Harding, B. W., Storms, M. A., et al., 1990
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13. SITE 772[1]

Shipboard Engineering and Scientific Parties[2]

HOLE 772A

Date occupied: 10 January 1989

Date departed: 12 January 1989

Time on hole: 1 day, 21 hr, 42 min

Position: 16°39.00′N, 119°42.00′E

Bottom felt (rig floor: m, drill-pipe measurement): 1540.0

Distance between rig floor and sea level (m): 10.5

Water depth (drill-pipe measurement from sea level, m): 1529.5

Total depth (rig floor, m): 1901.0

Penetration (m): 361.0

Number of cores: 18

Total length of cored section (m): 136.2

Total core recovered (m): 85.62

Core recovery (%): 62.9

Oldest sediment cored:
Depth sub-bottom (m): 275.5
Nature: Siliciclastic silt and fine-grained sand
Measured velocity (km/s): 1.64

Principal results: Site 772, near the mouth of Lingayen Gulf along the west coast of Luzon, was chosen as an alternate to the ENG-1 site, in Luzon Strait, because of gentler current conditions and the likelihood of finding basement at a relatively shallow depth beneath relatively thin sediment cover so that ODP's new diamond coring system (DCS) could be tested by drilling in hard rock. Basement was not attained, however.

Engineering objectives were the main focus and were partly realized in successful tests of the improved extended core barrel (XCB) and the pressure core sampler.

Only one hole was drilled, Hole 772A, which reached a total depth of 361 mbsf.

Scientific objectives were realized in describing and curating the cores, characterizing their magnetic and physical properties, and in active acquisition and curation of core samples for a geriatric core study conducted by curatorial personnel.

The lithology was uniform enough so that only one lithostratigraphic unit was recognized. Unit I consists of greenish gray siliciclastic silty clay and claystone. A minor lithology consists of well-rounded gravel composed of mafic to ultramafic pebbles of igneous rock, apparently washed in from elsewhere in the hole.

The clayey sediment is interpreted to have a hemipelagic origin and consists of quartz, volcanic glass, and minerals of mafic volcanic and/or plutonic igneous origin; scattered ash and organic streaks and layers are present. Microfossils, including foraminifers, radiolarians, diatoms, nannofossils, and spicules, are scattered to common.

BACKGROUND AND OBJECTIVES

Engineering Objectives

The first site to be drilled on Leg 124E, Site 772, was designated originally ENG-1, and the objective at that site was to locate basement rock beneath 150–200 m of sediment in less than 2000 m water depth. The reasons for both the small sediment thickness and shallow water were to get a thorough test of ODP's diamond coring system (DCS) during the first 2 weeks of Leg 124E. The DCS phase 1 design was intended for a maximum water depth of 2000 m in order to deploy the system rapidly and to prove whether or not the DCS "piggy-back" upgrades done by ODP engineers to fit both the *JOIDES Resolution* and deep water would work. Similar "piggy-back" drilling systems have been used offshore primarily in the North Sea but in water depths only up to 700 m. In addition to Site 772, three more sites were drilled without success in finding solid basement rocks that the system would best drill and/or core in.

Prior to deployment of the DCS at Site 772, three secondary engineering-development tools were tested while trying to locate basement rocks for the DCS. Three successful tests were performed on the redesigned extended core barrel (XCB), the pressure core sampler (PCS), and the pore-water-sampler colleted release tool. These tools required only several runs in order to show that the revisions made had indeed improved their performance. The DCS, on the other hand, had numerous parts and components that needed to work for testing of the entire system to be considered successful.

Scientific Objectives

The scientific objectives of Site 772, as of most of the other sites of this leg, were subordinate to the engineering objectives. They were intended to provide more complete information on the geology and geologic history of the drilled region. Thus the cores obtained at Site 772 were described as to their lithology, physical properties, and magnetic susceptibility. The degree of drilling disturbance noted should be of value in characterizing various coring techniques.

Whole-round portions of several of the cores recovered have been dedicated for use in a study, called a geriatric core study, by the ODP Curatorial Group. This study will determine the effects over time of changes in faunal assemblages and in the chemical and physical characteristics of the cores. The study began with initial sampling of the cores on board. Repeated sampling and analysis are continuing at specified intervals following storage of the cores in the ODP Gulf Coast Repository.

OPERATIONS

Introduction

The first site drilled by the *JOIDES Resolution* on Leg 124E, Site 772, was one that had not been previously identified in the Engineering Prospectus as one having basement underneath shallow sediment cover. A review of the seismic records during the port call in Manila by the science party revealed a possible

[1] Harding, B. W., Storms, M. A., et al., 1990. *Proc. ODP, Init. Repts.*, 124E: College Station, TX (Ocean Drilling Program).

[2] Shipboard engineering and scientific parties are as given in the listing of participants preceding the contents.

site at the north end of Lingayen Gulf approximately 35 mi west of San Fernando (Fig. 1). That site was characterized by approximately the depth of water that the engineers desired, and we hoped that shallow basement could be found. Since the original Prospectus sites were selected on a minimum of seismic data and no actual cored data, we decided to evaluate this alternate site en route to the original ENG-1 site, and at least to eliminate it if it proved unsuitable. A pilot hole for diamond coring system (DCS) testing was planned using the extended core barrel (XCB) system, which would also provide a hole in which a Navi-drill run or a pressure core sampler (PCS) run could be made. Furthermore, if shallow basement were found at the site, the anticipated rendezvous with the supply boat set up for 25 January would be much closer to Manila.

The 80-in.^{3} water guns were first deployed at 0830 hr on 9 January (all times given are Universal Time Coordinated or UTC). At 1245 hr we began maneuvering in order to locate an exact site for drilling. At 1900 hr a detailed survey was initiated, and on 10 January at 0447 hr a Datasonics releasable UAB-354B 18-kHz beacon was dropped. The *Resolution* was maneuvered back on site, and thrusters and hydrophones were lowered. By 1145 hr the bit had been made up, and the bottom-hole assembly (BHA) and drill pipe tripped to the seafloor. The top drive was picked up, and a test of the PCS was first run inside the drill pipe in order to see if the ball valve actuated properly. That test proved positive, and Leg 124E was off to good start.

Hole 772A

Hole 772A, the site's only hole, was drilled in 1540 m of water, as verified by drill-pipe measurement. The first advanced piston core (APC) was shot at 1436 hr, and full stroke was achieved. Four APC cores were on deck by 1625 hr with recovery of 104%. A second run with the PCS again was successful, followed by a dummy run of the pore-water-sampler colleted tool. Hole 772A was then cored with the XCB from 35.4 to 92.4 mbsf. The formation was not offering the resistance hoped for, since it was drilling at averages of 8–10 min per core. After washing down a stand (about 92 ft) to 120.7 mbsf, Core 124E-772A-12X was cut in 23 min with no recovery. Core 124E-772A-13W was washed another 28.2 m, and Core 124E-772A-14X recovered only 0.17 m of a full 9.7-m barrel. A third and final run with the PCS was made with Core 124E-772A-15P, with 1.0 m being cut in 4 min. Table 1 gives the coring summary at this site. The PCS run also revealed that phase 1 of the design had no major operating flaws. Beginning with Core 124E-772A-16X, we decided to alternately core, drill a stand, core, and drill a stand. But when Core 124E-772A-18X obtained no recovery at 361.0 mbsf, we decided to pull the drill string and proceed to the original ENG-1 site in Luzon Strait.

The releasable beacon that had been deployed was given the release code numerous times, and the ship was offset to all sides of the beacon. The beacon turned on and off but never would release, even with using various command frequencies. After laying down the drill string and pulling thrusters and hydrophones, we were under way to the next site at 0215 hr, 12 January.

SITE GEOPHYSICS

Prior to leaving Manila, it was decided that our first drilling site should be in the lee of Luzon rather than in the open-sea conditions of Luzon Strait, where the original ENG-1 site had been targeted. Several promising sites along the west coast of Luzon were discussed, with those on the general northwest extension of the Zambales Ophiolite of Tertiary age being preferred. Our primary source of information was a set of multichannel lines collected in 1982 by the *Vema* and published by Hayes and Lewis (1984). Based upon information acquired from the Philippine Bureau of Energy Development, the primary alternate ENG-1A site on the flank of the Vigan high was discarded, since more than 1.5 km of sediment was expected at that location. Since the *Vema* multichannel records showed several areas with less than 0.5 s (two-way traveltime) of sediment at sites about 40 nmi south of the ENG-1A site, it was decided to relocate ENG-1A (now Site 772) to this area west of the mouth of Lingayen Gulf.

For the testing of the diamond coring system, the engineers wanted (1) basement within 2000 m of the surface, (2) a sedimentary cover of 200–400 m, and (3) water depths of 1000–1500 m. The previous multichannel surveys suggested that this restrictive combination of conditions might be satisfied in the general vicinity of Site 772.

Geophysical surveys were commenced at 0730 UTC on 9 January along our generally northward track and were completed with the choosing of Site 772 at 0300 UTC on 10 January. Most of the survey was conducted at 9–11 kt, with ship's speed being reduced to 6–8 kt as we approached our target area. The survey pattern and resulting bathymetry are shown in Figure 2. The site lies on a regional west-dipping slope cut by many small canyons. The water-gun profiles in this survey generally show a shelf covered with more than 1 km of sediment. This sedimentary blanket thins to the west (see Fig. 3) and appears to reach a thickness of less than 300 m at the chosen site.

LITHOSTRATIGRAPHY

Unit I

(0–275.5 mbsf; Core 124E-772A-1H through Core 124E-772A-17X)

Only one lithostratigraphic unit was identified at Site 772. Unit I consists of greenish-gray to grayish-green siliciclastic silty clay, becoming claystone in Section 124E-772A-16X-1, and changing to silt and fine-grained sand at the top of Core 124E-772A-17X. The topmost part of the unit, Section 124E-772A-1H-1, is olive brown, grading to olive gray at about 7 cm; it changes to dark olive gray at the top of Section 124E-772A-1H-2, and then to greenish gray in Section -3 at 96 cm.

Bedding in Core 124E-772A-17X is distinct, in contrast to most of the cored interval, which is essentially structureless except for bioturbation. Convoluted, flaser, and wavy bedding is common in this core, as are slump folds; several volcanic clasts are present as well. The last core taken, Core 124E-772A-18X, had no recovery; total depth of the hole was 361 mbsf.

A minor lithologic component of Unit I is an interval of unknown thickness composed of well-washed and well-rounded channel gravel in the core catcher of Core 124E-772A-14X, the only recovery for that core (18 cm), bottoming at 168 mbsf. The gravel may have been artificially concentrated in the process of drilling Core 124E-772A-13W, a wash core, just above. The gravel is composed of mafic to ultramafic pebbles of igneous rock. Gravel in the bottom part is coated and covered with grayish green siliciclastic clay. The thickness of the gravel cannot be determined, because no core was recovered from 120.7 to 167.82 m, above; there is only a 1-m gap in recovery below.

The sediment is composed of quartz, volcanic glass, and minerals of mafic volcanic and/or plutonic igneous origin including amphibole, pyroxene, and olivine. The sediment is poorly sorted, and individual grains are angular to subrounded. Bioturbation occurs throughout and is especially noticeable in the top part. Other characteristics of the deposit are scattered layers, streaks, and nodules of ash, and scattered organic matter consisting largely of woody fragments and rootlets. Gray lenses of silt, sand, and foraminifer tests have filled some burrows.

Table 2 gives results of interstitial-water analyses, and Table 3, analyses of total carbon, nitrogen, and sulfur.

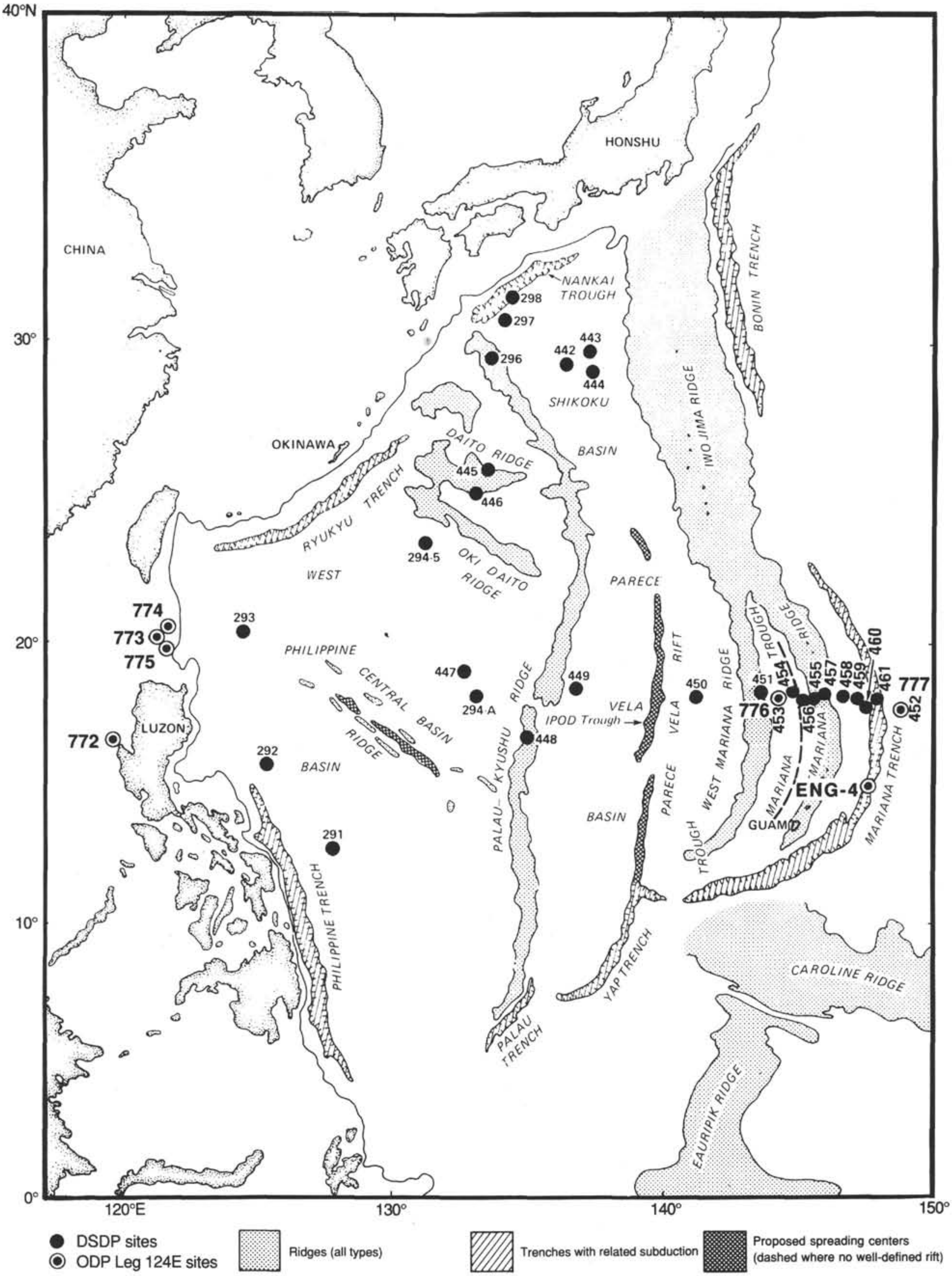


Figure 1. Map of western Pacific region showing DSDP sites and ODP Leg 124E sites. Adapted from Hussong et al. (1982, Fig. 1).

Table 1. Coring summary for Site 772.

Core no.	Date (Jan. 1989)	Time (UTC)	Interval cored (mbsf)	Length cored (m)	Length recovered (m)	Recovery (%)
124E-772A-						
1H	10	1450	0–5.9	5.9	5.95	101.0
2H	10	1520	5.9–15.4	9.5	10.00	105.2
3H	10	1550	15.4–24.9	9.5	10.04	105.7
4H	10	1620	24.9–34.4	9.5	10.04	105.7
5P	10	1745	34.4–35.4	1.0	0.87	87.0
6X	10	1930	35.4–44.9	9.5	0	0
7X	10	2045	44.9–54.4	9.5	9.81	103.0
8X	10	2135	54.4–64.0	9.6	3.72	38.7
9X	10	2235	64.0–73.5	9.5	9.79	103.0
10X	10	2330	73.5–82.9	9.4	9.72	103.0
11X	11	0105	82.9–92.4	9.5	8.25	86.8
12X	11	0610	120.7–130.1	9.4	0	0
13W	11	0800	130.1–158.3	28.2	0	(Wash core)
14X	11	0855	158.3–168.0	9.7	0.17	1.8
15P	11	1015	168.0–169.0	1.0	0	0
16X	11	1120	169.0–173.7	4.7	5.38	114.0
17X	11	1540	266.0–275.5	9.5	1.87	19.7
18X	11	2100	351.5–361.0	9.5	0	0
		Coring totals		136.2	85.61	62.9
		Washing totals		28.2	0.01	
		Combined totals		164.4	85.62	

Faunal constituents include scattered to common foraminifers and scattered radiolarians, diatoms, nannofossils, and spicules. Discoasters in the lowest part of the cored section exhibit characteristics suggestive of a Miocene or Pliocene age, beginning with Core 124E-772A-16X, at about 170 mbsf.

From core examination and smear-slide analyses, we interpret a hemipelagic origin for the sediment. It was deposited in relatively deep water, in a low-energy environment. At depth, oxygenation was taking place, as indicated by bioturbation and plant remains. The lower part of the sediment possibly reflects some tectonism and/or turbidite influxes, as indicated by coarser layers. Such events probably were catastrophic but irregular and resulted in deposition of channel gravel as well as turbidite sands. The scattered ash deposits point to distant volcanism and to possible tectonism.

PALEOMAGNETISM

Paleomagnetic studies made aboard ship during Leg 124E focused upon three aspects of the paleomagnetic record: (1) the polarity of the material recovered, (2) the magnetic stability of the measured remanence, and (3) geriatric studies of possible changes in magnetic properties of the cores during storage aboard the ship. In addition, a few ancillary studies were made to assist in the evaluation of sources of mechanical disturbance to the cores by the various experimental drilling techniques used during the leg.

The paleomagnetic properties of all cores from Site 772 were measured aboard ship using the ODP cryogenic magnetometer and the SUPERMAG software developed during Leg 124. Archive halves of the split core were measured for all cores, and at least one individual sample was taken from each core segment for studies of magnetic properties. In general the results from the advanced hydraulic piston corer (APC) were very good but were confined to the Brunhes magnetic epoch. Results from the extended core barrel (XCB) were more problematic owing to the presence of numerous "twist-offs" throughout the core. The magnetic record is disturbed by these breaks, which can be identified by an almost continuous variation in apparent declination and by the presence of apparent inclinations that vary between the APC inclination of about 30° and 90°. This range of inclination is to be expected from a core that consists of a number of short segments ("biscuits") of random declination. Despite the pervasive disturbance throughout the XCB cores, a reasonable record of the polarity of the core remains and can readily be surmised from the measurements of the archive halves of the core. The individual sample data provide support for this surmise.

Magnetic-stability studies of one or two specimens from each core section indicate that the magnetic remanence is stable throughout the APC-cored section (Cores 124E-772A-1H through -3H). The samples recovered by the XCB do not show a similar uniform response. In general the polarity of individual samples is the same as that observed during the whole-core measurements. The inclination of individual specimens is generally about 30° and is comparable to the inclination of the APC cores. Mostly this is significantly shallower than the inclination derived from the whole-core measurement for the same interval. A number of specimens from the XCB cores also show very steep or near-horizontal inclinations. Most of these specimens did not behave normally during demagnetization, and thus it is inferred that they were disturbed and/or remagnetized during drilling. The stability characteristics of a representative set of stable samples are shown in Figure 4.

The reversal stratigraphy for Cores 124E-772A-1H through -11X from Hole 772A is shown in Figure 5. Cores 124E-772A-1H through -8X are all normally magnetized. Core 124E-772A-9X is normal at the top but reversed from Section 124E-772A-9X-3 to the bottom of the core. Core 124E-772A-10X is reversed except for a thin normal interval in the lower part of Section 124E-772A-10X-4 and the upper half of Section -5. The remainder of Section -5 and Section -6 are anomalous, with some intervals showing exceptionally high intensities. Consistent reversed polarity characterizes most of Section -7. Core 124E-772A-11X is of normal polarity for the upper four sections but appears to be of reversed polarity at the base of the core. Core 124E-772A-16X (not shown in Fig. 5) is reversed throughout its length, and Core 124E-772A-17X is normal at the top and reversed at the base.

Although the polarity of the cores can be defined as discussed above, it is not possible to unambiguously correlate the results to the standard paleomagnetic time scale owing to lack of continuous coring. Most likely the upper normal interval (Cores 124E-772A-1H through -8X) is correlative with the Brunhes, and the base of Core 124E-772A-11X is probably slightly older than the Jaramillo magnetochron of the Matuyama epoch.

PHYSICAL PROPERTIES

Introduction

The objectives of the physical-properties program at Hole 772A were to help characterize the mass physical properties of a hemipelagic sediment (Unit I) and to provide an important link between geophysical and engineering data and the geological realities of the materials that constitute the sedimentary section described by shipboard stratigraphers and sedimentologists.

The physical-properties program consisted of obtaining the following measurements: (1) index properties—gravimetric determinations of bulk density, porosity, water content, and grain density; (2) vane shear strength—a relative measure of the resistance of the sediment to loads and a measure of its cohesiveness; (3) compressional-wave velocity—the speed of sound in the sediments; and (4) thermal conductivity—the ability of the sediment to transport heat.

Results

Index Properties

Two methods of determining the bulk densities and porosities of the sediment of lithostratigraphic Unit I were used for

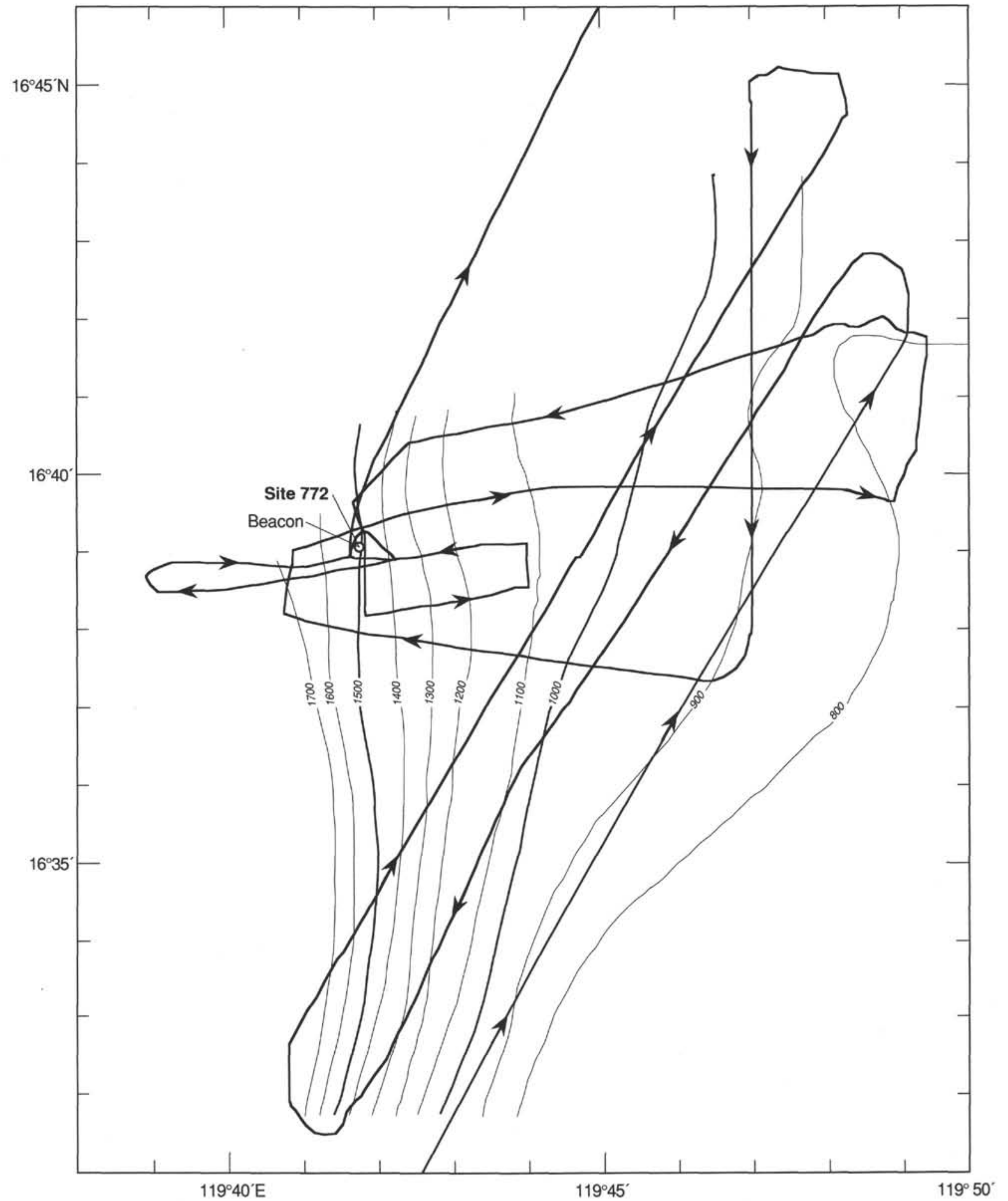


Figure 2. Bathymetry (in meters) superimposed on *Resolution*'s survey track in the vicinity of Site 772.

Hole 772A. Bulk density, porosity, and water content were determined at discrete points within the cores by gravimetric determinations in addition to the bulk density and porosity obtained from GRAPE (gamma-ray attenuation porosity evaluation) scanning of whole-round core sections. All core sections from Hole 772A were logged on the GRAPE unit except for those recovered by using the extended core barrel (XCB). Bulk density and porosities were computed assuming a grain density of 2.75 g/cm^3.

Index properties measured on samples are listed in Table 4. Profiles of bulk density, water content (dry basis), and porosity are illustrated in Figures 6 through 8.

The highly disturbed nature of the cores recovered by the XCB at this site precludes any definitive measure of the physical

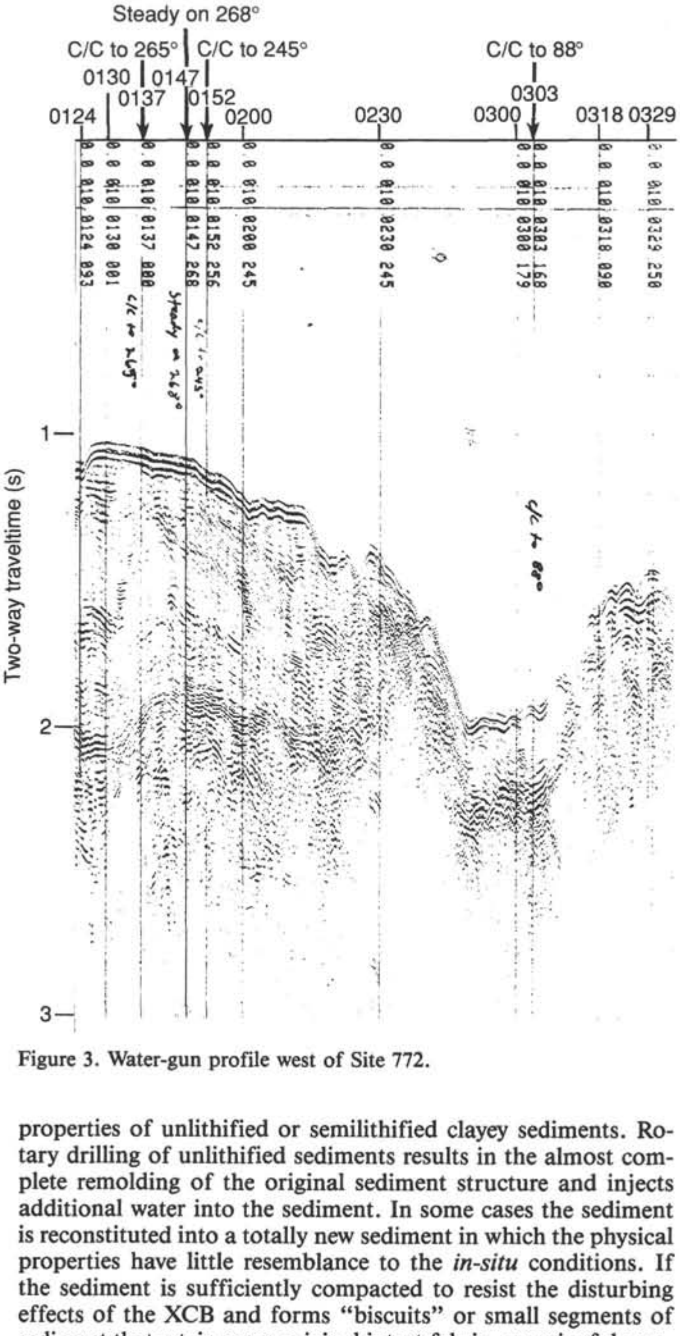


Figure 3. Water-gun profile west of Site 772.

properties of unlithified or semilithified clayey sediments. Rotary drilling of unlithified sediments results in the almost complete remolding of the original sediment structure and injects additional water into the sediment. In some cases the sediment is reconstituted into a totally new sediment in which the physical properties have little resemblance to the *in-situ* conditions. If the sediment is sufficiently compacted to resist the disturbing effects of the XCB and forms "biscuits" or small segments of sediment that retain some original intact fabric, meaningful measurements may be obtained from such material. During this leg when biscuits were present, physical-property measurements were restricted to them, and the remolded clay around the sediment biscuits was not measured.

Bulk density fluctuated above and below the 1.5-g/cm^3 level to a depth of 70 mbsf. At that level the bulk density increased in a steady fashion to values in excess of 1.6 g/cm^3 at a rate of 0.005 g/cm^3/m. Samples of mudstone at the 172.53- and 173.53-mbsf levels registered bulk densities of 1.6 and 1.63 g/cm^3 respectively. Core 124E-772A-17X, a silty sand recovered from 266 mbsf, contained sediment with bulk densities of 1.66–1.74 g/cm^3, the highest density values at Hole 772A. It is interesting to contrast the bulk-density values obtained by the two methods, GRAPE and individual sample determinations. Figure 9 displays the results of such a comparison. For the advanced hydraulic piston core (APC) samples (0–35 mbsf), the GRAPE gives much higher values for density than do the individual sample determinations, while the XCB samples (45–55 mbsf) have values much lower. This, of course, is the result of remolding and undercutting of the core by the XCB. Figure 10 contrasts filtered GRAPE data (solid line) with the individual sample method. The filtered GRAPE data are approximately 3.5% higher than the other method, a surprisingly small variation.

The porosity of Hole 772A sediments relative to depth is shown in Figure 8. Porosity has a similar profile as water content. The porosity in the upper 70 m of sediment averages approximately 76%. At the 70- to 89.42-mbsf level, porosity decreases at a rate of 0.21%/m. The porosity of the mudstone material at the 172.53- and 173.33-mbsf levels was 68.4% and 72.0% respectively. The silty clays at the 266.10- and 266.80-mbsf levels had porosities of 71.3% and 59.6%, the lowest at Hole 772A.

Compressional-Wave Velocity

Sonic velocities (V_p) in the sediment were measured using two methods. A continuous measurement of V_p was made through the whole core using a *P*-wave logger (PWL) installed next to the GRAPE source and detector. The Hamilton Frame velocimeter was utilized for the laboratory determination of V_p on individual samples removed from the core using procedures outlined by Boyce (1976). V_p was measured in only one direction, as the sediments in Hole 772A are bioturbated and acoustic anisotropy was at a minimum. Measurements on competent "biscuits" of core were made on sediments obtained by the XCB. Continuous PWL measurements were not made on XCB cores.

Figure 11 shows the V_p profile obtained by the Hamilton Frame for Hole 772A sediments, and Table 4 lists the V_p determinations. Figure 12 shows the values of V_p as obtained by the Hamilton Frame and the PWL for sediments recovered by the APC. In most cases the agreement between the two methods is very good.

The sediments recovered by the APC in Hole 772A (0–34.5 mbsf) have an average velocity of 1540 m/s. The sediments recovered by the XCB over the interval 45.56–89.43 mbsf have an average velocity of 1520 m/s. This drop in velocity is attributed to core disturbance and an increase in bulk density. The highest velocities measured were at the 172.53- and 173.33-mbsf levels. The mudstone at these levels had velocities of 1632 and 1644 m/s.

A profile of the impedance of the sediment from 0 to 90 mbsf is shown in Figure 13. The average impedance for the upper 70 m of sediment was 2320. The sediments deeper in the section had an impedance of approximately 2500 at the 82- to 88-mbsf level and 2630 at 173 mbsf.

Vane Shear Strength

The undrained shear strength of the sediment was measured using the motorized miniature vane device. Its operation and calculations follow procedures outlined by Boyce (1976). The shear-strength determinations for Hole 772A sediments are listed in Table 5 and illustrated in profile form in Figure 14. Shear strength increases at a rapid rate, 1.37 kPa/m to the 34.5-mbsf level. At the 45.5-mbsf level the shear strength decreases by 24.8 kPa and then increases at a rate of 0.84 kPa/m. Major fluctuations in strength occur at the 79.24- to 80.74-mbsf level, where strength decreases by 32.1 kPa.

Discussion

Shear strength reflects the condition of the cored sediments more than any other parameter. Examination of Figure 14 indicates that the recovered sediments are obviously highly disturbed below the 34.5-mbsf level, in some intervals having been completely remolded or reconstituted. The index properties of this hole indicate that the sediments are most likely underconsolidated; the strength data suggest otherwise. Assuming hydro-

Table 2. Interstitial-water geochemical data for Site 772.

Core, section, interval (cm)	Depth (mbsf)	pH	Alkalinity (mM)	Salinity (g/kg)	Chloride (mM)	Sulfate (mM)	Silica (μM)	Magnesium (mM)	Calcium (mM)	Mg^{2+}/Ca^{2+}
124E-772A-										
1H-1, 140–150	1.40	7.68	4.02	34.5	547	34.0	—	39.6	9.61	4.1
1H-1, 140–150	1.40	7.75	4.93	34.5	548	27.8	739	39.8	9.67	4.1
1H-1, 140–150	1.40	8.01	4.86	34.5	550	28.0	757	39.7	9.63	4.1
1H-1, 140–150	1.40	—	—	—	549	29.4	713	39.7	9.74	4.1
1H-2, 140–150	2.90	7.79	4.94	35.0	549	25.0	—	38.9	9.42	4.1
1H-2, 140–150	2.90	7.79	4.92	35.0	551	27.0	755	39.1	9.27	4.2
1H-2, 140–150	2.90	7.89	4.91	35.0	556	26.7	780	39.4	9.31	4.2
1H-2, 140–150	2.90	—	—	—	553	28.5	729	39.2	9.43	4.2
1H-4, 118–128	5.68	—	—	—	556	26.2	667	38.9	8.59	4.5
1H-4, 118–128	5.68	7.76	6.49	35.0	555	23.9	682	38.8	8.50	4.6
1H-4, 118–128	5.68	8.01	6.49	34.5	559	25.2	684	38.9	8.51	4.6
1H-4, 140–150	5.90	—	—	35.5	554	29.4	—	38.8	8.55	4.5
2H-1, 140–150	7.30	7.72	6.79	35.5	554	22.9	640	38.7	8.18	4.7
2H-1, 140–150	7.30	—	—	—	557	25.2	621	38.1	8.32	4.6
2H-1, 140–150	7.30	7.62	6.96	35.0	547	31.1	—	38.9	8.27	4.7
2H-1, 140–150	7.30	7.82	6.93	35.0	559	24.2	644	38.5	8.20	4.7
2H-2, 140–150	8.80	8.02	7.78	34.5	562	23.5	671	38.0	8.18	4.7
2H-2, 140–150	8.80	—	—	—	560	25.1	685	37.9	8.24	4.6
2H-2, 140–150	8.80	7.80	7.68	34.5	557	22.9	669	38.2	8.14	4.7
2H-2, 140–150	8.80	7.81	7.68	35.0	552	25.5	—	38.8	8.06	4.8
2H-4, 140–150	11.80	7.89	7.84	35.5	562	21.7	660	37.8	7.32	5.2
2H-4, 140–150	11.80	7.92	8.32	35.5	564	23.9	657	38.3	7.33	5.2
2H-4, 140–150	11.80	—	—	—	563	23.2	661	38.1	7.31	5.2
2H-4, 140–150	11.80	7.66	8.33	35.5	547	26.9	—	38.2	7.35	5.2
3H-3, 140–150	19.80	—	—	—	564	20.6	389	35.9	5.00	7.2
7X-3, 140–150	49.30	—	—	—	558	11.5	698	35.2	5.30	6.6
11X-2, 140–150	85.80	7.85	11.83	33.5	548	5.9	—	32.7	5.43	6.0
11X-2, 140–150	85.80	—	—	—	552	—	528	32.6	5.47	6.0
11X-2, 140–150	85.80	7.88	11.94	33.5	551	5.5	538	32.9	5.29	6.2
11X-2, 140–150	85.80	7.82	11.94	33.5	549	3.7	535	33.0	5.16	6.4

Table 3. Analyses for total carbon, nitrogen, and sulfur, Site 772.

Core, section, interval (cm)	Depth (mbsf)	Total carbon (%)	Nitrogen (%)	Sulfur (%)
124E-772A-				
1H-4, 113–114	5.63	2.09	0.10	0.23
1H-4, 114–115	5.64	2.02	0.10	0.29
1H-4, 118–128	5.68	2.08	0.09	0.26
2H-4, 140–150	11.80	3.36	0.09	0.12
3H-3, 145–150	19.85	2.64	0.09	0.16
7X-3, 145–150	49.35	4.35	0.08	0.07
11X-2, 135–136	85.75	3.09	0.07	0.11
11X-2, 136–137	85.76	2.86	0.07	0.15
11X-2, 137–138	85.77	3.02	0.08	0.14
11X-2, 138–139	85.78	3.07	0.08	0.15
11X-2, 140–150	85.80	2.58	0.08	0.18

static pressure as the equilibrium pore pressure at this site, vertical effective stresses were calculated using bulk-density data. Effective overburden stresses (σ_o') were determined so that the ratio of undrained shear strength (S_u) to effective overburden or vertical effective stress (S_u/σ_o') could be calculated. The vertical effective stress as a function of depth for Hole 772A is illustrated in Figure 15. The vertical effective stress for a typical Gulf of Mexico silty clay is presented on the graph as a comparison. The sediments of Hole 772A have a much lower vertical effective stress than those of the Gulf of Mexico. This is attributed to the low values of bulk density at Hole 772A.

The ratio of (S_u/σ_o') gives an indication of the degree of consolidation (compaction) or the strength derived from that expected of a normally consolidated clayey sediment. Clayey sediments that are normally consolidated have (S_u/σ_o') values between 0.2 and 0.5. Hole 772A sediments (Fig. 16) have values much higher than 0.5 in the upper 5-mbsf interval, which would indicate that they are highly overconsolidated. The sediment section from 5 to 35 mbsf is normally consolidated, and the sediments below 45 mbsf are highly underconsolidated. This high degree of underconsolidation is attributed to the disturbing effects of the XCB. The overconsolidation can be a function of the removal of preexisting overburden by erosion or mass-slumping processes or long intervals of nondeposition and diagenetic processes.

Thermal Conductivity

The thermal conductivity of the sediments sampled at Site 772 was measured following the methods of Von Herzen and Maxwell (1959) using the needle-probe technique. The needle probe was inserted through a drilled hole in the core liner so that the probe was oriented perpendicular to the core axis. Thermal conductivity ranged from 0.951 to 1.054 W/m/°C. Table 6 lists the values of thermal conductivity for the three cores tested.

Geotechnical Stratigraphy

The geotechnical stratigraphy (the process of delineating units and unit boundaries which have similar geotechnical and acoustic characters) of Hole 772A could have been difficult to obtain owing to the highly disturbed nature of the XCB cores. However, changes in trend, increases, and decreases of a particular property may indicate lithostratigraphic and seismic stratigraphic horizons.

Figure 3 displays a water-gun seismic profile of an area west of Site 772. The area drilled consists of layered sediments lapping onto a basement high. A high-resolution seismic profile (3.5 kHz) of the section drilled shows the sediment section to be discernible to a depth of 130 mbsf (Fig. 17). (Unfortunately, the original seismic record was lost; the record in this figure was reproduced from a photocopy.) The seismic sequence is typical of a valley-fill turbidite. Two high-amplitude events can be seen at

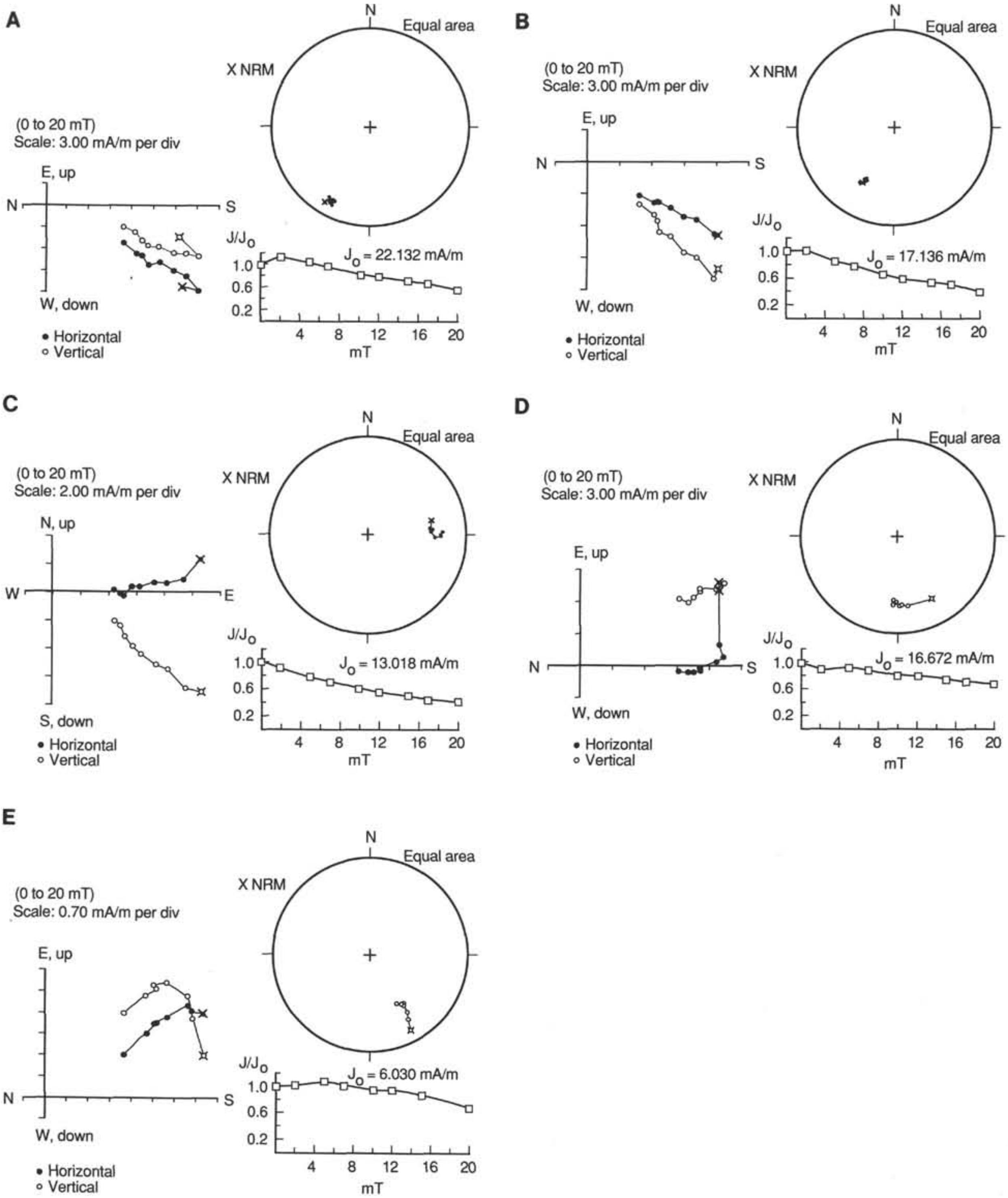


Figure 4. Zijderveld diagrams for a representative set of stably magnetized samples from Hole 772A. **A.** Sample 124E-772A-3H-1, 35 cm. **B.** Sample 124E-772A-3H-2, 35 cm. **C.** Sample 124E-772A-9X-1, 24 cm. **D.** Sample 124E-772A-9X-6, 94 cm. **E.** Sample 124E-772A-10X-2, 43 cm.

14 and 61 mbsf. Five intermediate-amplitude events are evident in the upper 10 m of section. Seismic events of intermediate to low amplitude are apparent throughout the section from 10 to 70 mbsf. Below 70 mbsf several low-amplitude events are present.

Figure 17 displays the boundaries between increasing and decreasing values of (1) bulk density, (2) water content, (3) porosity, (4) *P*-wave velocity, (5) impedance, and (6) shear strength. Major gradient changes were also used as markers for the shear-strength data. Major geotechnical zones and associated horizons were defined as those having four or more property boundaries. Minor geotechnical boundaries consist of one to three property boundaries. Figure 17 shows that four major geotechnical boundaries were identified and associated with correspond-

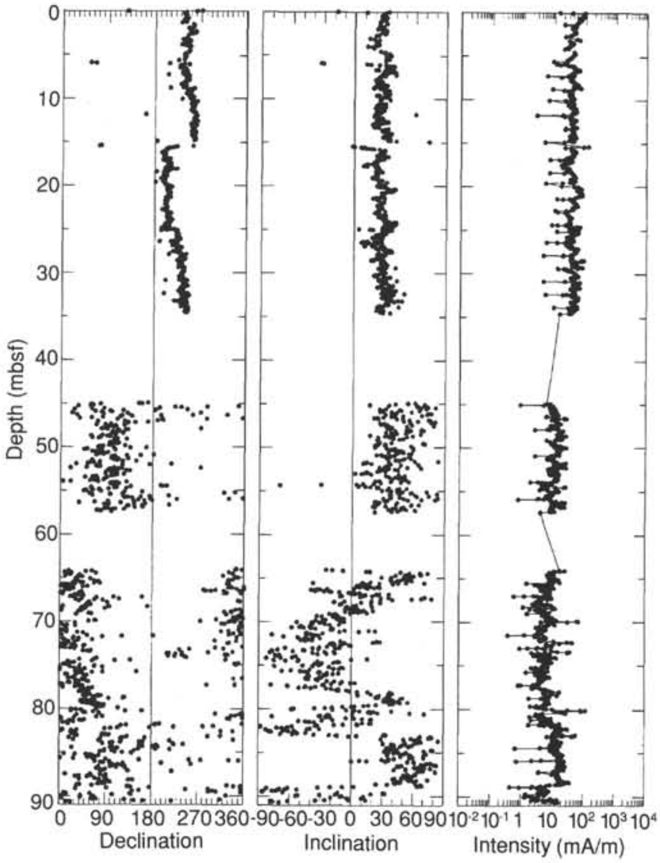


Figure 5. Reversal stratigraphy for Cores 124E-772A-1H through -11X. See text for explanation.

ing seismic horizons. Eight minor geotechnical zones were identified, six of which correspond to specific seismic horizons. The cores revealed no major lithostratigraphic changes in the upper 70 m.

It is interesting to note that, even though we were dealing with highly disturbed XCB cores below 35 m, the geotechnical signature was strong enough to allow us to correlate five out of seven geotechnical boundaries to seismic horizons in the sediment section deeper than 35 m.

Summary and Conclusions

The siliciclastic silty clays encountered in Hole 772A presented no unusual geotechnical parameters. The silty clays in the upper 5 m of the section were determined to be highly overconsolidated. This conclusion was based on the undrained-shear-strength and bulk-density data. The sediment in the 5- to 45-mbsf interval appeared to be normally consolidated. Sediment below the 45-mbsf level was highly underconsolidated. The underconsolidation of these sediments appears to be the result of the XCB coring process. All XCB cores were highly disturbed.

Four major geotechnical zones were delineated on the basis of changing trends, and decreasing and increasing values of bulk density, water content, porosity, *P*-wave velocity, acoustic impedance, and shear strength. The boundaries of the major geotechnical zones correlate with the major seismic horizons on the high-resolution seismic record of Site 772. Six out of eight minor geotechnical boundaries correlate with seismic horizons on the high-resolution profile.

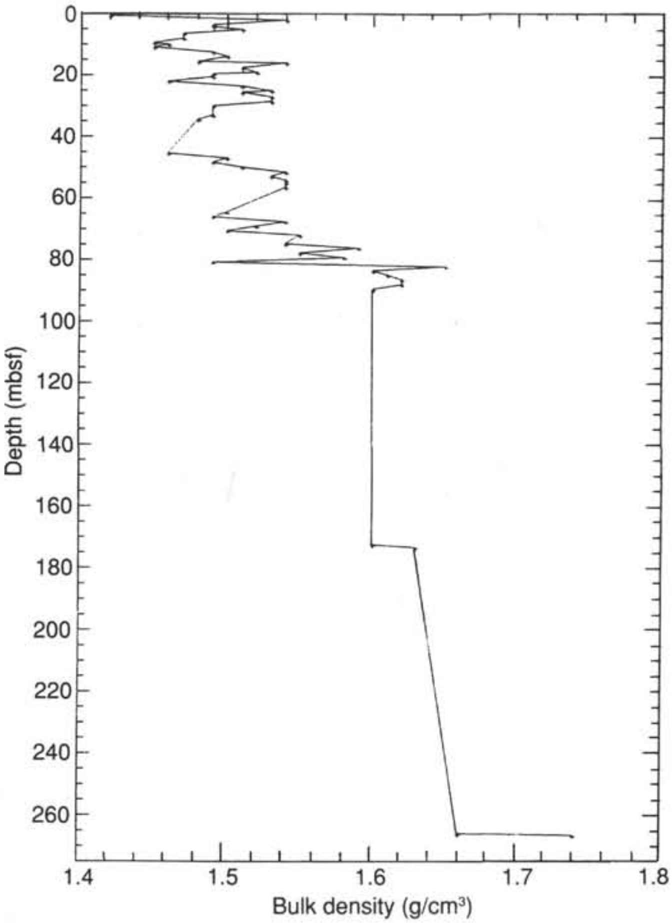
Table 4. Index properties and compressional-wave velocities, Hole 772A sediments.

Core, section, sample (cm)	Depth (mbsf)	Bulk density (g/cm³)	Grain density (g/cm³)	Porosity (%)	Water content (%)	*P*-wave velocity (m/s)
124E-772A-						
1H-1, 79	0.77	1.42	2.86	80.2	137.0	1528
1H-2, 57	2.05	1.54	2.62	72.3	93.2	1549
1H-3, 57	3.55	1.49	2.79	76.3	110.8	1550
1H-3, 57	3.55	—	—	—	—	1538
1H-3, 114	4.12	1.49	2.84	77.1	112.1	1538
1H-4, 57	5.05	1.51	2.65	74.3	102.2	1557
2H-1, 65	6.54	1.47	2.74	77.2	117.1	1541
2H-2, 65	8.04	1.47	2.80	78.4	120.1	1545
2H-3, 65	9.54	1.45	2.66	78.9	126.3	1544
2H-3, 65	9.54	—	—	—	—	1618
2H-3, 117	10.05	1.46	2.59	75.7	112.8	—
2H-4, 64	11.01	1.45	2.44	74.0	109.7	1530
2H-5, 65	12.52	1.49	2.76	76.2	110.7	1537
2H-6, 57	13.95	1.50	2.72	75.8	107.2	1554
2H-7, 65	15.53	1.48	2.77	79.0	121.4	1542
3H-1, 65	16.02	1.54	1.98	74.4	97.8	1536
3H-2, 65	17.52	—	—	—	—	1516
3H-2, 66	17.53	1.51	2.72	75.6	105.4	—
3H-3, 66	19.03	1.52	2.74	76.1	105.8	1525
3H-3, 112	19.50	1.49	2.67	76.3	110.4	1532
3H-4, 66	20.53	1.49	2.76	76.5	110.4	908
3H-5, 65	22.01	1.46	2.72	73.9	106.9	1536
3H-6, 65	23.52	1.51	2.83	73.6	99.3	1548
3H-6, 65	23.52	—	—	—	—	1543
3H-7, 65	25.02	1.53	2.68	72.8	95.6	1546
4H-1, 66	25.52	1.51	2.66	74.2	101.5	1534
4H-2, 66	27.02	1.53	2.72	73.1	94.8	1549
4H-3, 69	28.55	1.53	2.81	73.9	98.0	1532
4H-4, 67	30.03	1.49	2.67	76.5	111.6	1532
4H-5, 65	31.52	1.78	2.69	61.6	55.0	1538
4H-6, 65	33.02	1.49	2.88	74.2	104.0	1535
4H-7, 66	34.52	1.48	2.94	77.2	114.5	1533
7X-1, 70	45.56	1.46	2.52	75.3	111.7	1518
7X-2, 66	47.02	1.50	2.78	75.3	105.9	1521
7X-3, 65	48.51	1.49	2.90	76.1	110.0	1520
7X-4, 68	50.04	1.51	2.68	72.8	97.8	1519
7X-5, 74	51.60	1.54	2.85	74.7	99.1	1526
7X-6, 59	52.94	1.53	2.70	73.1	95.3	1499
7X-7, 34	54.19	1.54	2.67	72.5	93.1	1533
8X-1, 67	54.76	—	—	—	—	1516
8X-1, 67	55.03	1.54	2.85	75.8	102.1	—
8X-2, 67	56.53	1.54	2.76	74.9	99.0	—
8X-2, 67	56.54	—	—	—	—	1499
9X-1, 54	64.51	1.50	0.00	0.0	0.0	1523
9X-2, 56	66.03	—	—	—	—	1502
9X-2, 66	66.13	1.49	2.78	77.2	112.8	—
9X-3, 67	67.64	1.54	2.76	75.0	99.4	1528
9X-4, 56	69.02	1.52	2.79	76.0	105.4	1490
9X-5, 57	70.54	1.50	2.77	74.8	104.9	1520
9X-6, 54	72.01	1.55	2.82	74.1	95.8	1509
10X-2, 54	74.76	1.54	2.79	73.7	96.2	—
10X-2, 56	74.78	—	—	—	—	1527
10X-3, 54	76.25	1.59	3.03	76.0	96.3	1523
10X-4, 54	77.76	1.55	2.85	72.1	91.4	1536
10X-5, 54	79.26	1.58	3.13	73.2	90.4	1532
10X-6, 54	80.74	1.49	2.79	77.7	114.2	1509
10X-7, 47	82.19	1.65	2.90	70.1	76.8	1505
11X-1, 58	83.46	1.60	2.89	71.6	84.5	1534
11X-2, 55	84.92	1.61	2.92	71.7	83.5	1547
11X-3, 54	86.42	1.62	2.79	69.0	77.5	1547
11X-4, 74	88.12	1.62	2.79	70.1	79.3	1548
11X-5, 54	89.42	1.60	2.88	70.5	82.0	1547
16X-3, 57	172.53	1.60	2.67	68.4	77.8	1632
16X-3, 137	173.33	1.63	2.72	72.0	82.7	1644
17X-1, 11	266.10	1.66	2.80	67.4	71.3	—
17X-1, 81	266.80	1.74	2.75	63.4	59.6	—

SUMMARY AND CONCLUSIONS

Introduction

Site 772 (ENG-1A) was selected as an alternative to the Luzon Strait site (ENG-1) while en route to the latter. It was an at-



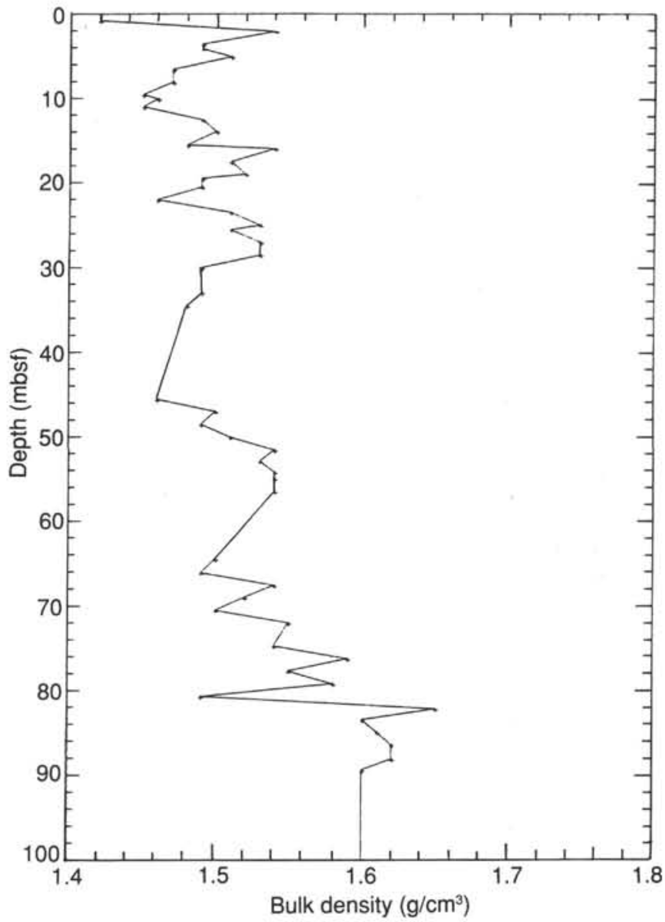


Figure 6. Bulk density vs. depth of samples for Hole 772A.

tempt to find a suitable diamond coring system (DCS) test site in a more sheltered (sea state and current) environment than that anticipated at ENG-1. Site requirements included shallow water (1000–1600 m), limited sediment cover (100–200 m), and relatively shallow basement rock. One hole was drilled at that site to a total depth of 1901 mbrf or 361 mbsf. The water depth for the site was 1540 mbrf.

Engineering Results

The DCS was not evaluated at Site 772, since it was determined that basement would not be reached at a shallow enough depth. The total-depth capability of the DCS "test" system for Leg 124E was defined as 2000 m. We had hoped to core a minimum of 100 m of crystalline rock with the DCS. That was no longer possible, as basement had not yet been reached at 1901 mbrf, and there was no indication that basement was attainable within a reasonable time period.

While coring the upper 351 m at the site, three other developmental systems were tested. Phase 1 of the newly completed pressure core sampler (PCS), the latest version of the extended core barrel (XCB-124E), and an expanded version of the pore-water-sampler "colleted" delivery system were all deployed.

The PCS was used twice, first in water as a pressure test only, and then in one additional run in sediment. A maximum hydrostatic pressure of 2200–2300 psi was recorded. Core was recovered on the second run but only at 500 psi retained pressure, well below calculated hydrostatic pressure. The reason for the low pressure was identified and corrected.

The XCB-124E system was deployed 10 times in several test configurations. The system held up well mechanically and was deemed successful from a handling/redressing perspective. Many more deployments in a variety of formations will be required to fully evaluate the system.

A "dummy" pore-water sampler (WSTP) package was deployed on the new "colleted" delivery system. That system decouples the water sampler from pipe motion through a 22-ft-long slip joint (increased from 11 ft in earlier models). The system was used only once and was evaluated primarily for ease of rig-floor handling.

In summary, the DCS testing was deferred to the original ENG-1 site (Site 773). The limited PCS system tests were successful. Additional testing was considered essential for a complete evaluation of the system. The few XCB deployments were considered successful from a mechanical-integrity point of view but were deemed inadequate for drawing any sweeping conclusions regarding the overall system performance. Significantly more XCB testing will be required. The mechanical handling and deployment testing of the new "22-ft, extended stroke" WSTP was successfully completed.

More complete test details for many of the systems are given in the major section preceding the site chapters under the heading "Contributed Papers."

Scientific Results

Lithostratigraphic results revealed expected hemipelagic clayey sediments at the site. Numerous core samples were collected for

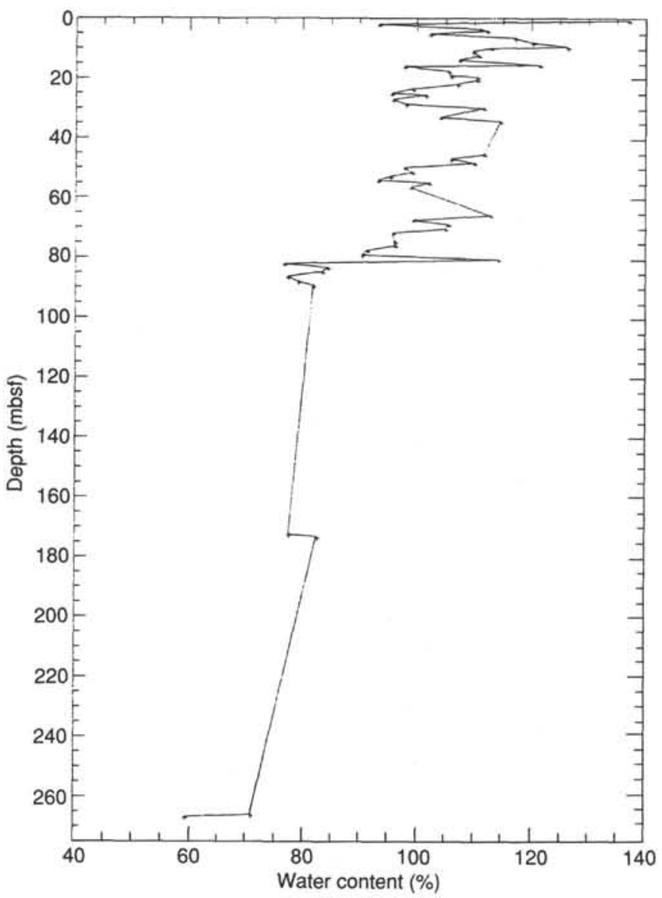


Figure 7. Water content vs. depth of samples for Hole 772A.

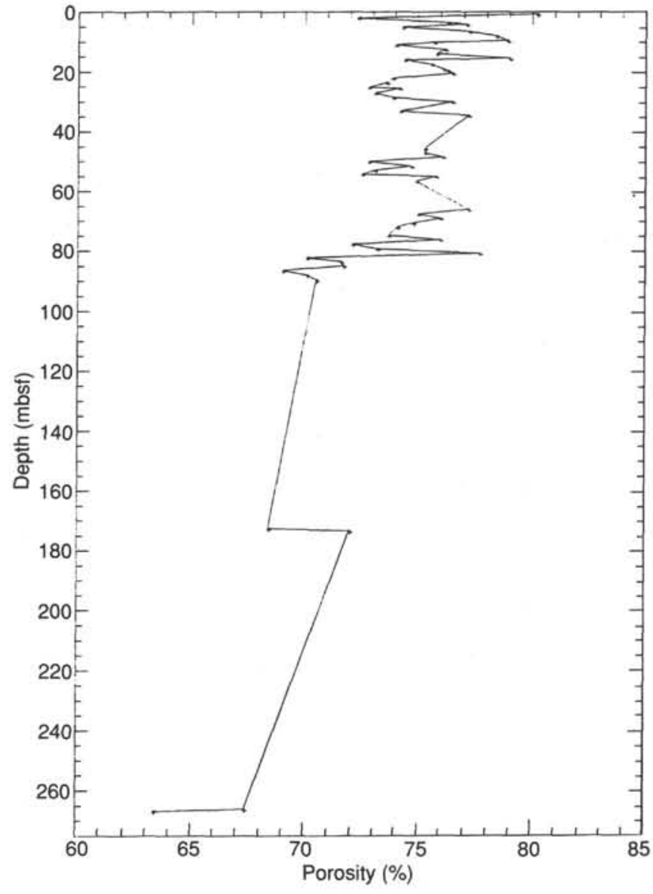


Figure 8. Porosity vs. depth of samples for Hole 772A.

the geriatric core study and will prove useful for long-term monitoring plans.

Paleomagnetic results indicated that the upper part of the cored interval is correlative with the Brunhes, and the base of Core 124E-772A-11X probably is slightly older than the Jaramillo magnetochron of the Matuyama epoch.

Physical-property studies showed that the siliciclastic clay in the upper 5 m of the cored section was highly overconsolidated. The sediment in the 5–45-mbsf interval was normally consolidated. Sediment below this level was highly underconsolidated, apparently as a result of the XCB coring process; these cores were all highly disturbed. Four major geotechnical zones were delineated on the basis of physical-property determinations. The boundaries of these zones correlate with major seismic horizons on the high-resolution profile of the site vicinity.

REFERENCES

Boyce, R. E., 1976. Definitions and laboratory techniques of compressional sound velocity parameters and water content, wet-bulk density, and porosity parameters by gravimetric and gamma ray attenuation techniques. *In* Schlanger, S. O., Jackson, E. D., et al., *Init. Repts. DSDP,* 33: Washington (U.S. Govt. Printing Office), 931–935.

Hayes, D. E., and Lewis, S. D., 1984. A geophysical study of the Manila Trench, Luzon, Philippines, 1. Crustal structure, gravity, and regional tectonic evolution. *J. Geophys. Res.,* 89(B11):9171–9195.

Von Herzen, R. P., and Maxwell, A. E., 1959. The measurement of thermal conductivity of deep-sea sediments by a needle-probe method. *J. Geophys. Res.,* 65:1535–1541.

Ms 124E-113

NOTE: All core description forms ("barrel sheets") and core photographs have been printed on coated paper and bound as Section 3, near the back of the book, beginning on page 139.

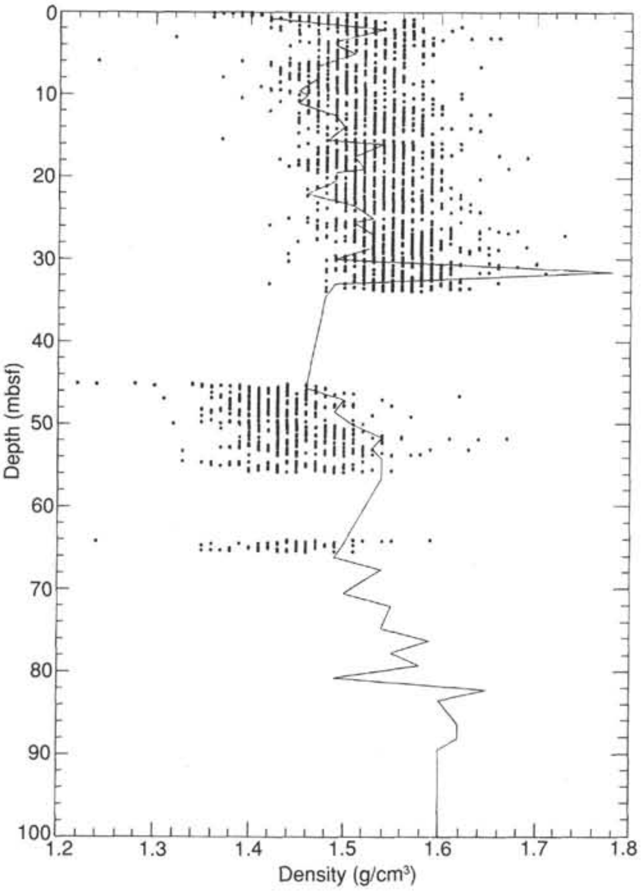


Figure 9. Laboratory bulk-density (solid line) and GRAPE bulk-density (dots) results vs. depth of samples for Hole 772A.

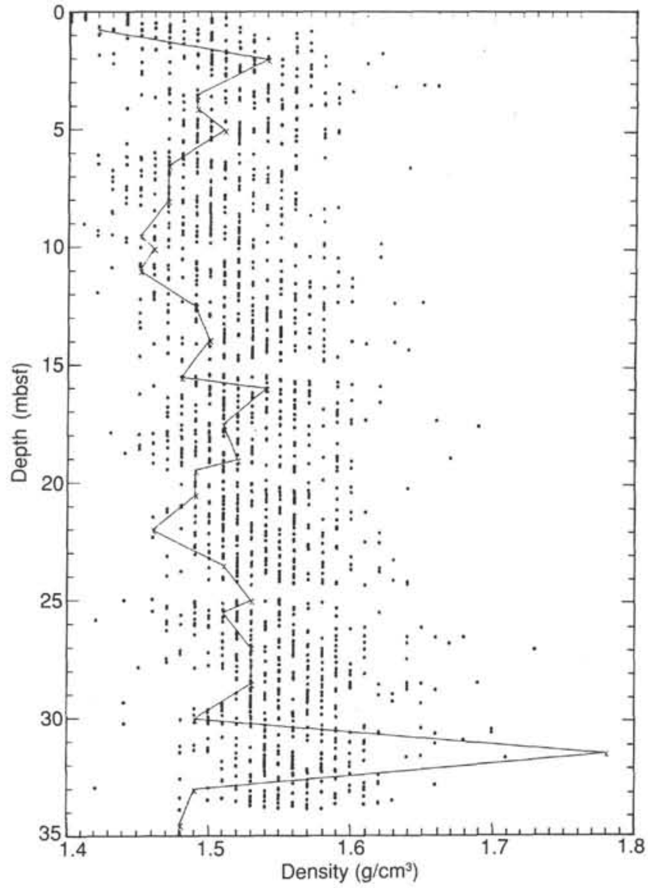


Figure 10. Laboratory bulk-density (solid line) and filtered GRAPE data (dots) vs. depth of samples for Hole 772A.

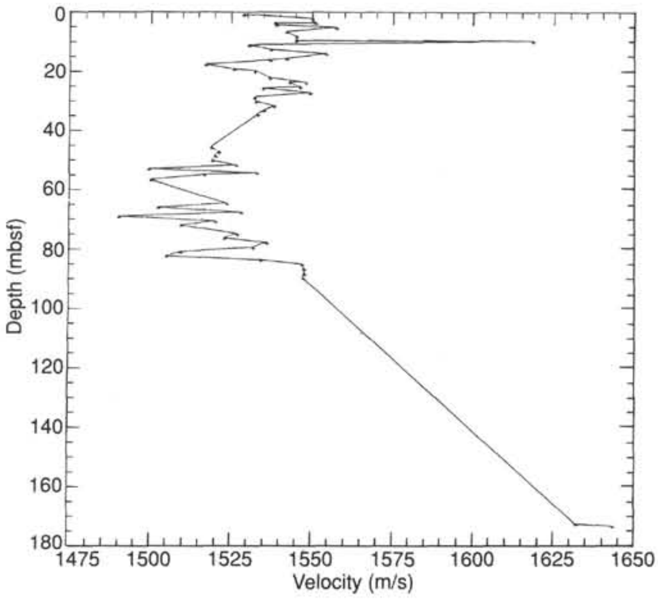


Figure 11. Compressional-wave velocity vs. depth of samples for Hole 772A.

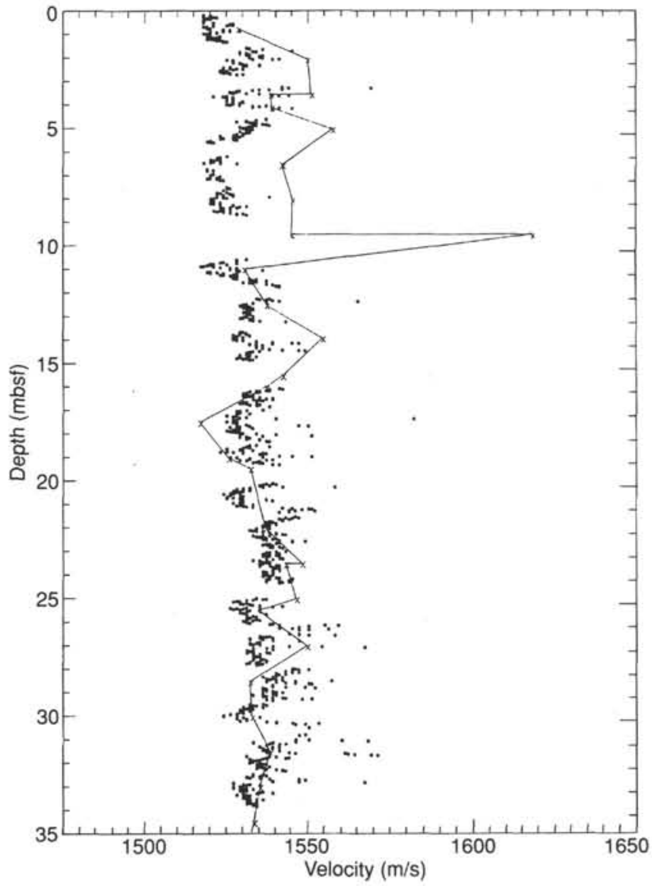


Figure 12. Hamilton Frame (solid line) and PWL compressional-wave (dots) velocities vs. depth of samples for Hole 772A.

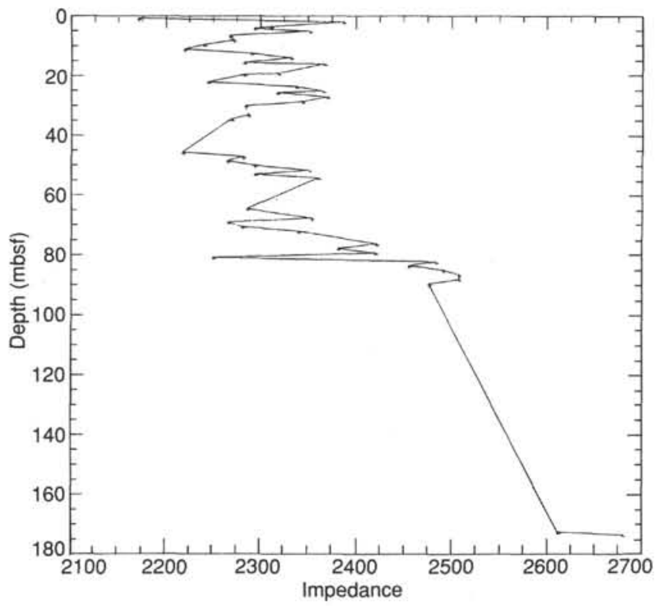


Figure 13. Acoustic impedance vs. depth of samples for Hole 772A.

Table 5. Undrained shear strength, Hole 772A sediments.

Core, section, sample (cm)	Depth (mbsf)	Shear strength (kPa)
124E-772A-		
1H-1, 76	0.75	6.10
1H-2, 62	2.10	12.20
1H-3, 62	3.60	13.80
1H-3, 116	4.15	13.80
1H-4, 62	5.10	19.90
2H-1, 61	6.50	17.40
2H-2, 61	8.00	16.60
2H-3, 61	9.50	21.10
2H-3, 113	10.02	18.30
2H-4, 61	11.00	23.70
2H-5, 61	12.50	30.60
2H-6, 61	14.00	31.50
2H-7, 61	15.50	31.00
3H-1, 61	16.00	39.60
3H-2, 61	17.50	30.10
3H-3, 61	19.00	34.60
3H-3, 116	19.55	30.60
3H-4, 61	20.50	30.10
3H-5, 61	22.00	35.50
3H-6, 61	23.50	45.40
3H-7, 61	25.00	37.30
4H-1, 61	25.50	39.30
4H-2, 61	27.00	45.90
4H-3, 61	28.50	37.10
4H-4, 61	30.00	35.70
4H-5, 61	31.50	43.70
4H-6, 61	33.00	49.50
4H-7, 61	34.50	51.70
7X-1, 61	45.50	26.90
7X-2, 61	47.00	27.70
7X-3, 61	48.50	42.20
7X-4, 61	50.00	26.90
7X-5, 61	51.50	34.20
7X-6, 61	53.00	26.90
7X-7, 21	54.10	33.50
8X-1, 71	55.10	36.40
8X-2, 71	56.60	34.90
9X-1, 51	64.50	37.10
9X-2, 57	66.00	53.10
9X-3, 71	67.70	45.10
9X-4, 51	69.00	43.70
9X-5, 51	70.50	51.00
9X-6, 51	72.00	42.20
10X-2, 61	74.84	43.00
10X-3, 51	76.24	54.60
10X-4, 51	77.74	56.80
10X-5, 51	79.24	54.60
10X-6, 51	80.74	34.20
10X-7, 61	82.34	25.50
11X-1, 71	83.60	51.00
11X-3, 51	86.40	63.30
11X-4, 71	88.10	72.10
11X-5, 51	89.40	51.70

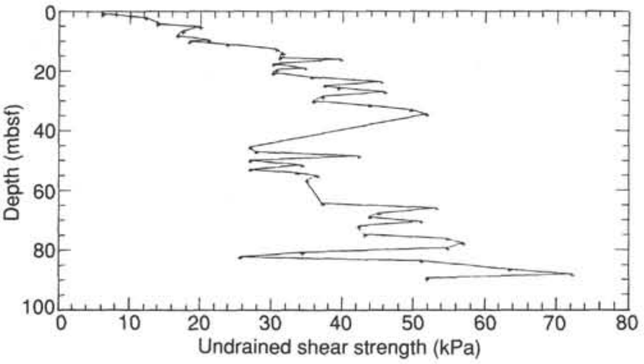


Figure 14. Undrained shear strength vs. depth of samples for Hole 772A.

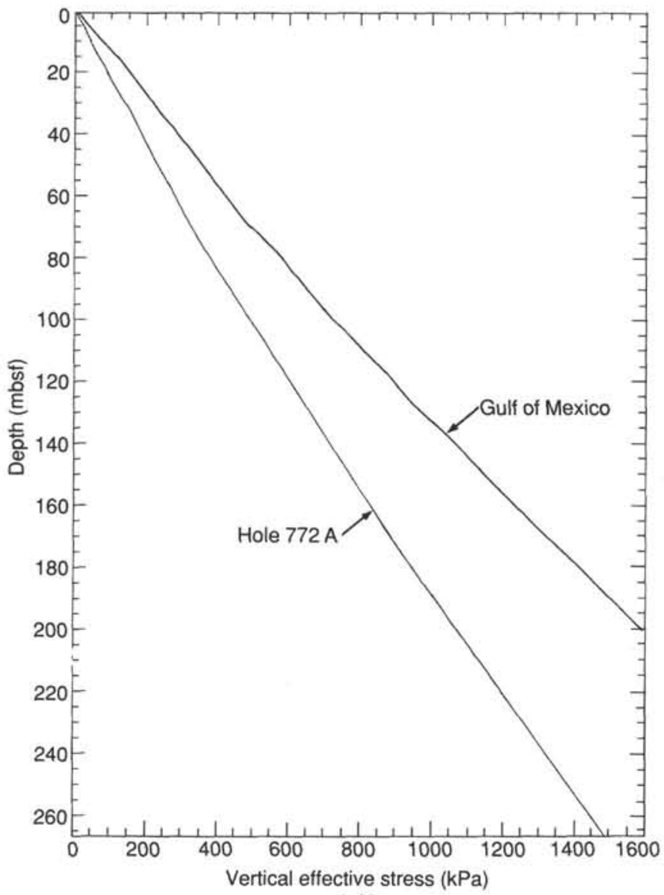


Figure 15. Vertical effective stress vs. depth for Hole 772A and Gulf of Mexico sediments.

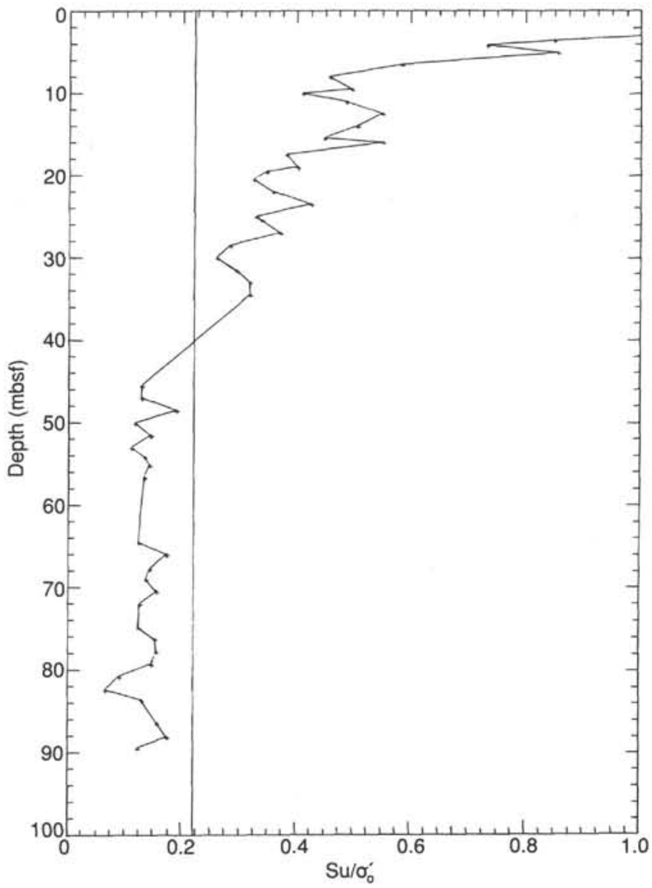


Figure 16. Ratio of undrained shear strength vs. depth for Hole 772A sediments.

Table 6. Thermal conductivity, Hole 772A sediments.

Core, section, sample (cm)	Conductivity (W/m/°C)
124E-772A-	
1H-1, 40	0.922
1H-2, 40	1.026
1H-3, 40	1.049
1H-4, 40	0.996
2H-1, 40	0.961
2H-2, 40	0.971
2H-3, 40	0.969
2H-4, 40	0.951
3H-1, 40	1.012
3H-2, 40	1.025
3H-3, 40	1.035
3H-4, 40	1.041
3H-5, 40	1.054
3H-6, 40	1.048
3H-7, 40	1.054

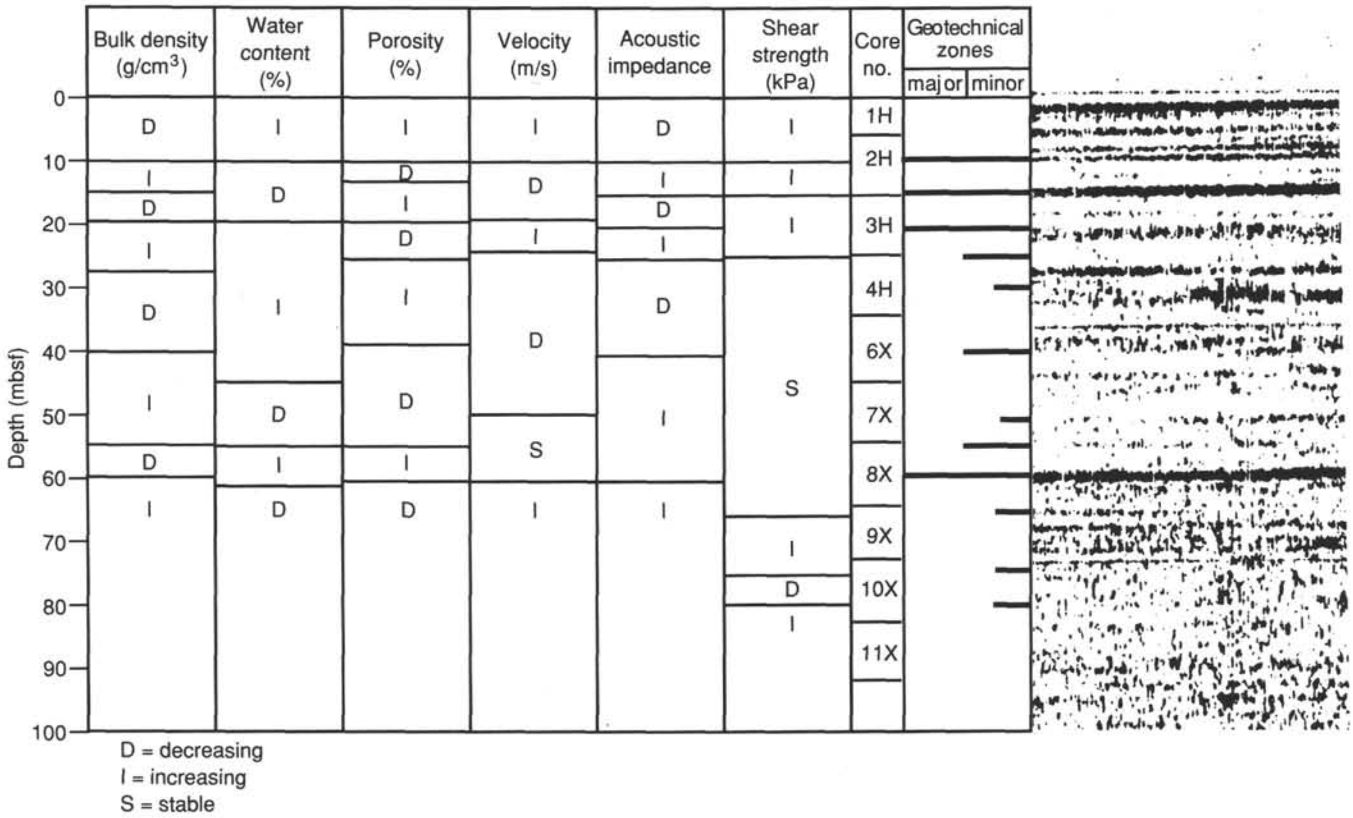


Figure 17. Geotechnical boundaries correlated with high-resolution seismic profile of Hole 772A.