3. SITE 68

Shipboard Scientific Party[1]

SITE DATA

Occupied: October 10-12.

Position: Latitude 16° 43.32'N.
Longitude 164° 10.36'W.

Water Depth: 5467 meters.

Total Depth: 15 meters in middle Eocene brown clay containing thin claystone and chert layers.

Holes Drilled: Two holes (1 standard core hole, 1 turbocore hole).

Cores Taken: Two cores in first hole; a third core run was unsuccessful.

RESULTS

A few centimeters of pelagic ooze containing mixed Quaternary, Miocene and Eocene Radiolaria overlies middle Eocene brown clay. Thin indurated claystone and chert layers starting about 9 meters below bottom increase in number and thickness below 13 meters. The first reflecting layer was estimated to be at 35 to 50 meters.

BACKGROUND

Site 68 was chosen by the JOIDES Pacific Advisory Panel (PAP Site 22) as a second priority site on the southwest side of the Hawaiian Ridge for correlation with the former Mohole site (Leg 7, Site 67; PAP Site 23) on the northeast flank of the Ridge. It lies near the center of a roughly circular basin between 5 and 6 kilometers deep and about 10 degrees across, bounded on the west and southwest by the Line Islands-Johnson Island Ridge, on the northwest by the Necker Ridge, on the north and northeast by the Hawaiian Ridge, and on the east and southeast by a group of seamounts lying between the island of Hawaii and the Line Islands.

[1]Joshua I. Tracey, Jr., U. S. Geological Survey, Washington, D. C.; George H. Sutton, University of Hawaii, Honolulu, Hawaii; W. D. Nesteroff, Université de Paris, Paris, France; Jon Galehouse, San Francisco State College, San Francisco, California; C. C. von der Borch, Scripps Institution of Oceanography (present address: Flinders University, Bedford Park, South Australia); T. C. Moore, Oregon State University, Corvallis, Oregon; U. Z. Bilal ul Haq, Geologiska Institutionene, Stockholm, Sweden (present address: Woods Hole Oceanographic Institution, Woods Hole, Massachusetts); and J. P. Beckmann, Geologisches Institute, Zurich, Switzerland.

This site was scheduled for Leg 7, but was omitted in order that an originally unplanned site west of the Line Islands could be occupied. It was chosen for the first hole on Leg 8 as an appropriate location to test a turbodrill. Few holes in the west-central Pacific had penetrated to igneous basement using conventional drilling. Generally, holes were terminated by chert layers of Eocene age. In addition to the operational testing of the turbodrill we hoped to penetrate any expected chert layers and reach igneous basement.

The drilling site was about 20 miles northeast of the site chosen by the SCAN survey. In the vicinity of the drilling site, the SCAN survey indicated about 38 meters (0.05 second) of transparent sediments overlying at least 120 to 150 meters (~ 0.15 second) of highly reflective sediments. The site is on the western margin of an area of low abyssal hills having relief of 90 to 180 meters. Just west of the site, the upper transparent zone seems to disappear, the relief decreases to less than 50 meters, and the depth of the deepest observed reflecting horizon increases to about 250 meters (0.3 second) below the bottom. In the whole of the survey area, subbottom reflectors are conformable with the sea floor, which is at a depth of 5300 to 5490 meters.

It was anticipated that chert would be found below the first subbottom reflector at 0.05 second.

A piston core at the SCAN site (16° 25.0'N, 164° 23.5'W) contained 2.8 meters of light brown clay overlying 6.2 meters of dryer, dark brown clay. The core catcher contained stiff, very dry, brown clay, probably representing the reflector observed at 7 meters beneath the sea floor on the 3.5 kHz echo sounder.

Site 68 is located on a nearly flat-topped rise about 8 miles across and 50 to 100 meters above its immediate surroundings. The *Challenger* airgun records at the site show reflections at 0.04, 0.10, and 0.20 seconds beneath the bottom (Figure 1 and Figure 12, Chapter 2). At 1.5 km/sec this implies depths below the bottom of 30, 75 and 150 meters, respectively. Although the deepest reflector is weak and sometimes absent, the observed horizons appear to be concordant with the bottom. However, some evidence for local slumping in the upper layer is indicated by discordant reflectors in a depression about 5 miles southwest of the site.

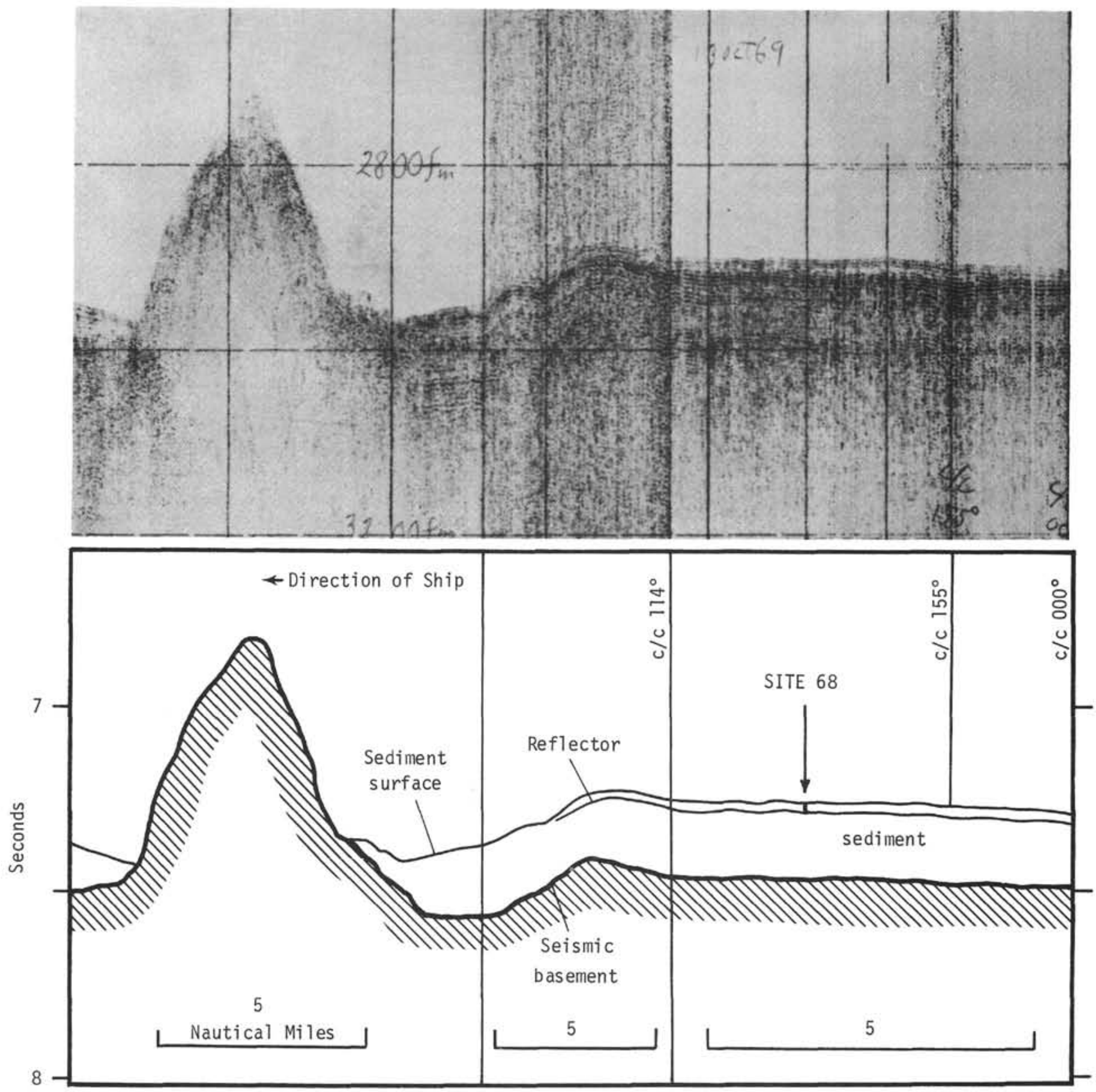


Figure 1. *Airgun record across Site 68 and interpretation.*

The hole terminated in chert; greatest sampled depth was about 15 meters; and mudstone and chert first appeared at a depth of 9 meters. Because of the length of the outgoing signal and the filter settings used (80 to 160 Hz) it is difficult to detect such shallow horizons under a fairly reflective bottom. As mentioned above, SCAN observed (on the 3.5 kHz echo sounder) a reflector at 4 fathoms (7 meters) in the vicinity and correlated it with a stiff, very dry brown clay obtained from the core catcher. It is likely that this also represents the top of the zone of mudstone and the stringers we encountered in the hole.

Since the hole ended in middle Eocene, from the reflection records it is likely that much older sediments exist above igneous basement at this location.

A topographic map of the vicinity of Site 68, airgun records, and further site information are given in Chapter 25.

OPERATIONS

A conventional wire line core assembly was used to drill Hole 68. Bottom was reached at 5467 meters and a 7.6-meter core was taken without circulation or rotation. A second core from 7.6 to 15 meters encountered a hard formation at about 9 meters, which required both circulation and rotation to cut. A third core was attempted from 15 to about 24 meters, but at completion of coring a drop in drill string weight was noted, and the inner core barrel could not be retrieved. On pulling the drill string, it was found that the bottom hole assembly had twisted off, leaving bit, core barrel and two drill collars in the hole.

Hole 69A was drilled using the turbocorer. Bottom was reached at 5480 meters and the hole "washed" to the first hard streak at 9 meters below sea floor. At this point the inner core barrel and instrument package were lowered on the Schlumberger wire line. Salt water was pumped at 550 gal/min with 1300 psi surface pressure. Turbine rotation was 1100 to 1200 rpm with no weight on the bit. When a bit weight of 11,000 to 15,000 pounds was attempted, turbine rotation varied from 200 to 900 rpm. Sea swells of 6 to 8 feet caused fluctuations in drill string weight of 10,000 to 35,000 pounds. At least a part of this fluctuation was imparted to the bit as evidenced by the wide and rapid variation in rotation. After several attempts to maintain a steady bit weight, the turbine stalled completely and could not be restarted. The inner barrel was recovered and contained a few chert fragments.

LITHOLOGY AND STRATIGRAPHY

At Hole 68, full core recovery was accomplished from the sea floor to the bottom of the hole at 15 meters. The first core is moderately disturbed, with occasional undisturbed zones; the second core is badly disturbed especially below the first section. Apart from the uppermost 0.2 meters of sediment, which is Quaternary, all sediment cored is of middle Eocene age.

Dominant lithology at this site is dusky brown phillipsitic clay which contains fragments of Radiolaria. A 15-centimeter thick bed of radiolarian ooze occurs in Core 1, separated from the clay by relatively sharp contacts. Fragments of brown indurated claystone and brown chert are present throughout Core 2, within a slurry of the brown clay. These chips first appear near the top of the core, and are present to the bottom of the hole. A slowing of drilling rate just below the top of Core 2 suggests that the uppermost cherty horizon is situated about 9 meters below sediment surface. The presence of these fragments and the need for moderate rotation and circulation below a depth of about 9 meters also suggest that the indurated and cherty horizons begin at this depth. Increased difficulty in drilling, especially in the third core run below 15 meters, indicates that the number and thickness of the horizons probably increases although no horizon took more than a few minutes to penetrate. The indurated material exhibits a marked conchoidal fracture and has a massive structure. Hardness varies from relatively soft to harder than a steel blade. Hardest samples appear to be typical chert.

Hole 68A, offset from 68, was a test hole for the turbodrill. The only sample obtained was composed of brown chert fragments from the core catcher, cored from a sediment depth of about 15 meters.

Figure 4 is a plot of age versus depth, based on the biostratigraphic zonations of the foraminifera, nannoplankton, and Radiolaria, with the time scale, in millions of years, based on that of Berggren (1969).

PHYSICAL PROPERTIES

Bulk density, grain-matrix density, per cent porosity, sonic velocity, sonic impedance and natural gamma are plotted for Core 1. Because of the fluid nature of the sediment in Core 2, no porosity samples were taken, and only sonic velocity and natural gamma are plotted.

Porosities range between about 75 and 85 per cent and most of the velocities are slightly lower than those for sea water at the laboratory condition (about 1.53 km/sec) as expected in this porosity range. The plot of velocity versus porosity (Figure 2) indicates that Site

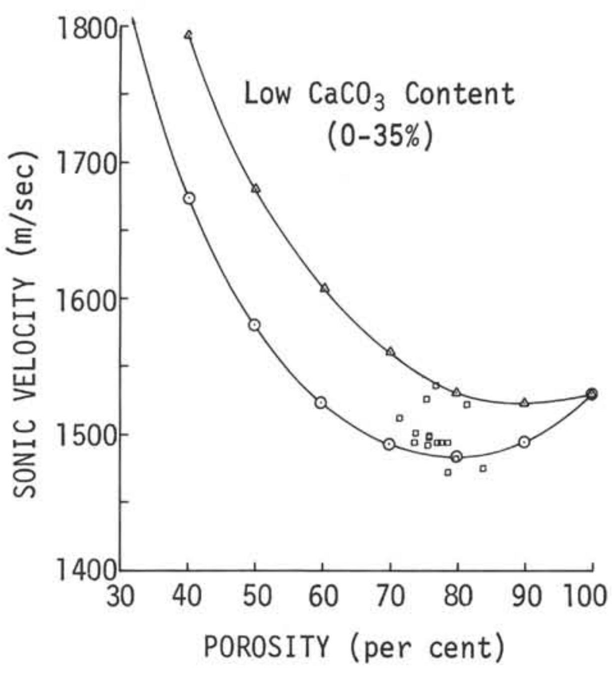


Figure 2. *Sonic velocity versus porosity of unlithified sediments from Site 68. All sampled sediments have less than 35 per cent calcium carbonate. Theoretical curves are based on the equation of Wood (1941). Upper curve, grain-matrix density 2.2 g/cm^3, appropriate for siliceous ooze. Lower curve, grain-matrix density 2.65 g/cm^3, appropriate for calcareous ooze.*

TABLE 1
Summary of Coring at Site 68

	Core No.	Interval Below Seafloor (meters)	Cored (m)	Recovered (m)	Comments
Hole 68	1	0.0-7.6	7.6	7.6+	
	2	7.6-15.0	7.3	7.3+	
	3	15.0-24.0?	9.1?	0.0	Total depth 24.0 m?
Total			24.1	14.9	62% recovery
Hole 68A	1	0.0-9.0			Drilled
	1	9.0-**	0.0	0.0	**No penetration; chips in catcher.

68 provides most of the low points in Figure 10, Chapter 2, for samples in the low calcium carbonate ($CaCO_3$) range (0 to 35 per cent). At Site 68 the dominant lithology is clay and most of the data lie near the theoretical curve for a grain-matrix density of 2.65 g/cm^3. Most low calcium-carbonate samples from other sites are highly siliceous ooze with a grain-matrix density near 2.2 g/cm^3, and the data cluster around the theoretical curve for that density.

The large scatter observed for the grain-matrix density is probably the result of errors in the volume measurement of the small porosity samples used for the determination. The mean value of grain density, about 2.5 g/cm^3, is reasonable and the scatter gives an indication of the reliability of the bulk density and porosity values.

Compressional wave velocities and densities of several pieces of chert and mudstone obtained in the core catchers of Core 2 of Hole 68 and Core 1 of Hole 68A are given in Chapter 2.

Natural gamma radiation of about 2000 counts observed for Core 1 was the highest encountered on Leg 8.

Three measurements of thermal conductivity were taken with the following results:

68-1-2 at 74 centimeters	1.78 cal/°C cm sec
68-1-2 at 118 centimeters	1.78 cal/°C cm sec
68-2-5 at 75 centimeters	1.63 cal/°C cm sec

Results of grain-size and carbon-carbonate analyses are tabulated in Appendices II and III, respectively.

PALEONTOLOGY

Foraminifera

Penetration at this site was 15 meters, and only two cores were taken. The sediment is a typical abyssal clay, and the washed residues consist essentially of Radiolaria, fish debris, and minerals (phillipsite and unidentified micronodules). Calcareous fossils are not present, although occasional specimens of agglutinated foraminifera are found. Apart from unidentified fragments referable to the family Astrorhizidae, there are single specimens of *Cyclammina* (?) sp. (Sample 68-1-3, 21 centimeters) and *Trochamminoides* (Sample 68-2-1, 47 centimeters). None of the foraminifera is age-diagnostic.

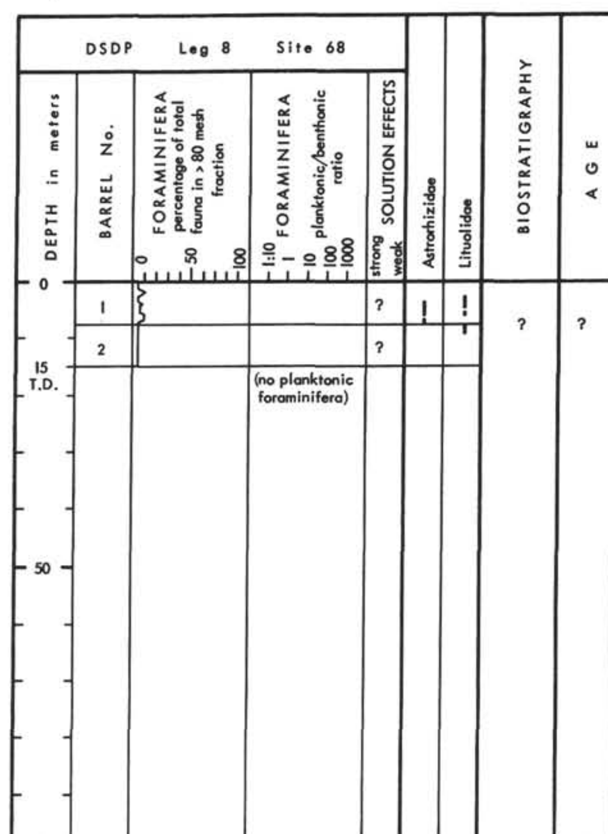


Figure 3. *Foraminifera of Site 68. Frequency and distribution.*

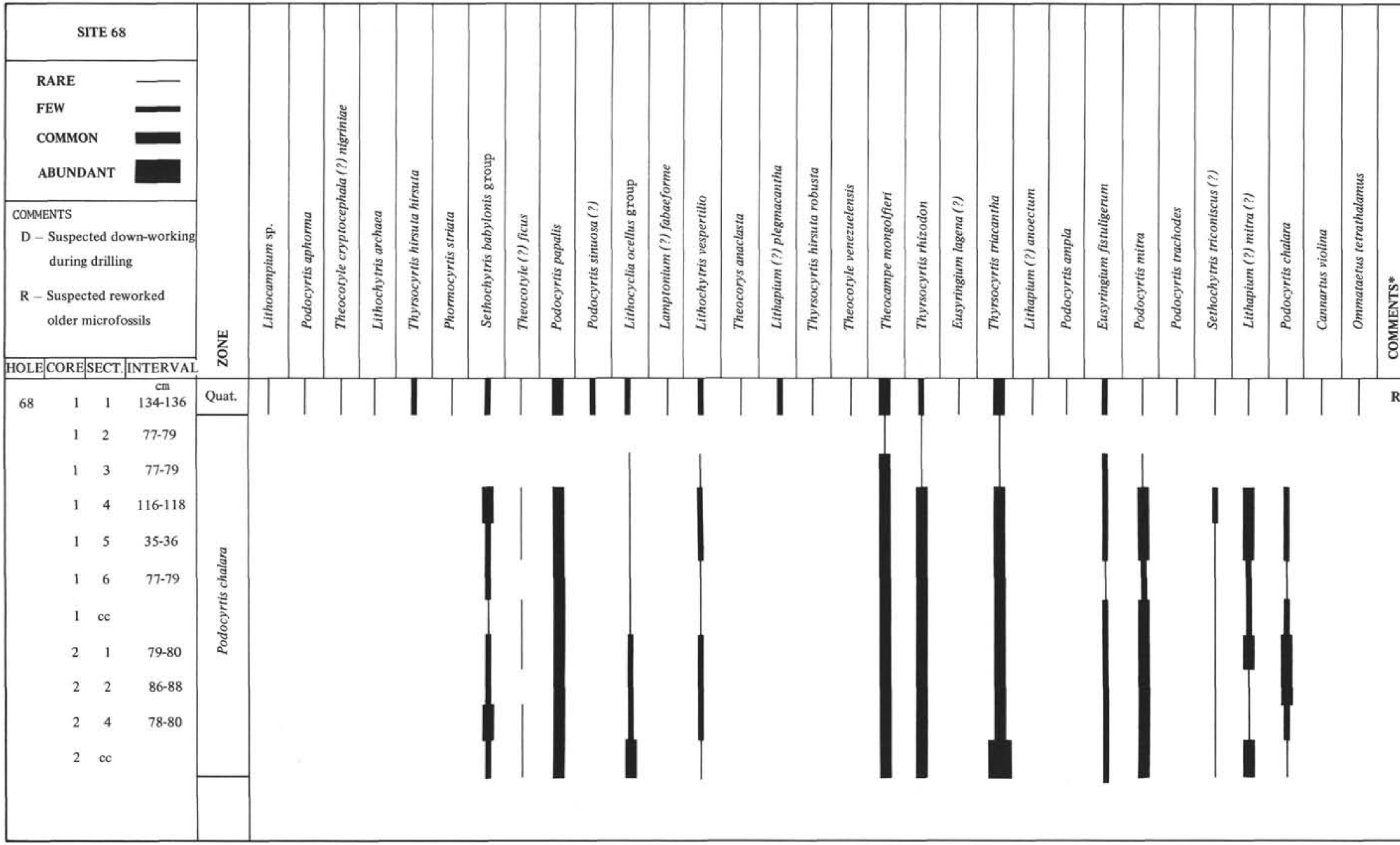


Figure 4. *Radiolaria at Site 68. Frequency, distribution and biostratigraphy.*

Radiolaria

Radiolaria from the surface sediment sample are moderately corroded and few in number. The presence of *Ommatartus tetrathalamus* indicates a Quaternary to late Pliocene age for this sample. An abundance of spines of orosphaerid Radiolaria and one questionable specimen of *Cannartus violina* suggest the presence of some Early Miocene material. By far the most abundant microfossils in this top sample are representative of the Middle Eocene. All biostratigraphic zones of the Middle Eocene may be represented. Certainly the *Theocampe mongolfieri* Zone (the lowest Middle Eocene zone) is indicated by specimens of *Phormocyrtis sriata, Podocyrtis aphorma, Theocotyle cryptocephala* (?) *nigriniae, Lithochytris archaea* and *Lamptonium* (?) *fabaeforme* (?) *chaunothorax.* Zones of the upper Middle Eocene are indicated by the presence of *Podocyrtis chalara, P. mitra* and *Sethochytris triconiscas* (?).

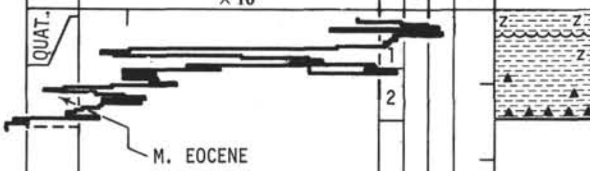
Just below this first sample, radiolarian tests become very rare and are highly corroded. Only a few Eocene Radiolaria survive. At approximately 4.4 meters below the seafloor, two thin layers of radiolarian ooze (Core 1, Section 4, 113 to 126 centimeters; Section 5, 34 to 36 centimeters) contain abundant, moderately well-preserved middle Eocene Radiolaria of the *Podocyrtis chalara* Zone.

Aside from the two small layers of radiolarian ooze, the abundance of radiolarian tests preserved in the sediment generally increases with depth in the hole. Below the zone of solution (approximately 4 meters below the sea floor) the sampled assemblage does not appear to have mixed older or younger faunas. The top sample, above the hiatus and zone of solution, contains faunas of many different ages, some of greater age than the *Podocyrtis chalara* Zone. Thus, some lateral transport of microfossils must be involved in the mixing of the near-surface sediments.

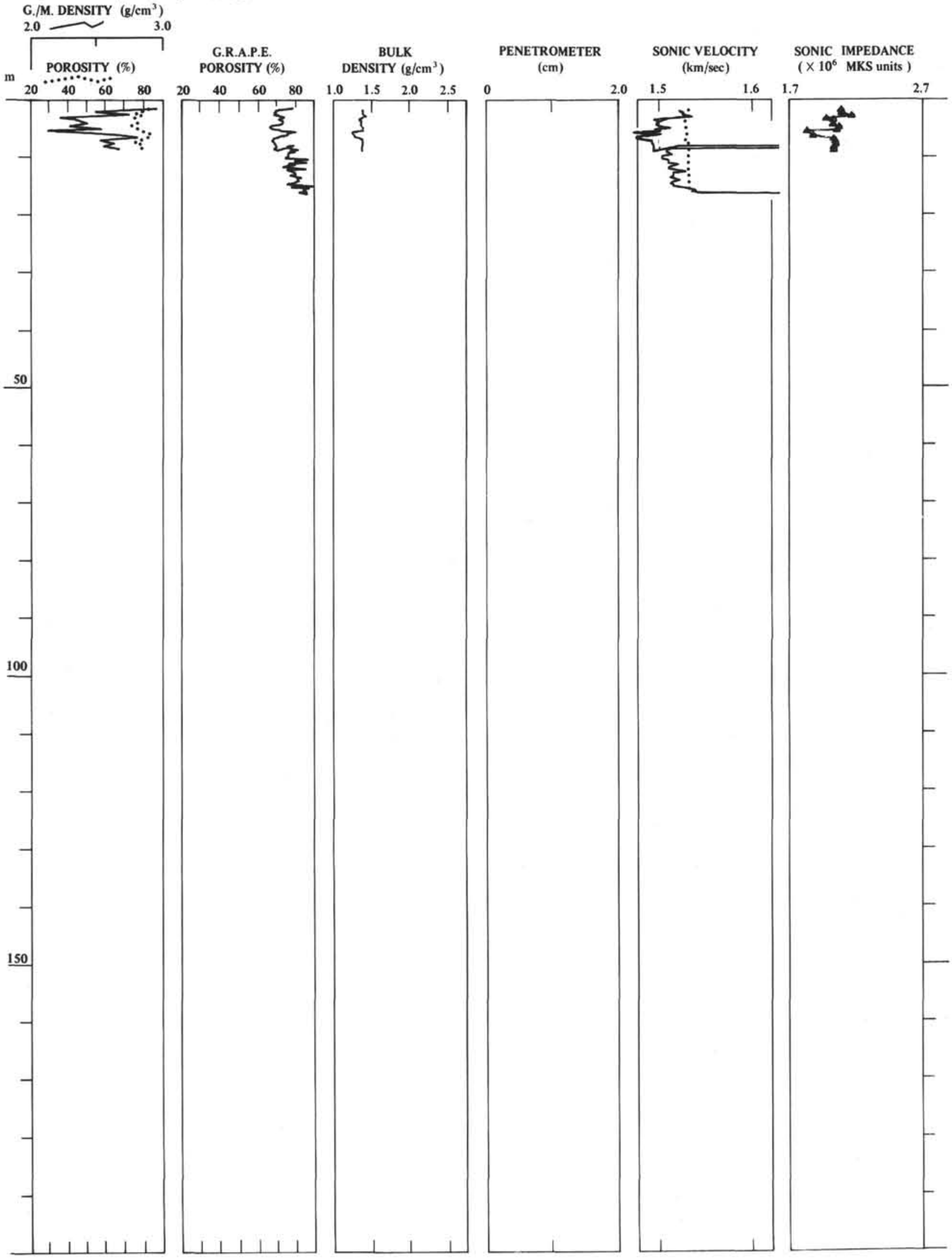
REFERENCE

Berggren, W. A., 1969. Cenozoic chronostratigraphy, planktonic foraminiferal zonation and the radiometric time scale. *Nature.* **224**, 1072.

AGE	NATURAL GAMMA * 1.5 (Counts/7.6 cm/1.25 min) × 10^3 2.0	CORE NO.	METERS	LITHOL.	LITHOLOGIC DESCRIPTION	% $CaCO_3$ 0 50 100
QUAT. / M. EOCENE		1, 2	50, 100, 150		Red Clay. Dusky yellow brown, with phillipsite. Thin bed siliceous ooze at top and at 4.4 m. Chert. Dusky brown. One piece in catcher and chips in barrel 2. Smear summary { Clays ~75% / Phillipsite 5-15% }	



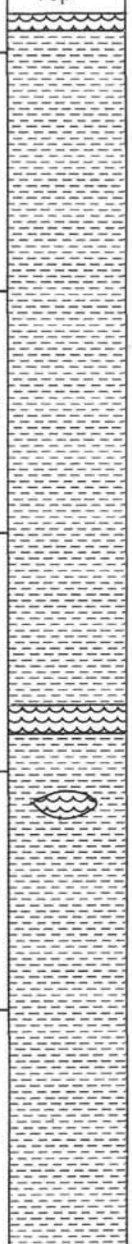
Physical Properties, Site 68



SITE 68 Core 1 Cored interval: 0-7.6 m (Sea floor surface represented at 120 cm in Section 1).

AGE	FORAMS	NANNOS	RADS	METERS	SECT. NO.	LITHOL.	LITHOLOGIC DESCRIPTION	% CaCO3 (0 50 100)
QUATERNARY			Quaternary	1	1	Top		
MIDDLE EOCENE	(absent)	(absent)	*Podocyrtis chalara*	2, 3, 4, 5, 6, 7, 8	2, 3, 4, 5, 6			

Top



Core slightly disturbed.

CLAY with PHILLIPSITE

Uniform texture.
Dusky yellow brown to very dusky red (5YR2/2).
Thin siliceous ooze beds (10YR4/4 yellowish brown) at top and 4.4 m.

Smear summary

Clay	75%
Phillipsite	5-15%
Apatite (fish)	< 5%

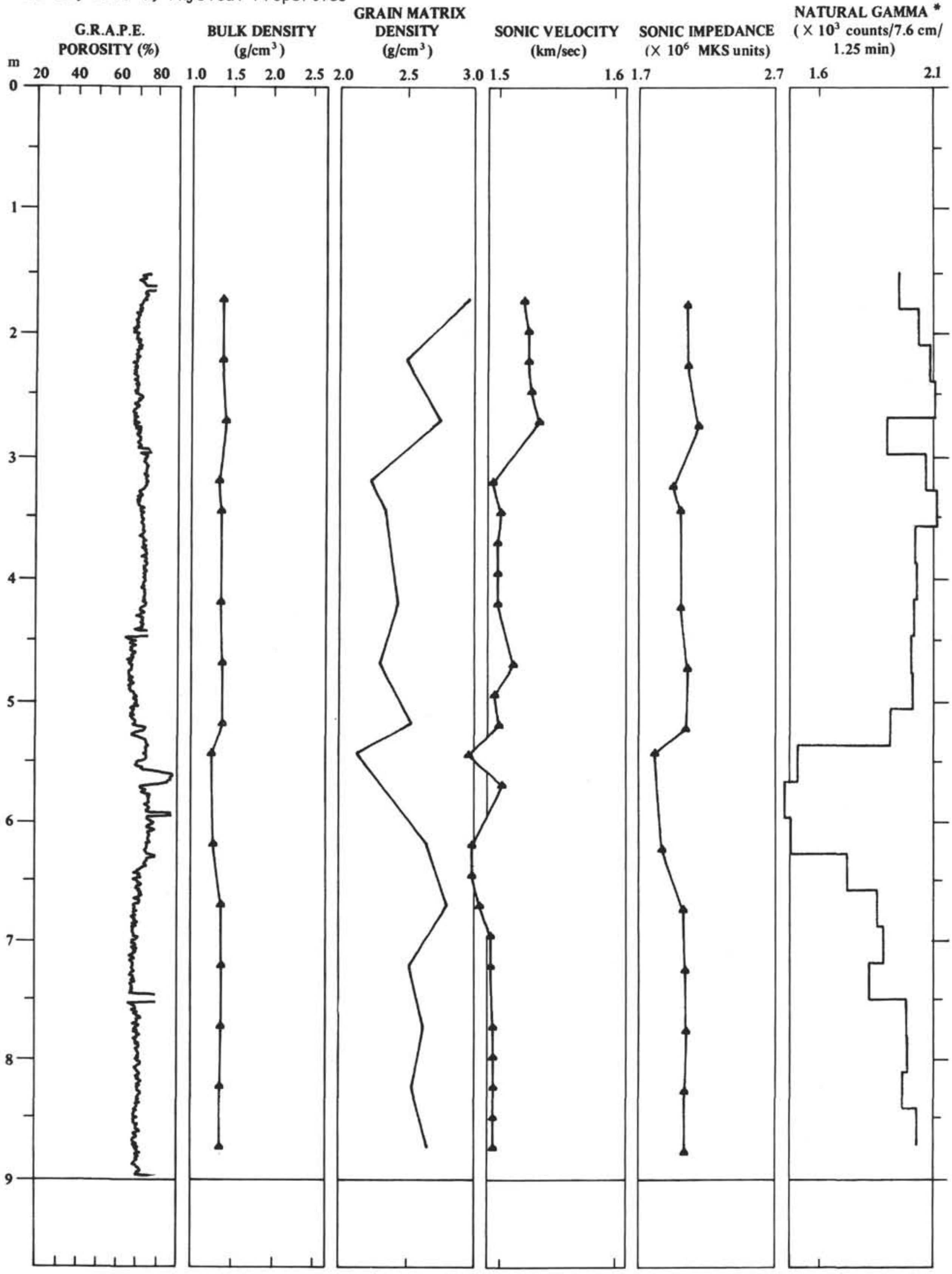
Mfsl. gp. (Sect. 1)	Preservation	Abundance
Foraminifera	Rare agglutinated benthonic forms only	
Calcareous nannoplankton		Absent
Radiolaria	Moderate	Few

Comments: Admixed Miocene and Middle Eocene Radiolaria.

Mfsl. gp. (Sect. 2-3)	Preservation	Abundance
Foraminifera	Rare agglutinated benthonic forms only	
Calcareous nannoplankton		Absent
Radiolaria	Poor	Very rare

Mfsl. gp. (Sect. 4,5-6)	Preservation	Abundance
Foraminifera	Rare agglutinated benthonic forms only	
Calcareous nannoplankton		Absent
Radiolaria	Moderate	Common

Site 68, Core 1, Physical Properties

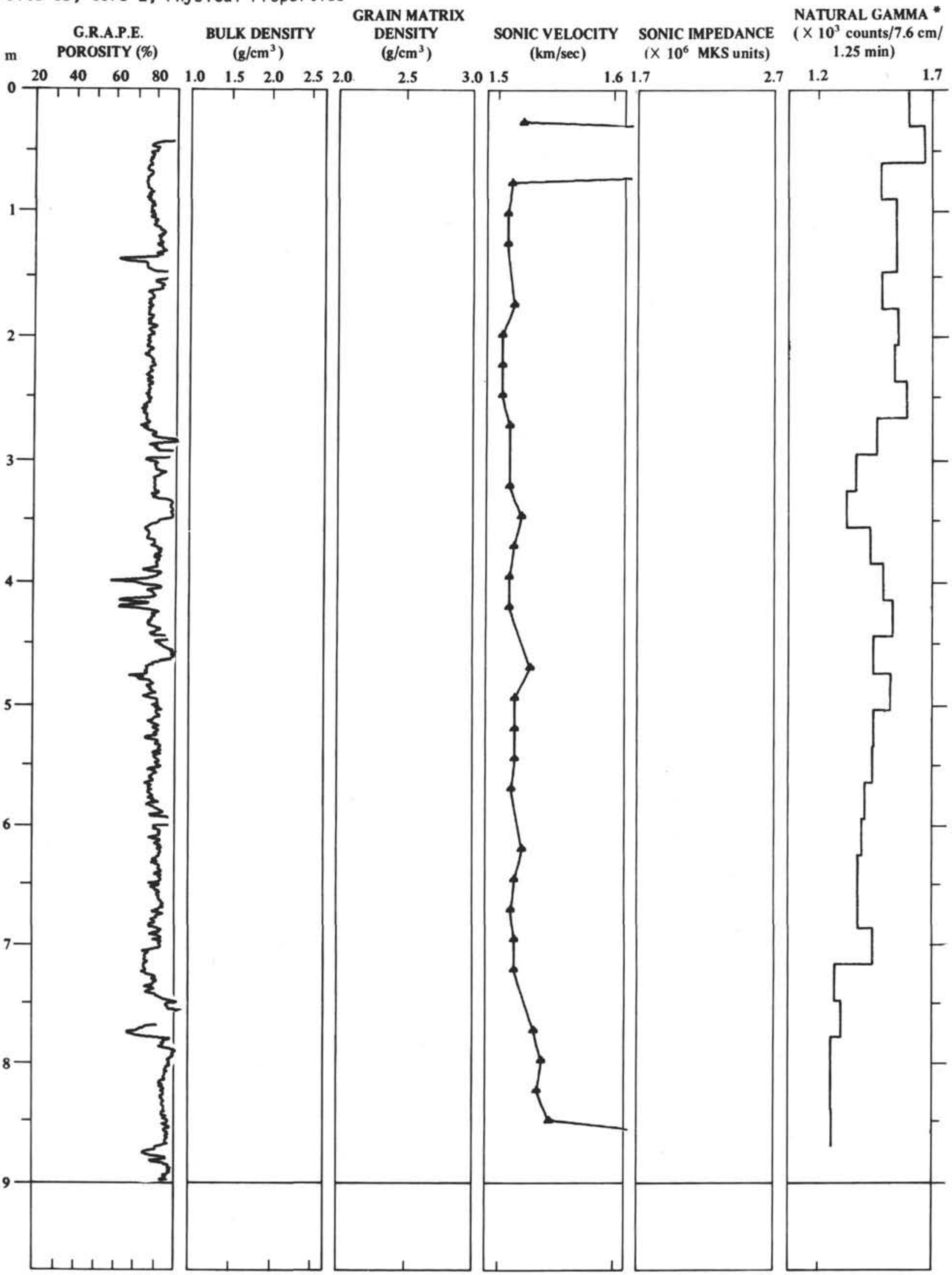


SITE 68 Core 2 Cored interval: 7.6-15 m

AGE	FORAMS	NANNOS	RADS	METERS	SECT. NO.	LITHOL.	LITHOLOGIC DESCRIPTION	% $CaCO_3$ (0 50 100)
MIDDLE EOCENE	(absent)	(absent)	*Podocyrtis chalara*	0–1.5	1	Top	Core badly disturbed. Cherty Claystone fragment. Brown. Probably top of indurated horizons.	
				1.5–3	2			
				3–4.5	3	Unopened		
				4.5–6	4		Clay w/ phillipsite. Dusky brown (5YR2/2). Scattered chips of Chert.	
				6–7.5	5		Smear summary Clay < 75% Phillipsite 5-15% Rads (fragments) 5-15%	
				7.5–9	6	Unopened		
					CC		Chert. Dusky brown (5YR2/2). Core 3 (15-24 m): No recovery. Total drilling: 24 m in Clay and Chert.	

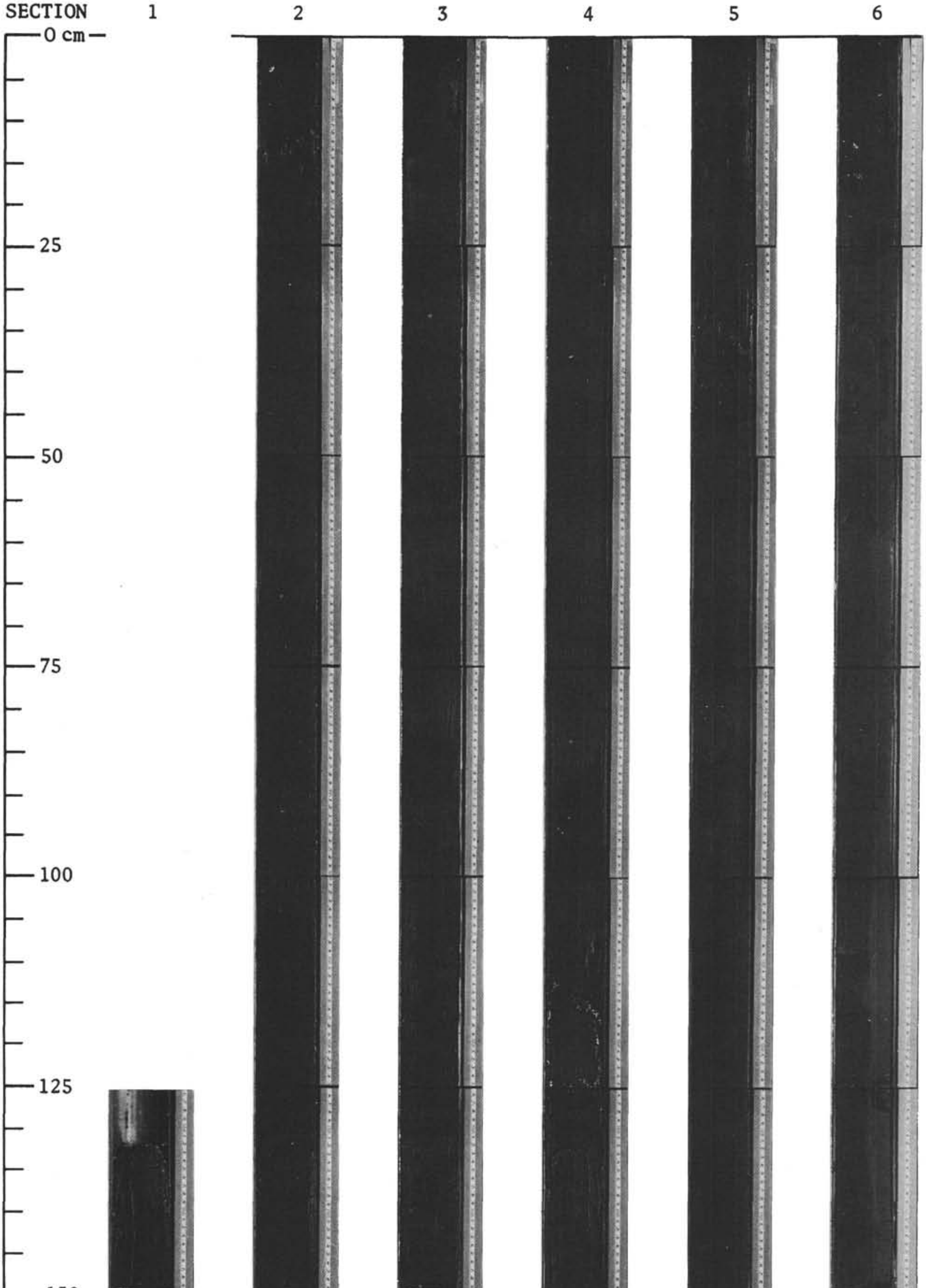
Microfossil group	Preservation	Abundance
Foraminifera	Rare agglutinated only	Benthonic forms
Calcareous nannoplankton		Absent
Radiolaria	Moderate	Common

Site 68, Core 2, Physical Properties

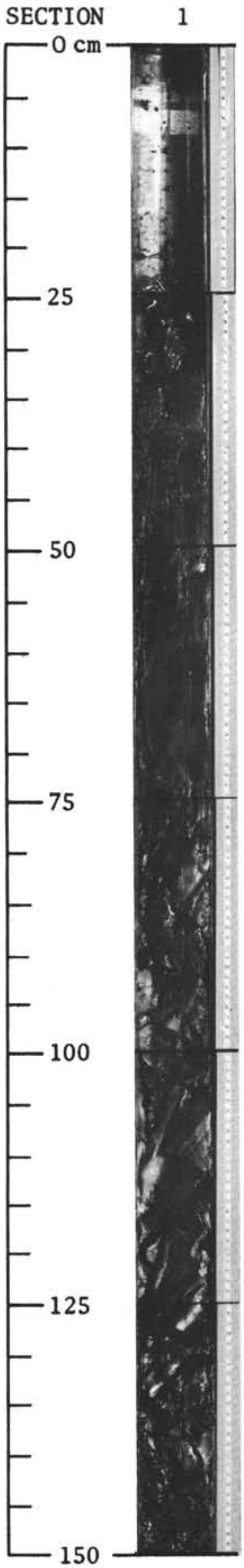


SITE 68A Core 1A Cored interval: 15 m

AGE	FORAMS	NANNOS	RADS	METERS	SECT. NO.	LITHOL.	LITHOLOGIC DESCRIPTION	% CaCO3 (0 50 100)
				1 2 3 4 5 6 7 8			Turbodrill trial. No perceptible penetration during coring. Chips recovered from the core catcher.	
					CC		<u>Chert and Claystone.</u> Dusky brown (5YR2/2)	



Site 68, Core 1, Sections 1-6.



Site 68, Core 2, Section 1.