OCEAN DRILLING PROGRAM

LEG 125 PRELIMINARY REPORT

BONIN/MARIANA REGION

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SCIENTIFIC REPORT

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ABSTRACT

Leg 125 drilled nine sites in the Mariana and Izu-Bonin forearcs to determine the origin and evolution of the forearc terranes and to investigate the dewatering of the subducted lithosphere. Six sites were located on or adjacent to serpentinite seamounts between the outer-arc high and the trench, four (Sites 778-781) on Conical Seamount in the Mariana forearc, and two on the Torishima Forearc Seamount in the Izu-Bonin forearc. The remaining sites (Sites 782, 785, and 786) were located along the eastern edge of the Izu-Bonin forearc basin. The principal scientific achievements of the leg were (1) recovery of the first evidence for Pliocene or younger magmatic activity in an extant intraoceanic forearc terrane; (2) the first deep penetration of the Eocene basement of the outer-arc high to recover over 650 m of boninite flows and hyaloclastite, andesite-dacite flows, breccias, sills, and dikes; (3) the confirmation that some forearc serpentinite seamounts can form at least in part by flows of clast-bearing serpentinite mud from a central conduit; (4) the discovery of mafic clasts within the serpentinite, having normal mid-ocean ridge and oceanic island affinities, that were metamorphosed in the greenschist and prehnite-pumpellyite facies; (5) the discovery of low chlorinity fluids of probable deep subduction-related origin at shallow levels within the summit of the seamounts; (6) the recovery of hydrocarbon- rich gases of probable subduction-related origin within the Mariana serpentinite seamount; and (7) the identification of numerous ash layers within the forearc basin sediments that indicate peaks of volcanic activity in the Eocene-Oligocene and from the late Miocene to the Holocene.

REGIONAL SETTING

The Bonin-Mariana region (Fig. 1) is made up of a complex series of arcs and basins formed since the start of westward subduction of Pacific lithosphere during the Eocene. Subduction of Pacific oceanic lithosphere is currently taking place at absolute velocities between 8 and 10 cm per year to the northwest; the subduction angle is about 12° at shallow depths, steepening in some places to nearly vertical below about 100 km.

The evolution of these arc and basin systems is thought to have begun in the early-middle Eocene, when westward subduction of Pacific lithosphere began beneath the West Philippine plate (Ben-Avraham and Uyeda, 1983; Karig, 1975; Ogawa and Naka, 1984). Development of the system continued through the early Oligocene, forming an intraoceanic volcanic arc. Rifting in the middle Oligocene split the entire arc system, and the southern part of the arc split again in the late Miocene.

The Mariana and Izu-Bonin forearcs differ in terms of both their tectonic evolution and plate-convergence characteristics. The northern half of the Izu-Bonin forearc has experienced relatively little deformation since subduction began (Honza and Tamaki, 1985) and is made up of a broad forearc basin filled with volcaniclastic and hemipelagic sediments that developed behind an outer-arc high (Fig. 2). The structure of the Mariana forearc is similar, but the forearc has undergone extensive vertical uplift and subsidence resulting from seamount collision, and from tensional and rotational fracturing associated with adjustments to plate subduction and to changes in configuration of the arc. There is a broad zone of serpentinite seamounts along the trench-slope break (outer-arc high) of the Mariana system. These seamounts are suggested to have formed by diapirism (Bloomer, 1983; Fryer et al., 1985b; Fryer and Fryer, 1987). In the Izu-Bonin forearc, chloritized mafic and serpentinized ultramafic rocks have also been dredged from a chain of local highs located less than 50 km from the trench axis along a lower-slope terrace (Ishii, 1985).

The modern 150-220-km-wide Izu-Bonin and Mariana forearcs may have formed by volcanism during arc development in the Eocene and early Oligocene. The origin and evolution of the forearc basement may have progressed in accordance with one of the following scenarios, each of which implies a different crustal structure:

1. The frontal arc and outer-arc high could have been continuous originally, and subsequently separated by forearc spreading.
2. The frontal arc and outer-arc high could have been built separately but nearly synchronously on former West Philippine plate crust.
3. The terrane could form part of a continuous Eocene arc volcanic province, possibly with overprints of later forearc volcanism.

The forearc stratigraphy should also record a history of the variations in intensity and chemistry of arc volcanism, and allow the correlation of these variations with such parameters as subduction rate and backarc spreading. Studies of the tephrachronology, and the frequency and geochemistry of ash and pyroclastic flow deposits in the forearc basin drill cores, will enable the various models of arc volcanism to be evaluated.

DRILLING OBJECTIVES

The prime aim of Leg 125 was to study two important and poorly understood aspects of the Izu-Bonin and Mariana forearc terranes:

1. The origin and evolution of the forearc terranes, investigated by drilling a series of holes through the sediments and into the basement of the Mariana and Izu-Bonin forearc basins (Sites 782, 785 and 786; Table 1, Fig. 3) and into serpentinite seamounts from the Mariana mid-forearc region (Sites 778-781; Table 1, Fig. 3) and Izu-Bonin lower-slope terrace (Sites 783 and 784; Table 1, Fig. 3).
2. Dewatering of the subducted lithosphere, investigated indirectly from the composition of forearc basin crust and directly from analyses of fluids, chemical precipitates, and metamorphic rocks from the serpentinite seamounts.

DRILLING RESULTS

Site 778

Site 778 (proposed site MAR-3B; 19°29.93'N, 146°39.93'E; water depth 3913.7 mbsl) is situated about halfway up the southern flank of Conical Seamount, a 1500-m high cone-shaped serpentinite seamount on the outer-arc high of the Mariana forearc basin, about 100 km west of the trench axis. The site is located in the center of a major serpentinite flow.

Two lithostratigraphic units are recognized (Fig. 4):

Unit I, Subunit IA (0-7.2 mbsf), contains middle/upper Pleistocene-Holocene serpentine clay overlying clay-sized serpentine. The bottom of this unit is sand- to silt-sized serpentine and serpentine marl.

Unit I, Subunit IB (7.2-29.8 mbsf), consists of lower-upper Pleistocene sandy marl containing cobbles and pebbles of serpentinite, vesicular volcanic rocks, and a foraminifer-bearing, serpentinite sandstone.

Unit II (29.8-107.6 mbsf) is made up of phacoidal, sheared serpentinite. The matrix is composed of serpentine, opaque minerals, epidote-group minerals, chlorite, talc, and olivine. A variety of clasts are present: variably serpentinized tectonized harzburgite (80%); metabasalts (15%); and other fragments including metagabbros, serpentinized dunites, and vein materials such as talc, carbonates and quartz (5%).

The serpentinite flow sequence in Unit II exhibits several structural features, including deformation of primary orthopyroxene, microbrecciation, ductile shearing of clasts, shear zones on all scales, a variably developed foliation parallel to shear-plane orientations, and open-to-isoclinal folding of bedding and foliation planes. These features may represent a combination of primary mantle tectonism, stresses related to intrusion and protrusion (flow emplacement) of the serpentinite diapir materials, and stresses resulting from post-protrusion remobilization.

The original mineralogy of the harzburgite clasts in Unit II was typically 70-85% olivine, 15-25% orthopyroxene with 1-2% clinopyroxene (mainly as exsolution lamellae in orthopyroxene), and spinel.

Analyses of interstitial pore water samples show a 10% decrease in chlorinity downhole. This decrease is interpreted as a relative decrease in admixture of seawater with similarly chlorine-poor fluids entrained in the serpentine flow material.

The principal conclusions of Site 778 investigations are as follows:

1. Forearc seamounts can be constructed at least in part from serpentinite flows emanating from a central conduit.

2. Low- to medium-grade metamorphism characterizes the source region of the serpentinite seamounts.

3. Dehydration of the subducted lithosphere may have played an important role in the serpentinization of the source region of the serpentinite seamounts.

4. The primary mantle material in the seamount is predominantly highly depleted tectonized harzburgite with subordinate dunite.

Site 779

Site 779 (19°30.75'N, 146°41.75'E; water depth 3947.2 mbsl) is a second flank site on Conical Seamount situated halfway up the southeast flank, about 3.5 km northeast of Site 778.

Three major lithostratigraphic units were recovered at Site 779 (Fig. 4):

Unit I (0-10.6 mbsf in Hole 779A, 0-9 mbsf in Hole 779B) comprises lower Pleistocene to Holocene unconsolidated sediments and flows consisting of clay, clay-sized serpentine, and lithic fragments in a matrix of sand-, silt-, and clay-sized serpentine.
Unit II, Subunit IIA (10.6-216.2 mbsf), is sheared serpentinite that contains clasts of variably serpentinized harzburgite and dunite in a serpentinite matrix.
Unit II, Subunit IIB (216.2-303.0 mbsf), is lower Pliocene to lower Pleistocene sheared serpentinite containing clasts of serpentinized harzburgite and dunite, as well as gabbro and metabasalt, in a serpentinite matrix with intercalations of detrital serpentine sediments.
Unit III (303.0-317.2 mbsf) is a serpentinite breccia exhibiting convolute layering.

The serpentine-rich material in Subunit IIB contains recrystallized carbonate minerals, kerogen, and lithified filamentous bacteria which are coated with opaque minerals. The presence of kerogen indicates a primary sedimentary origin for this material, an interpretation supported by the presence of horizontal bedding and nannofossils within the same unit.

Ultramafic rocks are mostly harzburgite and subordinate dunite, whose primary mineralogies are similar to Hole 778A. The degree of serpentinization varies but decreases downhole; serpentinite veins are common and show a polystage filling history. Mafic clasts are predominantly metabasalt and metagabbro. Common metamorphic minerals are clays, chlorite, pumpellyite, and rare albite and sphene.

Structures in the serpentinite are similar to those of Hole 778A, and thus indicate a similar history. The deformation of the matrix is consistent with gentle flowage under an applied load. The average density of the serpentine matrix is 2010 $kg.m^{-3}$. The density of the ultramafic clasts decreases with increasing degree of serpentinization and averages 2550 $kg.m^{-3}$.

The composition of interstitial pore water samples at Site 779 varies from 0 to 100 mbsf: pH increases to a maximum of 11.9; alkalinity increases five-fold; ammonium and sodium show significant but smaller increases; Ca decreases by 80%; salinity and chlorinity both decrease by 10%; and potassium and sulfate show small decreases. Magnesium is totally depleted below 80 mbsf. These results confirm the presence of a fluid other than seawater, possibly from the subducting plate, as proposed for Site 778. Hydrocarbons increase dramatically with depth in Hole 779A, with methane (up to 30% in one gas pocket), ethane, and propane present in most samples.

The principal conclusions from studies of Site 779 can be summarized as follows:

1. The site provides further evidence for the depleted nature of the mantle wedge beneath Conical Seamount.
2. The construction of Conical Seamount resulted from the flow of unconsolidated serpentine coupled with sedimentary processes.
3. Hydrocarbons are a significant component of the fluids associated with the seamount.
4. The source region of the serpentinite seamount has experienced medium-grade metamorphism.
5. Water derived from the subducted slab could be an important source of fluids involved in the serpentinization of Mariana forearc materials.

Site 780

Site 780 (proposed site MAR-3A; 19°32.5'N, 146°39.2'E; water depth 3090 mbsl) is situated on the west-southwest side of the summit of Conical Seamount, in an area shown by *Alvin* submersible dives to be sediment-covered and marked by active venting of fluids and precipitation of material from solution.

Two major lithostratigraphic units were recovered at Site 780 (Fig. 4):

Unit I (0-3.5 mbsf in Hole 780A; 0-18.2 mbsf in Hole 780B; 0-14.0 mbsf in Hole 780C; and 0-15.4 mbsf in Hole 780D) comprises middle Pleistocene to Holocene sand-, silt-, and clay-sized serpentine with rare intervals of foraminifer-rich serpentine clay and serpentine-rich silty clay.

Unit II (14.0-163.5 mbsf in Hole 780C and 15.4-32.4 mbsf in Hole 780D) comprises intervals of serpentinized ultramafic rocks in a matrix of sandy silt- and silty clay-sized serpentine sediment.

The sediments in Unit I contain 65%-75% serpentine with minor amounts of opaque minerals, aragonite, and foraminifers. The presence of delicate aragonite needles implies *in situ* authigenic growth after the serpentine was emplaced. The matrix in Unit II contains 70%-99% serpentine with minor to trace amounts of opaque minerals, clay, zoisite, chlorite, micrite, and garnet.

Serpentinized, tectonized ultramafic rocks and subordinate serpentinized dunites at Site 780 have primary mineralogies similar to those from Sites 778 and 779. Serpentinite veins are common. The muddy matrix recovered from Site 780 lacks the foliation and shear fabric of the matrix from the flank sites: the matrix may therefore be interpreted as the primary fabric of the upwelling serpentinite, upon which foliation and shear fabric are imposed by compaction, extension and pure shear during the downhill creep of serpentinite debris flows.

Logging in Hole 780C showed temperatures increasing steadily from seawater values (1.5°C) near the surface to 13.5°C at 60 mbsf; the water sampler temperature probe (WSTP) in Hole 780D measured a lower value, 3.15°C at 41 mbsf, and an estimated heat flow of 52 mW/m^2.

The density of the serpentinite matrix in Unit II ranges from 1750 to 2000 kg.m-3. Rheological measurements indicate that this matrix is a weak, highly non-ideal plastic material capable of supporting blocks up to 20 m across and compatible with models for diapiric injection of the serpentinite.

The composition of interstitial pore water samples changes significantly downhole: salinity decreases by 25%, chlorinity by 20%, Ca by >90%, Mg is totally depleted, sulfate nearly doubles, alkalinity increases from 2.5 to 34, pH increases from about 8 to 12.4, potassium increases significantly, and ammonium increases from 0 to 210. These changes take place within a few meters of the seafloor, showing that the fluid entrained within the serpentinite may mix with seawater only at very shallow levels. The magnitude and direction of these changes also differ from those of the flank sites.

The principal conclusions from study of Site 780 can be summarized as follows:

1. High pH, high alkalinity, very low Mg fluids can exist within a few meters of the seafloor at the summit of Conical Seamount, indicating that mixing between entrained fluids and seawater need not take place at depth.
2. Rheological studies support a model for the origin of the seamount by diapiric intrusion of variably serpentinized clasts supported by a low-density, plastic matrix.

<u>Site 781</u>

Site 781 (proposed site MAR-3C; 19°37.91'N, 146°32.56'E; water depth 4420.6 mbsl) lies on the lowermost flank of Conical Seamount about 7 nmi northwest of its summit. One lithostratigraphic unit, divided into three subunits, was defined (Fig. 4):

Subunit IA (0-72.32 mbsf) comprises upper Pliocene-?Holocene diatom-radiolarian silty clay that grades downward into vitric silty clay and vitric clayey silt.

Subunit IB (72.32-91.80 mbsf) is a massive basalt containing up to 30% phenocrysts and glomerocrysts of plagioclase, olivine, and clinopyroxene in a fine-grained groundmass. The basalt contains 2%-10% vesicles that increase in abundance and size toward the center of the subunit.

Subunit IC (91.80-250 mbsf) comprises middle-upper Pliocene to ?lower Pliocene vitric silty clay and vitric clayey silt.

Structures within the sediments in Subunit IA indicate deposition from gravity-driven mass flows: at least 19 turbidite sequences were identified, with thicknesses ranging between 1 and 180 cm and averaging 3-12 cm.

The principal point of interest from Site 781 is the presence of a thick, massive basalt of Pliocene or later age, the first evidence for such recent magmatic activity in any extant intraoceanic forearc terrane. The basalt (Subunit IB) is an island-arc tholeiite characterized by enrichment in large-ion-lithophile elements relative to high-field-strength elements. This indicates that the magma originated from the mantle wedge above, and hence was modified by fluids from, the subducting lithosphere. The basalt produced a strong reflector at 60 mbsf in the site survey and in a brief shipboard seismic survey, and may be a near-surface sill or a lava flow.

Site 782

Site 782 (proposed site BON-6B; 30°51.6'N, 141°18.8'E, water depth 2959 mbsl) is located on the eastern margin of the Izu-Bonin forearc basin, about halfway between the active volcanic arc and the trench. Two lithostratigraphic units have been defined (Fig. 5):

Unit I, Subunit IA (0-153.6 mbsf in Hole 782A), is Pleistocene to lower Pliocene, gray to yellow-greenish, homogeneous nannofossil marl containing scattered volcanic debris and volcanic ash layers.

Unit I, Subunit IB (153.6-337.0 mbsf in Hole 782A), is upper to lower Miocene light to dark gray nannofossil marl containing scattered volcanic debris and volcanic ash layers.

Unit I, Subunit IC (337.0-409.2 mbsf in Hole 782A), is upper Oligocene to upper Eocene vitric nannochalk intercalated with tuffaceous sediment and pebble-rich sands, gravelly conglomerates, and ash layers.

Unit II (409.2-476.8 mbsf in Hole 782A and 459.3-468.9 mbsf in Hole 782B) comprises angular to subrounded clasts of intermediate-acid lava.

Sedimentation rates increased from the Oligocene (~4-5 m/m.y.) and the middle Miocene (11 m/m.y.) through the late Miocene and early Pliocene (22 m/m.y.), to the late Pliocene and Pleistocene (36 m/m.y.). Two unconformities have been identified in the succession: one between the upper Oligocene and lower Miocene, the other between the lower Oligocene and upper Miocene. Over 100 volcanic ash layers have been identified.

The lavas of Unit II are slightly vesicular and contain phenocrysts of plagioclase, orthopyroxene, and clinopyroxene in a glassy groundmass. The rocks fall into two compositional groups, an andesite group and a dacite-rhyolite group, and are transitional between the tholeiitic and calc-alkaline volcanic-arc rock series.

Logging enabled us to divide the section penetrated by Hole 782B into three distinct units according to physical and chemical properties: an upper unit from 0 to ~300 mbsf, a middle unit from about ~300 to ~370 mbsf, and a lower unit from ~370 mbsf to the lower limit of logging at ~420 mbsf. The boundary between the upper and middle units is marked by a sudden downhole increase in density and resistivity, and may correspond to an increase in sediment compaction or to the Oligocene/Miocene unconformity. The boundary between the middle and lower units is marked by an increase and greater variability in compressional-wave velocity and density, together with an increase in silica and potassium. This boundary may correspond to the Eocene/Oligocene unconformity.

Preliminary measurements of magnetic inclinations from Hole 782A cluster around +50° and -50°, indicating little or no translation of the site since the late Eocene.

The principal conclusions drawn from studies of Site 782 are these:

1. Basement in this part of the forearc basin is Eocene.
2. The uppermost basement consists of intermediate-acid submarine volcanic rocks of island-arc tholeiite to calc-alkaline affinities.
3. Preliminary paleomagnetic data indicate little or no translation of the site since the late Eocene.

<u>Site 783</u>

Site 783 (proposed site BON-7; 30°57.86'N, 141°47.27'E, 4648.8 mbsl) is located on the northern, mid-flank portion of a seamount which forms part of a >500-km-long ridge which runs along the lowermost, inner wall of the Izu-Bonin Trench. Two lithostratigraphic units have been defined (Fig. 5):

Unit I (0-120.0 mbsf) is middle or lower Pleistocene to lower Pliocene or older glass-rich silty clay to claystone.
Unit II (120.0-158.6 mbsf) is phacoidal, sheared serpentine that contains clasts of serpentinized harzburgite.

Deformation observed in the sediments at Site 783 includes shear fabrics and convolute plastic folding within the claystones of Unit I and the phacoidal serpentine muds of Unit II. High-temperature pre-serpentinization and lower-temperature, post-serpentinization fabrics similar to those described for Conical Seamount are found in the ultramafic clasts of Unit II. Densities increase from 1470 to 1590 $kg.m^{-3}$ in the sediments of Unit I and cluster around 2100 $kg.m^{-3}$ in the serpentine of Unit II. Thermal conductivities average ~1 $Wm.K^{-1}$ in sediments and 1.9 1 $Wm.K^{-1}$ in the serpentine. Heat flow in the sediments is 23 mW/m^2.

Interstitial fluid compositions vary only slightly with depth in the sediment, a sharp discontinuity at the claystone/serpentine boundary and rapid chemical changes thereafter. The pH of the fluid increases from about 8 at the claystone/serpentine boundary to 9.5-10 at the bottom of the hole, and alkalinity, silica, magnesium, potassium, salinity, and sulfate decrease. Both calcium and chlorinity increase with depth.

The principal conclusions from investigations of Site 783 are these:

1. The seamount is made up, at least in part, of serpentinite.
2. The serpentinite is at least early Pliocene in age and hence older than Conical Seamount in the Mariana forearc.
3. There is structural evidence for deformation within the overlying sediments as well as within the serpentinite.
4. Serpentinization is still taking place, but without the low-chlorinity component identified at Conical Seamount.

Site 784

Site 784 (proposed site BON-7; 30°54.49'N, 141°44.27'E, water depth 4900.8 mbsl) is located approximately 7 km southwest of Site 783 on the lowermost, western flank of the same seamount on the inner wall of the Izu-Bonin Trench. The stratigraphic section recovered at Site 784 is divided into two lithologic units (Fig. 5):

Unit I, Subunit IA (0-126.4 mbsf) comprises upper Pleistocene to upper Miocene vitric clayey silt and claystone.
Unit I, Subunit IB (126.4-302.7 mbsf) is upper to middle Miocene or older vitric claystone.
Unit I, Subunit IC (302.7-321.1 mbsf) contains claystone and silt-sized serpentine of unknown age.
Unit II (321.1-425.3 mbsf) consists of phacoidal sheared serpentine microbreccia.

Lithologic Subunit IB may correlate with Subunit IB at Site 782 in the forearc basin on the basis of age and ash content. Sediments from Subunits IA and IB are laminated and contain abundant graded beds, structures indicative of current activity during sediment deposition. The sediment contains an abundant volcanogenic component and numerous ash layers. Subunit IC shows a clear interfingering of background pelagic sediments derived from the volcanic areas to the west and silt-sized serpentine from the topographic high to the east.

The ultramafic clasts from Unit II are of two types: variably serpentinized tectonized harzburgite and subordinate dunites. About 30 metabasalt clasts were also identified.

Deformation in Unit I claystones at Site 784 includes sets of *en-echelon* tension veinlets and sets of microfaults, some of which are clearly associated with water escape pipes. The zone of greatest microfaulting correlates directly with an interval of increased water content and porosity of the sediments. Most structures are extensional and can be shown to have formed in a non-hydrostatic stress regime.

The composition of interstitial waters varies with depth in the serpentinite, as at Site 783. Si decreases, and pH increases to 9.6. Alkalinity falls to a value about half that of seawater, sulfate and Mg decrease, Ca increases, and chlorinity, bromide, and salinity show no major changes. The concentration of sodium decreases with depth, although it increased at Site 783. As at Site 783, therefore, there is evidence for ongoing serpentinization at the Izu-Bonin seamount.

Average bulk densities are 1572 $kg.m^{-3}$ in the sediments of Unit I and 2188 $kg.m^{-3}$ in the serpentine of Unit II. Thermal conductivities average about 0.9 $Wm.K^{-1}$ in the sediments and 1.74 $Wm.K^{-1}$ in the serpentine.

Preliminary interpretation of paleomagnetic data indicates little translation since the Pliocene, although translation may have been significant between the middle Miocene and Pliocene.

The principal conclusions from studies of Site 784 are these:

1. The western lower flank of the seamount is made up of serpentinite.
2. The serpentinite is at least middle Miocene in age and hence the seamount is considerably older than Conical Seamount.
3. Structural evidence indicates that deformation within the more compacted sediments overlying the serpentinite was extensional.
4. Preliminary paleomagnetic evidence suggests significant translation of the site between the middle Miocene and the Pliocene.
5. Serpentinization is still taking place despite the lack of evidence for active protrusion.

<u>Site 785</u>

Site 785 (proposed site BON-6A; 30°49.47'N, 140°55.17'E; water depth 2660.8 mbsl) is located in the center of the Izu-Bonin forearc basin ~40 nmi east-northeast of the active volcano Tori Shima. One lithostratigraphic unit was drilled (Fig. 5):

Unit I (0-104.7 mbsf) consists of lower-upper Pleistocene pumice-bearing nannofossil ooze overlying a bed of porphyritic dacite-rhyolite pumice fragments, 1 mm to 6 cm in diameter.

The principal conclusion from this site is evidence for a major Pleistocene pumice bed in this part of the Izu-Bonin forearc basin.

Site 786

Site 786 (proposed site BON-6C; 31°52.5'N, 141°13.6'E; water depth 3062 mbsl) is located in the center of the Izu-Bonin forearc basin about 120 nmi east of the active volcano Myojin Sho.

The stratigraphic section recovered at Site 786 is assigned to four lithostratigraphic units (Fig. 6). Units I through III are defined only in Hole 786A (Fig. 6A), which recovered the sedimentary sequences at the site. Unit IV is defined in both Holes 786A and 786B (Fig. 6B).

Unit I (0-83.46 mbsf) consists of a succession of lower Pleistocene to middle Miocene nannofossil marls and clays.
Unit II (83.46-103.25 mbsf) contains upper Oligocene to middle Eocene nannofossil marl and nannofossil-rich clay, as well as a volcaniclastic sequence containing vitric ash and mineral fragments.
Unit III (103.25-124.90 mbsf) is a sequence of middle Eocene volcaniclastic breccias.
Unit IV (124.9-166.5 mbsf in Hole 786A and 162.5-826.6 mbsf in Hole 786B) comprises massive and brecciated flows, ash flows, and intercalated vitric siltstones and sandstones in the upper part of the unit, and pillow lavas and dikes or sills in the lower part. Igneous rock types include high-magnesian basalts, boninites, basalts, andesites, dacites, and rhyolites. Secondary minerals include hydrothermal deposits of pyrite and native copper.

Sedimentation rates were highest in the Pliocene (8.9 m/m.y.) and were lower (4.2 m/m.y.) between the latest Miocene and middle Miocene. A hiatus exists between the middle Miocene and the upper Oligocene; below this point, evidence indicates that the rate was very low (0.95 m/m.y.).

Hole 786B penetrated over 700 m into the massive, brecciated, and pillowed lavas and dikes of an Eocene volcano, providing information on the tectonic and volcanic activity that marked initiation of the subduction, and providing the deepest hole yet into a submarine volcanic edifice. A simplified stratigraphic column is shown in Figure 6. The upper part primarily contains welded ash flows and massive and brecciated lavas with interbedded clastic sediments. One of these sedimentary units is reddened and contains hydrated aluminium oxide, indicating a subaerial to shallow water environment. At deeper levels, pillowed and massive lavas dominate, initially cut by a small number of intrusive dikes and sills. The hole bottomed at 828.6 mbsf in dikes and sills with minor lava screens. The rock types range from basalt to rhyolite in terms of silica content, but about half the rocks belong to the boninitic series that is thought to characterize the early stages of subduction. Shear zones are common throughout the sequence, and there is abundant evidence of hydrothermal activity, including pyrite-rich breccias and one zone containing native copper. Microfossil determinations from sediments intercalated within the lavas showed that the sequence was middle Eocene (~42 Ma), similar in age to other parts of the outer-arc high.

Average bulk densities are 1.65 g/cm^3 in the sediments and 1.8 to 22.1 g/cm^3 in the volcanic sequences. Preliminary paleomagnetic data indicate little translation of the site since the late Miocene. Four suites of logging tools were run in Hole 786B, consisting of the Dual Induction Tool (DIT), the Digital Sonic Tool (SDT), the Natural Spectrometry Tool (NGT), the Lithodensity Tool (LDT), the Compensated Neutron Tool (CNT), the Induced Gamma-ray Spectrometry Tool (GST), the Aluminum Clay Tool (ACT), and the Borehole Televiewer.

The principal conclusions from investiations of Site 786 are these:

1. The penetration of over 650 m of Eocene volcanic crust shows that the basement in this region of the Izu-Bonin forearc consists of boninite flows and hyaloclastite, and andesite flows, breccias, and dikes.
2. Rocks recovered from the volcanic basement show extensive evidence of hydraulic fracturing and precipitation of sulfide and other minerals from hydrothermal fluids.
3. Preliminary paleomagnetic evidence indicates little translation of the site since the late Miocene.
4. Sedimentation rates were highest during the Pliocene, decreased between the latest Miocene and middle Miocene, and were quite low (from evidence below a hiatus) from the middle Miocene to the late Oligocene.

The most significant achievement at Site 786 was the deep penetration of an Eocene volcanic edifice which (a) provided a record of the construction and structure of the forearc volcanic basement and (b) provided a basis for the understanding of early arc magmatism in general and boninite petrogenesis in particular.

SUMMARY

Leg 125 drilled nine sites to answer fundamental questions about the magmatic, tectonic, and sedimentary evolution of the Mariana and Izu-Bonin forearcs, and the fluxing of subduction-derived fluids through the forearc mantle wedge. The principal results and conclusions from drilling in the Mariana and Izu-Bonin forearcs include the following:

1. A Pliocene or younger basalt flow or sill penetrated at Site 781 is the first evidence for such recent magmatic activity in any extant intraoceanic forearc terrane.
2. The uppermost basement recovered in Site 782 consists of Eocene intermediate-acid submarine volcanic rocks of island-arc tholeiite to calc-alkaline affinities.

3. The deep penetration of Eocene volcanic crust at Site 786 (a) provided a record of the construction and structure of the forearc volcanic basement and (b) provided a basis for the understanding of early arc magmatism in general and boninite petrogenesis in particular. The basement in that part of the Izu-Bonin forearc consists of boninite flows and hyaloclastite, and andesite flows, breccias, and dikes.

4. The identification of numerous ash layers within the forearc basin sediments indicates peaks of volcanic activity during the Eocene-Oligocene and from the late Miocene to the Holocene.

5. The volcanic basement at Site 786 shows extensive evidence of hydraulic fracturing and precipitation of sulfide and other minerals from hydrothermal fluids.

The principal results and conclusions from sites drilled in the Mariana and Izu-Bonin serpentinite seamounts (Sites 778-780, Sites 783 and 784) are as follows:

1. The Mariana serpentinite seamount may be constructed from protrusions of serpentinite mantle materials and/or flows of unconsolidated serpentine mud and entrained ultramafic and rare mafic clasts emanating from a central conduit.

2. Low- to medium-grade metamorphism characterizes the source region of the serpentinite that formed both seamounts.

3. Dehydration of the subducted lithosphere may have played an important role in the serpentinization of the source region of the serpentinite seamounts.

4. Hydrocarbons are a significant component of the fluids associated with the Mariana seamount.

5. The Izu-Bonin seamount is at least middle Miocene in age, hence older than Conical Seamount, and currently inactive in terms of flow generation.

6. Serpentinization is still taking place in the Izu-Bonin seamount, but without the low-chlorinity component identified at Conical Seamount.

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TABLE CAPTION

Table 1. Leg 125 Site Summary.

FIGURE CAPTIONS

Figure 1. Active plate boundaries and relict spreading centers in the Philippine Sea region. Barbed lines locate subduction zones, medium double lines locate active spreading centers, and thin double lines locate relict spreading centers. Basins and ridges are outlined by the 4-km bathymetric contour, except for the Izu-Bonin, West Mariana, and Mariana arcs, which are outlined by the 3-km contour. Magnetic anomalies 6 and 6B are shown by single thin lines in the Shikoku Basin. A: Amani Plateau. B: Daito Basin. D: Daito Ridge. H: Halmahera. L: Luzon. M: Mindanao. O: Oki-Daito Ridge.

Figure 2. Transect across the Izu-Bonin region showing locations of Leg 125 drill sites.

Figure 3. Location maps for ODP Leg 125, showing (A) the regional setting of the Izu-Bonin and Mariana forearcs, (B) the precise setting of the Izu-Bonin drill sites (Sites 782-786), and (C) the precise setting of the Mariana drill sites (Sites 778-781).

Figure 4. Summary lithostratigraphic columns of sites at the Conical Seamount (Sites 778 through 781).

Figure 5. Summary lithostratigraphic columns of Sites 782 through 785.

Figure 6. Summary lithostratigraphic columns of (A) Hole 786A and (B) Hole 786B.

Table 1. Leg 125 Site Summary

Hole	Latitude (°N)	Longitude (°E)	Water Depth (m)*	Number of Cores	Meters Cored	Meters Recov'd	Percent Recov'd	Meters Total Penetr.
778A	19°29.93'	146°39.93'	3913.7	13	107.6	22.8	21.2	107.6
779A	19°30.75'	146°41.75'	3947.2	37	317.2	73.2	23.1	317.2
779B	19°30.75'	146°41.75'	3947.2	1	9.0	8.7	96.7	9.0
780A	19°32.51'	146°39.27'	3086.8	1	3.5	3.5	100.0	3.5
780B	19°32.47'	146°39.22'	3094.0	2	18.2	10.3	56.6	27.7
780C	19°32.53'	146°39.21'	3083.4	18	163.5	14.4	8.8	163.5
780D	19°32.55'	146°39.20'	3088.9	6	30.9	9.1	29.4	41.8
781A	19°37.91'	146°32.56'	4420.6	27	250.0	39.6	15.8	250.0
782A	30°51.66'	141°18.85'	2958.6	50	476.8	278.3	58.4	476.8
782B	30°51.60'	141°18.84'	2965.9	1	9.6	0.1	1.0	468.9
783A	30°57.86'	141°47.27'	4648.8	18	168.2	47.0	27.9	168.2
784A	30°54.49'	141°44.27'	4900.8	45	425.3	218.3	51.3	425.3
785A	30°49.47'	140°55.17'	2660.8	11	104.7	18.4	17.6	104.7
786A	31°52.48'	141°13.58'	3058.1	19	166.5	85.0	51.1	166.5
786B	31°52.45'	141°13.59'	3071.0	72	666.0	190.1	28.5	828.5

*Water depth is given in meters below mean sea level, corrected from drill-pipe measurements from the rig floor.

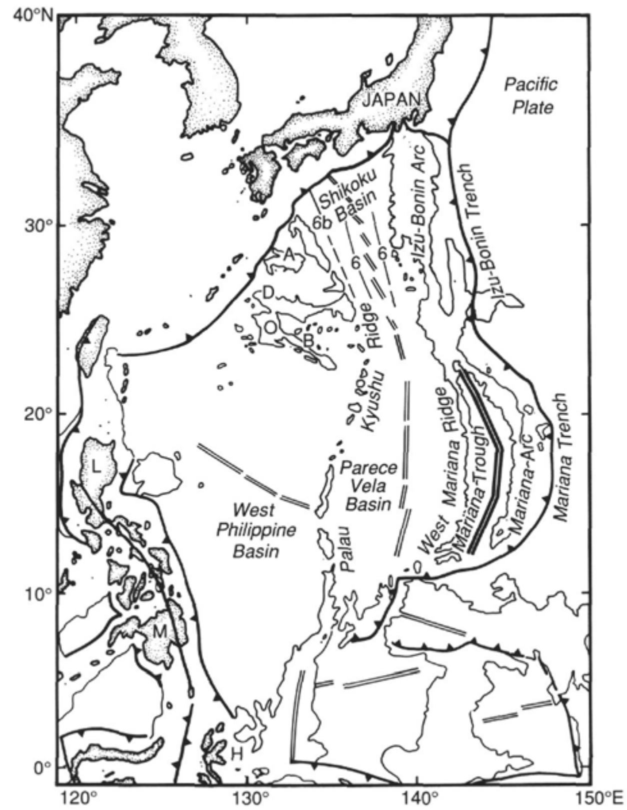


Figure 1.

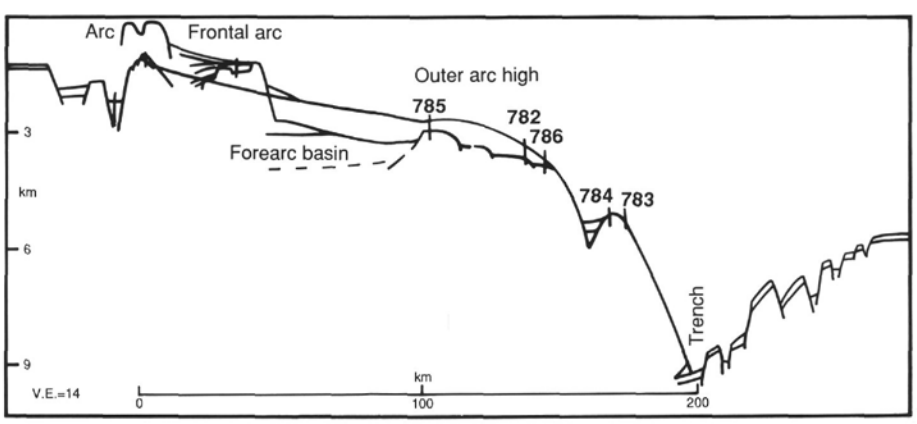


Figure 2.

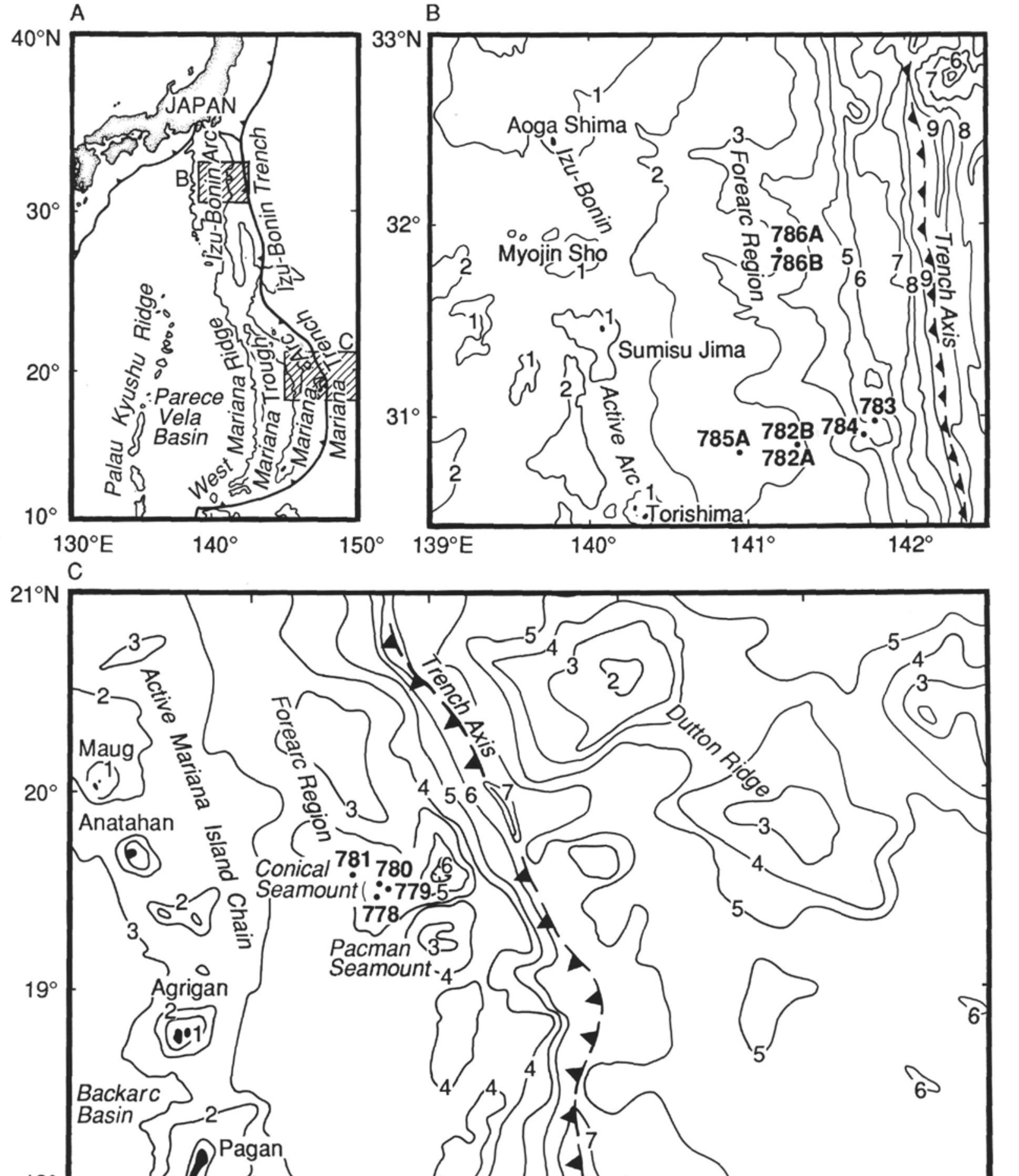

A
40°N
30°
20°
10°
130°E
140°
150°
JAPAN
B
C
Izu-Bonin Arc
Izu-Bonin Trench
Izu-Bonin Arc
Palau Kyushu Ridge
Parece Vela Basin
West Mariana Ridge
Mariana Trough
Mariana Arc
Mariana Trench
B
33°N
32°
31°
139°E
140°
141°
142°
Aoga Shima
Izu-Bonin
Myojin Sho
Sumisu Jima
Active Arc
Torishima
Forearc Region
Trench Axis
786A
786B
783
784
782B
782A
785A
C
21°N
20°
19°
18°
145°E
146°
147°
148°
149°
150°
Maug
Anatahan
Agrigan
Pagan
Active Mariana Island Chain
Backarc Basin
Forearc Region
Conical Seamount
Pacman Seamount
781
780
779
778
Trench Axis
Dutton Ridge

Figure 3.

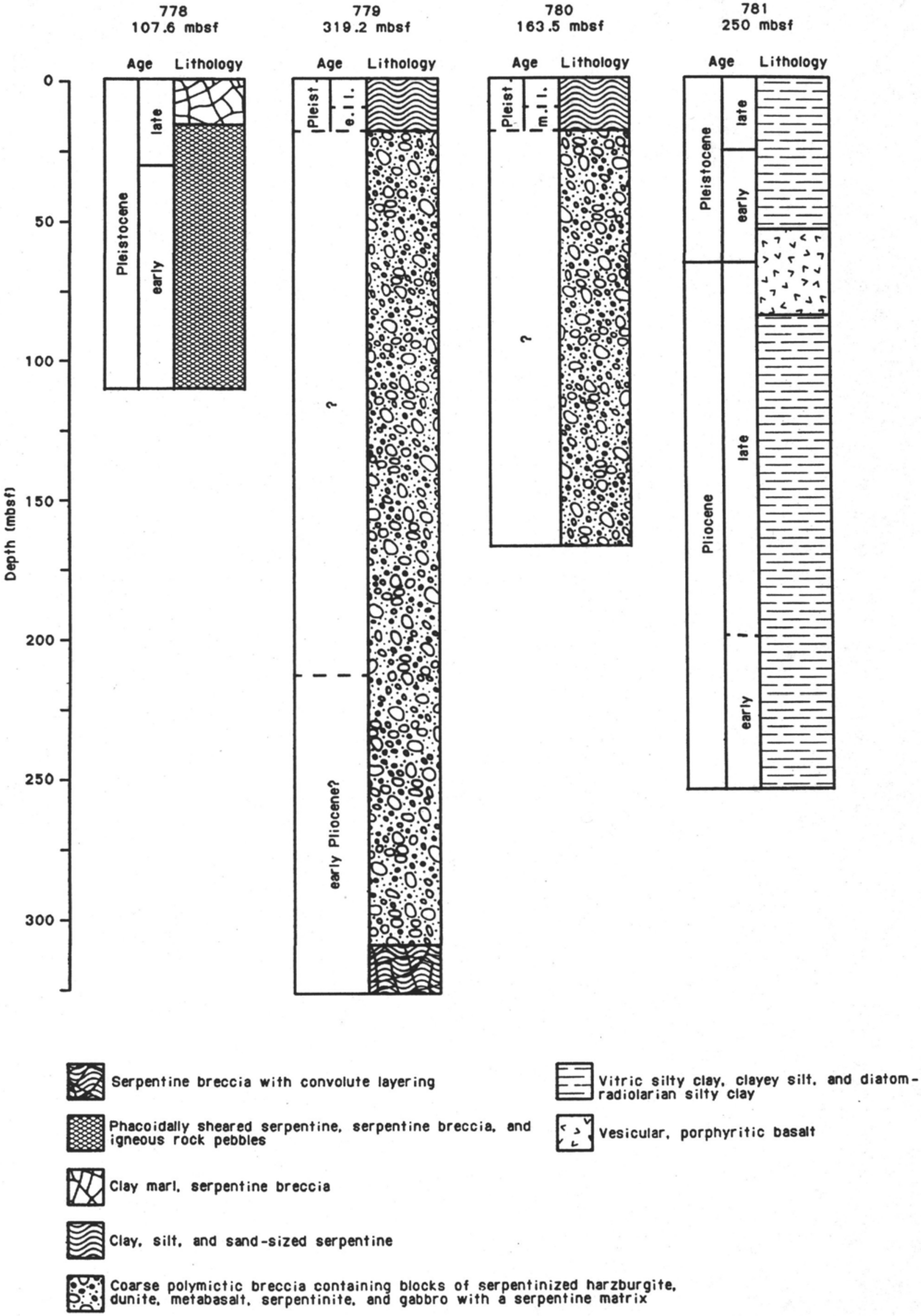
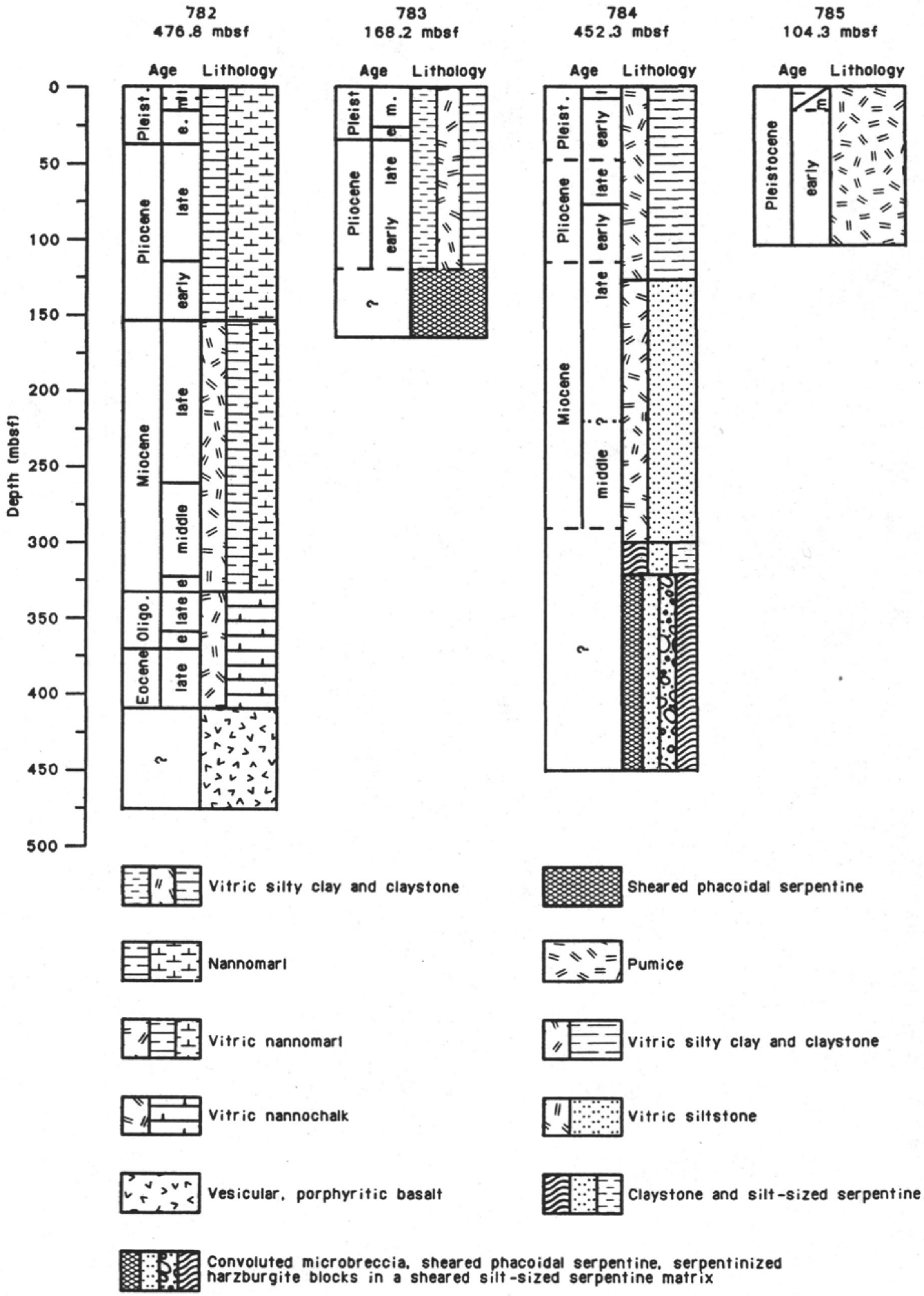

778
107.6 mbsf
779
319.2 mbsf
780
163.5 mbsf
781
250 mbsf
Age
Lithology
Depth (mbsf)
0
50
100
150
200
250
300
Pleistocene
late
early
Pleist
e.l.l.
?
early Pliocene?
m.l.l.
Pliocene
Serpentine breccia with convolute layering
Phacoidally sheared serpentine, serpentine breccia, and igneous rock pebbles
Clay marl, serpentine breccia
Clay, silt, and sand-sized serpentine
Coarse polymictic breccia containing blocks of serpentinized harzburgite, dunite, metabasalt, serpentinite, and gabbro with a serpentine matrix
Vitric silty clay, clayey silt, and diatom-radiolarian silty clay
Vesicular, porphyritic basalt

Figure 4.



782
476.8 mbsf
783
168.2 mbsf
784
452.3 mbsf
785
104.3 mbsf
Age
Lithology
Depth (mbsf)
0
50
100
150
200
250
300
350
400
450
500
Pleist.
Pliocene
Miocene
Oligo.
Eocene
Pleistocene
late
early
middle
m.
e.
?
Vitric silty clay and claystone
Nannomarl
Vitric nannomarl
Vitric nannochalk
Vesicular, porphyritic basalt
Sheared phacoidal serpentine
Pumice
Vitric silty clay and claystone
Vitric siltstone
Claystone and silt-sized serpentine
Convoluted microbreccia, sheared phacoidal serpentine, serpentinized harzburgite blocks in a sheared silt-sized serpentine matrix

Figure 5.

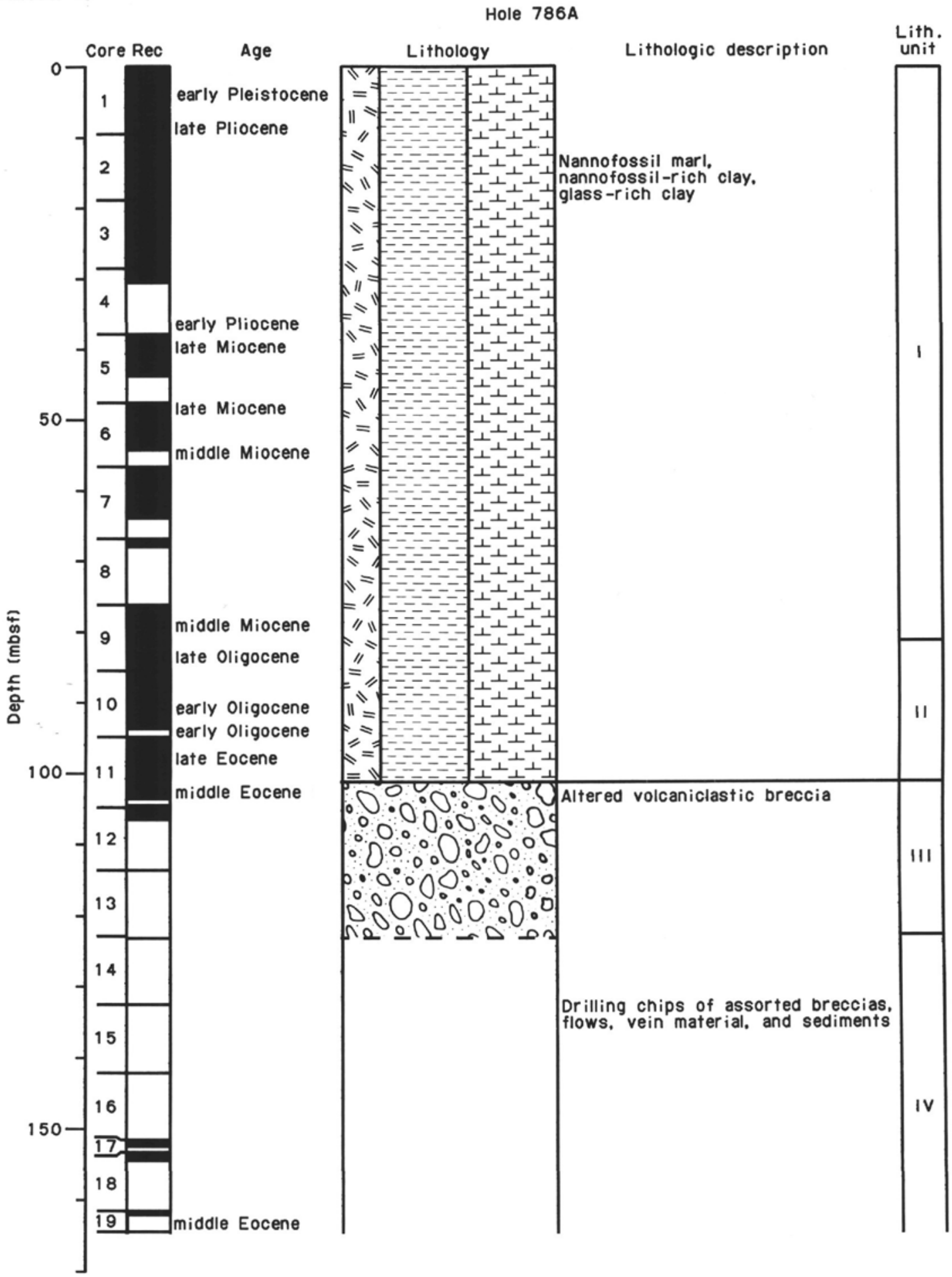

Hole 786A
Core Rec
Age
Lithology
Lithologic description
Lith. unit
Depth (mbsf)
0
50
100
150
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
early Pleistocene
late Pliocene
early Pliocene
late Miocene
late Miocene
middle Miocene
middle Miocene
late Oligocene
early Oligocene
early Oligocene
late Eocene
middle Eocene
middle Eocene
Nannofossil marl, nannofossil-rich clay, glass-rich clay
Altered volcaniclastic breccia
Drilling chips of assorted breccias, flows, vein material, and sediments
I
II
III
IV

Figure 6A.

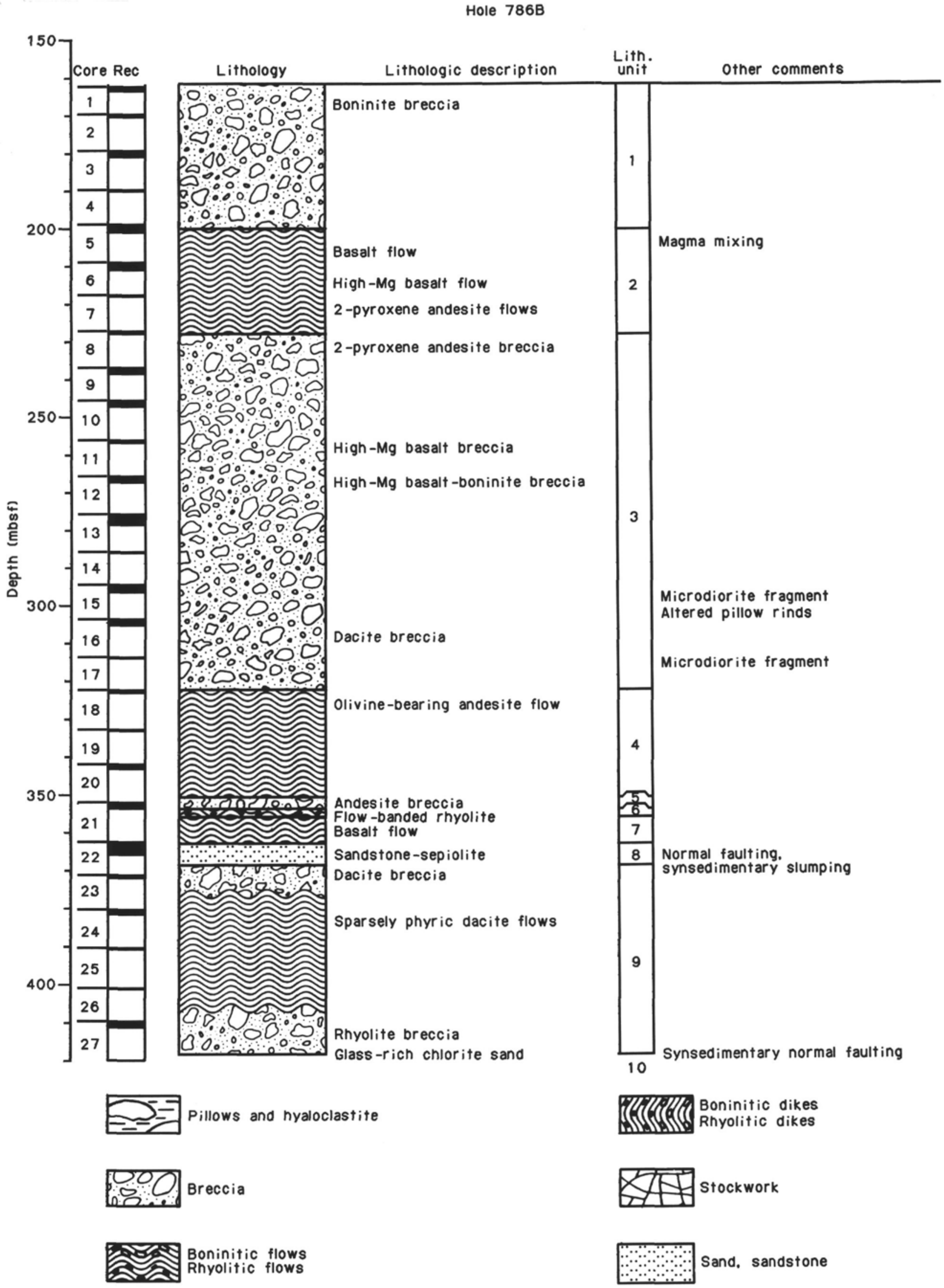

Hole 786B
Core Rec
Lithology
Lithologic description
Lith. unit
Other comments
Depth (mbsf)
150
200
250
300
350
400
Boninite breccia
Basalt flow
High-Mg basalt flow
2-pyroxene andesite flows
2-pyroxene andesite breccia
High-Mg basalt breccia
High-Mg basalt-boninite breccia
Dacite breccia
Olivine-bearing andesite flow
Andesite breccia
Flow-banded rhyolite
Basalt flow
Sandstone-sepiolite
Dacite breccia
Sparsely phyric dacite flows
Rhyolite breccia
Glass-rich chlorite sand
Magma mixing
Microdiorite fragment
Altered pillow rinds
Microdiorite fragment
Normal faulting,
synsedimentary slumping
Synsedimentary normal faulting
Pillows and hyaloclastite
Breccia
Boninitic flows
Rhyolitic flows
Boninitic dikes
Rhyolitic dikes
Stockwork
Sand, sandstone

Figure 6B.

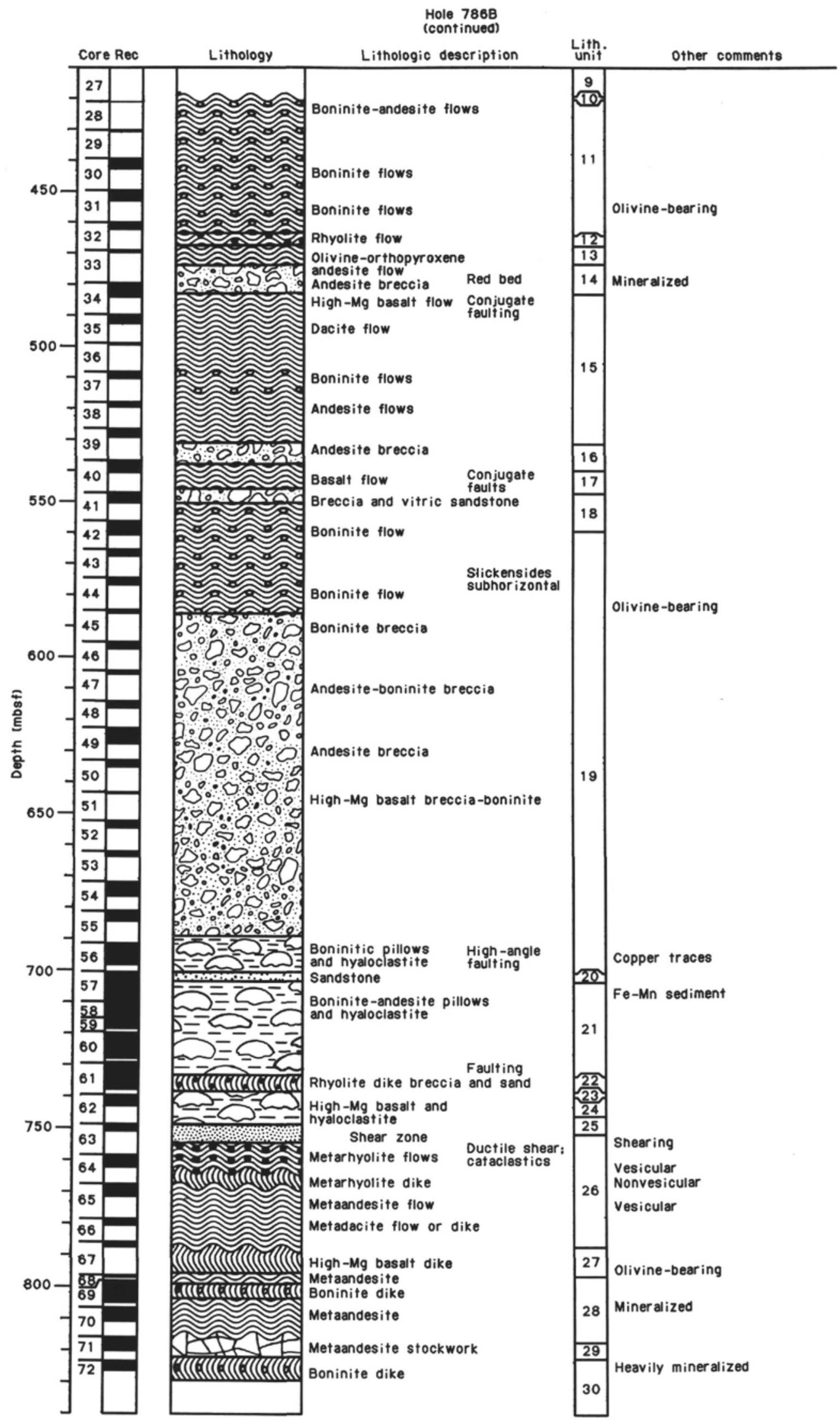


Figure 6B (continued).

OPERATIONS SYNOPSIS

The ODP Operations and Engineering personnel aboard *JOIDES Resolution* for Leg 125 were:

Operations Superintendent:	Thomas Pettigrew
Consulting Engineer:	Donald Cameron
Schlumberger Engineer:	James Coyne

INTRODUCTION

Leg 125 officially began with the first line passed at 2000Z, 15 February 1989, when *JOIDES Resolution (SEDCO/BP 471)* arrived in port at Apra Harbor, Guam. Leg 125 officially ended when the ship dropped anchor at 2300Z, 17 April 1989, upon arrival in port at Tokyo, Japan.

GUAM PORT CALL

The normal operations of crew changes, refueling, and on/offloading of freight were carried out without problems. The ship sailed on schedule, leaving Apra Harbor, Guam, at 0200Z, 20 February 1989.

GUAM TO SITE 778 (MAR-3B)

The 35-hr transit to the Mariana sites was made in calm weather and seas. Arrival time in the vicinity of the Mariana sites was such that a Global Positioning System (GPS) window did not exist. Since positioning for proposed site MAR-3A was highly critical and dependent on GPS, the decision was made to drill proposed site MAR-3B first.

SITE 778

Site 778 was established by dropping a recoverable beacon at 2030Z, 21 February, after 5 hr of pre-site surveying.

Hole 778A

Dr. P. Fryer had photographs and video tapes from dives on Conical Seamount in the research submarine *Alvin*. Based on that information, it was decided to forgo using the advanced hydraulic piston corer/extended core barrel coring system (APC/XCB) as proposed in the prospectus and to spud the hole with the rotary core barrel (RCB). A standard RCB bottom hole assembly (BHA) with ten 8 1/4-in. drill collars, mechanical bit release (MBR), and 9-7/8-in. bit was assembled and run. The mud line was established at 3924.4 m below the dual elevator stool (DES) by a punch core at 1445Z, 22 February, with 6.7 m of core recovered. The precision depth recorder (PDR) indicated the mud line to be at 3765.5 m and 6 hr was used in cautiously feeling for the seafloor.

The hole was unstable from the beginning and soon caused problems. After recovery of Core 125-778A-4R at 3954 m, the hole required cleaning on each connection. The hole continued to give problems by sticking and torquing the drill string. During retrieval of Core 125-778A-13R the hole caved in, sticking the drill pipe. The drill string was worked for 30 min with 200,000-lb overpulls before the BHA was freed. On repeated attempts to clean the hole, the drill string became stuck and the decision was made to abandon the hole.

The RCB coring system was used for the entire hole, recoverying 22.8 m in 13 deployments for a recovery rate of 21%.

Hole 778A and Site 778 were abandoned at 0925Z, 24 February, when the drill string was pulled clear of the seafloor.

SITE 779

Clearance was received from ODP management, the drill string was pulled to 3490 m, and the ship was moved in dynamic positioning (DP) mode 1.5 nmi to the northeast. A beacon was dropped at 1400Z, 24 February, establishing Site 779.

Hole 779A

The drill string was lowered to the seafloor and Hole 779A was spudded at 1700Z, 24 February. The water depth at Hole 779A was established at 3957.9 m below the DES by the first RCB core.

Hole problems began during the cutting of Core 125-779A-10R at 87.3 mbsf, after which a 20-bbl pill was pumped. Hole problems continued, and following recovery of Core 125-779A-11R a short trip from 53 mbsf to 97 mbsf was made, which improved hole conditions. After penetration to 170 mbsf and 51 hr of rotating time, the bit exhibited indications of failure. The decision was made to drop a free fall funnel (FFF), make a round trip for a new bit, reenter Hole 779A, and continue coring.

The Colmec TV camera was lowered in preparation for reentry. The FFF was found immediately, but owing to numerous rain squalls in the area, 1.5 hr was required for positioning the vessel before reentry, which was accomplished without incident. The TV camera was retrieved and after 3 hr of hole cleaning, the new bit was back at the previous total depth (TD).

Between taking Cores 125-779A-22R and 125-779A-23R, at a depth of 177.6 mbsf the bottom of the hole caved in and 8 m of hole was lost. After 4 hr of reaming from 158 mbsf to bottom and pumping high-viscosity mud sweeps, coring resumed. The hole still required cleaning after each connection. Owing to the high risk to the drill string and logging tools, logging Hole 779A was not considered safe. However, the decision was made to continue coring the hole as long as possible or until site time expired.

The last 100 m of the hole gave few problems and drilling continued to the end of allotted site time. The RCB coring system was used to TD of 4275.1 m (317.2 mbsf) recovering 73.2 m of core in 37 deployments for a recovery rate of 23 %. Hole 779A and occupation of Site 779 ended at 1700Z, 3 March, when the bit was back on deck and the vessel was under way.

Hydrocarbons in the form of methane and ethane were detected in Hole 779A. The gas posed no safety problems, since no quantity to speak of was thought to exist. The general consensus was that the seamount was full of fractures and permeable material and that plugging the hole would not stop any migration of gas.

Hole 779B

Before making the reentry into Hole 779A, a single punch core of mud line sediments was recovered, establishing Hole 779B at 2300Z, 27 February. The core barrel was retrieved with 8.7 m of serpentinite clay for a recovery rate of 97%.

SITE 780

Although Site 780 is located on the summit of Conical Seamount, 2.5 nmi from Site 779, a seismic survey was required to determine its exact location. The survey began during a GPS window at 1715Z, 3 March, in rough seas. Site 780 was established by dropping a beacon at 2245Z, 3 March.

Hole 780A

A standard APC/XCB BHA was made up with a soft-formation bit and lockable flapper valve (LFV). The trip in began at 0030Z, 4 March, when the drill bit was lowered through the drill floor. A small area was targeted for drilling so the TV camera was lowered to scan the seafloor for the best spud site. At 0845Z, 4 March, Hole 780A was spudded with the APC. The water depth was determined to be 3094.6 m from the DES by observing the drill string tag the seafloor.

Unfortunately, the APC barrel bent on impact when the first APC was shot. Efforts to retrieve the core barrel with the coring line proved futile. The drill string was manipulated in an attempt to break off the bent core barrel so the hole could be continued with the XCB and Pressure Core Sampler (PCS). The result was fouling the TV cable on the drill string and/or on the moon-pool doors, causing the TV cable to fail in the moon-pool area. The vibration isolated television (VIT) frame with TV camera and 3100 m of cable were lost.

Hole 780A officially ended with the bit back on deck at 1830Z, 4 March. The APC had been deployed one time to a depth of 3098.1 m (3.5 mbsf), recovering 3.54 m of core for a recovery rate of 101%.

Hole 780B

The vessel was offset 100 m west, and a standard RCB BHA was made up with a soft-formation bit and MBR. Hole 780B was spudded at 0530Z, 5 March. The first core barrel retrieved had a shattered liner and the hole had to be respudded. Respudding of Hole 780B occurred at 0645Z, 5 March, establishing the mud line at 3105.1 m from the DES.

The sinker-bar assembly was lost during attempted retrieval of Core 125-779B-3R. The bit apparently had followed the slope of a hard serpentinite layer, causing part of the BHA to break off. The drill string was tripped out, and Hole 780B officially ended at 1900Z, 5 March.. Two successful cores were recovered from Hole 780B to a total depth of 3132.8 m (18.2 mbsf) using the RCB and recovering 10.34 m of core for a recovery rate 57%.

Hole 780C

The vessel was offset 50 m north. Another standard RCB BHA was made up and tripped to the sea floor. Hole 780C was spudded at 1900Z, 5 March. The mud line was established at 3094.5 m below the DES with recovery of the first core. The same hard serpentinite layer as in Hole 780B was encountered at 3108.5 m (14 mbsf) in Hole 780C, and was penetrated after 1.75 hr of rotation. The hole was continued, but with considerable hole problems. At a TD of 3258.0 m (163.5 mbsf), the hole finally collapsed and 20 m of hole was lost.

The shipboard scientists had hoped to log the hole. Although hole conditions were not favorable, the bit was released and the logging line was rigged up. The first and second logging runs were aborted owing to cable-head problems. By the time the logging tools reached open hole the hole had closed in and logging had to be curtailed. A temperature measurement was the sole result of the logging effort.

A total of 18 RCB cores were taken from Hole 780C, recovering 14.44 m of core for a recovery of 9%. Hole 780C officially ended with the BHA back on deck at 1830Z, 8 March.

Hole 780D

Owing to poor recovery in Hole 780C, the vessel was offset 50 m northwest and, using the new XCB (124E), Hole 780D was spudded at 0100Z, 9 March. During retrieval of the first core barrel, at 1100 m below the DES, the coring line parted ~25 m above the sinker bar assembly. When finally recovered, the first core barrel was found to be empty. Hole 780D was respudded at 0700Z and the first core established the mud line at 3100.1 m below the DES. The hard serpentinite layer was encountered at 3117 m (16.9 mbsf) and 7.5 hr of rotating time was required to penetrate it with the XCB bit. A standard carbide-tooth center bit was used to drill the first meter of the 1.5-m-thick layer. An impregnated diamond cutting shoe was installed on an XCB core barrel and deployed. A noticeable increase in penetration rate was achieved and a small core of the serpentinite was recovered.

After penetrating the hard serpentinite layer, the Water Sampler Temperature Probe (WSTP) was deployed at a depth of 3120.5 m (20.4 mbsf). The water-sampler valve failed to open but temperature data were gathered. The WSTP was deployed again at 3127.5 m (27.4 mbsf) and 3141.4 m (41.8 mbsf). The second deployment resulted in a water sample but no temperature data. The third deployment resulted in acquisition of both a water sample and temperature data.

Hole 780D and Site 780 were abandoned at the request of the Co-Chief Scientists and officially ended at 1345Z, 10 March, with the bit back on deck. The XCB was deployed 6 times in Hole 780D, coring 30.9 m and recovering 9.1 m of core, for a recovery rate of 28.1%. Drilling produced another 10.9 m of penetration to a TD of 3141.4 m (41.8 mbsf).

SITE 781

Hole problems prevented deep penetration into the top of Conical Seamount at Site 780, leaving unused some of the allotted time. A site near the northern base of the seamount was proposed for drilling, with the hope of obtaining samples of the underlying basement. With clearance to drill to 250 mbsf obtained from ODP management, *JOIDES Resolution* was under way at 1345Z, 10 March, and a seismic survey was conducted to determine the best location for the site. Site 781 was established with the dropping of a beacon at 1730Z, 10 March.

Hole 781A

The vessel was positioned over the beacon and the trip in with the drill pipe began at 2000Z. A standard RCB BHA with a soft-formation bit was used to spud Hole 781A at 0315Z, 11 March. The first RCB core barrel retrieved had recovered 6.95 m of core to establish the mud line at 4431.7 m below the DES. No hole problems were encountered. Basalt was penetrated from 72.6 mbsf to 91.8 mbsf with little difficulty. Very little core was recovered from below the base of the basalt, to a TD of 4681.7 m (250 mbsf). Hole 781A was abandoned after reaching the depth restriction at 250 mbsf. There were 27 RCB coring runs made recovering 39.6 m of core, for a recovery rate of 15%. Hole 781A and Site 781 officially ended at 0900Z, 13 March, with the bit back on deck and *JOIDES Resolution* under way for the Bonin sites.

SITE 782

The 770-nmi transit form Site 781 to Site 782 was completed in 75.75 hr. Site 782 was established at 0900Z, 16 March, by dropping a beacon. Since a GPS window did not exist and no good satellite location fixes were obtained during the approach to the site, additional surveying was performed after beacon drop to ensure that the site location was correct.

Hole 782A

The vessel was positioned over the beacon at 1300Z, 16 March. A standard APC/XCB BHA, including a non-magnetic drill collar, was made up with a soft-formation bit and LFV. The mudline was declared to be at 2969.5 m below the DES and coring commenced. Hole 782A was officially spudded at 2200Z, 16 March. Core orientation began with Core 125-782A-5H and continued through Core 125-782A-9H. Heat flow measurements were taken after Cores 125-782A-4H at 38.3 mbsf and -7H at 66.8 mbsf.

Two yellow and one red alarms were sounded by the Automatic Station Keeping (ASK) system during the first 36 hr of drilling in Hole 782A. The false excursion alarms were caused by loss of beacon signal due to the high noise level of the thrusters and aeration under the ship's hull caused by rough seas. Approximately 12 hr of coring time was lost during the first 36 hr of Hole 782A. Rough seas and the heave of the ship caused the latch safety-release pins on the sinker bars to shear during deployment of the APC. While round tripping the sinker bar assembly to change shear pins, the core barrels remained in the BHA and were subjected to the heave of the ship, causing core disturbance. At the request of the Co-Chief Scientists, the XCB was deployed. The first retrieval of the XCB also resulted in a sheared pin. Finally, with calmer weather and the use of the XCB, coring proceeded without sheared pins.

Excellent recovery was achieved as the hole was advanced to 3369.2 m (399.5 mbsf). At that depth an extensive ash layer was encountered and recovery fell dramatically. A noticeable increase in penetration rate occurred at 3440 m (470 mbsf) while drilling in andesite, and the bit plugged. The barrel was dropped during retrieval and attempts to latch onto the barrel were futile. All circulation was lost and the decision was made to trip out of the hole.

The pipe was pulled to 3427 m (457 mbsf), where it became stuck during a connection. Further attempts to free the drill string failed and it had to be severed at 1340Z, 20 March. An explosive charge was used to sever the second joint of 5-1/2-in. drill pipe above the 7-1/4-in. drill collar.

The drill pipe was pulled out of the hole and, with the severed joint back on board at 2230Z, 20 March, Hole 782A officially ended. The APC had been deployed 9 times, coring 85.5 m and recovering 90 m of core for a recovery rate of 105%. The XCB was deployed 41 times, coring 391 m and recovering 188 m of core for a recovery rate of 48%. The hole had been advanced to a TD of 3446.5 m (476.8 mbsf).

Hole 782B

Since the basement objective of Site 782 had not been achieved, a standard RCB BHA with an MBR and bit was made up to core a second hole. The vessel was offset 100 m to the south and the pipe trip back to the seafloor began at 2230Z, 20 March. The seafloor was tagged at 0700Z, 21 March, 2977 m below the DES. The hole was drilled to 3436.3 m (459.3 mbsf) when hole problems began in the form of bit plugging and increasing torque. Only one 9.6-m RCB core was cut, recovering 0.1 m of core for a recovery rate of 1%. The hole was drilled 459.3 m and cored 9.6 m to a TD of 3445.9 m (468.9 mbsf).

A wiper trip from 3387 m to 3436 m was made in preparation for logging. The MBR released without any problems and the hole was filled with KCl mud. The logging equipment was rigged up, the BHA was raised to 71 mbsf, and logging commenced. Two successful logging runs were carried out. The first used the DIT (dual induction tool), HLDT (dual lithodensity tool), SDT (sonic digital tool), and the NGT (natural gamma-ray spectrometry logging tool). The second run used the GST (induced gamma-ray spectroscopy logging tool), GPIT (general purpose inclination tool), ACT (aluminum clay tool), CNT (compensated neutron porosity tool), and the NGT. Logging run #3 was with the magnetic susceptibility tool, which flooded 100 m below the keel and had to be retrieved, ending the logging program.

The Schlumberger equipment was rigged down and the pipe trip out of the hole began at 0800Z, 23 March. Site 782 officially ended at 1345Z, 23 March, when the BHA was back on deck and the vessel was under way for Site 783.

SITE 783

After a 26-nmi transit, Site 783 was established at 2030Z, 23 March, by deployment of a beacon.

Hole 783A

Since the nature of the material on the surface of the site was unclear from seismic records, a standard RCB BHA with hydraulic bit release (HBR) was deployed. The pipe trip began at 2200Z, 23 March, and Hole 783A was spudded at 0500Z, 24 March. The first RCB recovered 9.71 m of core, establishing the mud line at 4660 m below the DES. Recovery was sporadic in ash, silt and serpentine claystone. No notable problems occurred until Core 125-783A-18R was being cut, when drill-string torque and circulation pressure increased considerably. A mud pill, circulation of high-viscosity mud, and a wiper trip did not improve hole conditions, so the hole was abandoned.

The RCB was deployed 18 times to a TD of 4828.2 m (168.2 mbsf), recovering 46.95 m of core for a recovery rate of 27.9%. Two heat flow measurements were taken at 4702.7 m (42.7 mbsf) and 4750.9 m (90.0 mbsf) with good results. With the drill string pulled to 4100 m and the vessel under way for Site 784 in DP mode, Hole 783A and Site 783 officially ended at 0215Z, 26 March.

SITE 784

The vessel moved ~4 nmi around the seamount in DP mode. A beacon was deployed at 0630Z, 26 March, establishing Site 784.

Hole 784A

The trip back to the sea floor began at 0700Z and Hole 784A was spudded at 0830Z, 26 March. The first RCB core recovered 1.4 m of core to establish the mud line at 4912.1 m below the DES. The RCB was deployed 45 times to TD of 5337.4 m (425.3 mbsf), recovering 218.3 m of core for a recovery rate of 51.3%.

During preparations for logging, the bit failed to release several times. A core barrel was run in the hole to check for bit release, but became stuck at 21 mbsf. After retrieval of the core barrel, the drill string was tripped out of the hole. Five joints of drill pipe had bent, six stands above the BHA.

With the BHA back on board and the vessel under way for Site 785 at 0100Z, 31 March, Hole 784A and Site 784 officially ended.

SITE 785

The 44 nmi transit to Site 785 ended at 0645Z, 31 March, with the deployment of a beacon, establishing Site 785.

Hole 785A

A standard APC/XCB BHA with LFV, non-magnetic drill collar, and bit was made up and run in the hole. A center bit was dropped and a jet-in test performed. Only 32 m was penetrated in 90 min. The BHA was then pulled clear of the sea floor and the center bit retrieved.

An APC barrel was run in and Hole 785A was spudded at 1800Z, 31 March. The first core barrel established the mud line at 2672.0 m below the DES. The second APC core barrel recovered 8.2 m of fine pumice, which had enough frictional drag upon entering the core barrel to cause extrusion of 1 m of the core liner through the upper end of the APC. However, the APC was used to core 19 m, recovering 17.7 m of core for a recovery rate of 93%.

The XCB was deployed from Cores 125-785A-3X to -11X, 2700.5 m (28.5 mbsf) to a TD of 2776.8 m (104.7 mbsf), recovering 0.62 m of fine pumice and ash for a recovery rate of 0.08%. Rotating time per XCB core was only 5 min, indicating that the small amount of fine pumice recovered was not cuttings but was coming from the formation being cored. The pipe began sticking and the hole began to fill shortly after switching to the XCB. Mud was circulated, with no relief from the hole problems.

The BHA had been put at risk in the hope of passing through the layer of pumice and ash. If the layer had been penetrated, an attempt at setting the reentry cone and casing would have been feasible. Several things were becoming evident. First, to drill further would most likely result in loss of the BHA. Second, the hole was already deeper than the reentry core and casing could be jetted in without passing out of the layer of pumice and ash. Third, even if the reentry cone and 16-in. casing were set, a stable hole could not be maintained to allow setting of a string of 11-3/4-in. casing. Based on the above, the decision was made to abandon the site.

With the bit back on board and the vessel under way for Site 786 at 1030Z, 1 April, Hole 785A and Site 785 officially ended. A total of 104.7 m had been cored in 11 coring runs, recovering 18.4 m of core for a recovery rate of 17.6%.

SITE 786

The inability to drill at Site 785 left time for drilling alternate proposed site BON-6C. The 64-nmi transit was made in 10.5 hr, including 4.75 hr of surveying time. A beacon was deployed at 2015Z, 1 April, to establish Site 786.

Hole 786A

A standard APC/XCB BHA with LFV, non-magnetic drill collar, and soft-formation bit was assembled and deployed. Three APC water cores were taken to a depth of 29 m below the PDRdepth of 3034 m. Then the drill string was tripped in until weight was taken by the seafloor. The BHA was picked up 7.5 m and another APC was shot at 1715Z, 2 April, recovering 9.7 m of core to establish the mudline at 3069.5 m below the DES and officially spud Hole 786A.

The first three APC core barrels recovered 29.6 m of core for a recovery rate of 103%. The XCB was then deployed from Core 125-786A-4X through -19X, from 3098.2 m (28.7 mbsf) to a TD of 3236 m (166.5 mbsf), recovering 55.3 m of core for a recovery rate of 40.1%. In total, 166.5 m were cored in 19 coring runs, recovering 85 m of core for a total recovery rate of 51%. Heat flow measurements were taken at 3098.2 m (28.7 mbsf) and 3146.3 m (76.8 mbsf).

Upon reaching basement, a round trip was made for the RCB and with the XCB bit back on deck at 0300Z, 4 April, Hole 786A officially ended.

Hole 786B

A standard RCB BHA was made up with an MBR and medium-formation bit. As the BHA was tripped in, the vessel was offset 30 m to the south. The seafloor was tagged at a depth of 3082.4 m below the DES, and Hole 786B was officially spudded at 0845Z, 4 April. The hole was washed to a depth of 3245 m (162.6 mbsf) and coring commenced.

The RCB was deployed 72 times, coring 666 m and recovering 190.1 m of core for a recovery rate of 28.5%. Hole TD was 3911 m (828.6 mbsf). With the allotted leg time coming to an end, the decision was made to stop coring and log the hole.

The BHA was pulled to 3184 m and the logging line was rigged up. Six suites of logging tools were run in Hole 786B. Log #1 (DIT-SDT-NGT) was run to 3531.4 m where a bridge was encountered. The logging tools would not pass the bridge so the hole was logged from that point upward. Log #2 (HLDT-CNT-NGT) was run to 3469.5 m where another bridge was encountered. Again the tools would not pass the bridge and the hole was logged from that point upward. The Schlumberger equipment was rigged down and the pipe was run in the hole to clear the bridges. The hole was clear from 3531 m to 3820 m, and the BHA was raised to 3531 m so the bottom of the hole could be logged.

The third logging suite (DIT-HLDT-CNT-SDT) was run to 3903.4 m and the hole was logged from that point upward to 3546.6 m. The fourth suite (GST-ACT-NGT) was run to 3903.4 m and the hole was logged to the mud line. The fifth logging run consisted of the BHTV, which failed downhole. During the sixth logging run, the backup BHTV was run in the hole and the interval from 3625 to 3546.6 m was logged before logging time expired.

The BHTV was pulled out of the hole and the logging equipment rigged down. The BHA was pulled to the drill floor at 0800Z, 16 April, officially ending Hole 786B. The BHA was then inspected and stood in the derrick. With the BHA back on deck the vessel was under way at 1130Z, 16 April, and occupation of Site 786 officially ended.

SITE 786 TO TOKYO

A survey was performed, including dropping sonobuoys, over Site 786 before steaming north to Tokyo. At 1430Z, 16 April, the seismic gear was retrieved and the transit began. The 252-nmi transit to Tokyo was made in 35.5 hr. The anchor was dropped at 2300Z, 17 April 1989, officially ending Leg 125.

LOGGING SUMMARY

Logging on Leg 125 was successful in Holes 782B and 786B.

HOLE	DEPTH (mbsf)	LOGGING ACTIVITY
778A	107.6	None, unstable hole
779A	317.2	None, unstable hole
779B	9.0	None, single punch core
780A	3.5	None, bent APC core barrel
780B	18.2	None, lost OCB assembly
780C	163.5	Rigged up, RIH, tools failed at cable head, hole collapsed
780D	41.8	None
781A	250.0	None, time limit reached (this was a contingency hole proposed by the Co-Chiefs)
782A	476.8	None, unstable hole, shot off BHA
782B	468.9	Log #1 DIT-HLDT-SDT-NGT good logs Log #2 GST-GPIT-ACT-CNT-NGT good logs Log #3 Magnetic susceptibility, tool flooded, no logs
783A	168.2	None, unstable hole
784A	425.3	None, bent pipe during hole conditioning
785A	104.7	None, unstable hole
786A	166.5	None, opt for "B" hole
786B	828.6	Log #1 DIT-SDT-NGT, bridge at 449 mbsf, log to mudline Log #2 HLDT-CNT-NGT, bridge at 387 mbsf, log to mudline Wiper trip, bridges between 365 - 449 mbsf only penetrated by rotating and circulating, BHA positioned at 449 mbsf Log #3 DIT-HLDT-CNT-SDT, 821 - 464 mbsf Log #4 GST-ACT-NGT, 821 - mudline Log #5 BHTV, tool failed Log #6 BHTV, backup tool functioned properly, 80 m logged

OCEAN DRILLING PROGRAM
SITE SUMMARY REPORT
LEG 125

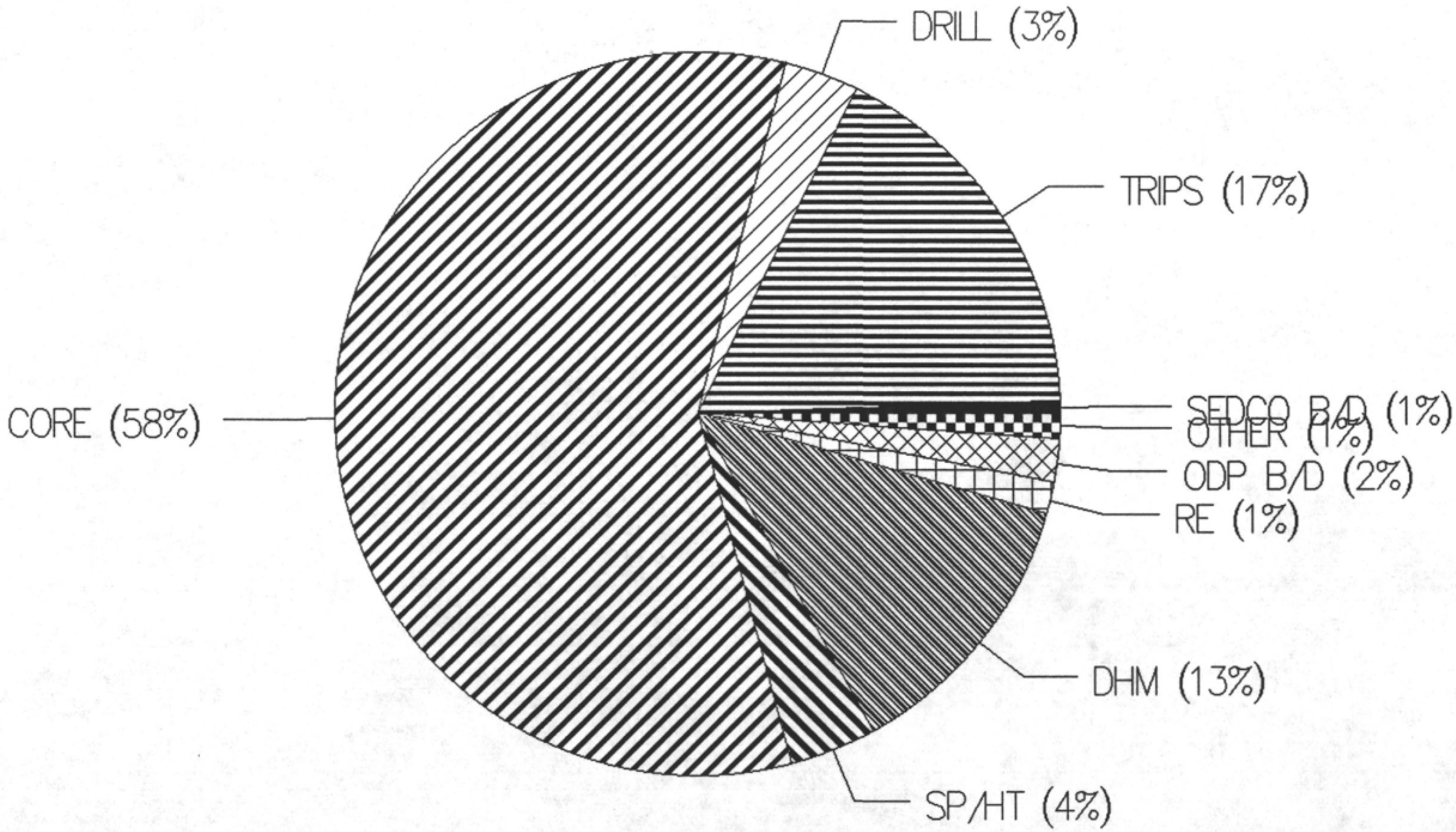
HOLE	LATITUDE	LONGITUDE	DEPTH METERS	NUMBER OF CORES	METERS CORED	METERS RECOVERED	PERCENT RECOVERED	METERS DRILLED	TOTAL PENETRATION	TIME ON HOLE	TIME ON SITE
778A	19-29.93N	146-39.93E	3924.4	13	107.6	22.8	21.2	0.0	107.6	79.25	79.25
779A	19-30.75N	146-41.75E	3957.9	37	317.2	73.2	23.1	0.0	317.2	174.00	
779B	19-30.75N	146-41.75E	3957.9	1	9.0	8.7	96.7	0.0	9.0	1.50	175.50
780A	19-32.51N	146-39.27E	3094.6	1	3.5	3.5	100.0	0.0	3.5	21.25	
780B	19-32.47N	146-39.22E	3105.1	2	18.2	10.3	56.6	9.5	27.7	23.00	
780C	19-32.53N	146-39.21E	3094.5	18	163.5	14.4	8.8	0.0	163.5	72.00	
780D	19-32.55N	146-39.20E	3100.1	6	30.9	9.1	29.4	10.9	41.8	43.25	159.50
781A	19-37.91N	146-32.56E	4431.7	27	250.0	39.6	15.8	0.0	250.0	63.00	63.00
782A	30-51.66N	141-18.85E	2969.7	50	476.8	278.3	58.4	0.0	476.8	109.50	
782B	30-51.60N	141-18.84E	2977.0	1	9.6	0.1	1.0	459.3	468.9	63.50	173.00
783A	30-57.86N	141-47.27E	4660.0	18	168.2	47.0	27.9	0.0	168.2	52.75	52.75
784A	30-54.49N	141-44.27E	4912.1	45	425.3	218.3	51.3	0.0	425.3	114.50	114.50
785A	30-49.47N	140-55.17E	2672.0	11	104.7	18.4	17.6	0.0	104.7	26.00	26.00
786A	31-52.48N	141-13.58E	3069.5	19	166.5	85.0	51.1	0.0	166.5	54.80	
786B	31-52.45N	141-13.59E	3082.4	72	666.0	190.1	28.5	162.5	828.5	296.50	351.30
Totals :				321	2917.0	1018.8	34.9%	642.2	3559.2		1368.80

OCEAN DRILLING PROGRAM
OPERATIONS RESUME
LEG 125

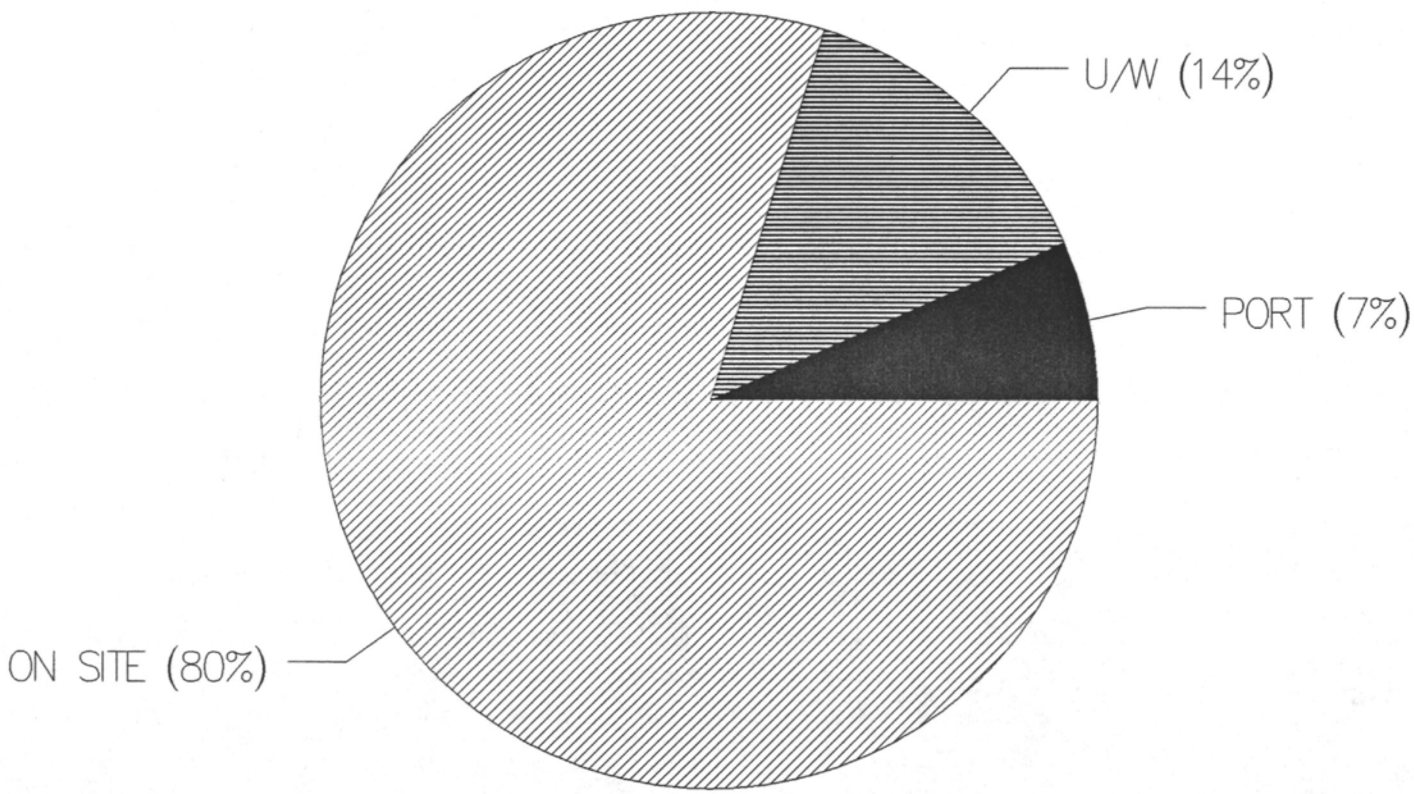
Total Days (2/16/89 - 4/18/89)		61.1
Total Days in Port		4.3
Total Days Under Way		8.2
Total Days on Site		48.6
Trip Time	8.3	
Coring Time	28.2	
Drilling Time	1.7	
Logging/Downhole Science Time	6.2	
Reentry Time	0.6	
Mechanical Repair Time (Contractor)	0.4	
ODP Repair Time	1.0	
Stuck Pipe/Hole Trouble	1.7	
Other	0.5	

Total Distance Traveled (nautical miles)	1640.0
Average Speed (knots)	8.4
Number of Sites	9
Number of Holes	15
Total Interval Cored (m)	2917.0
Total Core Recovery (m)	1018.8
Percent Core Recovered	34.9
Total Interval Drilled (m)	642.2
Total Penetration (m)	3559.2
Maximum Penetration (m)	828.5
Maximum Water Depth (m from drilling datum)	4912.1
Minimum Water Depth (m from drilling datum)	2672.0

LEG 125
ON SITE TIME DISTRIBUTION



LEG 125
TOTAL TIME DISTRIBUTION



TECHNICAL REPORT

The ODP Technical and Logistics personnel aboard *JOIDES Resolution* for Leg 125 of the Ocean Drilling Program were:

Laboratory Officer:	William Mills
Asst. Laboratory Officer:	Matt Mefferd
Yeoperson:	Michiko Hitchcox
Curatorial Representative:	Peggy Myre
Computer System Manager:	William Meyer
Electronics Technician:	Michael Reitmeyer
Electronics Technician:	Barry Weber
Photographer:	Stacey Cervantes
Chemistry Technician:	Joseph Powers
Chemistry Technician:	MaryAnn Cusimano
X-ray Technician:	Donald Sims
Marine Technician/ Core Lab:	Terri Beehner
Marine Technician/ Underway Geophysics Lab:	Kenneth du Vall
Marine Technician/ Paleomagnetics Lab:	Nicholas Evans
Marine Technician/ Underway Geophysics and Thin Section Labs:	Jenny Glasser
Marine Technician/ Physical Properties Lab:	Mark Simpson
Marine Technician/ Shipping/Storekeeper:	Charles Williamson

INTRODUCTION

Leg 125 was the first of two consecutive Ocean Drilling Program legs scheduled to study the Bonin-Mariana region. The objectives were to study (1) the origin and evolution of forearc terranes, (2) the nature and origin of serpentinite bodies in interoceanic forearcs, and (3) the dewatering of the lithosphere during subduction. To accomplish these tasks *JOIDES Resolution (SEDCO/BP 471)* sailed from Agana, Guam, on 20 February 1989 (noon) with a total crew of 108 (47 science and technical staff). After drilling15 holes at 9 sites, Leg 125 officially ended at 0600 hr, 18 April 1989, for a total of 49 days at sea.

PORTCALL: AGANA, GUAM

Busy, hectic, crazy ...these expressions are used to describe any normal port call. Scheduled inspections by the United States Coast Guard (USCG) and American Bureau of Shipping (ABS) added further complications. The concerns of the USCG visit centered around explosive and radioactive materials carried on board. Specifically, they requested certification documents for explosive and radioactive materials used aboard ship. These documents had not been requested at previous U.S. port calls. We were able to produce all licenses, certifications, and shipping documents requested during previous port calls, and the ship was released for departure.

An ABS inspection was scheduled also for this portcall. This included both the ship's annual equipment inspection and the inspection of recent modifications to the paleontology and chemistry laboratories. During the lab stack inspection, numerous minor deficiencies were found. The inspector noted that the elevator shaft was being used as a path for running electrical and computer cables. This problem was corrected before the ship sailed. The removal of these cables resulted in a temporary shutdown of the ship's computer communications network, the TOTCO Visulogger II equipment, and power to the paleontology lab's fume hoods. With cores due on deck in two days, both ODP marine technicians and the SEDCO electricians worked around the clock cutting new access hatches into the lab stack's main mechanical/electrical trunk, and the cables were installed. All affected systems except the TOTCO Visulogger II were operational prior to the first core on deck.

LAB OPERATIONS

The short transit (35 hours) from port to our first site allowed little time for scientists and new Marine Technicians to become familiar with lab equipment and procedures. After one week of coring, core processing settled into a normal, if unsteady, routine. The recovery of serpentinite proved to be a real challenge. The serpentinite cores had to be treated as both sedimentary and metamorphic rock, requiring that curatorial and descriptive procedures be very flexible.

The X-ray fluorescence, thin section, and inorganic chemistry labs processed more samples than usual (see lab statistics in Table 2), because of the large amount of igneous and metamorphic rock recovered.

Table 2. Laboratory Statistics: Leg 125

General statistics	
Sites	9
Holes	16
Meters of core recovered	1078.89
Number of samples taken	6738
Samples analyzed	
Inorganic carbon	830
Total carbon-CNS	180
Water chemistry	96
Rock-Eval	37
Thin sections	297
XRF (major & minor elements)	153
XRD	286
Underway geophysics	
Total nautical miles transit1	660
bathymetry	1243
magnetics	987
seismic	110
Downhole tool runs	
Heat flow only	9
Heat flow & in-situ water	3

NEW EQUIPMENT

Several new pieces of analytical equipment installed on Leg 124E received their first real test under field conditions. The Multi-Sensor Track (MST), the Atomic Absorption (AA) unit, the Carbon-Nitrogen-Sulfur analyzer (CNS), the Macintosh II work stations, the Local Area VAX cluster, and the Micrologic Commander Loran-C radio navigation receiver were all new to ship routine.

The MST was developed to combine three existing whole-round analytical instruments, Gama Ray Attenuation Porosity Evaluator (GRAPE), Sonic Velocity (*P*-wave) and Magnetic Susceptibility, into one instrument. The MST also provides space for easy addition of more sensors in the future. Some minor repairs were needed for the existing sensors and additional fine tuning on the track system is required, but we are satisfied with the MST's overall performance.

Both the AA and CNS performed well. The AA played an important role in analyzing trace amounts of Ca and Mg in interstitial waters originating from mantle sources.

The Macintosh II work stations were used extensively for post-processing of shipboard data. The AlisaShare fileserver, which allows fast and easy access to VAX data files, proved to be a valuable addition to the shipboard computer system.

During Leg 124E two MicroVax 3500s, a WORM optical disc, and eight terminal servers were installed as a local-area cluster with the existing VAX 11/750. This upgrade to the existing system is four times more powerful than the original system, and clearly demonstrated its usefulness during the end-of-the-leg time crunch.

A Micrologic Commander Loran-C radio navigation receiver was installed in the underway geophysics lab. Loran-C is not as accurate as the shipboard global positioning system (GPS), but it is a useful navigation aid when GPS is unavailable and was especially helpful in locating drilling sites, since the original site surveys were done using Loran-C.

LAB SOFTWARE

The following software was installed this leg:

SIOSEIS: used in post-processing seismic data
HARVI: database program used to input visual core descriptions
PHYSPROPS: database program for the physical properties lab

Several new command files were created to assist scientists in accessing and plotting magnetics and physical properties data. The SMOOTH navigation software was upgraded to allow more user control over scaling output. The shipping program S2S was revised to provide the user with a more convenient method of printing shipping documents.

SAFETY

The technical staff organized and high-graded the chemicals bottles that are used in the labs. Special attention was given to proper storage methods, including what types of chemicals can be stored safely together. All technicians were reminded of the large volume of safety reference material kept aboard ship.