4. SITE 46

Shipboard Scientific Party[1]

SITE DATA

Occupied: June 25, 1969.

Position: Fracture zone ridge on abyssal floor of Pacific:
Latitude 27° 53.0'N.
Longitude 171° 26.3'E.

Water Depth: 5769 meters.

Cores: One core.

Total Depth Subbottom: Nine meters twisted off in Cretaceous cherty and ashy clays.

MAIN RESULTS

The oceanic crust at this site is older than Late Cretaceous; lithified ash beds record a Late Cretaceous to Eocene or Oligocene episode of vulcanism.

BACKGROUND

At Site 45 the upper opaque unit of the seismic profiles had been found to contain lithified ashes and chert. These beds were encountered at very shallow depths below the sea floor, which left the brittle bottom-hole assembly unsupported, and led to its failure. Thus, the primary objective of the site, which was to determine the age and character of reflecting Horizon B′ and basement, had not been achieved. Two alternatives were considered: (1) To drill at a place with sufficient soft cover (upper transparent seismic layer) thereby burying the bottom-hole assembly before encountering hard drilling; (2) to drill at a site where the upper opaque layer is absent.

The first alternative was discarded for the following reason: over most of the area the thickness of the upper transparent layer is too small to provide adequate protection to our bottom-hole assembly. Adequate thickness appeared to exist on several small graben blocks along the *Argo* survey track to the westward, but offered two difficulties: (1) the presence of some strong reflectors (cherts?) within the upper transparent layer, and (2) excessive depth (300 meters +) to B′, possibly beyond the reach of bits having to penetrate cherty sequences.

The second alternative—to drill where the lower transparent layer comes to the surface and Horizon B′ lies at shallow depth—was therefore chosen. Such a place was presumed to exist on the flanks of some of the submarine hills or scarps, and the *Argo* profile was examined toward this end. The most promising site of this type, toward the west of Site 45, was a set of three hills at 2200 hours, May 23–0100 hours, May 24 on the *Argo* track. When reconstructed on a 1:1 scale (Figure 1), those hills appeared resolved, from east to west, into: (1) a small gentle anticline with a comparatively thin but complete stratigraphic section, (2) a larger anticline with a small normal fault on the east side, and (3) a steeper half-anticline with a major fault scarp on the eastern side. It appeared possible that the upper opaque and the lower transparent layer might outcrop on the east flank of the second feature, and almost certain that all of the section must come to the surface in the high fault scarp of the third.

The second feature was chosen, the *Argo* record confirmed that the three features trend NE-SW, and the largest and northwestern one, was the most obvious prospect for an exposure of the older beds. The profiler (Figure 2) vaguely revealed a reflective zone at a depth of some 3080 fathoms and this was taken to be Horizon B′, somewhat higher than anticipated from the *Argo* survey. Positioning the ship in its final approach with the precision depth recorder alone, the beacon was planted some 30 meters above the presumed outcrop of B′, hoping to obtain a seat in the "lower transparent" layer. The beacon came to rest at a depth of 5769 meters, some 20 meters higher than the spot aimed for, but well within the target area (no wider than about 200 meters).

The *Challenger* topographic and magnetic profiles across Site 46 are shown in Figure 3 and bottom soundings in Figure 4.

OPERATIONS

Site 46 was occupied on June 24, 1969. The fault scarp was located, crossed and recrossed with the

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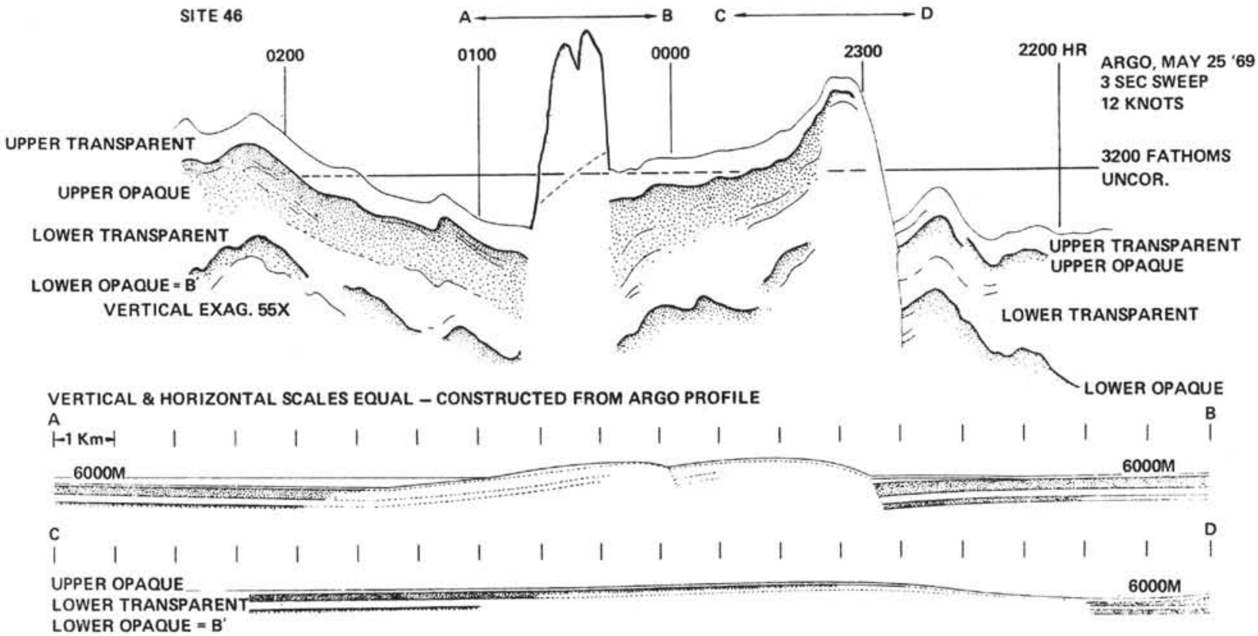

Figure 1. Argo *profile and section drawing at Site 46.*

profiler, and the final approach was made by depth recorder. The beacon was dropped at 0730 hours. Pipe could be washed in only 2.5 meters, and a core was taken here. The attempt to drill ahead resulted in failure of the bottom-hole assembly, and the site was abandoned at 1200 hours, June 25.

TABLE 1
Summary of Coring at Site 46

	Interval Cored (Below Mudline)		Recovery	
Core No.	(ft)	(m)	(ft)	(m)
46.0-1	0-30	0.0-9.1	30	9.1
Water depth: 5768.9 meters (18,927 feet)				

NATURE OF THE SEDIMENTS

At Site 46 the only successful core recovered 9 meters of water-rich sediment that was exceedingly disturbed and mixed; consequently the core sections were sampled only at the ends and were not split at the time of recovery.

The major lithology throughout the core is brown silty zeolitic clay in which clay minerals predominate, and limonitic grains are common. The zeolites (chiefly phillipsite?) are silt-size, euhedral laths with ragged margins and numerous tiny inclusions; very commonly they occur as crossed intergrowth twins. Limonitic grains are present in a number of forms such as: (1) silt to clay size, rounded to subangular granular aggregates,

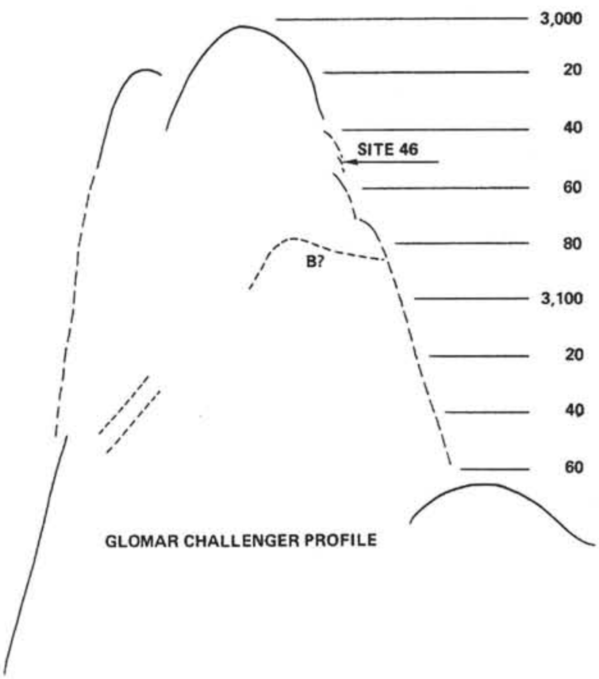

Figure 2. Challenger *profile at Site 46.*

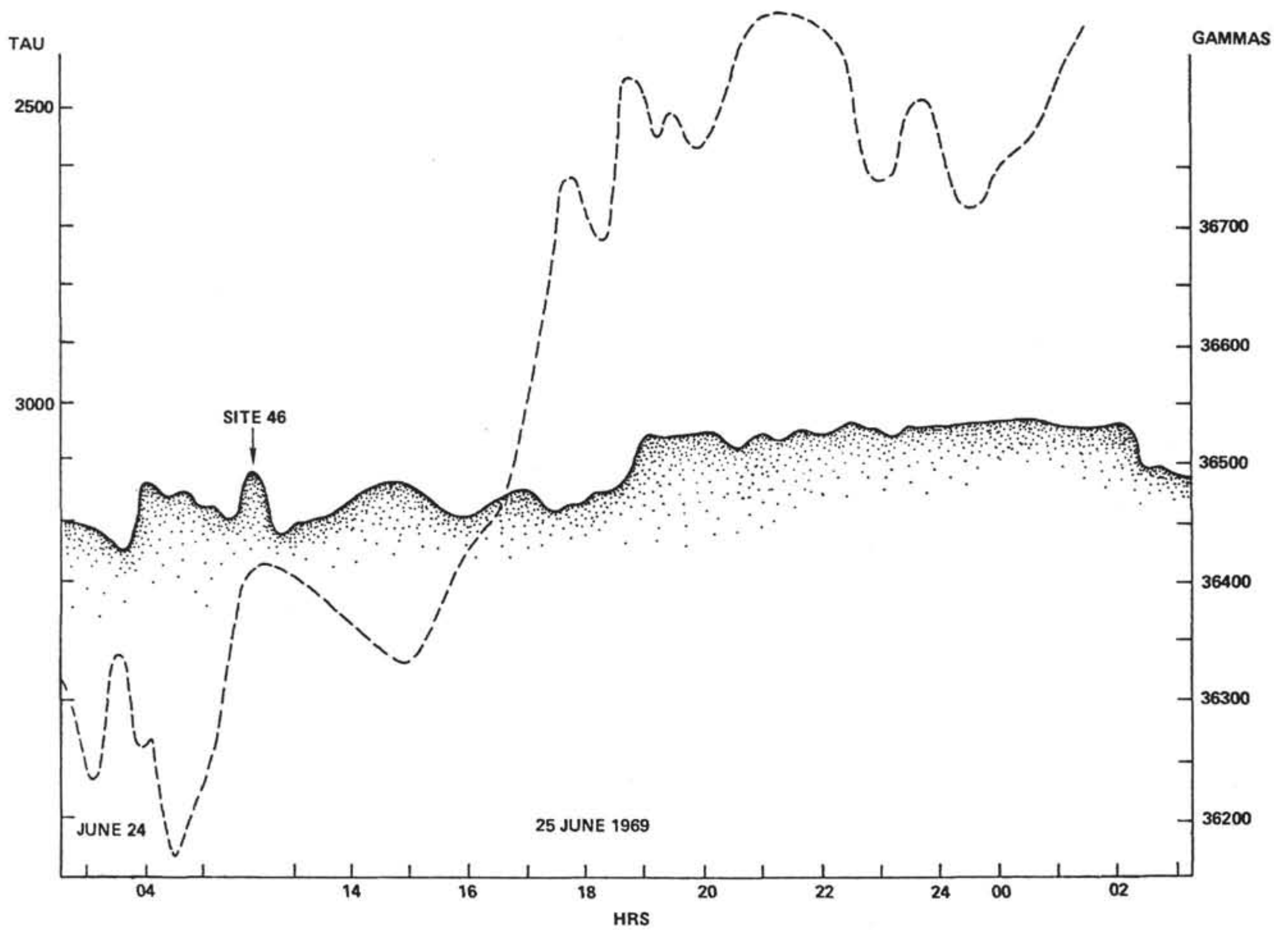

Figure 3. Challenger *bathymetric and magnetic profile at Site 46.*

(2) tiny circular rings (doughnut-shaped), and (3) more complex pretzel-like forms and elongate curved rods. Minor components, present in amounts generally less than 5 per cent, are coccoliths, pyrite, hematite, silt-size grains of quartz and feldspar (although both appear considerably more abundant in the X-ray diffraction studies of Rex), and altered volcanic glass; a very small amount of brown, unaltered glass is also present. Among the altered glass fragments are yellow palagonite, palagonite that has been altered to weakly birefringent clay minerals, and granular aggregates containing feldspar microlites, clay minerals, and small iron-oxide grains.

Mixed with this brown clay, as small fragments and isolated patches, are lesser amounts of the following materials:

A. Soft, light reddish and white zeolitic volcanic ash. This sediment has abundant clay minerals; sand-size grains of altered volcanic rock fragments and fine sand to silt size euhedral zeolites are common, and present in about equal amounts. The volcanic fragments are highly zeolitized and appear to have been glass shards. Also present are small amounts of limonitic and hematitic grains, euhedral barite crystals, and radiolarian internal molds of secondary quartz.

B. Punky and friable fragments of very light reddish-brown, fine-grained, radiolarian-rich mudstone that commonly contain either hollow molds–sometimes rimmed by opaline silica (see Chapter 38)–of dissolved Radiolaria or radiolarian molds filled by secondary quartz (Chapter 38). This material is similar to that recovered in the core catcher of Core 3, Hole 45.1.

C. Very hard, conchoidally fracturing chert that is light reddish-brown, has a waxy luster, and contains about 40 per cent radiolarian remains in 60 per cent of very fine-grained matrix. This matrix appears to consist of a mixture of microcrystalline quartz, clay minerals and small limonitic grains. Radiolarian remains are evident either as internal molds of fibrous chalcedonic quartz or as unfilled, circular cavities; these two types of preservation tend to alternate in layers. A few radiolarian tests have interior fillings of opaline silica, but no well-preserved skeletons are observed.

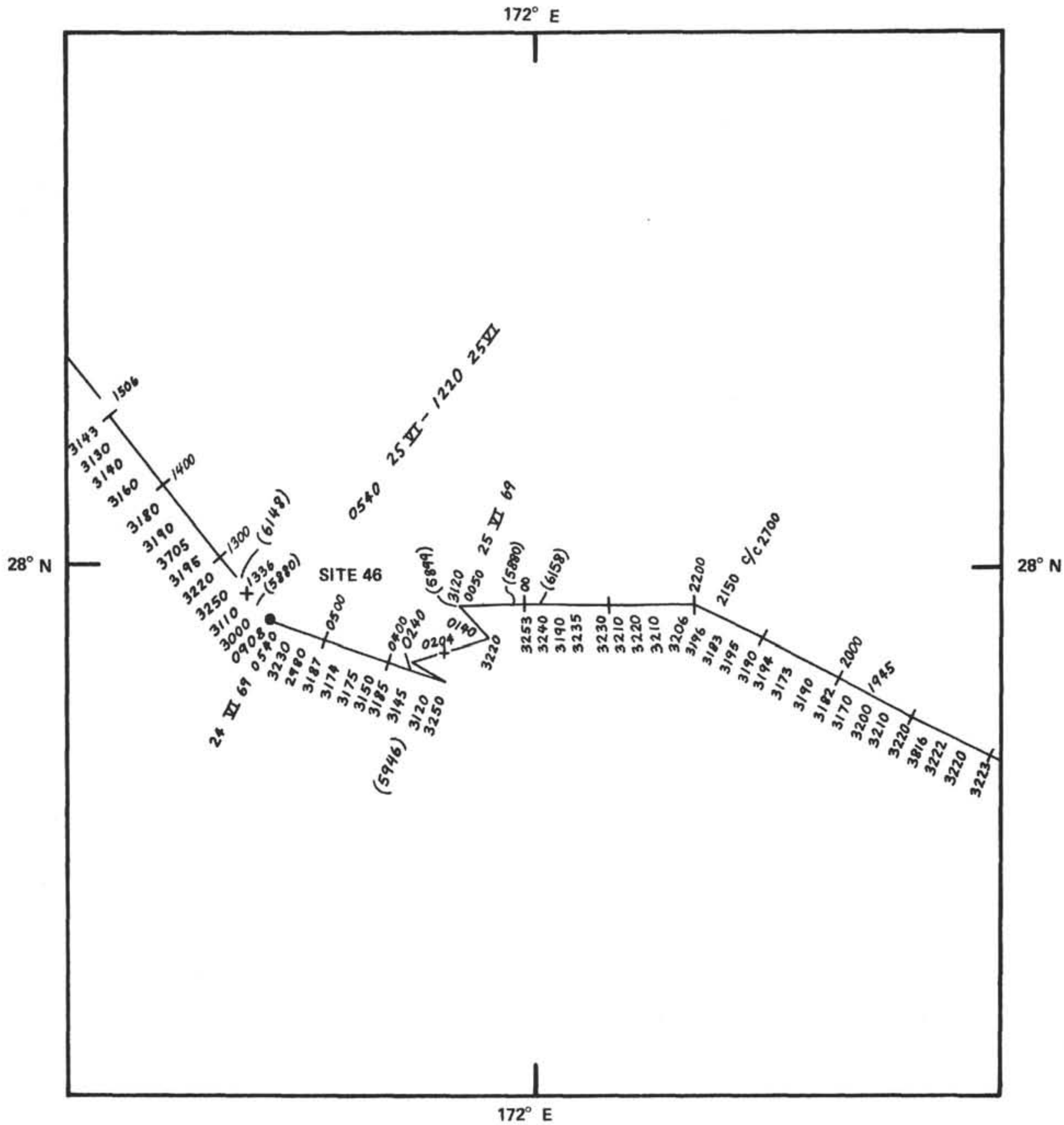

Figure 4. *Bottom soundings in area of Site 46.*

In the limited samples available it appears that rock types B and C above are in some cases interlayered producing alternate bands, 1 to 10 centimeters thick, of very hard and more friable rock. Other than degree of induration, both types of rocks are petrographically similar. Noteworthy is the fact that the radiolarian internal infillings of secondary quartz are abundant only in the mudstone, chert and unlithified ash layers and are absent in the brown zeolitic clays of this core. This may be due to a higher rate of deposition for the volcanic and more siliceous layers, and more rapid burial of the radiolarian tests, thus enhancing their chances for preservation even if only as secondary internal molds. In contrast, absence of radiolarian remains in the more slowly sedimented brown clays may reflect their total dissolution at or near the sediment-water interface.

It should be emphasized that the sediments in this core are thoroughly mixed, and all types of material mentioned above occur throughout the core. Although small angular fragments of mudstone and chert are most common in the top part of the core, they also occur in lesser amounts in all parts of it and probably represent thin lithified layers that are interbedded with soft brown clay, and that were disrupted during coring.

PHYSICAL PROPERTIES

Cores from this site were so water saturated that they were not split, consequently all physical property measurements may not represent *in situ* conditions.

Natural Gamma Radiation

Oligocene to Cretaceous brown zeolitic silty clay with ash layers was recovered from the upper 10 meters at Hole 46.0. Natural gamma radiation ranged from 150 to 2050 counts, with an average of about 800 counts/7.6-cm core segment/1.25 minutes. Several high gamma counts of 2050, 1650 and 1400 were recorded from unopened sections (see core plots). Since these high radiation layers correlate to intervals of low porosity on the GRAPE analog graphs, it is possible that they may be related to ash layers or to consolidated layers of zeolitic clay.

Porosity and Wet-Bulk Density

Porosity and wet-bulk density of the Oligocene-Eocene-Cretaceous brown zeolitic clay and ash, collected from 0 to 10 meters below the sediment surface at Hole 46.0 ranged from 71 to 97 and 1.15 to 1.50 g/cc, respectively. The two modes were 90 per cent and 1.20 g/cc and about 70 per cent and 1.40 g/cc (see core plots). The high porosity and low density of about 95 per cent and 1.10 g/cc are probably those of the disturbed-liquefied sediment. These porosity variations could not be compared directly to the lithology as the cores were not split. However, a low-porosity and high count suggest these intervals may be zeolitic volcanic ash (see core plot) or consolidated zeolitic clay.

Sound Velocity

Sound velocity measurements through Cretaceous-Oligocene brown zeolitic clay with ash, retreived from 0 to 10 meters at Hole 46.0, ranged from 1.50 to 1.53 km/sec and averaged 1.51 km/sec.

Penetrometer

Penetrometer measurements could not be made on sediments from Site 46 as the cores were not split.

Thermal Conductivity

One thermal conductivity measurement of 2.38×10^{-3} $cal^{-}(^{\circ}C^{-1} cm^{-1} sec^{-1})$ was obtained from Core 1, Section 2, at 85 centimeters. This core was not split, but the disturbed sediment is probably Oligocene-Cretaceous brown zeolite clay.

CONCLUSIONS

(1) The feature drilled is indeed a tilted fault block with Cretaceous exposed on the southeast flank.

(2) The first and only core yielded a mixture of watery Eocene brown clay and of Cretaceous ash, radiolarian chert, and possibly brown clay as well. The Cretaceous assignment is based on Radiolaria which, while of Cretaceous type, are too poorly preserved to be specifically or even generically identifiable; no closer age assignment has been achieved.

(3) The rock types in this core are much like those recovered from the "upper opaque" at Site 45, with the addition of radiolarian chert.

(4) It may, therefore, be concluded that the upper opaque layer contains beds as old as Cretaceous.

(5) Drilling probably continued into the lower part of the Upper Opaque layer; this may imply either that the lower transparent layer is thinned in this structure (which may predate most of the sediments), or that the vague reflection on the profile record lies above Horizon B′.

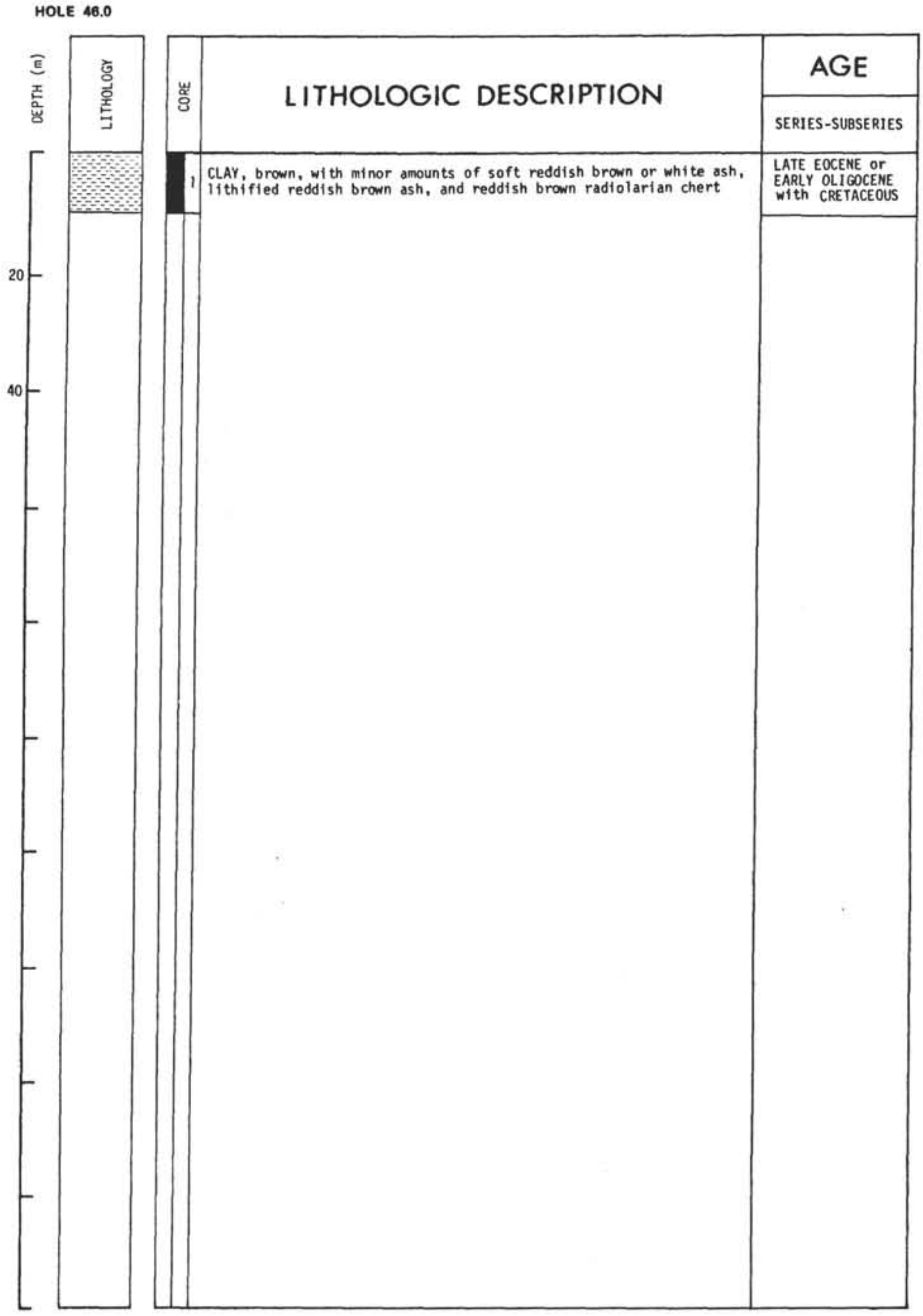

Figure 5. *Summary of lithology in Hole 46.0.*

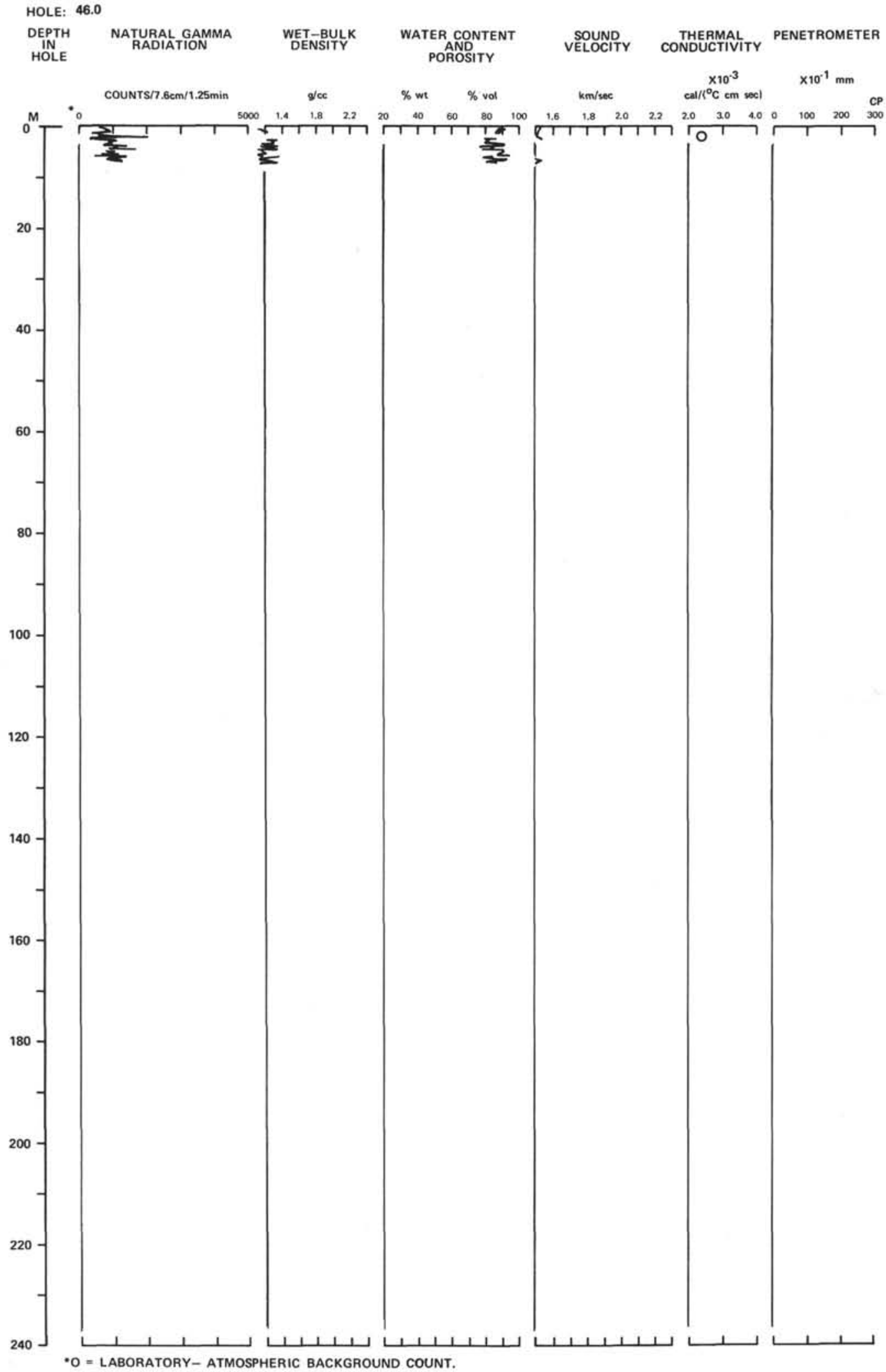

Figure 6. *Summary of physical properties in Hole 46.0.*

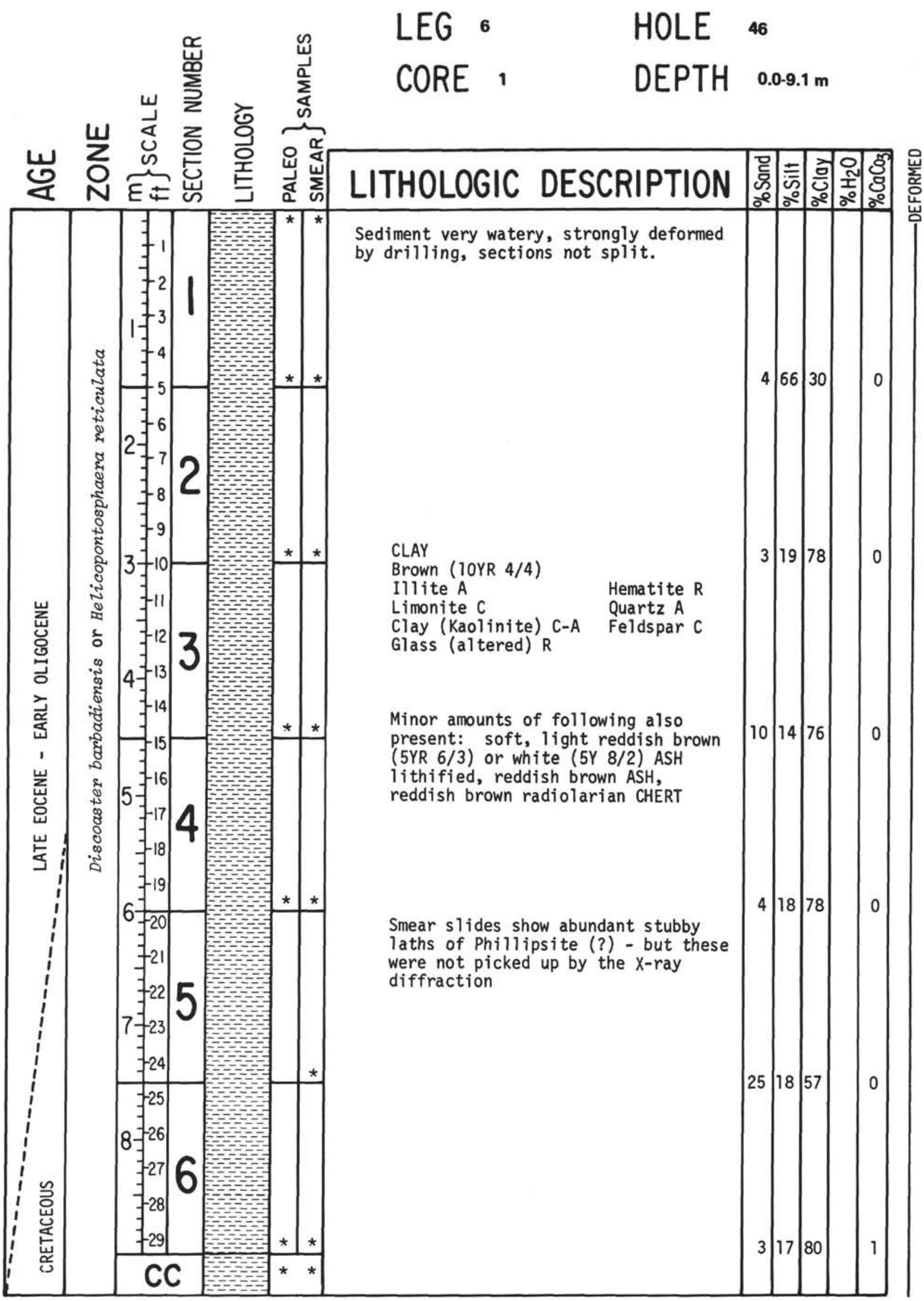

Figure 7. *Summary of lithology in Hole 46.0 Core 1.*

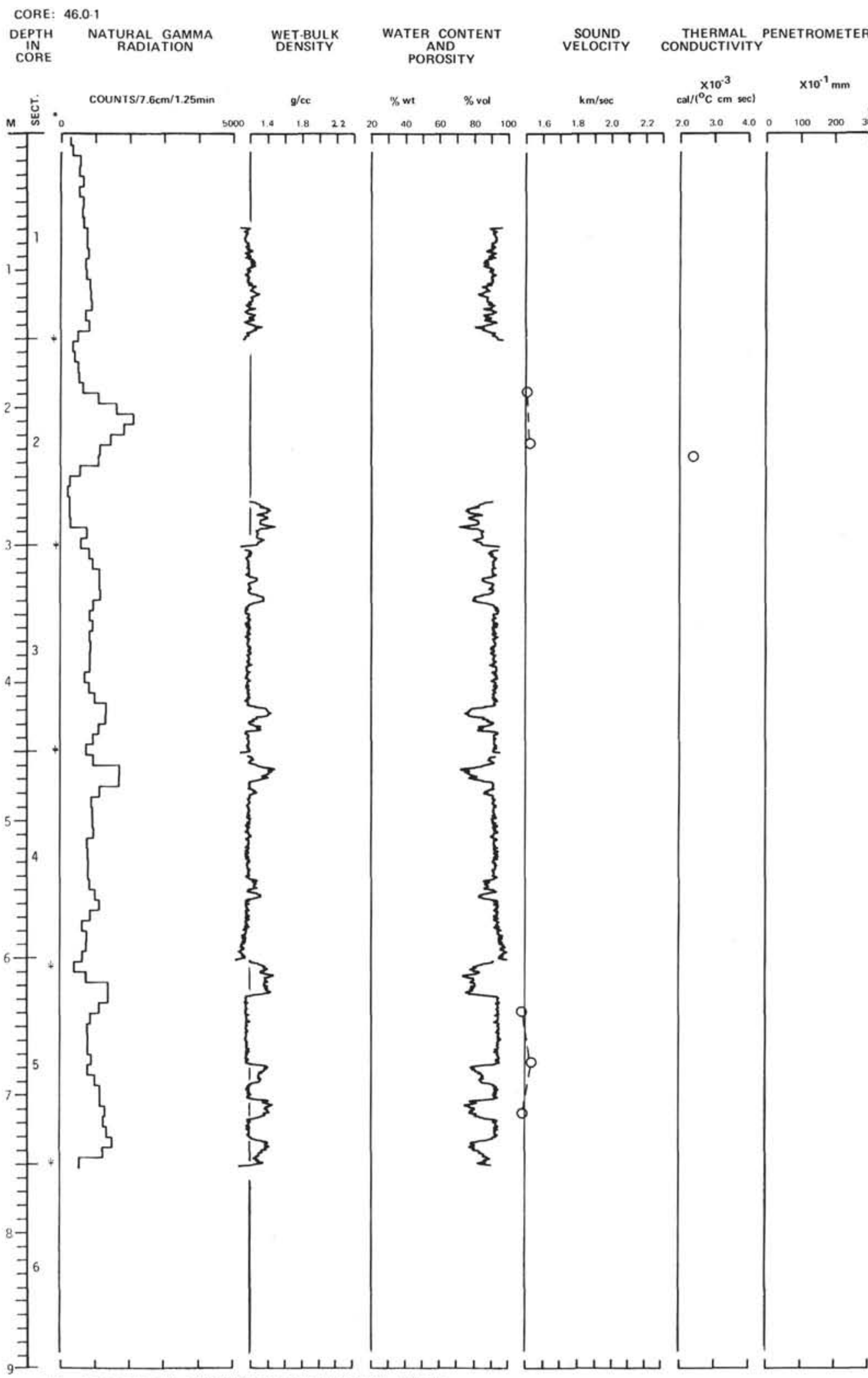

Figure 8. *Summary of physical properties in Hole 46.0 Core 1.*

LEG 6 **HOLE** 46.0

CORE 1 **DEPTH** 0.0-9.1 m

FORAMINIFERA	NANNOPLANKTON	RADIOLARIA
None	Assemblages of rare lower Oligocene to upper Eocene fossil nannoplankton are present throughout the single core recovered from this hole. Because of the limited number of taxa present and the obvious mixing of lithologies in this core, definite assignment of these assemblages to lower Oligocene or upper Eocene is not possible. Species present include *Coccolithus bisectus* and *Cyclococcolithina formosus*.	This core contains poorly preserved (quartz infolled) Cretaceous radiolarians derived from hard, light-colored rock fragments scattered throughout the core. A thin section contains rare better preserved specimens. The clay bulk of the core contains very rare specimens of Cenozoic species. TOP: *Dictyomitra spp.* and spiny-ringed saturnalins. BOTTOM: *Dictyomitra spp.* and spiny-ringed saturnalids.

Figure 9. *Summary of biostratigraphy in Hole 46.0 Core 1.*