Fryer, P., Pearce, J. A., Stokking, L. B., et al., 1990
Proceedings of the Ocean Drilling Program, Initial Reports, Vol. 125

13. SITE 785[1]

Shipboard Scientific Party[2]

HOLE 785A

Date occupied: 31 March 1989

Date departed: 1 April 1989

Time on hole: 1 day, 3 hr, 45 min

Position: 30°49.47′N, 140°55.17′E

Bottom felt (rig floor; m; drill-pipe measurement): 2672.0

Distance between rig floor and sea level (m): 11.20

Water depth (drill-pipe measurement from sea level; m): 2660.8

Total depth (rig floor; m): 2776.70

Penetration (m): 104.70

Number of cores: 11

Total length of cored section (m): 104.70

Total core recovered (m): 18.42

Core recovery (%): 17.6

Oldest sediment cored:

Depth (mbsf): 57.61

Nature: nannofossil ooze, pumice

Earliest age: early Pleistocene

Principal results: Site 785 is located in the center of the Izu-Bonin forearc basin about 40 nmi east-northeast of the active volcano Torishima. The objectives of this site were to study (1) the uplift and subsidence history of the forearc basin at this locality; (2) the temporal record of sedimentation, depositional environment, paleoceanography, and intensity and nature of arc volcanism; (3) the nature and age of the igneous basement of the forearc basin; and (4) the microstructural deformation and the large-scale rotation and translation of the forearc. A thick near-surface layer of pumice and ash encountered in Hole 785A produced high torque on the drill string and caused the hole to collapse after drilling to a depth of 104.7 m below seafloor (mbsf) with a recovery of 17.6%.

The single lithologic unit at Site 785, Unit I, is of late to early Pleistocene age and consists of 2 m of light brown pumice-bearing nannofossil ooze overlying a pumice bed. The ooze is dominated by calcareous nannofossils with smaller amounts of foraminifers, micrite, radiolarians, diatoms, sponge spicules, clay, quartz, and vitric fragments. The pumice bed contains fragments of light gray to gray, porphyritic dacite-rhyolite pumice, 1 mm to 6 cm in diameter, in a poorly sorted matrix of mainly vitric particles. The average bulk density of the pumice is 1.3 g/cm^3. The principal result from this site is the evidence for a major Pleistocene pumice bed in this part of the Izu-Bonin forearc basin.

BACKGROUND AND SCIENTIFIC OBJECTIVES

Site 785 is located at 30°49.47′N, 140°55.17′E, in a water depth of 2660.8 m on the outer half of the Izu-Bonin forearc, about 120 km west of the axis of the Izu-Bonin Trench (Fig. 1). The objectives of drilling at this site are similar to those of Site 782 in the study of the following:

1. The stratigraphy of the forearc and hence both the temporal variations in sedimentation, depositional environment, and paleoceanography and the history of intensity and chemistry of arc volcanism;
2. The uplift/subsidence history of the central part of the forearc to provide information about forearc flexure and basin development as well as on the extent of any vertical tectonic activity that may have taken place since formation of the forearc terrane;
3. The nature of igneous basement forming the central basin of the forearc, to answer questions concerning the nature of volcanism in the initial stages of subduction, the origin of boninites, and the formation of the 200-km-wide arc-type forearc crust; and
4. The microstructural deformation and the large-scale rotation and translation of the forearc terrane since the Eocene.

As at Site 782, the first of these objectives can be addressed partly through detailed studies of the sediments recovered at Site 785. These sediments contain a record of the history of intensity and composition of arc volcanism, which might help to place some constraints on hypotheses regarding the controls over variations in such subduction processes as convergence rates and episodicity of backarc spreading.

The second objective can be investigated through a combination of sediment analysis and evaluation of logging results linked to the study of digital seismic-reflection data from the forearc. Multichannel seismic (MCS) surveys of the Izu-Bonin forearc have revealed a complicated basement that is commonly seismically stratified and cut by dipping reflectors. Like Site 782, Site 785 was selected in the hope of sampling the hitherto unstudied upper forearc basement to constrain some of the parameters required for modeling forearc evolution. Several lines of evidence suggest that fairly stable conditions have prevailed since the anomalous Eocene phase of arc-basin development (see "Background and Objectives" section, "Site 782" chapter, this volume). Comparing the results of drilling at Site 785 with those from other holes across the forearc and using backstripping techniques for cored/logged holes as well as analyses of the seismic stratigraphies of interconnecting MCS profiles will provide constraints on models for forearc evolution. Microstructures in the drill cores should also help in determining the intensity of faulting in space and time across the forearc terrane.

The third objective of this site, to determine the nature of volcanism in the initial stages of subduction, can be achieved through the evaluation of several hypotheses for the origin and evolution of the Izu-Bonin forearc terrane over the past 40 m.y. One of the most intriguing aspects of this evaluation will be to provide information about how the various models for forearc evolution relate to the formation of supra-subduction

[1] Fryer, P., Pearce, J. A., Stokking, L. B., et al., 1990. *Proc. ODP, Init. Repts.*, 125: College Station, TX (Ocean Drilling Program).

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

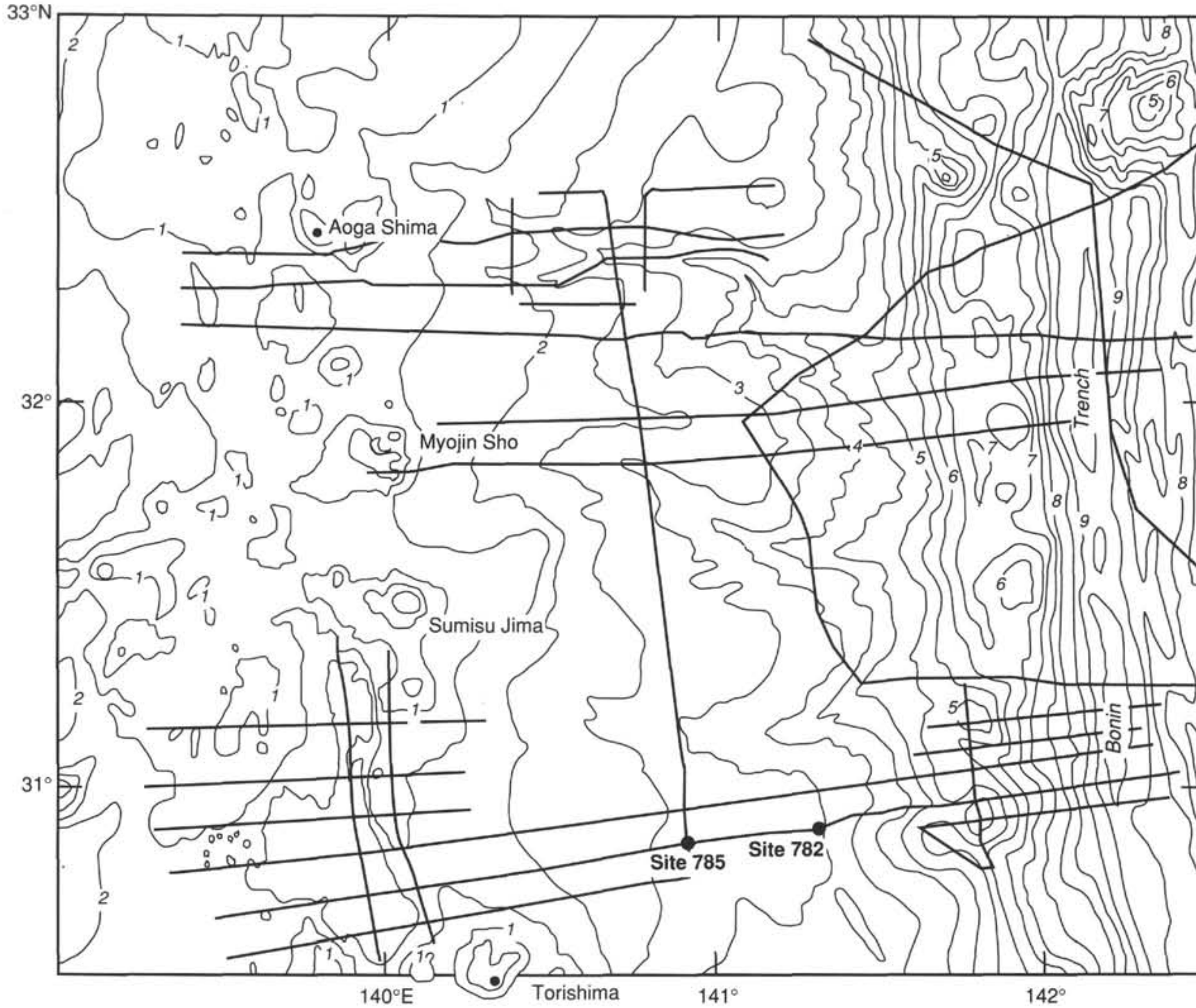

Figure 1. Bathymetry (in kilometers) of the Izu-Bonin forearc area showing the locations of Sites 782 and 785.

zone ophiolites. Detailed discussion of this aspect of the objectives is presented in the "Background and Objectives" section of the "Site 782" chapter.

The fourth objective of the site, the study of microstructures and plate rotations, can be addressed through a further study of the paleomagnetic properties of the cored materials, as at Site 782.

OPERATIONS

Transit to Site 785

The 44-nmi transit to Site 785 began at 0100UTC and ended at 0645UTC, 31 March 1989. Site 785 was established by the deployment of a beacon.

Hole 785A

A standard advanced hydraulic piston corer/extended core barrel (APC/XCB) bottom-hole assembly (BHA) with a lockable flapper valve, nonmagnetic drill collar, and bit was prepared and run in the hole. A center bit was lowered and a jet-in test performed. Only 32 m was penetrated in 90 min. The BHA was then pulled clear of the seafloor, and the center bit was retrieved.

An APC core barrel was deployed, and Hole 785A was spudded at 1800UTC, 1 April. The first core barrel established the mud line at 2660.8 m below sea level (mbsl). The second APC core recovered 8.2 m of fine pumice, which had sufficient frictional drag upon entering the core barrel to cause 1 m of the core liner to extrude through the upper end of the APC. The APC cored 19 m, recovering 17.7 m of core for a recovery rate of 93% (Table 1).

The XCB was deployed from Cores 125-785A-3X to 125-785A-11X, recovering only 0.62 m of fine pumice and ash for a recovery rate of 0.08% (Table 1). Rotating time per XCB core was only 5 min, indicating that the small pieces of pumice recovered in Cores 125-785A-5X through 125-785A-7X were not cuttings, but came from the interval being cored. Shortly after switching to the XCB, the pipe began to stick and the

Table 1. Coring summary for Site 785.

Core no.	Date (April 1989)	Time (UTC)	Depth (mbsf)	Length cored (m)	Length recovered (m)	Recovery (%)
125-785A-						
1H	1	1815	0.0–9.5	9.5	9.52	100.0
2H	1	1845	9.5–19.0	9.5	8.25	86.8
3X	1	2130	19.0–28.5	9.5	0.00	0.0
4X	1	2230	28.5–38.3	9.8	0.00	0.0
5X	1	2330	38.3–47.8	9.5	0.33	3.5
6X	2	0130	47.8–57.3	9.5	0.01	0.1
7X	2	0130	57.3–66.8	9.5	0.31	3.3
8X	2	0230	66.8–76.2	9.4	0.00	0.0
9X	2	0315	76.2–85.7	9.5	0.00	0.0
10X	2	0400	85.7–95.2	9.5	0.00	0.0
11X	2	0445	95.2–104.7	9.5	0.00	0.0
Coring totals				104.7	18.42	17.6

hole began to fill in. Mud was circulated, but did not relieve the hole problems.

The BHA had been risked whene we were trying to pass it 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 justified. Further drilling, however, would probably result in loss of the BHA. In addition, the reentry cone and casing could not be jetted-in deeply enough to pass through the layer of pumice and ash. Even if it were possible to set a reentry cone and 16-in. casing, the hole was not sufficiently stable to allow us to set a string of 113/4-in. casing. The hole therefore was abandoned.

Site 785 officially ended at 1030UTC, 1 April, when the bit was back on board and the vessel was under way for Site 786 (proposed Site BON-6C). A total of 104.7 m was cored in 11 coring runs, recovering 18.4 m of core with 17.6% recovery (Table 1).

LITHOSTRATIGRAPHY

Only one lithologic unit is described for the stratigraphic succession recovered at Site 785 (Table 2). Poor core recovery and unstable drillhole conditions were caused by a thick (greater than 102 m) pumice sequence that terminated drilling at 104.7 mbsf.

Unit I

Sections 125-785A-1H-1 to 125-785A-11X-CC; depth, 0.0–104.7 mbsf.
Age: Pleistocene.

Approximately 2 m of light brownish-gray to gray (2.5Y 6/2 to 7.5YR 6/0) nannofossil ooze overlying the pumice layer was recovered in Sections 125-785A-1H-1 and 125-785A-1H-2. The ooze forms the uppermost sediment at Site 785 and contains nannofossils (51%–79%), foraminifers (5%–8%), micrite (3%–10%), radiolarians (2%–3%), diatoms (3%), sponge spicules (1%), clay (5%–20%), quartz (2%–3%), and vitric fragments (2%–3%). Mottling and burrows occur throughout the 2-m-thick sequence with the exception of one bed of normally size-graded silty glass-rich nannofossil ooze, suggesting a pelagic turbidite, and eight thin (each about 5 mm thick) grayish olive green (5GY 3/2) laminae below the graded bed. Small (between 1 mm and 2 cm in diameter) pumice fragments are scattered within the ooze.

Pumice fills the interval from Sections 125-785A-1H-3 through 125-785A-2H-CC and Cores 125-785A-5X and 125-785A-7X; subsequent cores had no recovery. On the presumption that all coring was done within the same pumice bed, 102.75 m is inferred as a minimum thickness for the pumice layer. In general, the pumice fragments are light gray to gray (7.5YR 7/0 to 7.5YR 6/0), subangular to rounded, 1 mm to 6 cm in diameter (i.e., the approximate diameter of the core barrel), and in a poorly sorted mixture that includes black (10YR 2/1) granules and coarse-sand-size vitric particles; it remains unclear how much of these shape and size characteristics is the result of abrasion and breakage during drilling.

BIOSTRATIGRAPHY

Evidence from calcareous nannofossils, planktonic foraminifers, and diatoms indicates that the sediments retrieved from Site 785 are Pleistocene in age. Nannofossil evidence shows that the late/middle to early Pleistocene boundary lies between Samples 125-785A-1H-2, 0 cm, and 125-785A-2H-CC.

Calcareous Nannofossils

All samples examined from Hole 785A contain abundant well-preserved Quaternary nannofossil assemblages. Samples 125-785A-1H-1, 145–150 cm, and 125-785A-1H-2, 0 cm, contain late/middle Pleistocene assemblages (Zones CN14b/CN15) characterized by *Gephyrocapsa oceanica*, *Gephyrocapsa caribbeanica*,and *Helicosphaera hyalina*. Samples 125-785A-2H-CC, 125-785A-5X-CC, 125-785A-6X-CC, and 125-785A-7X-CC are early Pleistocene in age (Zone CN14a) with assemblages characterized by *Pseudoemiliania lacunosa*, *G. oceanica*, *G. caribbeanica*, *Calcidiscus macintyrei*, and *Helicosphaera sellii*.

Foraminifers

Abundant, well-preserved, Quaternary foraminiferal assemblages were found in all samples examined from Hole 785A. Samples 125-785A-1H-1, 145–150 cm, and 125-785A-1H-2, 0 cm, contain Pleistocene (Zone N22) assemblages characterized by *Globorotalia truncatulinoides*. Samples 125-785-2H-CC, 125-785A-5X-CC, 125-785A-6X-CC, and 125-785A-7X-CC are early Pleistocene (lower Zone N22), based on the co-occurrence of *G. truncatulinoides* and *Globorotalia tosaensis* (Samples 125-785-2H-CC, 125-785A-5X-CC, and 125-785A-7X-CC) and *G. truncatulinoides* and *Neogloboquadrina humerosa* (Sample 125-785A-6X-CC).

Common, well-preserved specimens closely resembling *Pulleniatina praecursor* were found in all of the samples examined. This may be evidence for a reworking event (though preservation and abundance seem too high) or that the range for *P. praecursor* in the northwest Pacific actually extends into the early Pleistocene.

Diatoms

The diatom assemblages at Site 785 are Pleistocene in age, and they vary from few to common in abundance and are poorly to moderately preserved.

Sample 125-785A-2H-CC is the first sample with zonal markers and is assigned to the late/middle Pleistocene *Pseudoeunotia doliolus* Zone by the presence of *P. doliolus* and the absence of *Nitzschia reinholdii*. Both *P. doliolus* and *N. reinholdii* are present in Sample 125-785A-5X-CC; this sample therefore belongs to the early Pleistocene *N. reinholdii* Zone. Samples 125-785A-6X-CC and 125-785A-7X-CC contain no diatoms.

Table 2. Lithologic units recovered at Site 785, Leg 125.

Lithologic unit	Cores	Depth (mbsf)	Dominant lithology	Stratigraphic age
I	785A-1H-1, 0 cm, to 785A-11X-CC	0.0–104.7	Nannofossil ooze, pumice	Pleistocene

Table 3. Total nitrogen, carbon, inorganic carbon, organic carbon and carbonate carbon in sediments at Site 785.

Core, section, interval (cm)	Depth (mbsf)	Total nitrogen (wt%)	Total carbon (wt%)	Inorganic carbon (wt%)	Organic carbon (wt%)	$CaCO_3$ (wt%)
125-785A-						
1H-1, 71–73	0.71			4.51		37.6
1H-2, 12–14	1.62	0.24	4.02	3.59	0.43	29.9
1H-3, 34–36	3.34			0.06		0.5
1H-4, 23–25	4.73			0.06		0.5
1H-5, 98–100	6.98			0.05		0.4
2H-1, 72–74	10.22			0.07		0.6
2H-2, 70–72	11.70	0.11	0.43	0.20	0.23	1.7
2H-3, 70–72	13.20			0.07		0.6
2H-4, 99–101	14.99			0.07		0.6
2H-5, 29–31	15.79			0.01		0.1
2H-6, 34–36	17.34			0.12		1.0

Note: Total sulfur was below the detection limit of 0.06 wt% in all samples analyzed for total carbon, nitrogen, and sulfur.

Table 4. Results of headspace-gas analyses of sediment at Site 785.

Core, section, interval (cm)	Depth (mbsf)	Methane (μL/L)[a]	(μM)[b]
125-785A-			
1H-2, 0–1	1.51	11	0.9

[a] Microliters of methane per liter of wet sediment, assuming a sample volume of 4.2 cm^3 of sediment.
[b] Micromoles of methane per liter of interstitial water, assuming a porosity of 50%.

SEDIMENT/FLUID GEOCHEMISTRY

Sediment Geochemistry

Sediments from Site 785 were analyzed aboard ship for inorganic carbon and for total carbon, nitrogen, and sulfur using the techniques described in the "Explanatory Notes" chapter (this volume). The organic carbon content was then calculated by difference. The results are presented in Table 3 and Figure 2. Except for two samples from 0.71 and 1.62 mbsf, the $CaCO_3$ content of the sediments is less than 2%, and generally less than 1%. The two uppermost samples (125-785A-1H-1, 71–73 cm, and 125-785A-1H-2, 12–14 cm) have about 38 and 30 wt% $CaCO_3$, respectively. The only two samples analyzed for total carbon, nitrogen, and sulfur, from 1.62 and 11.70 mbsf, contain about 0.4 and 0.2 wt% organic carbon, respectively, and half these concentrations of nitrogen. Sulfur was not detected and therefore is less than about 0.6 wt%.

Fluid Geochemistry

The single sediment sample (1.51 mbsf) analyzed for light hydrocarbons was found to contain only 11 mL/L (Table 4).

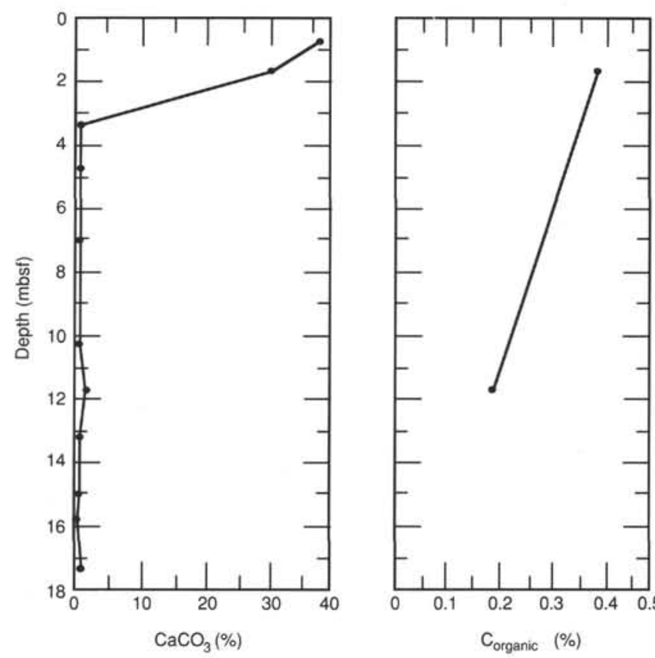

Figure 2. Calcium carbonate and total organic carbon (in wt%) in sediments at Site 785.

Only one sample of interstitial water was obtained at Site 785, from 1.48 mbsf (Table 5). Its composition is very similar to that of seawater, except for a slight increase in alkalinity, ammonia, silica, and potassium and a slight decrease in sulfate and magnesium. These changes are typical of surficial samples from the other sites in this area (Sites 782–784). As at these other sites, the changes indicate that bacteria are oxidizing organic matter and reducing seawater sulfate at Site 785.

Table 5. Composition of intersitial waters from sediment at Site 785.

Sample number	Core, section, interval (cm)	Depth (mbsf)	Vol. (mL)	Squeeze temperature (°C)	pH	Salinity (R.I., %)	Salinity (calcium, %)	Chlorinity (mmol/kg)	Alkalinity (meq/kg)	Sulfate (mmol/kg)	Na (mmol/kg)
Surface seawater (17 March 1989)					8.25	35.6	34.65	539.2	2.689	27.78	462.0
IW-1	1H-1, 145–150	1.48	51	2	7.93	36.1	34.50	539.7	2.957	25.81	461.8

Table 6. Remancnce data for the discrete samples taken from Sections 125-785A-1H-1 and 125A-1H-2.

Core, section, top of interval (cm)	Natural remanent magnetization			Remanent magnetization (10 mT)			Remanent magnetization (20 mT)			
	Declination (degrees)	Inclination (degrees)	Intensity (mA/m)	Declination (degrees)	Inclination (degrees)	Intensity (mA/m)	Declination (degrees)	Inclination (degrees)	Intensity (mA/m)	Polarity
125-785A-										
1H-1, 56	33.3	48.6	50.9	30.8	47.1	41.5	30.4	48.3	30.0	N
1H-1, 133	43.0	48.9	29.0	34.9	48.6	24.3	36.0	47.3	19.0	N
1H-2, 4	15.0	42.9	77.2	20.0	41.0	69.1	15.9	40.0	55.8	N

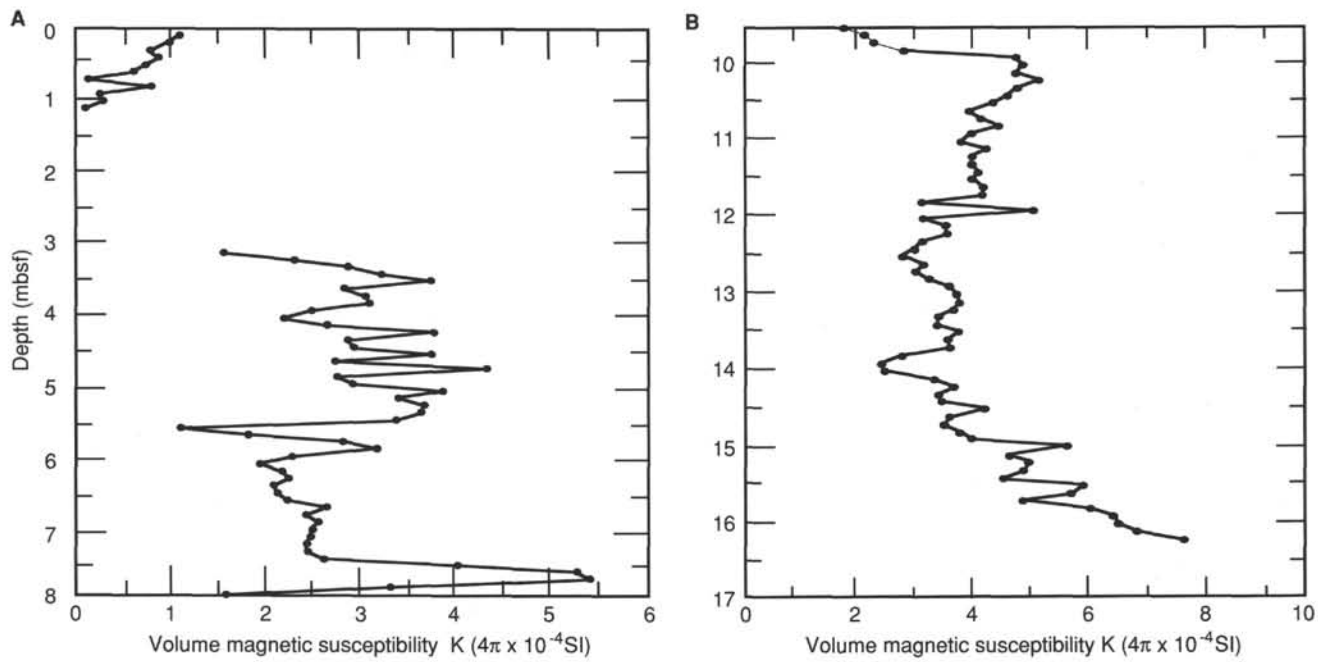

Figure 3. Downhole plots of magnetic susceptibility. **A.** Core 125-785A-1H. **B.** Core 125-785A-2H.

PALEOMAGNETISM

Magnetic Remanence

The natural remanent magnetization (NRM) of the archive core halves of undisturbed nannofossil ooze in Section 125-785A-1H-1 and in the upper 35 cm of Section 125-785A-1H-2 was measured using the cryogenic magnetometer. Intensities vary between 9.5 and 72.4 mA/m. The sections were then demagnetized to 10 mT, which reduced their intensities by 8% to 25%. The polarity of the archive halves is normal. The NRM intensities of three discrete samples taken from the working halves of Sections 125-785A-1H-1 and 125-785A-1H-2 and measured in the cryogenic magnetometer range from 19 to 77.2 mA/m. These samples were then demagnetized to 5, 10, 15, and 20 mT, which reduced their intensities by 28% to 41% (Table 6). The discrete samples also carry a normal polarity. Nannofossil assemblages from Sections 125-785A-1H-1, 145–150 cm, and 125-785A-1H-2, 0 cm, are late/middle Pleistocene in age (Zones CN14b/CN15), which suggests a correlation of material from this level with the Brunhes Normal Polarity Chron.

The interval from Section 125-785A-1H-3 through Core 125-785A-2H contains pumice and vitric ash. However, the material was too disturbed by drilling to provide reliable polarity information.

Magnetic Susceptibility

Magnetic susceptibilities of whole cores from Site 785 were measured using the multisensor track. Figure 3 plots the variation of susceptibility with depth in the upper two cores from Hole 785A. Values range up to 1×10^{-3} SI units in the nannofossil ooze in the first two sections of Core 125-785A-1H. The magnetic susceptibility of the pumice in Sections 125-785A-1H-3 through 125-785A-1H-6 and in Core 125-785A-2H ranges from 1×10^{-3} to 2×10^{-4} SI units.

PHYSICAL PROPERTIES

The low recovery and the nature of the material in Hole 785A precluded measurement of most physical properties for this hole. We could not measure compressional-wave velocity, electrical resistivity, or shear strength in any of the cores. However, the index properties, bulk and grain density, porosity, water content and void ratio were measured (Table 7).

The bulk density of sediment from Hole 785A averages about 1.6 g/cm^3, and pumice averages about 1.3 g/cm^3 (Table

Table 5 (continued).

K (mmol/kg)	Ca (mmol/kg)	Mg (mmol/kg)	Si (μmol/kg)	NH_3 (μmol/kg)
10.11	10.18	52.48	0	0
11.05	10.10	50.62	335	23

Table 7. Index properties for Hole 785A.

Core, section, interval (cm)	Depth (mbsf)	Bulk density (g/cm³)	Grain density (g/cm³)	Porosity (%)	Water content (%)	Void ratio
125-785A-						
1H-1, 71–73	0.71	1.59	2.5	62.6	42	0.63
1H-2, 12–14	1.62	1.54	2.55	66.8	46.1	0.67
1H-3, 34–36	3.34	1.38	2.01	65.6	50.6	0.66
1H-4, 23–25	4.73	1.34	2.22	74.6	59.4	0.75
1H-5, 98–100	6.98	1.28	2.11	76.6	63.6	0.77
1H-6, 8–10	7.58	1.31	2.21	76.4	61.8	0.76
2H-1, 72–74	10.22	1.42	2.05	63.4	47.5	0.63
2H-2, 70–72	11.7	1.48	2.01	54.8	39.4	0.55
2H-3, 70–72	13.2	1.49	2.13	58.7	41.9	0.59
2H-4, 99–101	14.99	1.66	2.25	48.2	30.8	0.48
2H-5, 29–31	15.79	1.77	2.38	48.6	29.2	0.49
2H-6, 34–36	17.34	1.63	2.33	54.6	35.7	0.55

7). The grain density of sediment is 2.5 g/cm³ and that of pumice is 2.0 g/cm³.

SUMMARY AND CONCLUSIONS

Site 785 (30°49.47′N, 140°55.17′E, in a water depth of 2660.8) is located in the center of the Izu-Bonin forearc basin about 40 nmi east-northeast of the active volcano Torishima. The single hole drilled at this site penetrated 104.7 m with 17.6% recovery before a thick, near-surface layer of pumice and ash prevented further drilling (Fig. 4). The stratigraphic section recovered at Hole 785A was assigned to one lithologic unit; Unit I is of early to late Pleistocene age and consists of 2 m of light brown pumice-bearing nannofossil ooze overlying a pumice bed.

The ooze is made up nannofossils (50%–80%), foraminifers (5%–8%), micrite (3%–10%), radiolarians (2%–3%), diatoms (3%), sponge spicules (1%), clay (5%–20%), quartz (2%–3%), and vitric fragments (2%–3%). Samples have normal magnetic polarity, placing it within the Brunhes Normal Polarity Chron.

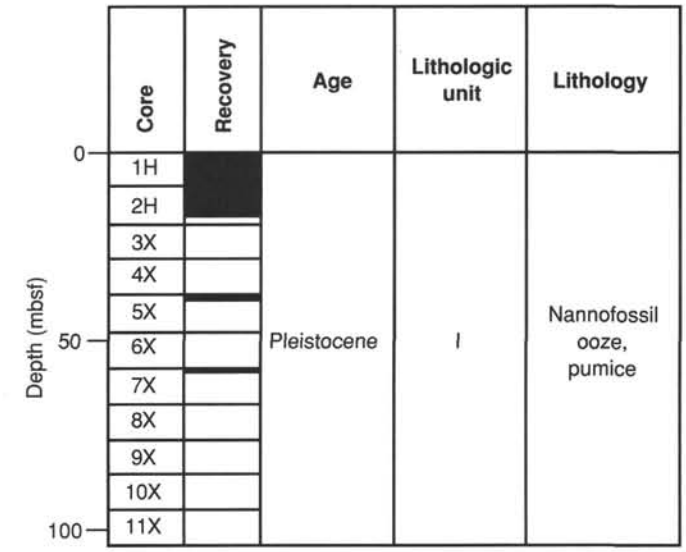

Figure 4. Core recovery and lithologic summary, Hole 785A.

The pumice bed contains light gray to gray pumice fragments, 1 mm to 6 cm in diameter, in a poorly sorted matrix that includes black granules and coarse-sand-sized vitric particles. The pumice and vitric fragments consist of highly vesicular dacitic-rhyolitic glass with phenocrysts of plagioclase feldspar, clinopyroxene, and orthopyroxene. Studies of physical properties show that the average bulk densities are 1.6 g/cm³ in the sediments and 1.3 g/cm³ in the pumice; grain densities are 2.5 g/cm³ in the sediments and 2.0 g/cm³ in the pumice.

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

Ms 125A-113

NOTE: All core description forms ("barrel sheets") and core photographs have been printed on coated paper and bound as Section 4, near the back of the book, beginning on page 383.