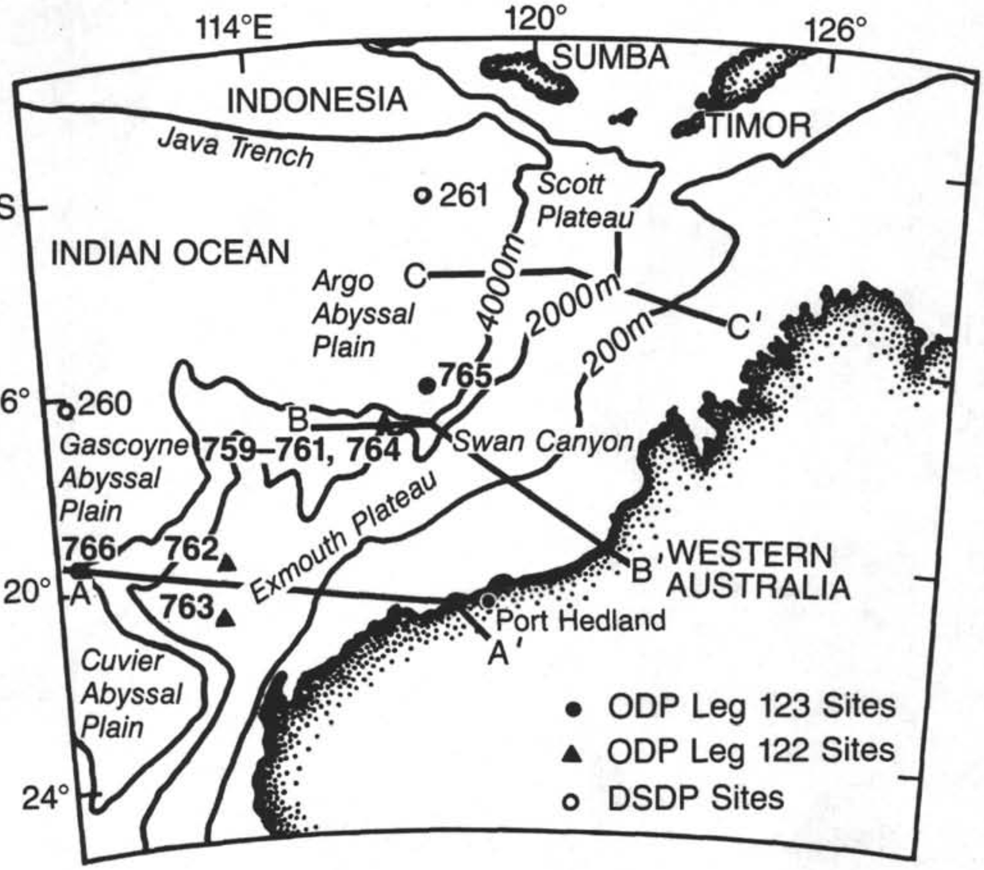


Figure 3. Geography of northwestern Australia and location of ODP Sites drilled on Leg 122 and Leg 123. Location of DSDP Site 261 is shown also. The transects A-A', B-B', and C-C' refer to the geological cross sections in Figure 5.

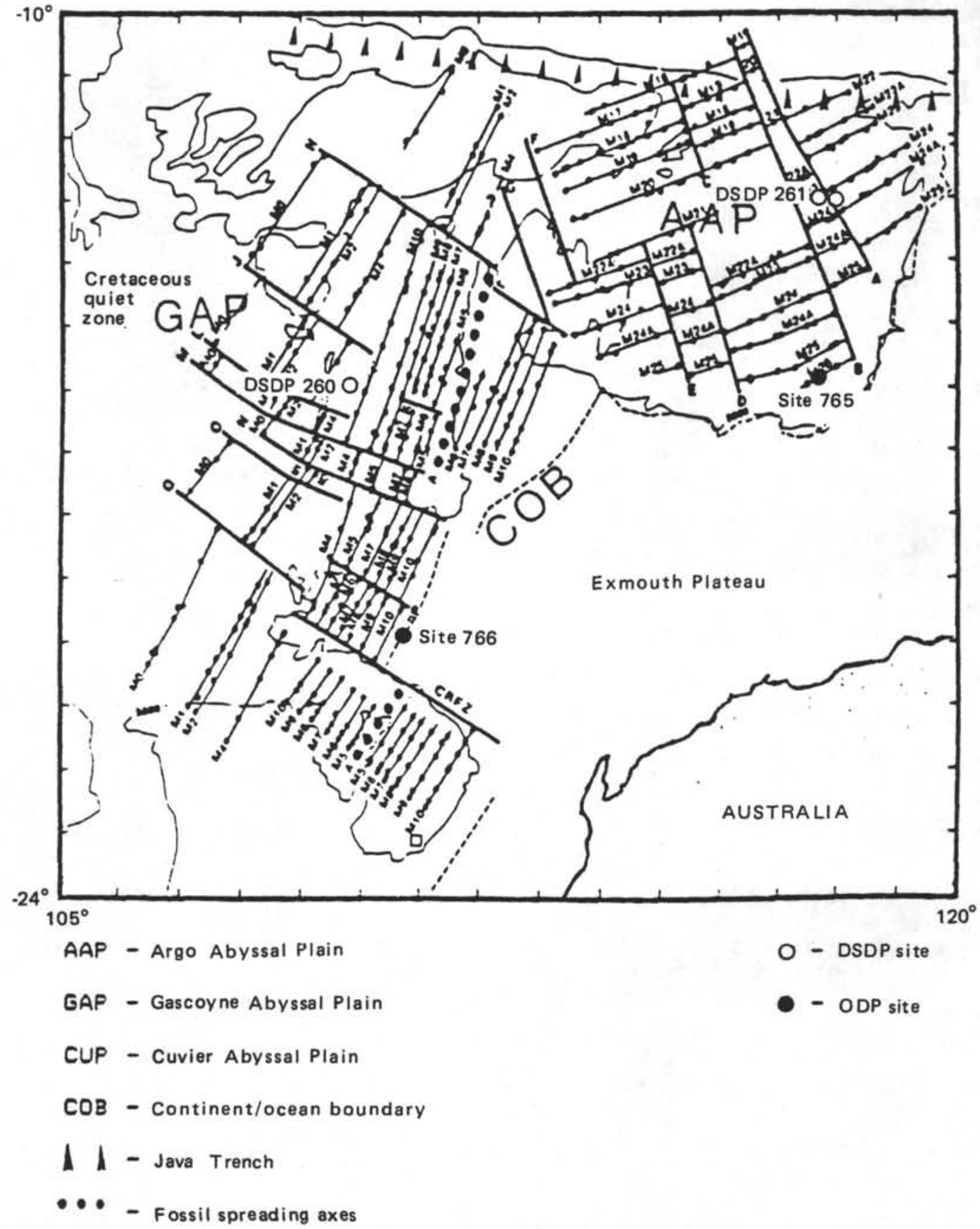


Figure 4. Geomagnetic isochrons and fracture zones overlain on the 500 m isobath. Dots indicate marine magnetic anomaly picks and the dotted line is the continent/ocean boundary (COB). CRFZ is the Cape Range Fracture Zone. Modified from Fullerton et al. (in press).

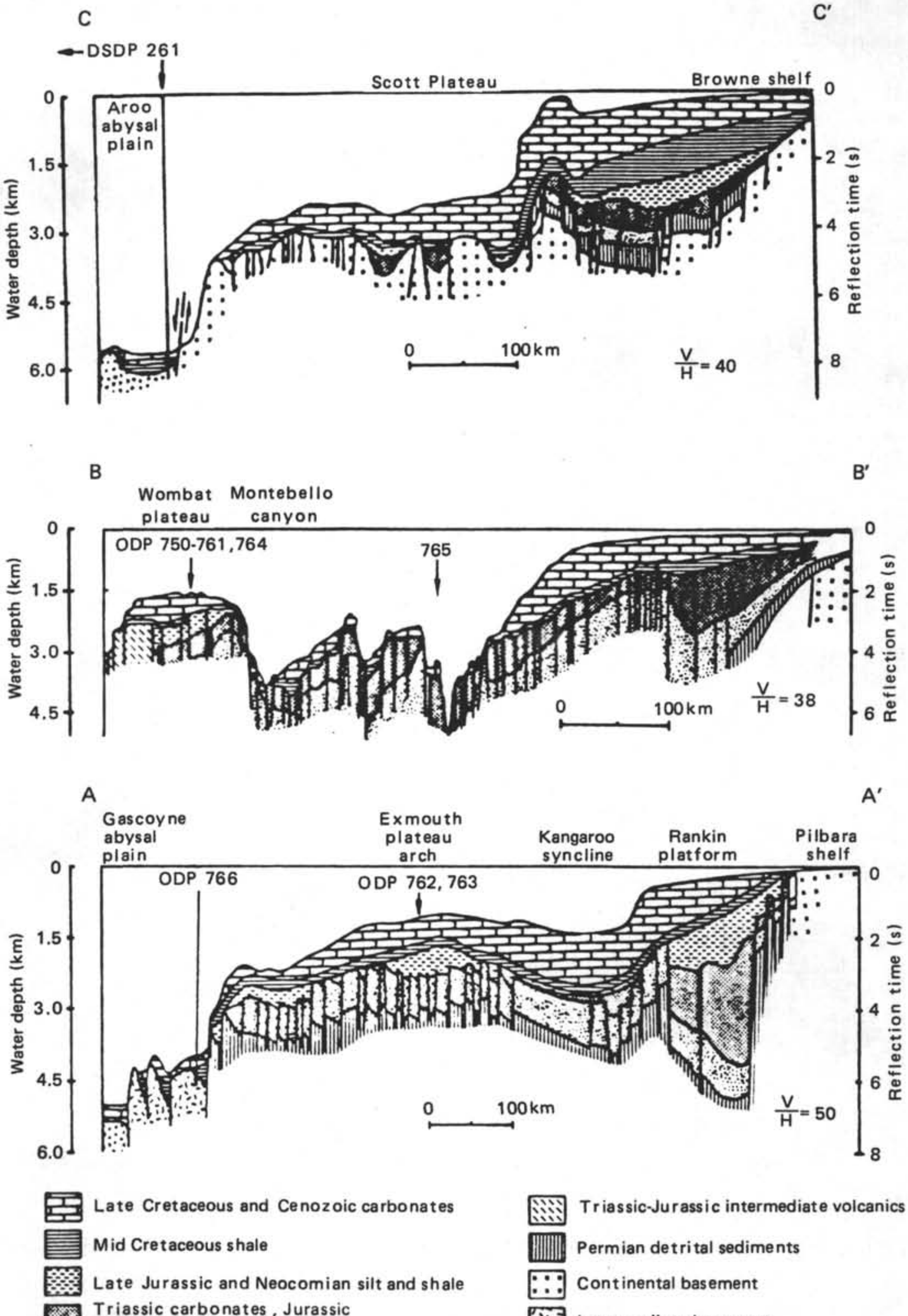


Figure 5. Schematic geological cross sections across the northwestern Australian margin and adjacent ocean basins, showing the approximate locations of ODP Leg 123 Site 765, Argo Abyssal Plain, Site 766, Gascoyne Abyssal Plain, ODP Leg 122 sites, and DSDP Site 261 (after von Stackelberg et al., 1980; von Rad and Exon, 1982; Bradshaw et al., 1988). Transect locations are shown in Figure 3.

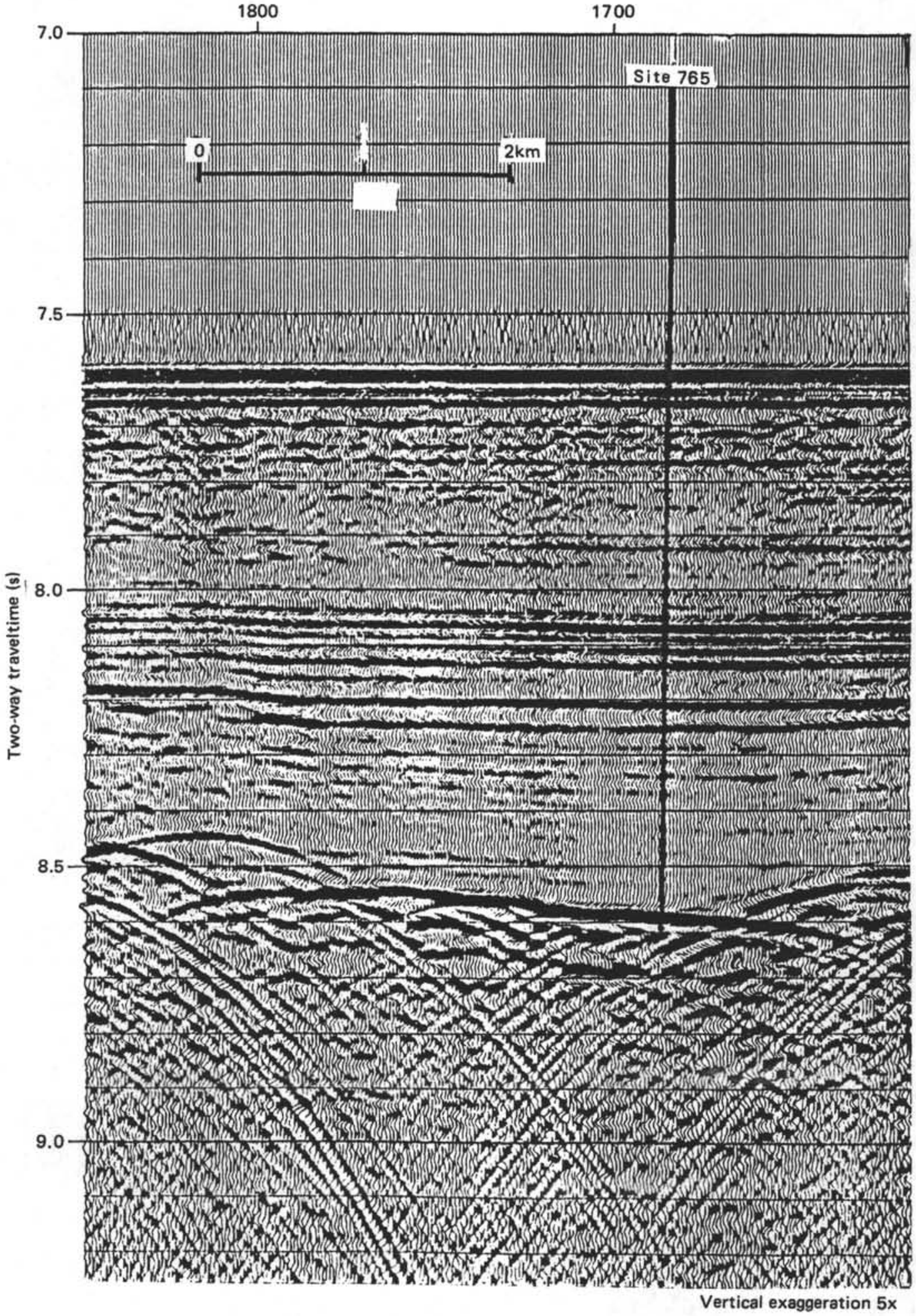


Figure 6. Segment of Rig Seismic Line 56/23C showing location of Site 765, Argo Abyssal Plain.

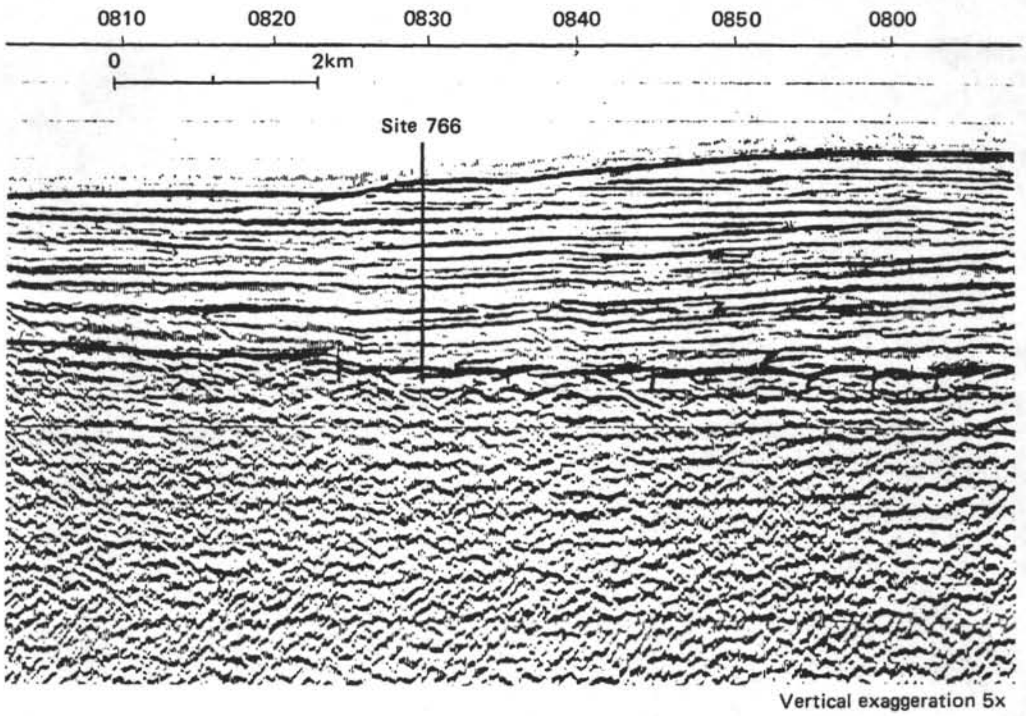


Figure 7. Segment of Rig Seismic Line 55/2 showing location of Site 766, Gascoyne Abyssal Plain.

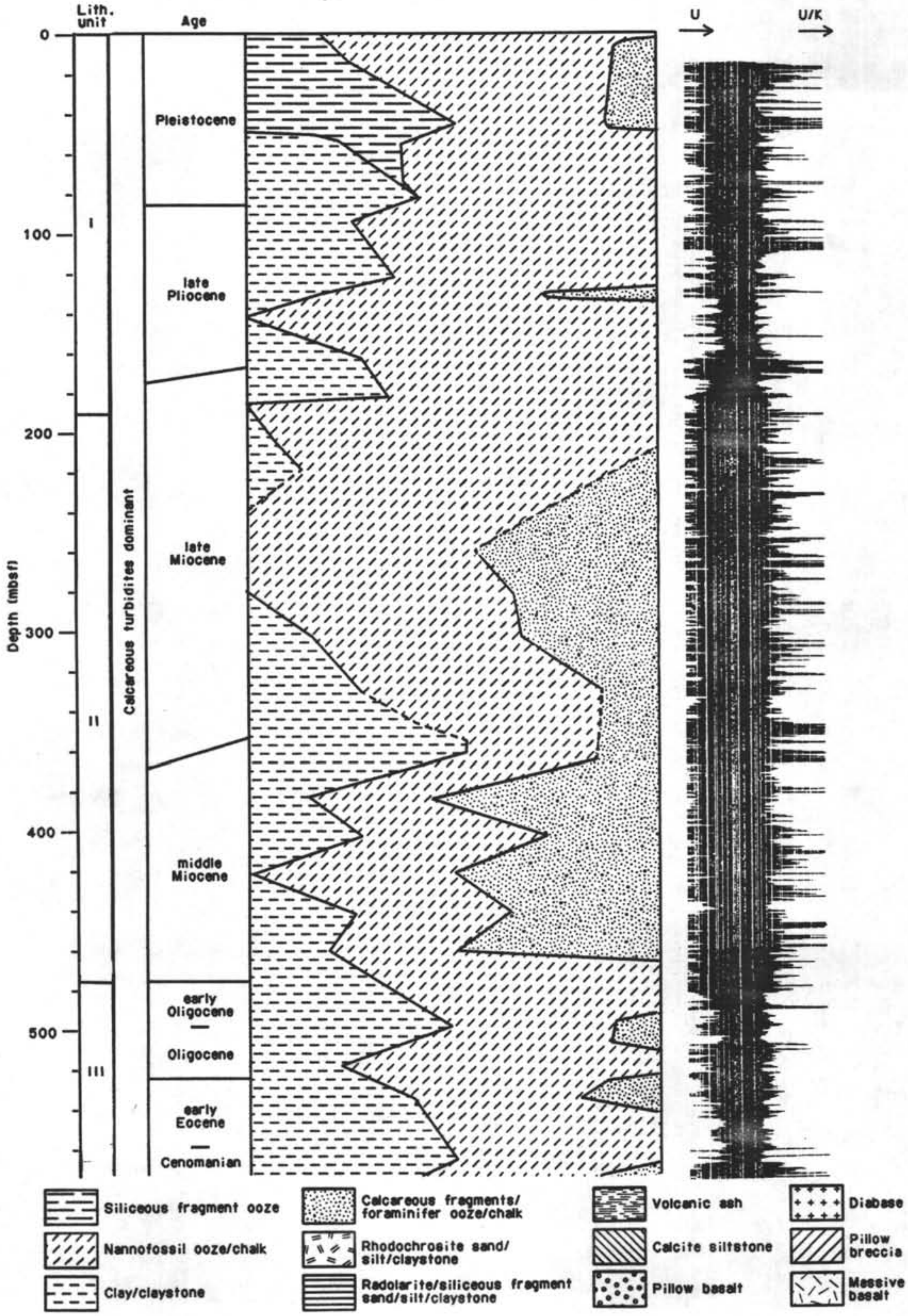


Figure 8A. Stratigraphy of Site 765, with stratigraphic representation of principal lithologies using multivariate analysis of all smear-slide lithologic data in over 700 samples. The downhole K and U/K anomalies that assist in lithostratigraphy were obtained from spectrometer logs.

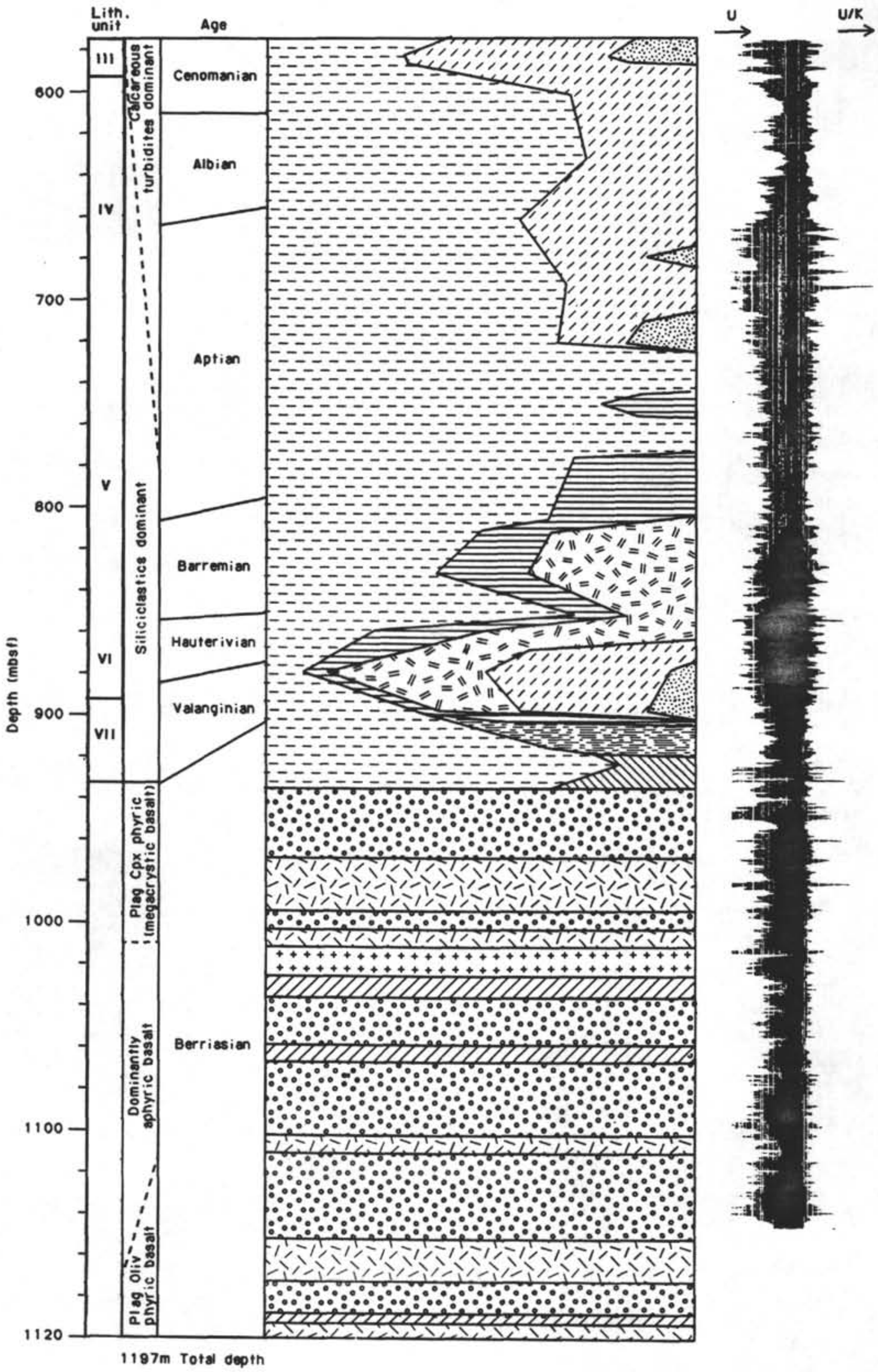


Figure 8A (continued).

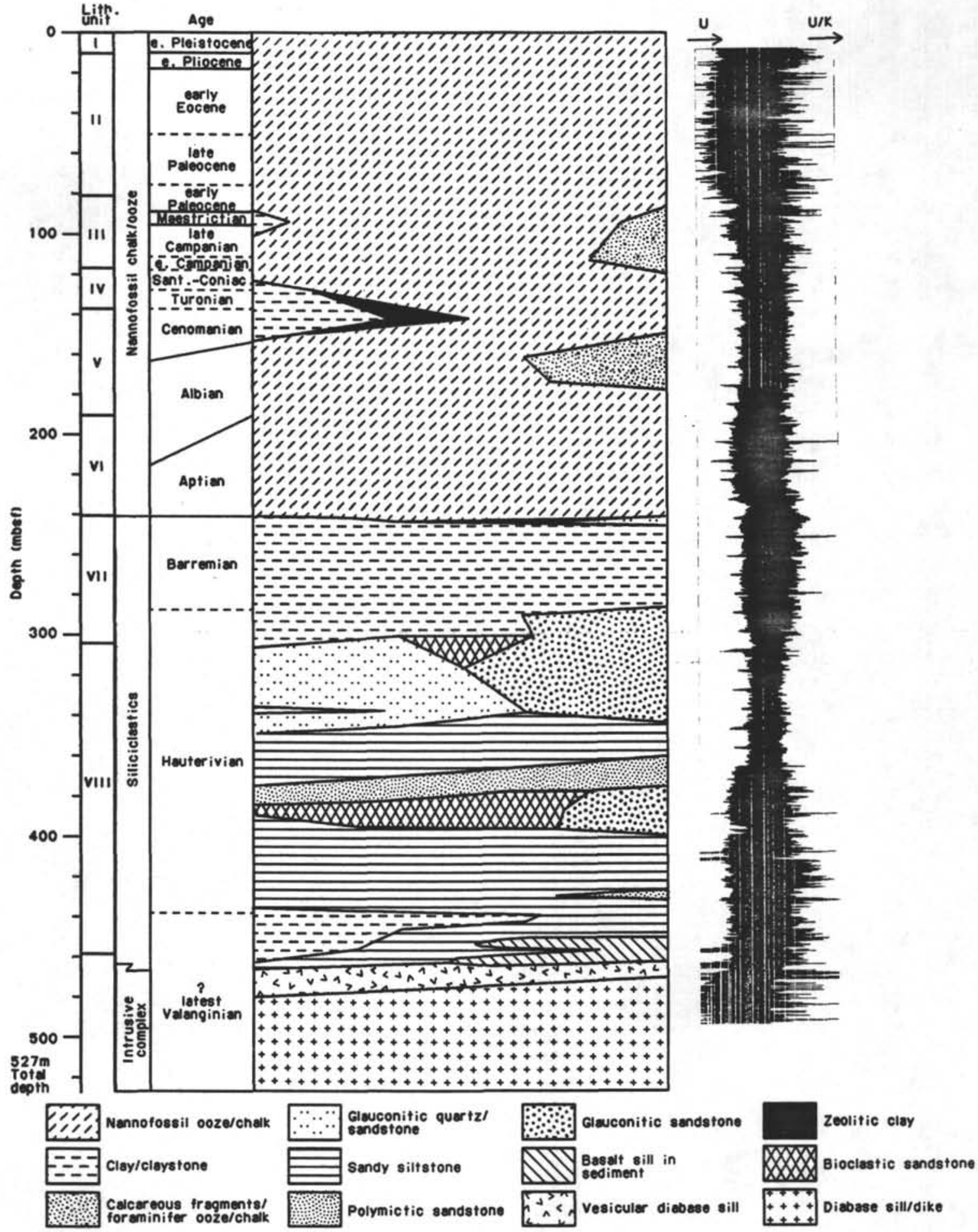


Figure 8B. Stratigraphy of Site 766, with stratigraphic representation of principal lithologies using multivariate analysis of all smear-slide lithologic data in over 700 samples. The downhole K and U/K anomalies that assist in lithostratigraphy were obtained from spectrometer logs.

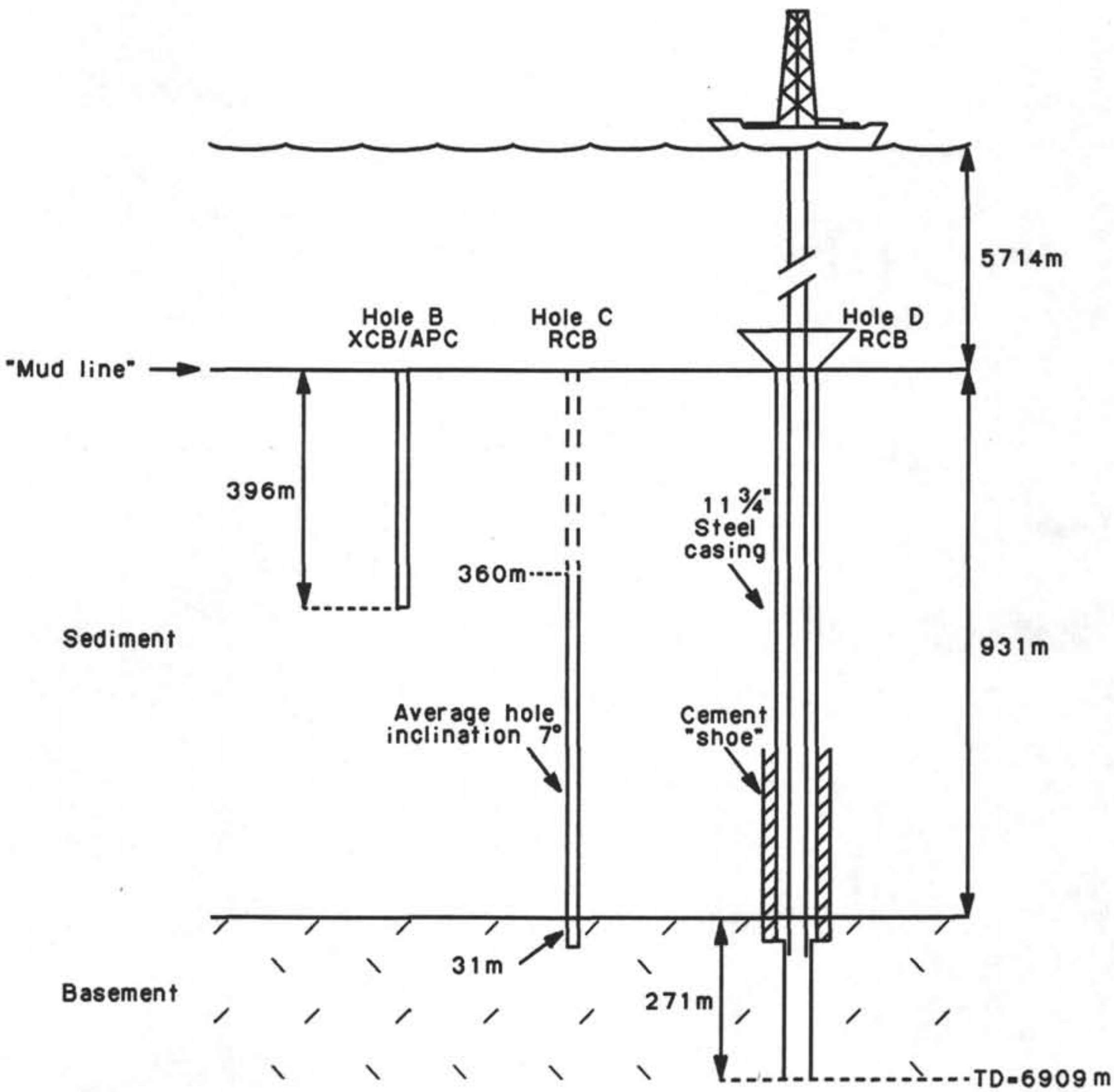


Figure 9. Summary of drilling operations at deep ocean reentry Site 765. Depths are given in meters below sea floor. Hole 765A, a failed mud-line attempt, is not shown.

OPERATIONS SYNOPSIS

The ODP Operations and Engineering personnel aboard JOIDES Resolution for Leg 123 were:

Operations Superintendent:	Pat Thompson
Development Engineer:	Mike Storms

LEG 123 OPERATIONS SYNOPSIS

Leg 123 of the Ocean Drilling Program involved the investigation of two sites in the Indian Ocean. The first and longest portion of the voyage was spent drilling Site 765 (AAP1B) using APC, XCB, RCB and reentry techniques. The second portion of the leg was spent drilling Site 766 (EP2A) to determine the origin of the basement rocks and the age of the near-basement sediments. The second site was cored using the rotary core barrel.

Much of the preliminary operational planning for Site 765 was based on the results of DSDP Leg 27, particularly Site 265 near Timor, where high penetration rates existed down to basement rocks. Consequently, planning for Site 765 included coring a pilot hole and then setting a reentry cone and casing through the sediments to basement. Water depth and sediment thickness at Site 765 indicated a need to suspend the heaviest loads the vessel's hoisting system had ever handled. Selection of the drill-string pipe sizes and bottom-hole-assembly (BHA) components was accomplished using computer models to minimize the loads on the derrick and stress in the drill pipe.

The scientific objectives at Site 765 were realized using APC/XCB techniques for recovery down to the indurated sediments. The RCB was then used to core down and into basement. The logging program in the sediments was only partially successful owing to deteriorating hole conditions.

The basement drilling employed reentry techniques and was accomplished using three core bits. A complete suite of Schlumberger logs and three televiewer runs were completed. The hydrofracture portion of the downhole experiments was less than successful, owing to hardware problems. The clamped geophone experiment was partially successful in the sediment section but experienced problems with the signal-to-noise ratio in the basement rocks.

The major objectives of Site 766 were accomplished by rotary coring the sediments and basement rocks and then releasing the bit to conduct the logging program. Through-pipe logging obtained mineral chemistry data over the complete section and excellent open-hole logs were obtained of the upper section.

SINGAPORE PORT CALL

Leg 123 commenced 28 August 1988 at 0700 hr in Singapore harbor. Port call activities were completed rapidly and the vessel was able to depart for Site 765 at 1458, 31 August 1988. Besides crew change, fueling, resupply, and off-loading of shipments, two special activities were carried out: repair of the Cyberex unit and installation of the sonar dome.

SINGAPORE TO SITE 765

After departing Singapore, the ship sailed the shallow waters of the Java Sea for two days. The geophysical equipment was not streamed until after traversing the Lombok Straits and entering deep water. The ship was diverted 11 nmi from a rum line course to Site 765 in order to run a geophysical line over DSDP Site 261. A geophysical survey was operated between Site 261 and Site 765 (proposed site AAP1B) in order to tie in the new site with the regional geology. The site approach began 10 nmi from the site. Ship's speed was slowed to 5 kt and the approach controlled using both dead reckoning (DR) and geophysical data, as GPS navigation was not available for several hours. A beacon was deployed at 0230, 7 September 1988, but failed to function. Ship's position was maintained in the area using transit satellites and DR navigation until 1630 when GPS data allowed the ship to return to the location of the original beacon drop. A second beacon was deployed and the vessel was positioned over the beacon.

Hole 765A

Site operations began in excellent weather and sea conditions. Roll was never greater than 5° and most of the time the ship was motionless. At the beginning of the cruise SEDCO requested that the total suspended derrick load not exceed 680,000 lb until the derrick manufacturer finished a capacity review of the structure. With this caveat as a limit, a standard three-stand APC/XCB BHA was assembled and 5480 m of 5-in. drill pipe was picked up. The bit was positioned 5 m above the PDR depth of 5731.9 m and an APC mud-line core taken. The APC recovered 9.7 m indicating the bit was below the mud line. The pipe was pulled back to 5731.9 m and a 1-3/4-hr "jet test" conducted to determine the setting depth of the conductor pipe. After completing the jet test the drill string was pulled to 5728 m to spud Hole 756B.

Hole 765B

Core 123-765B-1H recovered 9.3 m of soft ooze, establishing the mud line at 5728.2 m. Piston coring continued down to 173.3 m below seafloor (mbsf), and XCB coring continued down to 395.6 mbsf. Hole 765B ended in indurated clay mixed with sand. A drift shot taken on the last core indicated that the hole angle was 5.9°. This angle matched closely the formation dip observed in the cored sediments.

Hole 765C

The pipe was tripped back to the ship and the BHA was changed to RCB configuration. The hole was started by drilling to 350.2 mbsf using a button center bit and then was continuously cored to total depth. The RCB system was effective in the stiff clay and indurated sands, with good to excellent recovery throughout the section. Some hole problems were encountered with Core 123-765C-47R, when the pipe was stuck for 2 hr. The problem started while taking a drift shot with the bit near the bottom of the hole (hole drift 3-3/4°). An overpull of 70,000 lb was required to free the pipe.

Coring resumed after repeated reaming of the sticky zone that grabbed the pipe, and displacing 50 bbl of gel mud. Still, bottom fill of 3 m was common between wiper trips. The hole was cored 28 m into basement to a total depth of 964.4 mbsf.

The hole was slugged with 40 bbl of high viscosity mud, and the pipe tripped up to 180 mbsf and back to bottom. The bit stopped on 40 m of fill. The hole was redrilled to original depth and thoroughly cleaned. After releasing the bit, the pipe was tripped back to 180 mbsf. The first suite of Schlumberger logging tools was made up and the hole logged down to 470 mbsf, where the tools stopped on a firm bridge. The logging tools were retrieved and the pipe moved down to 518 mbsf and then back to 470 mbsf. The same tools were run back into the hole, but would not go out the end of the mechanical bit release top connector (MBR). The tools were pulled out of the pipe and a center bit dropped to de-plug the MBR. The pipe was relocated to 518 mbsf and the side-entry sub (SES) installed. Using the SES the end of the drill pipe was able to follow the logging tools down the hole and wash out bridges as they occurred until the tools reached 765 mbsf. At this depth the formation bridged between the logging tools and the end of the drill pipe. It became difficult to drag the tools back into the pipe. The drill pipe was pulled back to 180 mbsf and the SES removed. The top section of Hole 765B was logged with the sonic tools from 180 to 470 mbsf and the hole was abandoned.

Hole 765D (Reentry Hole)

The reentry cone was moved into the moon pool area and a 90.5 m conductor string of 16-in. casing was assembled and latched into the cone. A BHA with a 14-3/4-in. drill bit was assembled and latched into the cone-casing assembly. The cone, casing and BHA were lowered to the seafloor and jetted into the bottom until the cone mud skirt was resting at 5734.3 m. A 14-3/4-in. diameter hole was then drilled to 947.9 mbsf. The surface casing hole terminated 20 m into basalt.

The hole was filled with 10.5 lb/gal mud containing 3% KCl. The TV was run to the seafloor on the drill pipe, and the cone was observed as the pipe was released from the cone. The pipe was tripped back to the ship and a string of 11-3/4-in. surface pipe assembled.

The hole was reentered. Casing was run to the bottom of the hole and the hanger latched into the cone. As landed, the casing shoe was 5 m into basement rock. A 15-m, 14-3/4-in. diameter rathole was left below the casing to accommodate material that fell in from above as the casing was run to bottom. The cement string was released from the cone and the annulus between the casing and borehole displaced with 15 lb/gal cement slurry back to the surface. Later, the sonic logs indicated a cement bond around the bottom 200 m of casing and only in sections above this point. Five bbl of cement was displaced on top of the latch down plug and the pipe was tripped back to the ship.

A five-stand RCB BHA with a Hydrolex jar below the top stand was assembled and the pipe was tripped back to the seafloor. Hole 765D was reentered and the cement plug extending 3 m below the casing shoe was drilled out. After breaking through the cement, the bit ran to bottom without resistance, indicating that the KCl-weighted mud had been effective in holding back the swelling formation encountered in the pilot hole.

Three 9-7/8-in. TCI medium chisel insert core bits were used to core Hole 765D to total depth. Penetration rate in the altered basalt averaged 2.25 m/hr including wireline time. Jamming of the core liner was a problem in the early cores, and the decision was made to core without liners. The recovery improved dramatically, but removal of the core from the inner barrel remained a minor problem. Recovery in the basalt was poor. Later, the caliper and sonic logs indicated the 9-7/8-in. hole to be enlarged in places to over 15 in. Apparently the formation was breaking out from the overburdened stresses and the shock loads imposed by the roller bits. Possibly, diamond bits would have imparted less shock to the rock and drilled a better hole with fewer places for the stresses to initiate breakouts. The hydraulic frictional losses in the 5500-m drill string were 3000 lb at 140 strokes. The cuttings returned in the core barrel were small and hole cleaning was effective as indicated by lack of fill. The shirt-tail wear and cone erosion that so plagued the core bits used at Hole 504B and the ridge crest drilling were nonexistent in this hole. Primary failure mode of the core bits was bearing wear. The excellent cutting structure life is attributed to the highly altered nature of the basalt.

<u>Logging with the Schlumberger tools</u>: After recovering Core 123-765D-27R, the hole was displaced with 40 bbl of high viscosity mud and the pipe tripped back to the ship. The next BHA included a logging bit and Tam Retrievable Formation Tester. The hole was reentered and the bit placed two stands below the reentry cone. The first logging run was the seismic stratigraphy combination. Good logs were obtained.

The second run was the geochemical combination. The log was almost completed when the tools pulled tight inside the 11-3/4-in. casing 106 m below the bit. Repeated logging cable pull cycles up to 8000 lb failed to free the tools, and the decision was made to deploy the Kinley crimper and cutter tools. The Kinley crimper was clamped around the cable and dropped down the pipe. However, the logging tools were released and pulled into the pipe while the cable was worked up and down as part of the Kinley deployment procedures. The geochemical tool was pulled back to the rig. No observable damage was noted to the tools or the cable. The reason for a 20-m long 3-3/4-in. diameter logging tool sticking in a 10.88-in. I.D. casing string remains a mystery.

Logging - first televiewer: The first televiewer run ended at 3500 m down the drill pipe when the tool stopped rotating. The back-up televiewer unit was deployed and run to bottom. The hole was logged successfully up to the casing.

Logging - vertical seismic profiling: The VSP tools were deployed and run down to 1000 m where they were stopped and a cycle check of the clamping arm conducted. The tool cycled and released successfully but stuck fast inside the pipe 20 m below the test point. Pull cycles of 8000 lb failed to dislodge the tool. The Kinley crimper was deployed and worked down with cyclic loading. Before the Kinley crimper was fired, the VSP tool released and was retrieved. It was discovered that two 3/8-in. bolts had vibrated loose and fallen down the pipe. The last time these bolts failed was during DSDP operations in 1975. When the VSP tool was stopped to test the clamping arm, the bolts wedged the logging tool pressure case in the upset of a tool joint. No further line wiper problems were encountered.

The VSP (clamped geophone) was redeployed. The 16-in. casing landing tool was set in the cone, and 15,000 lb of weight applied to hold the drill string motionless and reduce noise in the well bore. The geophone was run out the end of the pipe and clamped 20 m below the bit. The geophone gain was adjusted based on a seismic signal produced by hanging the 1000 in^3 water gun and one air gun off the port crane.

The geophone was run to the bottom of the well and data were collected by moving the sonde up the hole and clamping every 10 m. Total time for the experiment was 27 hr. Success in the basalt was not good because of weak seismic signals at these depths. The data obtained from the cased section of the hole were usable but interrupted by pipe noise. The VSP tools were recovered and the piped moved down the casing to 875 mbsf. This was to be the location for the first packer test, placing the bit below the zone where the second GST Schlumberger log had mysteriously stuck in the casing.

Third Schlumberger log: The last log of the first bit trip was with a Schlumberger lithodensity tool. Both the open and cased portions of the hole were logged through the pipe. The tool also provided an inclinometer log that indicated Hole 765D to be vertical within 1°.

Packer operations on the first bit: A packer inflation go-devil was dropped and the drill string pressured up. There was no indication of set, and pump flow indicated a large bypass of fluid past the go-devil. The go-devil was retrieved for inspection, redressed with new parts, and redeployed. Indication of packer set in the casing was obtained at 1500 psi drill pipe pressure. Per the Tam operating manual, an upward pull of 5000 lb was placed on the drill pipe, and the pump pressure increased to 2500 psi, where the setting plug sheared out. The packer started sliding up the hole, and the driller raised the blocks about 10 m to keep the drill string out of compression. The pump pressure was bled off at the stand pipe valve to release the pressure under the packer. The weight indicator indicated that the drill string heave characteristics had changed and the driller was able to slack 15,000 lb of weight down on the packer indicating the element was set in the casing. The scientist conducting the experiment asked for two 1200-psi pulse tests. These were completed without problems and the formation appeared to be permeable. A 250-gpm flow test was then conducted by running the rig pumps at 50 strokes. After 2 min, the weight indicator indicated that the packer was again sliding rapidly up the casing. The SEDCO Superintendent stopped the mud pumps as the stand pipe pressure climbed above 2200 psi. This rapid change in pressure was unexpected after the results of the earlier flow tests and caused some surprise. The driller moved the blocks another 10 m up the derrick to relieve the weight on the packer element, and the pressure was bled off at the stand pipe. A pull test indicated that the packer was still set but the blocks were now in a position where it was not possible to deflate the packer without recovering the inflate go-devil. The packer was deflated and the pipe was moved down the hole to 1140 mbsf for a second packer test. The second set was not successful and the Kuester downhole pressure recorders indicated that the packer element had failed. The pipe was tripped back to the vessel for the straddle packer BHA. Subsequent inspection of the drilling packer indicated that the element wires were ripped in a manner that could happen when high axial loads are placed on a set packer. Perhaps the packer element failure occurred when it was necessary to set weight down the element in order to insert the deflate go-devil into the pipe. However, a pull check conducted after go-devil insertion indicated that the packer was still set. This indication may have been hole drag.

Logging bit no. 2: A 5-ft long 5-1/2-in. drill pipe "pup" was used to space between the two packer elements. The bottom go-devil was installed at the rig floor, the tools run to bottom and the hole reentered. The packer was run to bottom of the hole and the fill tagged at 1160 mbsf with the rig pumps running at 60 strokes and pumping out the frac ports. The bit was moved up 2 m and the setting go-devil dropped to attempt inflation. The go-devil did not seat and bypassed 50 strokes at 1300 psi. The drill string was slacked off 4 m but took no weight. The pump gauge indicated that the packer cycled normally only when the bit sat on top of the fill. When the drill string was lifted, the weight indicator did not indicate drag from an inflated element. The packer was moved 30 m up the hole, and inflation attempted; again there was no indication of inflation. The upper inflate go-devil was retrieved and inspected. Marks on the no-go ring indicated that it had passed through the landing shoulder of the upper packer and seated on top of the bottom go-devil. This would explain the failure of the go-devil to seat in the upper packer and hold pressure. New "O" ring seals were installed on the go-devil and the unit was pumped back down. The go-devil landed and the packer developed pressure normally. It was possible to hold 2500 psi without leakoff but there was still no sign of inflation. The packer experiment was abandoned and the drill pipe tripped back to the vessel.

After leaving the site packer inflation was attempted on deck. The go-devil held pressure but the element would not inflate. When disassembled it was found that the axial inflation ports in the control sub were plugged with fine basalt cuttings and pipe dope. With these ports clogged, flow into the element was blocked and inflation was not possible.

The straddle packer experiment exhausted the allotted time for Site 765, and the drill string was pulled back to the ship. Hole 765D was left in serviceable condition for future work. The commandable beacon attached to the reentry cone was turned off and may aid in site location should another attempt be made to work at this site.

TRANSIT BETWEEN SITES 765 AND 766

After a transit of 45 hr, Site 766 was approached from the east. The site was located by both geophysics and satellite navigation. The 3.5-kHz echo sounder indicated sufficient sediment to bury the BHA and the beacon was dropped at 2042, 19 September 1988.

SITE 766

Hole 766A

A five-stand RCB BHA was used with a bumper sub below the top stand of collars to provide a jar point in case the BHA became stuck. The bit was selected to better drill the sticky clays above the shale-basalt section.

Hole 766A was spudded at 4008 m (drill pipe depth based on a corrected PDR depth of 4016 m). It was continuously cored down to a total depth of 4535.2 mbsf. Recovery was average for the RCB system in the upper sediments, but the cores were highly disturbed. Recovery improved after passing through the chert section at 200 mbsf and into the shales. One 30-m section of coarse sand gave cause for concern. However, the hole drilled without fill or torque. After the basalt was reached at 540 mbsf, the bit performed flawlessly and recovery was almost 100%.

The bit was released after hole conditioning and the hole displaced with logging mud fortified with 3% KCl. The end of the pipe was moved back to 246 mbsf. The Schlumberger seismic stratigraphy tool was run from the end of the pipe to 15 m above the top of the basalt (443 mbsf) where it stopped on a bridge. The hole was logged from the bridge to 246 mbsf, and the logging tools pulled out of the hole. The pipe was tripped down through the bridge to 10 m above the bottom of the hole. The weight indicator took 25,000 lb and the bumper sub closed as the end of the pipe passed through the bridge. The hole was circulated with 50 strokes of the mud pump for 30 s to clear the end of the pipe. The geochemical logging tool was run to bottom, and the hole was logged through the pipe up to the mud line. An excellent log was obtained. The pipe was pulled back to

246 mbsf, and the hole logged from above the basalt with the Schlumberger lithodensity tool. An excellent log was obtained in the shale section, and the gamma was logged up to the mud line.

TRANSIT: SITE 766 TO SINGAPORE

The ship was prepared for sea, and the additional 5 hr remaining for science operations was used to run a post site-survey southeast of the site and to conduct a sonobuoy run over the site. At 1600 hr the seismic gear was retrieved and the vessel proceeded to Singapore at 11.5 kt average speed. Anchor was dropped in Singapore harbor at 0700, 1 November 1988.

LOGGING SUMMARY

A summary of logging runs follows:

765C:
- Log No. 1 SeisStrat (TLT-DITE-MCD-LSS-NGT)
  From 180 mbsf to 480 mbsf
  Data quality: Good
- Log No. 2 SeisStrat from 480 mbsf to 760 mbsf
  Data quality: Good
- Log No. 3 LithoDensity (LDT-CNT-NGT)
  From 181.92 mbsf to 477.2 mbsf
  Data quality: Good

765D:
- Log No. 1 SeisStrat w/TLT
  From 53.78 mbsf to 1185.4 mbsf
- Log No. 2 GeoChem (GST-ACT-NGT)
  From seafloor to 1170 mbsf
  Data quality: Good
- Log No. 3 Borehole televiewer w/TLT
  From 932 mbsf to 1168.6 mbsf
  Data quality: Acceptable
- Log No. 4 Vertical Seismic Profile (VSP)
  From seafloor to 1161 mbsf
  Data quality: Acceptable
- Log No. 5 LithoDensity (LDT/CNL-NGT-GPLT-w/TLT)
  From seafloor to 1157.2 mbsf
  Data quality: Good
- Log No. 6 Borehole televiewer w/TLT
  From 933 mbsf to 1170.6 mbsf
  Data quality: Excellent

766A:
- Log No. 1 SeisStrat w/TLT (DIL-NGT-SONIC)
  From 245.4 mbsf to 448 mbsf
  Data quality: Good
- Log No. 2 GeoChem (GST-ACT-CN2-NGT)
  From seafloor to 527 mbsf
  Data quality: Good
- Log No. 3 LithoDensity (LDT/CNL w/TLT)
  From seafloor to 448 mbsf
  Data quality: Very Good

ODP OPERATIONS
SITE SUMMARY REPORT
LEG 123

HOLE	LATITUDE	LONGITUDE	DEPTH METERS	NUMBER OF CORES	METERS CORED	METERS RECOVERED	PERCENT RECOVERED	METERS DRILLED	TOTAL PENETRATION	TIME ON HOLE	TIME ON SITE
765A	15-58.541S	117-34.49E	5731.9	1	9.6	9.6	100.0%	0.0	9.6	23.50	0.00
765B	15-58.541S	117-34.49E	5728.2	41	395.6	270.6	68.4%	0.0	395.6	72.00	0.00
765C	15-58.541S	117-34.49E	5728.2	65	613.7	373.0	60.8%	350.2	963.9	292.00	0.00
765D	15-58.541S	117-34.49E	5724.2	27	247.0	77.2	31.3%	947.9	1194.9	602.50	990.00
766A	19-55.985S	110-27.13E	4008.0	55	527.2	349.2	66.2%	0.0	527.2	156.00	156.00
	Totals :			189	1793.1	1079.6	60.2%	1298.1	3091.2		1146.00

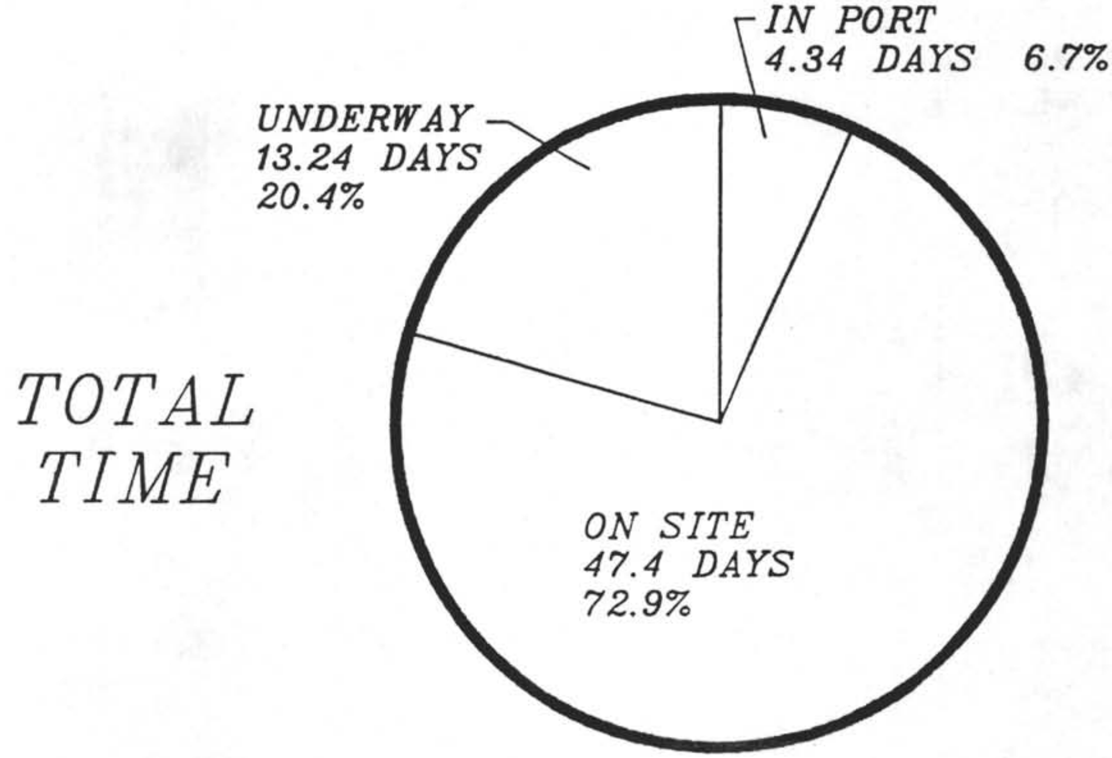
OCEAN DRILLING PROGRAM
OPERATIONS RESUME
LEG 123

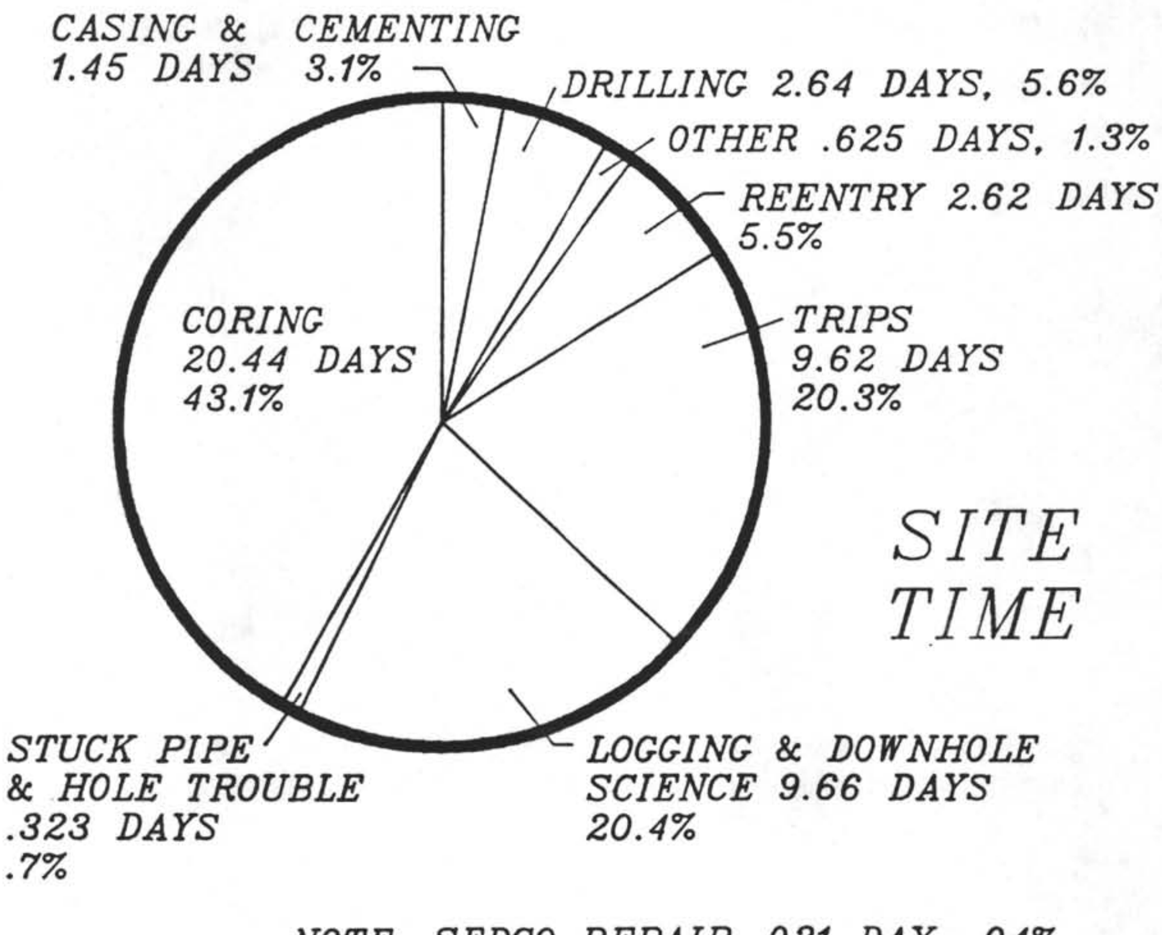
Total Days (8/28/88 - 11/1/88)	65.00
Total Days in Port	4.34
Total Days Under Way	13.24
Total days on Site	47.42

Trip Time	9.66
Coring Time	20.44
Drilling Time	2.64
Logging/Downhole Science Time	9.66
Reentry Time	2.62
Mechanical Repair Time (Contractor)	0.02
Casing and Cementing Time	1.45
Downhole Trouble Time	0.32
Other	0.61

Total Distance Traveled (nautical miles)	1485.0
Average Speed (knots)	11.5
Number of Sites	2
Number of Holes	5
Total Interval Cored (m)	1793.1
Total Core Recovery (m)	1079.6
Percent Core Recovered	60.2
Total Interval Drilled (m)	1298.1
Total Penetration (m)	1722.1
Maximum Penetration (m)	6919.2
Maximum Water Depth (m from drilling datum)	5728.2
Minimum Water Depth (m from drilling datum)	4008.0

TIME DISTRIBUTION - LEG 123





NOTE: SEDCO REPAIR .021 DAY, .04%

TECHNICAL REPORT

The ODP Technical and Logistics personnel aboard JOIDES Resolution for Leg 123 of the Ocean Drilling Program were:

Laboratory Officer:	Randy Current
Computer System Manager:	John Eastlund
Curatorial Representative:	Dan Quoidbach
Yeoperson:	Dawn Wright
Electronics Technician:	Dwight Mossman
Electronics Technician:	Jim Briggs
Photographer:	John Beck
Chemistry Technician:	Kathy Baisley
Chemistry Technician:	Valerie Clark
X-ray Technician:	Bettina Domeyer
Marine Technician:	Daniel Bontempo
Marine Technician:	Brant Bullard
Marine Technician:	Fabiola Byrne
Marine Technician:	Gus Gustafson
Marine Technician:	Kazushi Kuroki
Marine Technician:	Dan Lizarralde
Marine Technician:	Mark Neschleba

TECHNICAL REPORT

INTRODUCTION

Leg 123 began 28 August 1988, at the Loyang Offshore Dock, Singapore, and was the second half of a 4-month effort to drill a depth transect across the Exmouth Plateau. The two sites planned were located (1) at the southeastern part of the Argo Abyssal Plain, which was a reentry site and occupied most of the leg, and (2) at the foot of the western escarpment of the Exmouth Plateau.

PORT CALL

Port call commenced 28 August. A repair technician from Cyberex met the ship and immediately went to work on the power conditioner. Air and surface freight were onloaded, and air freight was offloaded. All microscopes and the Zodiac inflatable boat were removed to appropriate local shops for repair, and empty gas bottles were refilled. At 1300, 31 August, the ship moved to anchorage where final installation of the sonar dome was completed, and the ship was refueled. A camera crew from Living Tape Productions of London, England, came aboard to film the labs and interview key personnel for "Oceans of Wealth," a documentary to be shown in England.

UNDERWAY ACTIVITIES

The ship got under way for Site 765 (proposed site AAP1B) at 1500, 1 September 1988 via DSDP Site 261. Upon leaving port the sonar dome was tested for proper operation, and underway watches were set when the ship moved to the Argo Abyssal Plain. A comparison was made between the hull-mounted transducers and the dome at 12 kt in calm seas. While the 12-kHz records were greatly improved, the results from the 3.5-kHz test were not as conclusive. The sea state picked up to about 4 to 5 between sites, and another comparison was made. The signals from the dome were acceptable, but bottom was never seen with the aft 3.5-kHz transducers. The new depth correction to the DES is 18.1 m.

On the approach to DSDP Site 261 the ship was slowed and seismic gear was streamed. After passing the site the ship speeded up to 8 kt and a line was run to Site 765 where the ship again slowed to survey speed. The site selection line for 766 was uneventful. A 4-hr survey and sonobuoy run completed Site 766.

Three sonobuoys were deployed this leg. The first was used on the approach to Site 765 and failed after less than 1 hr. Another sonobuoy was dropped upon departure for Site 766. For this run we used the whip antenna mounted at the aft end of the helipad, and were able to receive the signal somewhat longer than the first, although it faded at a range of about 8 nmi. A third sonobuoy was deployed upon leaving Site 766. It has been recommended that we mount our antenna on the derrick and use an amplifier to help maintain the signal longer.

REGULATED POWER

The Cyberex power conditioner was down when the ship arrived in Singapore. A repair technician was brought aboard as soon as the ship made anchorage and immediately began work on the system. Not much was seen or heard from him until just before the ship was due to sail, when he reported the system was again fully operational. Several fuses and switching transistors were replaced, and all spare circuit cards were tested. The technician indicated that a major part of the problem was due to misadjustment of the circuitry, which had put an extreme load on some parts of the system. A load test was conducted using lamps, heatguns, and ovens for about three days before the more delicate systems were brought online. Early in the leg the VAX reported a power problem which turned out to be a blown fuse in the charger, and at one point the batteries were disconnected for a few days for cleaning. Regulated power was extremely reliable and stable this leg.

ON-SITE ACTIVITIES

The ship spent 36 days on site in drilling mode and 11 days logging. Core recovery was moderate, with a total of 1783.5 m drilled and 1070.39 m recovered, averaging 60%. Intervals between core arrival on deck ranged from 2 hr for the upper sections to well over 6 hr in basalt.

Three holes were logged this trip. Hole 756C was plagued with bridging problems, and the logging program was terminated. Just over 7 days was devoted to logging in Hole 765D. In addition to the full complement of Schlumberger tools, the borehole televiewer, vertical seismic profiler (VSP), and two packers were deployed. Near the end of the second Schlumberger run in Hole 765D the tool stuck unexplainably in casing, but was freed. The straddle packer was loaded with cuttings and would not inflate. Hole 766A was logged with the lithodensity and geochemical tool strings.

A medical emergency prompted the helicopter evacuation of a Catermar cook. The on-board diagnosis of a probable kidney stone was confirmed by the attending physician in Australia.

BRIDGE DECK

During the port call a new software package developed by J. Ogg, a shipboard scientist sailing on Leg 123, was installed on the paleomagnetics lab's IBM-PCAT-compatible. A color monitor was purchased in Singapore for proper display. A multiple communication port board had been purchased by ODP and shipped special air freight, but did not arrive in time for our departure. The system was declared operational just before our arrival on site. Some modifications to existing VAX routines were necessary to accommodate the difference in filename length allowed by the PC, and for the communication between the PC and VAX. At present the system is considered to be fully operational.

At about the midpoint of the leg the super saw (used to longitudinally halve sections of lithified core) started making bad sounds and was disassembled. The shaft bearings were bad, and the bearing surfaces on the shaft were worn. An attempt was made to sleeve the shaft for a proper fit but the shaft had been bent, and so a new shaft was made on board.

The GRAPE and P-wave logger were not used extensively this leg because there were relatively few suitable cores. Both pieces of equipment performed as usual. P-wave data were plotted without blocking and produced interesting plots. Two distinct traces plotted at an average of 75 m/s separation. This is thought to be an artifact of the vertical scanning system, and should be resolved when the MST arrives. In the meantime, the trace representing the higher velocities seems to correlate well with discrete samples run on the Hamilton Frame.

Thermal conductivity was run on nearly every core. It was suggested that we look into the possibility of an insulating sleeve or blanket to reduce the effects of lab temperature fluctuations, as the temperature drift measured in the cores seemed excessive.

FOC'SLE DECK

The chemistry lab was kept moderately busy this leg with routine sampling. The Rock-Eval was used to run over 200 samples with only minor problems experienced in the printer. Headspace samples were taken from every core and monitored for light hydrocarbons on the Carle GC.

The X-ray lab was used heavily this leg; about 700 scans were run on the X-ray diffraction unit. The X-ray fluorescence unit was used for a large number of sediment samples to establish a global geochemical reference hole in the Indian Ocean.

Over 300 thin sections were made this cruise. A vacuum line was run to the Leco Varicut saw, and a new jig was made in order to eliminate adhering the slides to the jig with melted wax.

There were seven scientists in the paleontology lab this trip, and the lab was quite busy. A technician was assigned to the lab to prepare paleontological samples at the second site.

All microscopes were cleaned and adjusted in Singapore. Other than the usual fine tuning and parts search, all performed well.

The SEM was disassembled and packed along with its spares and supplies for return to ODP.

MAIN DECK

This leg saw moderate use of the computer systems after regulated power was declared safe and the VAX was brought on line. The heaviest users were paleomagnetics lab Picsure plots, the SLIDES application, and vertical seismic profiling. The new generation of PRODUCT software appears to work well. Measurements were made in the machine room and system manager's office in preparation for the upcoming local area cluster upgrade, and for installation of the Ethernet cables to the downhole measurements and underway geophysics labs. The Halon fire extinguishing system was tested this leg using rig air instead of Halon. It was noted that an inordinately strong pull was required to activate the system owing to the number of corners the cable must make, and the overall length of the run.

The new Mitsubishi large-screen TV was built onto a pedestal against the aft end of the science lounge and the bookcases were rearranged to accommodate this installation. Performance appeared quite satisfactory, and the unit was used extensively.

PHOTOGRAPHIC LAB

Parts for the water chillers and several boxes of film arrived in Singapore after the ship sailed. The last word we had before sailing was that the shipment was sitting in Anchorage, Alaska. New plumbing parts were purchased in Singapore, repairs were made, and the chillers now work fine. New copper water lines were installed by the SEDCO engineers this trip; this job will be finished during the Leg 124 port call and should improve the quality of the potable water throughout the lab stack.

ELECTRONICS LAB

Several reentries kept both ETs busy working on the TV/sonar system. An implosion of the flotation balls in the beacon mounted on the VIT frame destroyed one camera and severely damaged the telemetry pod. The large diameter sonar also had its share of problems. Toward the end of the cruise the pressure case was destroyed when the end cap galled. A new case is scheduled for Leg 124.

The new TOTCO system required the services of a full-time ET to get it into some form of operation and keep it there. Some of the sensors are not functional, and the software scaling factors are incorrect in some cases. It is hoped that with the replacement of the bad sensors and with adequate documentation the system will become a valuable tool.

FANTAIL AND UNDERWAY LAB

The underway lab had minimal use this leg, owing to relatively short surveys and only two sites. Navigation data were collected when the ship was under way, and the magnetometer and PDRs were run when appropriate.

The 1107 GPS performed flawlessly this leg. Speed was input manually because the automatic pit log was malfunctioning, owing to a fuel/water leak in the pit log trunk. SEDCO will not be able to effect repairs until drydock.

Minor problems were experienced with the Versatec plotter at the beginning of the leg, but were corrected by the ETs. False "toner out" indications were shutting down the plotter. Indications were that air was getting into the lines. Modifications recommended by the factory were performed, which will prevent this from happening again.

During the transit to the first site the starboard streamer was replaced with a newly rebuilt one from Teledyne. It was tested leaving Site 766 and functioned well. The old streamer removed from the winch was stripped of its jacket and returned to ODP for a scheduled overhaul.

The Woods Hole VSP was run this leg. ODP's Bolt 1500-in.^{3} air gun was used in conjunction with WHOI's 1000 in.^{3} chamber, along with the 400 in.^{3} water gun. Minor problems were resolved during a test firing and the experiment proceeded as planned. Both tools were used; the first one was retrieved after a test clamping at 1000 m inside the pipe. About 24 hr into the experiment the water gun blew a hose fitting, was repaired promptly, and the experiment continued.

STOREKEEPING

Two special air shipments did not arrive in Singapore in time to reach the ship before sailing. These contained frozen photo supplies and a special communications board for the PC in the paleomagnetics lab.

MATMAN worked very well this trip. One item to note is the lack of a database containing the shipping addresses of the regular sea-going staff for use by S2S. This would save the storekeeper a considerable amount of time each leg and has been recommended for future implementation.

SAFETY

The METS team continued to practice with the SEDCO emergency team on a weekly basis. A small fire was reported on the forward end of the core catwalk. Several empty D-tube boxes had been staged there in preparation for a trip to the burn basket. A marine technician responded immediately by notifying the bridge, and then with an extinguisher contained the fire until the emergency team arrived on the scene. The cause of the fire was determined to be a cigarette, which had been carelessly discarded. The fire safety suit box at that location sustained minor burns, and the box was cleaned and painted.