3. SITE 172

The Shipboard Scientific Party[1]

ABSTRACT

Site 172 was continuously cored to a depth of 24 meters in a sediment pond 140 kilometers south of the Murray fracture zone. The upper 9 meters consist of a moderate brown pelagic clay which changes to a zeolite-rich brown clay, brown clay zeolitite and zeolitite in the lower 9 to 24 meters. An Early Oligocene (35 to 38 my) nannofossil horizon occurs near an extrusive basalt encountered at 24 meters. These sediments are older than the 29 my age indicated by a recent identification of magnetic anomaly 8 in the "disturbed" zone. The age discrepancy suggests that the magnetic anomalies in the "disturbed" zone are still not identified correctly.

SITE SUMMARY

Date Occupied: 5-6 June 1971.

Position (Satellite):
Latitude: 31°32.23′N
Longitude: 133°22.36′W.

Number of Holes: Two.

Water Depth: 4767 meters.

Penetration: 24 meters below sea floor.

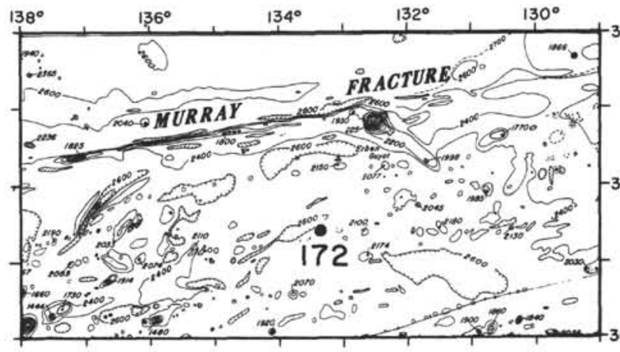
Number of Cores:
Hole 172: Four.
Hole 172A: One.

Total Core Recovered:
Hole 172: 24 meters, 100 percent (26.5 meters were actually recovered because of repeated sampling by Core 3; see Operations, Drilling Program (Appendix A) for explanation).
Hole 172A: Core catcher, fragments.

Age of Oldest Sediment: Lower Oligocene near basement.

Acoustic Basement:
Depth: Obscure, but basalt encountered at 4790 meters below sea floor.
Nature: Extrusive basalt.

Basement: Obscure, but probably basalt.



BACKGROUND AND OBJECTIVES

Site Description

Site 172 is located in a region of hilly topography about 140 km south of the Murray fracture zone and lies within the crustal blocks between the Murray and Molokai fracture zones (Figure 1). North of the site, the Murray has a vertical displacement of about 1250 meters with the south block up-thrown relative to the northern one.

According to Malahoff and Woollard (1970), the fracture zone east of 137°W is characterized by a prominent scarp and rugged topography of the Baja California seamount province to the south of the scarp. West of 137°, the fracture zone changes strike and the scarp changes into a horst-and-graben tectonic setting.

In the vicinity of the site, the relief varies between 4370 and 4850 meters. The regional structural trend is unknown,

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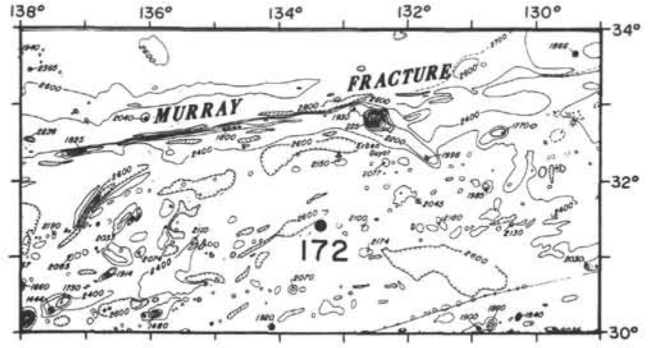

Figure 1. *Bathymetry in the vicinity of Site 172 (Chase et al., 1970). Contours in fathoms.*

but our limited survey information suggests that it may be north-south in the area of Site 172. This site is located in what appears to be a small sediment pond or basin within the hilly topography. The pond is about 1 km wide and 3 km long and apparently strikes in a north-south direction (Figure A1). Sediment thickness was estimated to be 105 meters (0.1 sec) in the center of the pond from seismic reflection profiles (Figure 2).

Site 172 lies within a magnetic "disturbed zone" between the Murray and Molokai fracture zones (128°W to 140°W) as shown by Atwater and Menard (1970). Additional east-west magnetic traverses made by Malahoff and Handschumacher (1971, figs. 1 & 4) in this area show a set of magnetic anomalies that can be roughly matched from one profile to another between 30°20′N and 32°20′N latitude. When these anomalies are compared with the standard north Pacific magnetic profile (Heirtzler, et al., 1968), a pattern of younger magnetic anomalies, roughly symmetrical about anomaly 7 and extending to anomaly 13, is set in the magnetic anomalies associated with the west flank of the spreading East Pacific Rise. On the basis of these comparisons. Malahoff and Handschumacher propose a secondary spreading center which was initiated during anomaly 13 time (38 million years ago) and which ceased about anomaly 7 time (27 million years ago). A spreading rate of 2.9 cm/year is calculated for the 11 million year history of the ridge.

Magnetic anomalies were monitored as the *Challenger* approached Site 172 (see Operations–Site 172, Appendix A for details). The drill site was selected on the westernmost occurrence of anomaly 8 as defined by Malahoff and Handschumacher (1971). Figure 3 shows the total-force residual magnetic lineations made by Malahoff and Handschumacher (J & K) and *Challenger* (GC) in the vicinity of the drill site. The *Challenger* magnetic profile most closely matches profile J in geographic location and pattern. The position of anomaly 8 is shown on all three profiles. Anomaly patterns are similar on the western limb of the proposed spreading center (8 to 10), but the same anomalies are difficult to interpret on the eastern limb.

Site Objectives

The objectives of Site 172 were as follows:

1. Date the sediments directly above basement at the position of the proposed anomaly 8 and determine if this anomaly has been correctly identified.

2. Fill in the line of biostratigraphic information that has been obtained along 140° longitude by previous legs. Although Site 172 is located to the east of the line, it is the only site drilled between the Murray and Molokai fracture zone and it should be correlative with the biostratigraphic sections farther to the west.

LITHOLOGIC SUMMARY

General Statement

The 23.5 meters of continuously cored sediment at Holes 172 and 172A is of pelagic origin. Main components include brown clays and zeolitites with a minor amount of nannofossil ooze near the base of the section. The three stratigraphic units described below are based upon sediment type; the fourth unit is basalt.

Lithologic Units

Unit 1 (0-9.0 m; Core 1, Section 1 to Core 1, Section 5)

Unit 1 extends from the sea floor surface to the middle of Section 5, Core 1 and exhibits slight coring disturbance. This unit is a uniform brown clay which contains <4 percent zeolites and 10 to 20 percent ferromagnesian micronodules along with clay minerals. The sediments are soft to firm and usually moderate brown. Several small (0.5 to 2 cm) manganese nodules were found at the top of the core and one was found in Section 4 at a depth of 5 meters. Rare arenaceous benthonic foraminifera are the only fossil material present.

Unit 2 (9.0-23.0 m; Core 1, Section 5 to Core 3, Section 4, 50 cm)

With the exception of some grayish brown intervals, Unit 2 is similar in color to Unit 1. Drilling disturbance within this interval is moderate to high. The sediments are mostly firm, although some are soupy or semi-indurated. A more diverse lithology is present here than in Unit 1, largely as a result of varying proportions of zeolites in the pelagic brown clay. A gradual increase in zeolites marks the upper few meters of this unit and produces a zeolite-rich brown clay. With a progressive increase in zeolite content lower in the unit (11 to 16 m), the sediments become classified as brown clay zeolitites and zeolitites (Section 2-2, lower part, to Section 2-6, upper part). Some of the zeolitites contain essentially no pelagic clay. The zeolite content decreased in Section 2-6 and produces a brown zeolite-rich clay in the remaining portion of the section. Zeolitite reappears in Section 3-1 which then changes to mostly zeolite brown clay in the lower portion (19-23 m) of Unit 2. The large amounts (15 to 20%) of semi-indurated zeolitite fragments throughout this interval are no doubt the result of fragmentation of bedded sediments by drilling. As might be expected, the amount of ferromagnesian minerals in the sediment, which ranges from 0 to 20 per cent, shows an inverse relationship to the zeolite content. One manganese nodule occurs in Section 2-1. The fossil elements occurring in Unit 2 include rare nondiagnostic arenaceous benthonic foraminifera, found throughout the interval. Lower,

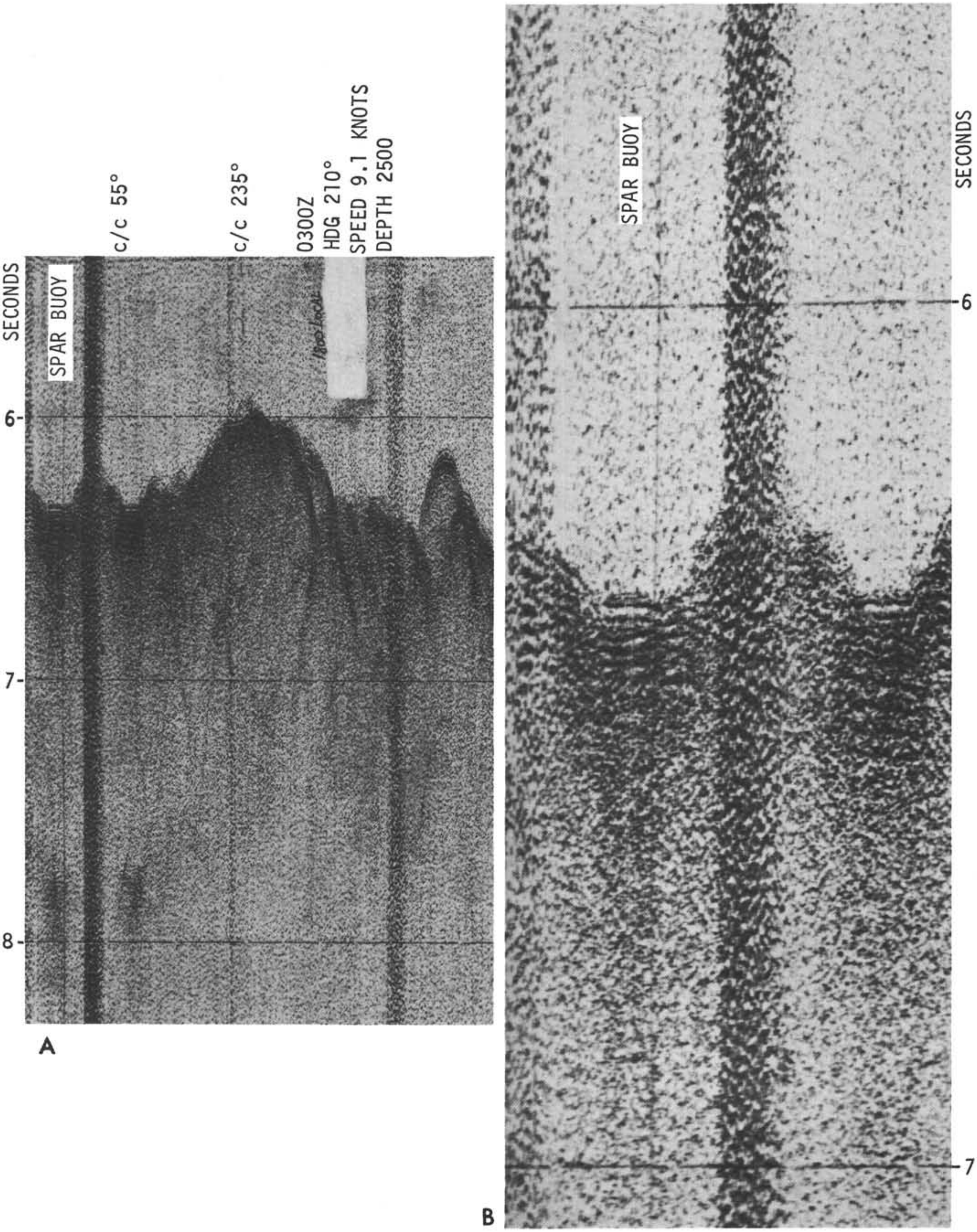

Figure 2. A. *Seismic reflection profile across Site 172 (from* Glomar Challenger*).*
B. *Enlarged section of reflection profile at Site 172.*

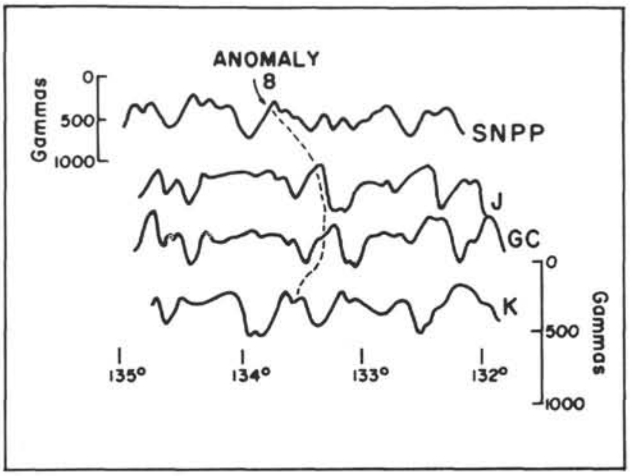

Figure 3. *Total-force residual magnetic anomaly lineations in the disturbed magnetic zone south of the Murray Fracture Zone. SNPP = Standard North Pacific Magnetic Profile. J and K = magnetic profiles after Malahoff and Handschumacher (1971). GC = magnetic profile made by* Glomar Challenger *near the drilling site. Interpretation of anomaly 8 from Malahoff and Handschumacher (1971).*

Oligocene nannofossils occur in one 50-cm-thick bed and as rare thin streaks and scattered individual fossils. As will be shown later, these nannofossils are not believed to be age-significant for this unit. A few radiolarians and diatoms found in the upper portion of Unit 2 (core catcher of Core 1) are believed to be displaced by drilling from the top portion of Unit 1.

Unit 3 (23.0-23.5 m; Core 3, Section 4, 50 cm to Core 3, Section 4, 100 cm)

Unit 3 occupies a half-meter interval in Section 3-4 and shows only slight coring deformation. The top of this unit is marked by approximately 10 cm of pale orange nannofossil ooze which also contains planktonic foraminifera. Both the faunal and floral material indicate an Early Oligocene age for the ooze. The ooze is in sharp contact with a 40-cm-thick layer of brown clay which constitutes the lower portion of Unit 2. This brown clay, which has a high ferromagnesian content (30 to 40%), is compositionally unique to this hole. It is also a darker brown than any of the overlying brown clays. The base of Unit 3, which is believed to represent the lowermost stratigraphic interval penetrated, exhibits no effects of contact metamorphism.

Beneath Unit 3 are approximately 3.5 meters of sediment which are believed to be displaced by drilling (see Appendix A, Site 172), and therefore not in stratigraphic succession. Lithologically, this sediment interval contains highly deformed and soupy sediments plus microfossils already encountered higher in the hole. These sediments occupy the interval from 23.5 to 26.5 meters (Section 3-4, 100 cm to Section 3-6).

Unit 4 (23.5-24 m; Core 4)

Basalt fragments up to 3mm in diameter were recovered from the core catcher of Holes 172 and 172 A. About 80 per cent of the fragments are fine-grained, gray basalt. About 20 per cent are composed of black glass with angular edges and conchoidal fracture surfaces. Orange yellow palagonite is commonly associated with the glass and white zeolite crusts are rare.

Thin sections were made of twelve of the fragments onboard the *Challenger*. The fine-grained gray basalt consists of pyroxene, plagioclase, and rare olivine phenocrysts in a holocrystalline groundmass of plagioclase, pyroxene and much cloudy nondescript material. In two of the fragments, the groundmass contained many fragments of opaque minerals. The pyroxene has very poor crystal form and shows no indication of alternation. Crystals average 0.1 to 0.4 mm in diameter. The plagioclase phenocrysts occur in euhedral to subhedral laths with an average length of 0.5 to 0.6 mm. They are clear and progressively zoned with well-defined twinning and have a composition of approximately An_{64} to An_{75}. Plagioclase in the groundmass is very fine-grained and cloudy. In most sections, the pyroxene and plagioclase phenocrysts tend to group together into aggregates, but there are also isolated individual crystals. In two sections, prismatic, stubby crystal forms of orange brown altered olivine were observed. Other thin sections have small, clear olivine pseudomorphs of a mineral that is probably iddingsite.

The glassy phase of the basalt has phenocrysts of olivine and plagioclase in glomeroporphyritic aggregates similar to that of the holocrystalline phase. The glass is yellowish brown with microfracturing and is completely extinct under cross-polarized light. Two of the glassy fragments have yellowish, low-relief palagonite rims and one chip is nearly all palagonite except for dark, nearly opaque borders around the phenocrysts.

In four sections, rare vesicles occur with a maximum diameter of 0.20 mm and a minimum size of 0.03 mm. Their total volume is less than 0.5 percent of the rock. They appear to be filled with a radiating low-birefringent, fine-grained mineral that is probably a zeolite.

In general, the basalt fragments are similar in composition to typical deep-sea tholeiitic basalts described by other workers (see MacLeod and Pratt, Chapter 31, this volume, for complete descriptions).

PALEONTOLOGIC SUMMARY

Introduction

Microfossils (except fish remains and arenaceous benthonic foraminifera) are essentially absent from most of the 24 meters cored at Site 172 with the exception of a thin (15 cm) coccolith-rich carbonate ooze at 22 meters. Abundant, moderately well- to poorly preserved coccolith floras and several solution-resistant species of planktonic foraminifera indicate that this horizon is of early Oligocene age; the coccolith flora is assigned to the *Ericsonia subdistichus* Zone of Roth, Baumann, and Bertolino (1971) and the sparse planktonic foraminifera to Blow's (1969) zones P18 or P19 equivalent to an estimated radiometric age of 32 to 38 my B.P. based on the time scale of Berggren (1969; 1972). Greatest reliance is placed upon the well-preserved coccolith floras at this site further narrowing the estimated radiometric age to 35 to 38 my B.P. Additional horizons within the 17 to 24 meter interval at Site 172 yield sparse calcareous microfossils; however, species composition and abundance indicate that they represent contaminants from the lower Oligocene carbonate ooze encountered at 22 meters.

It is important to note that the presence of a fossiliferous Oligocene calcareous ooze beneath an upper Tertiary sequence of brown clays is typical of other abyssal portions of the eastern Pacific area adjacent to and within the equatorial region. This characteristic sequence of lithologies has been interpreted as evidence of a depression of the calcium carbonate compensation zone below about 5000 meters during portions of the Oligocene (Arrhenius, 1963; Heath, 1969) and alternately as an expression of a postulated change in the rate and site of maximum planktonic productivity during this interval (Reidel and Funnel, 1964). A detailed discussion of this widespread early Oligocene-early Miocene sedimentary event is given in this volume by Wise (Chapter 15).

Diatoms

Diatoms are absent from almost all sediments cored at Site 172. The only specimens recovered in the acid-cleaned fraction coarser than 63 microns are badly corroded fragments of *Coscinodiscus marginatus, C. lineatus*, and *Ethonodiscus rex*. All three species exhibit long biostratigraphic ranges and are resistant to dissolution; none have biostratigraphic significance in this instance.

Calcareous Nannofossils

Calcareous nannofossils at Site 172 are essentially restricted to the 15-cm-thick calcareous coccolith-rich ooze occurring at 22 meters. This horizon represents a nearly pure nannofossil ooze yielding small amounts of zeolite in insoluble residues (*Fide* H.J. Schrader). The preservation of nannofossils is good to poor with discoasters in a good state of preservation but with many placoliths heavily etched in the central areas. The assemblage is dominated by *Reticulofenestra bisectus* with abundant *Discoaster aster* (5 and 6 rays), *D. woodringi*, and large (20μ) specimens of *Reticulofenestra umbilica. Bramlettius serraculoides, Coccolithus eopelagicus, Cyclococcolithus formosus, Sphenalithus predistentus*, and *S. pseudoradians* are also common. This assemblage is characteristic of the lower Oligocene *Helicopontosphaera reticulata* zone of Bramlette and Wilcoxon (1967). This interval has been further studied and subdivided by Roth et al. (1971) into two zones, the lower-most of which is the *Ericsonia subdistica* zone. The nannoflora in Sample 173-3-4(48) can be readily referred to this zone and is roughly equivalent to nannofossil zone NN21 of Martini and Worsley (1970) and to Blow's (1969) planktonic foraminiferal zones P17 through P18.

Foraminifera

Planktonic foraminifera are absent throughout most of the sediments cored at Site 172 with the exception of a sparse lower Oligocene assemblage occurring within the coccolith-rich ooze horizon at 22 meters. A total of only seven solution-resistant species were identified from this horizon attesting to the severe dissolution of these forms. Moreover, fragments of planktonic species are common and the few complete tests recovered exhibit severe solution effects in the form of thin test walls, pitting, and loss of internal structure.

The reduced nature of the planktonic fauna found at 22 meters precludes precise biostratigraphic resolution of this horizon. However, five of the species recognized, *Globorotalia opima nana, Catapoydrax unicava primativa, Catapsydrax unicava unicava, Globigerina prasaepsis*, and *Globigerina* cf. *angiporoides*, suggest this horizon is within Blow's (1969) zones P18 or P19 of the lower Oligocene.

Scattered and rare specimens of broken and complete arenaceous benthonic foraminifera occur throughout all cores recovered at Site 172. Calcareous benthonic species were found only within the lower Oligocene calcareous ooze at 22 meters. A total of more than 20 benthonic species are present at this particular horizon; however, none of these species are stratigraphically diagnostic and all represent typical elements of mid-Tertiary to Recent lower bathyal-abyssal benthonic foraminiferal biofacies of the North Pacific Ocean.

Radiolaria

Core 1 at this site contains rare well-preserved species of radiolaria including *Theocorythium* sp. cf. *T. trachelium, Siphonosphaera polysiphonia, Heliodiscus asteriscus, Eucyrtidium acuminatum, Arstrobium miralestense*, and *Euchitonia elegans*. Although the lower stratigraphic limits of these species are not accurately kown, they are all known from living samples and/or from Recent sediments. No diagnostic Tertiary species were seen and the assemblage is probably Quaternary.

Very rare, poorly preserved fragments of radiolarians were found in Core 3. Other portions of cores at Site 172 are barren of radiolarians.

Spores and Pollen

Palynomorphs are entirely absent from sediments recovered at Site 172. The absence of pollen and spores is likely due to the isolation of this site from a major land mass or the result of oxidation of the sediment after deposition.

Fish Remains

Cursory examination of relatively abundant and well-preserved fish remains (mainly fish teeth) in sediments at Site 172 was made by Phyllis B. Helms of Scripps Institution of Oceanography. This preliminary analysis suggests that Sections 172-3(CC) through 172-16-2 contain a complete Miocene section with transitional Upper Oligocene and Lower Pliocene sediments present at either end of the column (Helms, personal communication to S. Kling, February 7, 1972).

PHYSICAL PROPERTIES

Physical properties measured at Site 172 include GRAPE bulk density and porosity, as well as bulk density and porosity by the shipboard method (syringe), acoustic velocity, and natural gamma radiation. The natural gamma radiation is not reported here due to time limitations.

Core 1 was punched without rotation and circulation but increased rotary motion of the bit was required to penetrate lower layers. The most obvious variations of bulk density and porosity with depth therefore probably reflect mainly drilling disturbance. However, the variation of GRAPE bulk density at a relatively constant porosity in Core 2 may show the influence of less dense ash layers.

The laboratory measurements of bulk density and porosity were made using a new volume for syringe units that is 2 per cent less than a previous volume per unit. The agreement between GRAPE and laboratory measurements is much closer than the comparisons reported in earlier cruises. Nonetheless, the GRAPE and laboratory measurements appear to have a constant difference, but this is difficult to evaluate considering the small number of laboratory measurements.

Sonic velocities were measured in four areas considered to be undisturbed and representative. The lowest measurement is on an ash layer. Each area was measured in three different spots and the agreement is good. There is a slight increase of velocity with depth. The absolute value of these velocities is in question because instrument operation instructions were not aboard ship. Standard blocks of leucite gave consistent but slightly low values. However, a velocity of 1700 m/sec applied to seismic reflections gives an event that corresponds to the lower basalt reflector (see correlation of seismic records with lithology). In view of the unexpected drilling termination in basalt, this possible confirmation of velocity should be viewed with caution.

The reproducibility of delay time and thickness measurements was evaluated for the Hamilton frame sonic velocimeter after it was noted that test block thicknesses easily varied ±0.005 cm and time delay measurements could vary ±10 μsec/cm. A sample of four repeated measurements on three test blocks showed a reproducibility of 1 per cent with maximum limits of ±2 per cent.

CORRELATION BETWEEN REFLECTION RECORDS AND THE STRATIGRAPHIC COLUMN

The seismic records indicate a 90- to 105-meter-thick section of sediment. This pick was made on dipping reflectors in the first two traverses across the basin (Figure 2). Therefore, it was surprising to encounter hard volcanic rock at 24 meters. Assuming a velocity of 1700 m/sec, the first reflector occurs at 10 to 12 meters, the second at 22 to 25 meters with subsequent reflectors at 38, 55, 69, 89 and possibly 105 meters. Records made while the ship was on site indicate that significant reverberation is recorded when the gun is deep. Therefore, it could be argued that the seismic record shows reverberations from a flat reflector. However, the slight dip of reflections below a horizontal bottom surface argues against reverberations. Furthermore, although the first three reflectors are about 13 meters apart, deeper reflectors are 17 and 21 meters apart. This also suggests that the reflectors are geologic horizons and not instrumental events resulting from a ringing outgoing signal.

One possible explanation is that the sedimentary section was off to one side of the ship and because it presented a good reflecting surface it was recorded strongest. The echo sounding record shows many side "ghosts" which indicate weakly reflecting features.

SUMMARY AND CONCLUSIONS

This site is located 140 km south of the Murray Fracture Zone in a region of hilly topography It lies within a magnetic "disturbed" zone between the Murray and Molokai Fracture Zones. Although *Challenger* seismic reflection records show approximately 0.1 second of sediment in a small basin or pond in the area where Site 172 was drilled, reverberations and thin sediment cover make interpretation difficult.

Two holes were drilled at Site 172. The first hole was continuously cored to a depth of 24 meters at which point a hard basalt layer was encountered and the drilling terminated. The second hole, Hole 172A, produced no new information.

The sedimentary section consists predominately of pelagic moderate brown clay in the upper 9 meters which changes to a zeolite-rich brown clay, brown clay zeolitite and zeolitite in the lower 9 to 23 meters. A horizon of pale orange nannofossil oozes occurs in the lower part of the latter interval in close proximity to basalt. The abundant coccolith flora and sparse planktonic foraminifera in this horizon indicate an Early Oligocene age (35 to 38 my, according to Berggren, 1969) for the sediment near the basalt. Although the sediments above the ooze are essentially barren of conventional microfossils, fish teeth indicate a rather complete Miocene section. Assuming continuous deposition from the lower Oligocene to the present, a sedimentation rate ranging from 0.6 to 0.7 m/my is calculated for the site. Calcareous benthonic foraminifera present in the Lower Oligocene interval are typical of lower bathyal-abyssal assemblages throughout the Pacific Basin and do not allow resolution of major changes in bathymetry at these depths. However, the fauna is indicative of depths greater than 2500 meters.

Glassy to finely crystalline basalt fragments were recovered in the two holes drilled at Site 172. Chemical analysis of the oxide content indicates tholeiitic basalt with a composition between tholeiitic basalts from spreading ridges and tholeiitic basalt from seamounts and oceanic islands (MacLeod & Pratt, Chapter 31, this volume). The K_2O content of Site 172 basalt is slightly higher than that found in basalts on spreading ridges and may argue against a ridge origin. Trace element abundances also are typical of oceanic tholeiitic basalts. The volcanic material recovered at Site 172 most likely originated through rapid quenching in sea water of either a tuff-breccia or pillow flow.

The thin lens of Early Oligocene calcareous oozes found at Site 172 may be the northern extension of Early Oligocene to Early Miocene carbonate associated with the eastern equatorial belt of high productivity described by

Tracey et al. (1971). If this is correct, it may be further evidence for a depressed calcium carbonate compensation level below 5000 meters as suggested by Arrhenius (1952) and Heath (1969) for this period.

Because of the uncertainties involved in the interpretation of the seismic reflection profiles, there is still a question as to whether the basalt flow encountered is actually a basalt flow within the sedimentary sequence in the basin or whether it is true oceanic basement. If Site 172 was located on magnetic anomaly 8 as proposed by Malahoff and Handschumacher (1971), a basement age of approximately 29 million years should have been obtained from the overlying sediments, as predicted from the oceanic magnetic time scale of Heirtzler et al. (1968). The 35 to 38 million year age of sediments drilled is somewhat older than the predicted age and if there is another section of sediment below the basalt, the basement would be much older than that indicated for anomaly 8. Although the *Challenger* magnetic profile most closely resembles profile J given by Malahoff and Handschumacher (1971, fig. 4), it is still not evident that their anomalies or the *Challenger's* match the standard North Pacific profile. In particular, there is a poor fit between anomalies 9 to 13 traced by the *Challenger* and those of the North Pacific standard profile (Heirtzler and other, 1968) shown by Malahoff and Handschumacher. Because this is a magnetically "disturbed" zone, it is important that known and easily identifiable anomalies be traced as far as possible into the zone from east and west.

Until additional geophysical data can be obtained, the data obtained at Site 172 will remain somewhat inconclusive with respect to basement age. However, the oldest sediments drilled above basement are older than predicted which might suggest that anomaly identifications in the "disturbed zone" are still not clear.

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APPENDIX A. OPERATIONS

Site Survey

Because limited data were available for Site 172, the magnetic anomalies were monitored closely while approaching the drill site on the westernmost occurrence of anomaly 8 (133°28'W). Magnetic values were reduced to residual anomalies using a local regional gradient beginning at 136°W (Figure 3). Anomalies matched well with the standard Pacific curve for anomalies 14 through 17; however, anomalies 11 through 13 could not be identified. The ship's speed was reduced to 8 knots at 1344 hours to obtain a better seismic reflection record. At 1450, course was changed to 090° T and speed was maintained. The identification of magnetic anomalies was questionable until 1630 when the decision was made to cross the probable anomaly 8 for confirmation. This anomaly was confirmed at 1735 after both flanks were identified but no site suitable for drilling was located near the anomaly. Assuming from Malahoff and Handschumacher (1971) that the rugged topography assoiated with the Murray fracture diminished to the south, the ship's course was changed to 210° T at 1704 to return to the magnetic crest of anomaly 8 and also to search for sediment ponds in the area. A small pond of sediment was seen on the reflection record at 1855 slightly west of the crest of anomaly 8. After crossing the pond, the vessel was turned to a reciprocal course (055° T at 1910 (Figure 4). A spar buoy was dropped during the second crossing at 1917 and the ship continued on course to retrieve geophysical gear before coming about to occupy the position marked by the buoy. The ship stopped at 2006 and a beacon dropped in at 2018 in 2526 fathoms (uncorrected) of water. The depth recorder was run until the ship was stabilized over the beacon and a final depth determination was made after the beacon was on the bottom. The uncorrected depth from the transducer remained 2526 fathoms. Corrected by Mathews Tables

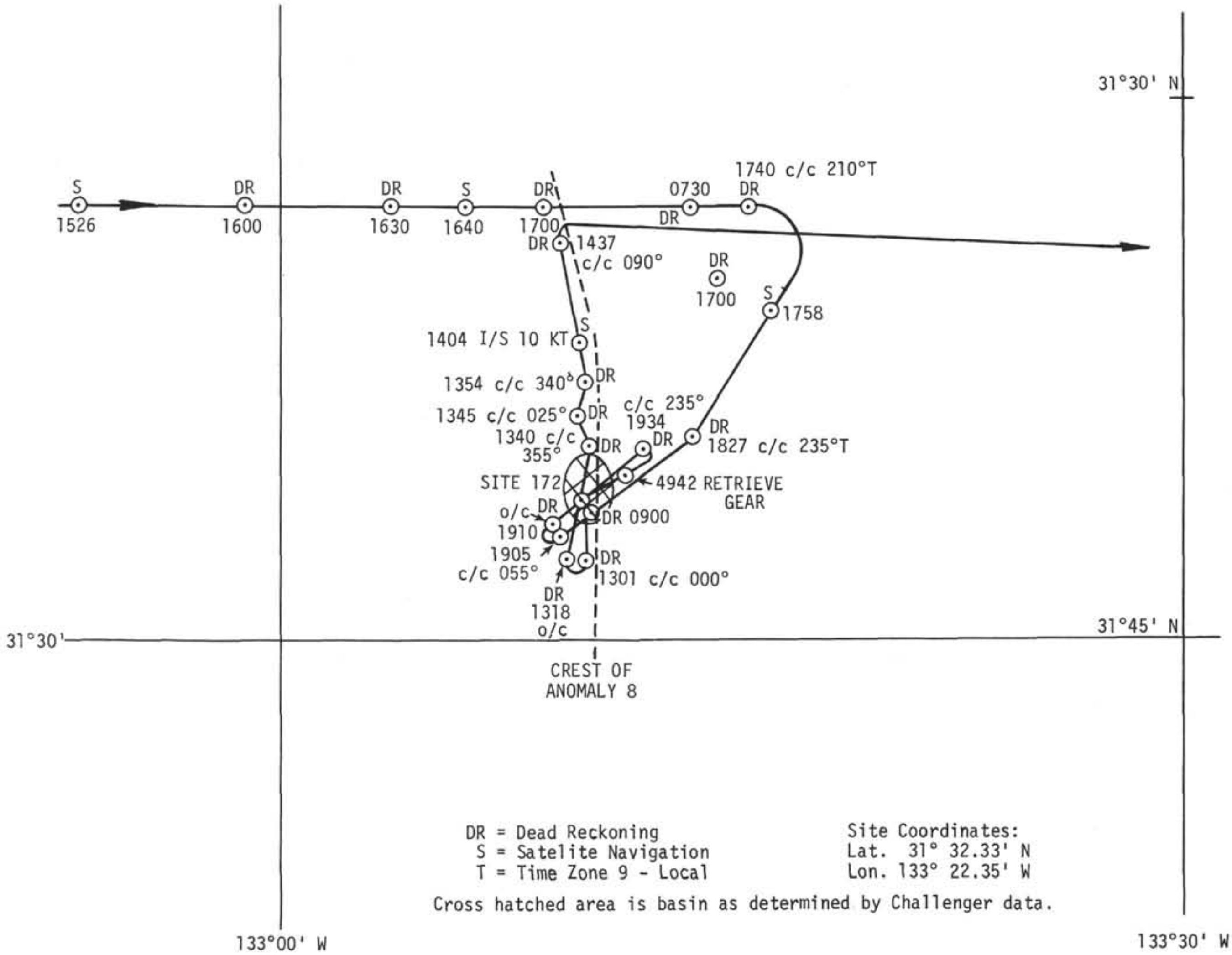


Figure 4. Glomar Challenger *pre-site survey of Site 172. Cross-hatched area is basin as determined by* Challenger *data.*

(area 42), the depth was 4748 meters, but corrected from more recent north Pacific sound velocity data (Richard C. Latham, Hawaii Institute of Geophysics, written communication, 1971) the depth was 4762 meters below the transducer. When the latter depth was corrected to the derrick floor, it corresponded closely to the drill pipe depth to bottom of 4777 meters.

Drilling Program

After the vessel was stabilized over the site, the beacon began to fail. A second beacon was launched at 0235 hours and positioned 91 meters south and 30 meters east of the first beacon.

Site 172 was continuously cored to a depth of 24 meters below the sea floor. The drill pipe made contact with the sea floor at a depth of 4777 meters from the derrick floor, which was the corrected echo sounding depth. The first 9 meters of sediment was penetrated without rotation of the bit and a 9-meter core obtained. In the interval from 18 to 24 meters below the sea floor, the bit was stopped by a hard layer. Drilling continued for approximately 20 minutes after which the core was pulled. A 9-meter core (Core 3) was recovered with only 5 meters of penetration. Basalt fragments were recovered in the core catcher. Another attempt was made to core the basalt, but only a few fragments were collected in the core catcher of the fourth core. Table 1 gives a summary of the coring.

TABLE 1
DSDP Site 172 Coring Summary

Core	Cored Interval Below		Cored	Recovered	
	Derrick Floor (m)	Bottom (m)	(m)	(m)	(%)
1	4767-4776	0-9	9.0	9.0	100.0
2	4776-4785	9-18	9.0	8.5	94.4
3	4785-4790	18-23	5.0	9.0	180.0[a]
4	4790-4791	23-24	CC	CC	–

Total: 24 meters cored, 26.5 meters recovered (100.0%)[a]

Water Depth: 4767 meters

Sediment Penetration: 24 meters below sea floor

[a]More than 100% recovery was obtained largely due to repeated coring of the last 1-2 meters on top of basalt layer (Core 3).

An examination of the sediments in Core 3 shows that the top 430 cm contain abundant fragments of semi-indurated zeolitite, representing beds of zeolitite, broken up by the coring process. Below this level, there was 60 cm of sediment consisting of a nannofossil ooze and a brown clay which has about 40 per cent ferromagnesian minerals and no zeolites. Both lithologies are different from those cored higher in the section. The base of this material lies at a depth of 24 meters below the sea floor or at a depth of 5 meters in Core 3. The sediments recovered from 5 to 9 meters in Core 3 represent a highly deformed mixture of material similar in lithology and age to that recovered in the previous 5 meters of Core 3. This indicates that the lowermost 4 meters of sediment in Core 3 represent a duplication of previous lithologies and repeated sampling of the sediment lying directly above the basalt.

The vessel was moved to a position 457 meters south and 30 meters east of the first site. A hole was jetted down to a depth of 24 meters below the sea floor at Hole 172A before encountering a hard layer. After 45 minutes of drilling the drill pipe and core were pulled. Only a few basalt fragments were recovered in the core catcher.

Because there was insufficient sediment cover to stabilize the bottom hole assembly, Hole 172A was abandoned.

Drilling Specifications

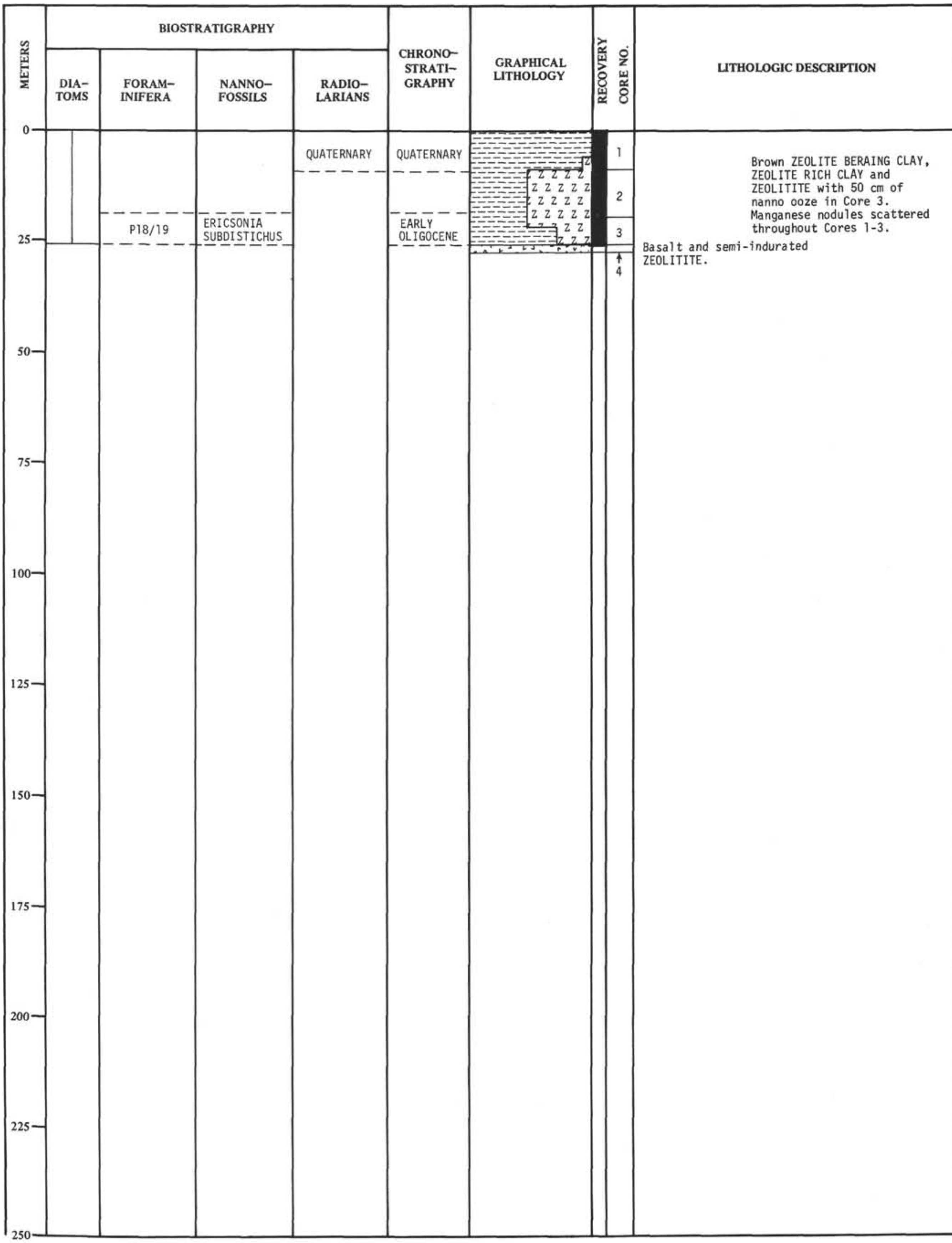
A standard bottom hole assembly was run on this site because of the expected thin layer of sediment. The coring assembly consisted of a 9-7/8" Smith 4 cone insert core bit, a core barrel, three 8-1/4" drill collars, a bumper sub, three 8-1/4" drill collars, two bumper subs, two 8-1/4" drill collars, and a 7-1/4" drill collar.

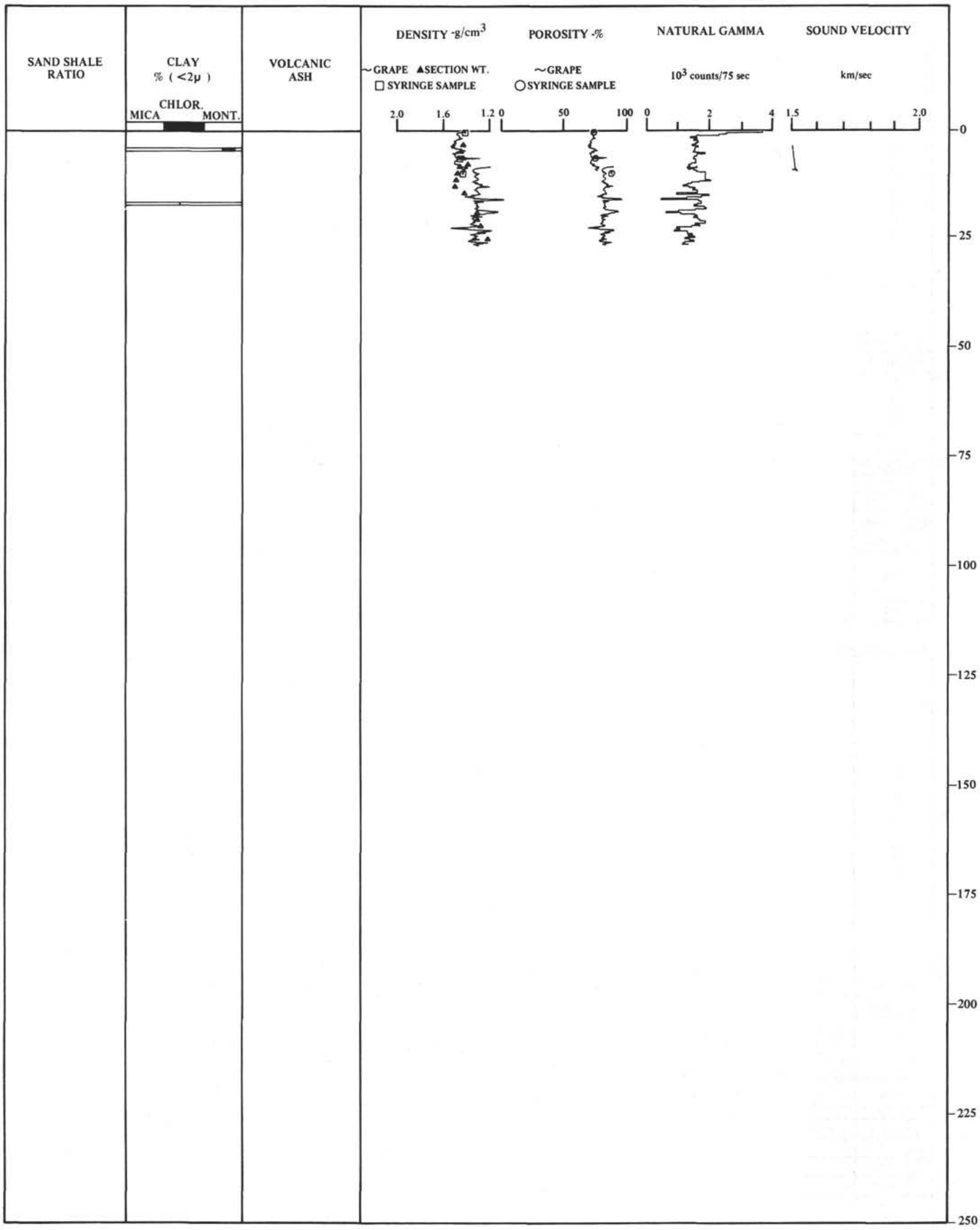
Post-drilling Site Survey

A post-drilling survey was made at Site 172 to (a) determine if the drill did bottom in oceanic basement or in a lava flow on top of a 100 meter thick section of sediment, and (b) determine if the magnetic anomaly identified as 8 was actually an older anomaly as indicated by the basement age of 32-38 million years obtained with fossils.

An answer to the first question was sought by making a clearer seismic record along the axis of what was thought to be a north-south striking basin, using lower frequencies of the seismic signal. During the drilling, a series of tests were run with the seismic system which indicated that filtering the return signals to exclude frequencies between 10 and 40 or 10 and 80 cycles made much clearer records than previous underway filter settings of 80 and 160 cycles. The geophysical gear was streamed at 1245, while the ship was on a course of 180° T and speed of 4 knots. The system used was a 20 in.^{3} and an 80 in.^{3} air gun firing at 5 second intervals and held near the water surface to reduce reverberation. Soon after we departed the site, the echo sounder recorded rough topography and this, in addition to other factors, made it impossible to obtain a clear seismic record. At 1301, the course was changed to a near reciprocal, 005° T, for a pass over the beacon. During this time, it became apparent that even at 4 knots the 10-phone EVP 23 eel does not have the low frequency noise cancellation capabilities that the 100-phone Recon and MP-7, 8- or 16-hydrophone arrays have, and that the higher frequency settings commonly used with the *Challenger* seismic system are necessary to reject low frequency water noise. The seismic record was therefore no better than the one made in the pre-drilling site survey. About 9 minutes after crossing the beacon, the records showed the wall of the basin and the course was changed to 008° T, then 025° T, and finally 340° T in a sawtooth search pattern, but only rough topography was encountered. Thus, it appears that Hole 172 was drilled at the edge of a small basin and that Hole 172A was probably on or close to the flank of the basin.

The character of the magnetic anomaly pattern was further investigated by continuing the previous 090° T track to about anomaly 10. This bracketed anomaly 8 by magnetic information both east and west of Site 172. A 090° course change was made at 1437. Magnetic anomalies were identified across the spreading center proposed by Malahoff and Handschumacher to anomaly 10 or 11. Then the ship proceeded on a course of 038° T to the next site.


METERS
BIOSTRATIGRAPHY
DIA-TOMS
FORAM-INIFERA
NANNO-FOSSILS
RADIO-LARIANS
CHRONO-STRATI-GRAPHY
GRAPHICAL LITHOLOGY
RECOVERY
CORE NO.
LITHOLOGIC DESCRIPTION
0
25
50
75
100
125
150
175
200
225
250
QUATERNARY
QUATERNARY
P18/19
ERICSONIA SUBDISTICHUS
EARLY OLIGOCENE
1
2
3
4
Brown ZEOLITE BERAING CLAY, ZEOLITE RICH CLAY and ZEOLITITE with 50 cm of nanno ooze in Core 3. Manganese nodules scattered throughout Cores 1-3.
Basalt and semi-indurated ZEOLITITE.


SAND SHALE RATIO
CLAY % (<2μ)
CHLOR.
MICA
MONT.
VOLCANIC ASH
DENSITY -g/cm3
~GRAPE ▲SECTION WT.
□ SYRINGE SAMPLE
2.0 1.6 1.2
POROSITY -%
~GRAPE
○SYRINGE SAMPLE
0 50 100
NATURAL GAMMA
10³ counts/75 sec
0 2 4
SOUND VELOCITY
km/sec
1.5 2.0
0
25
50
75
100
125
150
175
200
225
250

Site 172 Hole Core 1 Cored Interval: 0-8*

AGE	ZONE	FORAM*	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
QUATERNARY		B	B	R/G	B → B	1	0.5, 1.0	MN			Medium brown CLAY grading into ZEOLITE BEARING BROWN CLAY at top of sec. 6, becoming brown ZEOLITE RICH CLAY at bottom of sec. 6. Several small MANGANESE NODULES at top of sec. 1 and one in sec. 4. Rare, authigenic carbonate, glass, and zeolites throughout core. Very slight mottling in secs. 1 and 2. Sediments soft to firm, very little drilling disturbance.
		B			B	2					
		B			B	3					
		B			B	4		MN			
		B			B	5					brown ZEOLITIC CLAY
NEOGENE (?)		B				6		VOID			*8 meters cored, 9 meters recovered.
		B	B	B	B	Core Catcher					

Smear Slide
BROWN CLAY

Clay	80-85%
Silt	5%
Glass	4%
Phillipsite	4%
Carbonate	2%

Explanatory notes in chapter 1
*PLANKTONIC FORAMINIFERA

Site 172 Hole Core 2 Cored Interval: 9-18

AGE	ZONE	FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
NEOGENE (?)		B			B → B	1	0.5, 1.0	MN			Brown, ZEOLITE BEARING CLAY near top changing to brown CLAY ZEOLITITE in middle of core and then back to brown, ZEOLITE BEARING CLAY at bottom. Bottom color moderate brown to grayish brown.
		B			B	2					Local zeolite layers 10-40 cm. thick; lighter in color and semi-indurated.
		B			B	3					Manganese nodule in section 1.
		B			B	4					Carbonate found in zeolite poor intervals. Rare quartz and feldspar proportional in amount to zeolite content.
		B			B, B	5		VOID			Bedding massive; local drilling breccia of semi-indurated zeolitite.
		B			B	6					
		B	B	B	B	Core Catcher					

Typical Smear Slide
Brown ZEOLITE RICH CLAY

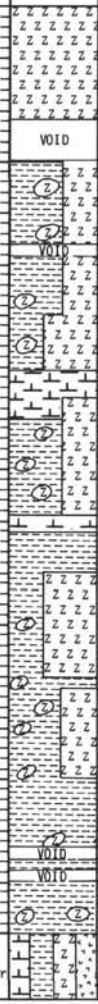
Clay	73%
Phillipsite	20%
Silt	5%
Carbonate	2%

Minor Lithology Smear Slide
Brown CLAY ZEOLITITE

Phillipsite	65%
Clay	31%
Quartz and Feldspar	4%

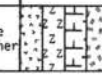
Explanatory notes in chapter 1

Site 172 Hole Core 3 Cored Interval: 18-23.5

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
? / EARLY OLIGOCENE / ?	P18/19 Ericsonia subdistichus Zone (Reworked material)	B				1	0.5, 1.0	 VOID			Brown ZEOLITITE at top of core changing to brown ZEOLITIC CLAY in sec. 2-5.
					B	2		VOID			Yellow NANNO OOZE near middle of core underlain by 30 cm. of brownish-red CLAY. All sediments below this clay (i.e. lower 4 meters) are believed to represent duplication of younger beds.
		B									Zeolitites are semi-indurated and grayish-orange in color. Their relatively greater induration than that of the red CLAYS results in formation of a drilling breccia.
					B	3					Where underformed, bedding contacts are sharp, otherwise streaked or brecciated. First rare nannofossils in Section 1; first bedded nannofossils in Section 3.
		R/P									
		R/P	A/G		B	4					Typical Lithology Smear Slides-1: ZEOLITITE: Phillipsite 90%, Clay 10%
					B						
					B	5					Minor Lithology Smear Slides: NANNO OOZE: Nannos 95%, Clay 5%; BROWN CLAY: Clay 95%, Phillipsite 2%, Carbonate 1%, Calc. forams Tr., Qtz. and feldspar Tr.
		R/P									
		R/P			B	6		VOID, VOID			
		R/P			B						
		R/P		R/P	B	Core Catcher					Chips of BASALT in Core Catcher.

Explanatory notes in chapter 1

Site 172 Hole Core 4 Cored Interval: 23.5-24.5

AGE	ZONE	FOSSIL CHARACTER: FORAM	NANNO	RAD	DIATOM	SECTION	METERS	LITHOLOGY	DEFORMATION	LITHO. SAMPLE	LITHOLOGIC DESCRIPTION
?		B	B	B	B	Core Catcher					CORE CATCHER ONLY

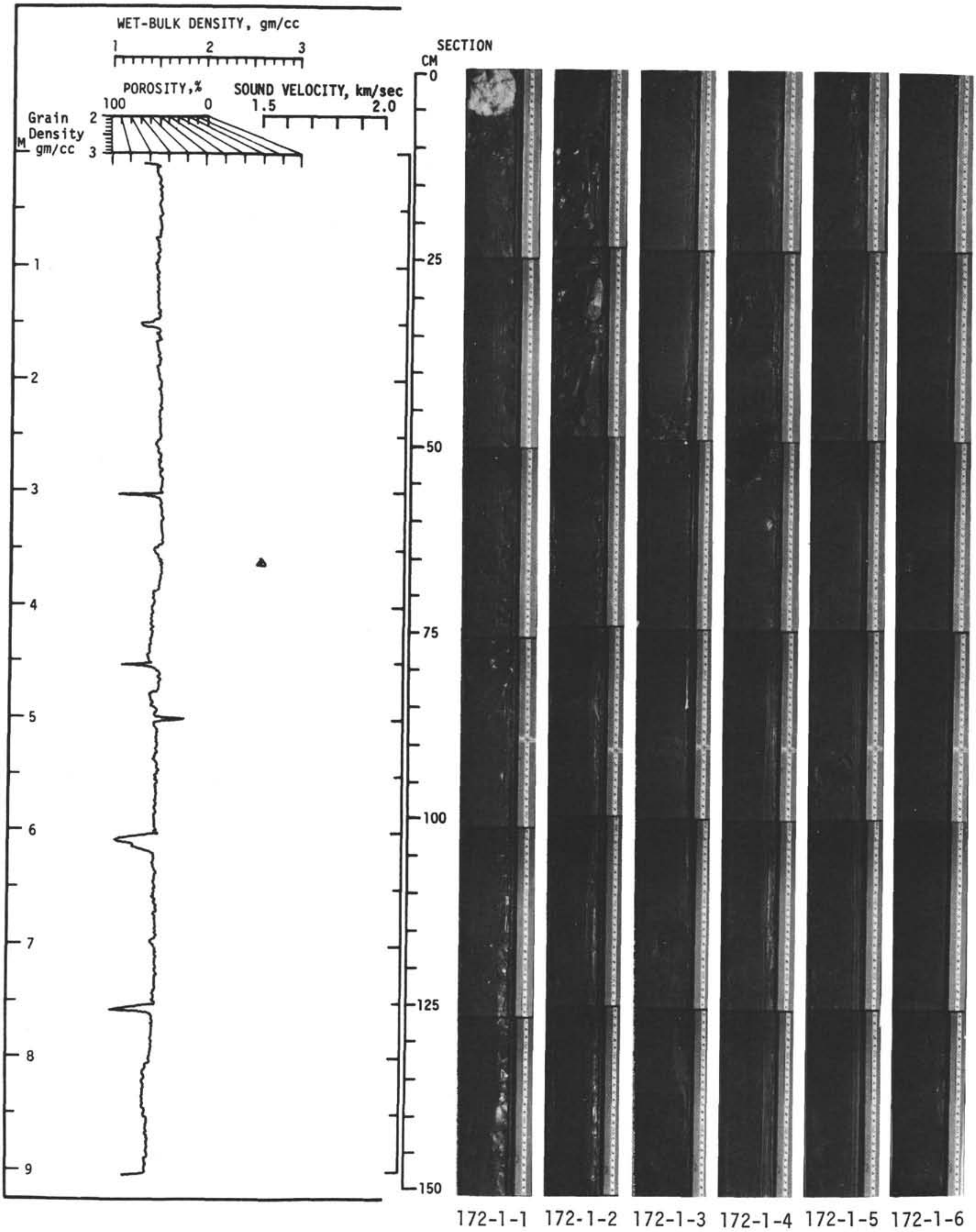
Most sediment barren with the exception of common fish teeth which suggest a Pliocene to Lower Miocene sequence.

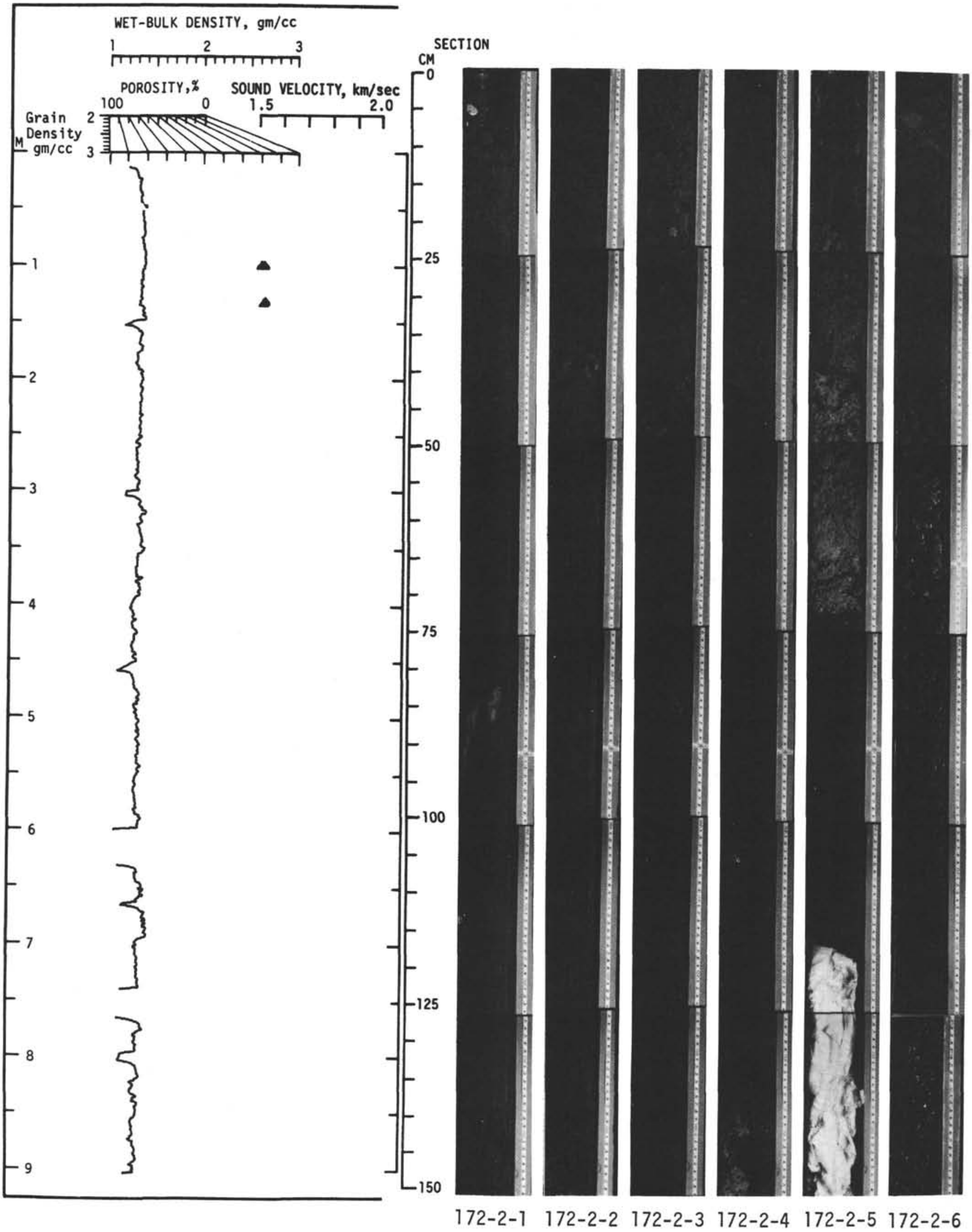
CORE CATCHER ONLY

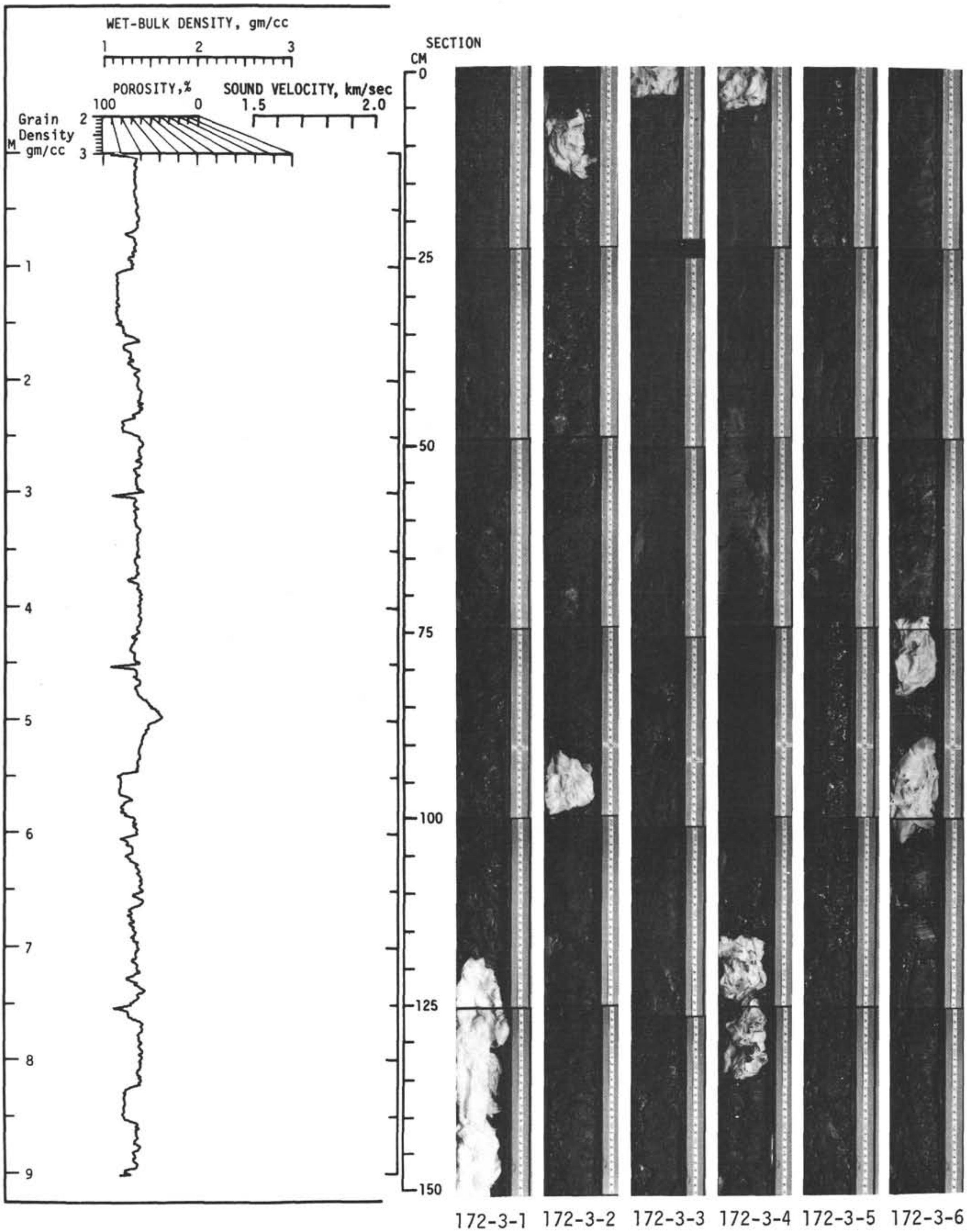
1. BASALTIC GLASS fragments with some palagonite; fine grained, gray.
2. Porphyritic BASALT with plagioclase laths (An 40) and olivine; some amygdules.
3. Chips of semi-indurated ZEOLITITE.

In addition, there were small amounts of sedimentary material, compositionally similar to that occurring in Core 1-3.

Explanatory notes in chapter 1


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
SOUND VELOCITY, km/sec
1.5
2.0
Grain Density gm/cc
2
3
M
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
172-1-1
172-1-2
172-1-3
172-1-4
172-1-5
172-1-6


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
SOUND VELOCITY, km/sec
1.5
2.0
Grain Density gm/cc
2
3
M
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
172-2-1
172-2-2
172-2-3
172-2-4
172-2-5
172-2-6


WET-BULK DENSITY, gm/cc
1
2
3
POROSITY,%
100
0
SOUND VELOCITY, km/sec
1.5
2.0
Grain Density gm/cc
2
3
M
1
2
3
4
5
6
7
8
9
SECTION
CM
0
25
50
75
100
125
150
172-3-1
172-3-2
172-3-3
172-3-4
172-3-5
172-3-6