12. WESTERN NILE CONE – SITE 131

The Shipboard Scientific Party[1]

SITE DATA

Occupied: September 18-20, 1970.

Position: Within an interchannel area of the distal part of the western Nile Cone in the Levantine Basin of the eastern Mediterranean.
Latitude: 33° 06.39′N;
Longitude: 28° 30.69′E.

Holes Drilled: Two holes (131 and 131A).

Water Depth: 3035 and 3037 meters, respectively.

Cores Taken: One and five, respectively.

Total Penetration: 49 and 272 meters, respectively.

Deepest Unit Recovered: Indurated foraminiferal ooze (limestone) of Pleistocene age.

MAIN RESULTS

Drilling to a depth of 272 meters established that the prominent subsurface reflecting horizon of the Nile Cone area corresponds to an interval comprising lithified detrital sandstones and partly indurated terrigenous clays of Pleistocene age and demonstrates that this horizon is not an extension of Reflector M, as had been previously postulated. The strata penetrated accumulated at a very high rate, possibly exceeding 30 cm/10^3y, and they are inferred to have generally been deposited by turbidity currents, exfor a few very thin intercalations of calcareous-rich pelagic ooze. The mineral composition of both the fine-grained clay components and the clastic sands is diagnostic of a Nile River source for the vast majority of the terrigenous components.

BACKGROUND

Having first established that the acoustically stratified and deformed sediments on the Mediterranean Ridge at Site 130 were of a predominantly terrigenous facies, and then suspecting that this clastic material came from the south by way of the Nile submarine distributary system, it was deemed scientifically worthwhile to drill an additional confirmatory hole directly into the Nile Cone itself, to test if both locations had indeed shared a common sediment source.

Of primary geologic interest was the identification of a prominent subbottom reflecting horizon which could be traced from the very shallowest regions of the Nile Cone to its distal extremity (see Plate 18 of Hersey, 1965) and which could be seen to continue out beneath the Herodotus Abyssal Plain and extend even into the southern flank of the Mediterranean Ridge (Figure 1). Layers of both acoustically transparent and acoustically stratified sediments above the reflecting horizon are clearly prograded on the Cone itself, being considerably thinner in the deeper water regions of the Levantine Basin. Where meandering deep-sea channel systems are developed their confining levees comprise only a local increase in thickness of an uppermost stratified sediment layer (Figure 2).

In recognizing and commenting on the prograded nature of the upper strata on the Nile Cone as revealed in the initial continuous seismic-reflection profiles obtained from this region of the eastern Mediterranean Sea, Hersey (1965) stated (p.86) that "the lower slope (of the cone) is not receiving sediment at present, although this does not preclude the possibility that modern sediments are being transported downslope to deep water."

Objectives

By selecting a prospective drill site on the lower reaches of the Cone, the Mediterranean Advisory Panel proposed to explore the reason why the relative sediment thickness above the prominent subbottom reflector in the deeper water areas was so thin. For example, if the strongly reflective interface was correlatable to Reflector M as had been proposed by Ryan *et al.* (1971) in their Figure 20, this would mean that only a little over a hundred meters of sediment had accumulated here since the Miocene in what was considered by most marine geologists to be a high-deposition-rate sedimentary province.

If it turned out that the reflecting horizon was not the top of an evaporite layer, contrary to what had been the case for Reflector M in other regions of the Mediterranean (e.g., see discussions of Sites 122, 124, 125, 132 and 134 in Chapters 4, 6, 7, 13 and 15, respectively), the advisory panel considered it worthwhile to drill some depth into and beneath this horizon to learn the reasons for its marked reflectivity and widespread distribution.

The layer immediately above the reflector is markedly transparent and is analogous in its acoustic signature to the relatively uniform blanket of pelagic ooze of Pliocene and Pleistocene age found on the Mediterranean Ridge in the Ionian Basin at Site 125. However, contrary to the distribution on the Ridge, the thickness of the transparent layer on the lower Nile Cone is anything but uniform. In fact, as illustrated most explicitly in Figure 1, it is markedly greater in thickness in the topographic lows, particularly beneath the Herodotus Abyssal Plain and southern flank of

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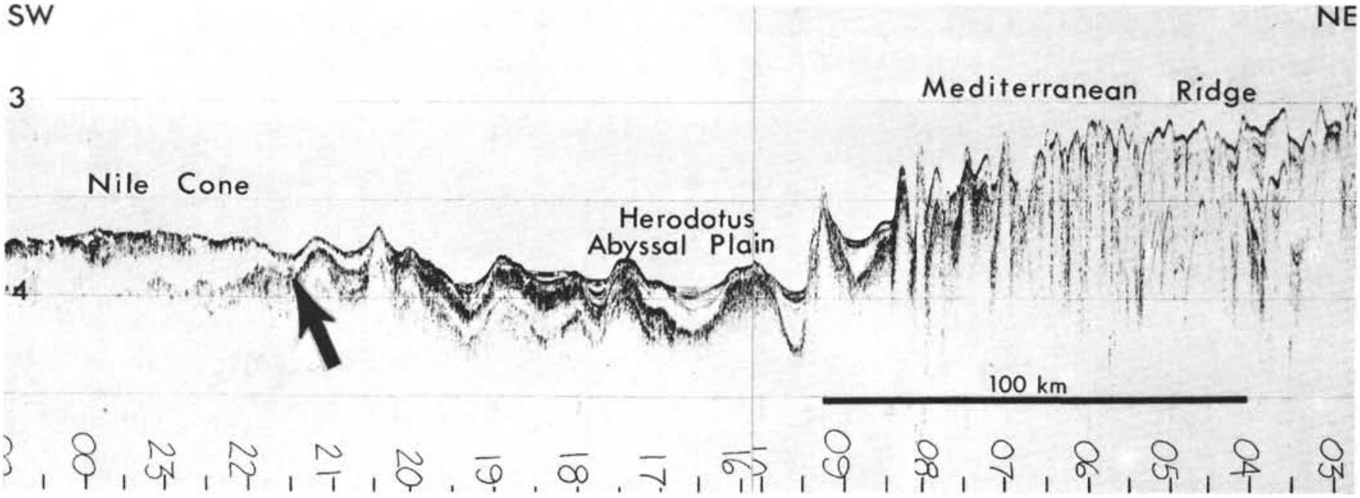

Figure 1. *A northeast-to-southwest oriented reflection profile made by the* Robert D. Conrad *across the Mediterranean Ridge, Herodotus Abyssal Plain, and distal Nile Cone. Note the extensive subbottom reflector, identified with an arrow, which passes from the cone into the ridge to a point where the superficial sediments are severely distorted. The transparent layer above the reflecting horizon is markedly thicker in topographic depressions and is practically absent over the crests of intrabasin hills. This seismic line was obtained in 1965 with an airgun sound source and appears as text Figure 22 in Ryan* et al. *(1971). The vertical scale is in seconds of two-way travel time. Vertical exaggeration is approximately 55:1.*

the Mediterranean Ridge, and is almost entirely lacking on the crests of intrabasin hills.

Thus, there also existed in the prospective drilling program a high priority incentive for learning the facies, origin, and cause of the differential distribution of this transparent layer as well.

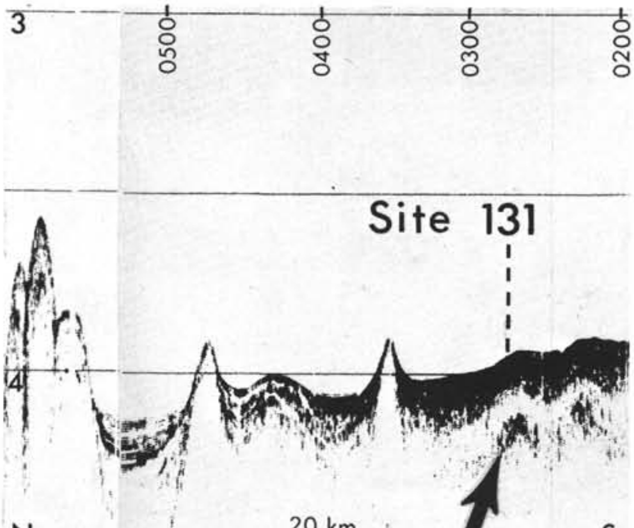

Figure 2. *A south-to-north portion of the* Robert D. Conrad *seismic line across the western Nile Cone where it extends into the souther flank of the Mediterranean Ridge. Site 131 is located on a small knoll in the distal region of the cone where the uppermost stratified interval is somewhat thinner than usual. The prominent subbottom reflector discussed in the text is shown with an arrow and lies 0.165 second below the sea bed at the drilling location.*

Strategy

The Mediterranean Advisory Panel chose to locate Site 131 on an existing *Robert D. Conrad* reflection profile, traversing the western portion of the distal Nile Cone (Figure 2) so as to place the drill hole directly in line between the previous Site 130 on the Mediterranean Ridge and the Nile Cone channel system. However, as learned from the experience of previous legs of the Deep Sea Drilling Project, any open hole drilling on a submarine cone or fan presents hazards as to potential collapsing and caving when penetrating through loose sand bodies. Although the intermediate transparent layer discussed above was not believed to be interstratified with sand layers because of its acoustic homogeneity, more superficial acoustically stratified layers were present, particularly near the deep-sea channel systems and their natural levees, and these regions were indeed likely areas of sand accumulation (see Figure 3). In fact, many piston cores in the Lamont-Doherty collection from the vicinity of the Nile Cone channels (e.g., Cores V10-53 and V10-55) contained layer after layer of well sorted sand alternating with mud and ooze (Emery *et al.*, 1966).

Because of the desirability of placing the drill hole in an interchannel area in order to recover a representative clastic sequence, if one were present, and yet because these same areas were characterized by an uppermost acoustically stratified interval comprising most of the internal structures of the levee systems, a conflict arose concerning where to locate the hole and yet avoid the fate of immediately encountering a thick, loosely consolidated sand body. As a compromise solution, the eventual drill site was targeted on the flank of a slight knoll which had the geometric appearance of a diapir. If this was a correct diagnosis, perhaps the youngest strata (deposited after the knoll was formed) would have been bypassed by turbidity currents transporting sand and thus the location would not offer a

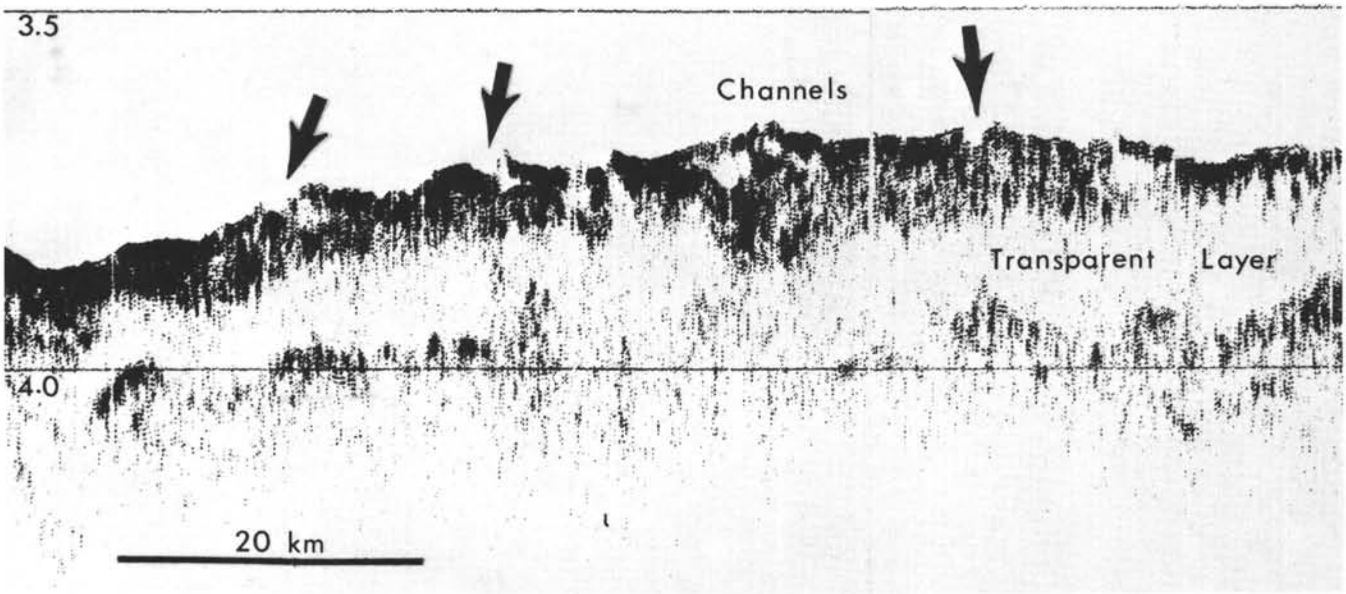

Figure 3. *A crossing of box-shaped deep-sea channels (arrows) and their slightly raised natural levees on the lower Nile Cone. Note the occurrence of acoustically stratified sediments above the transparent layer around the channel complex suggestive of the possible presence of alternating sequences of sands and clays. Vertical scale is in seconds.*

particularly great danger. Furthermore, at this proposed position the uppermost stratified layer was somewhat thinner than usual (making the danger zone also correspondingly thinner) and the time increment to the prominent subbottom reflector was only about 0.165 second (two-way reflection time) allowing the hole to be drilled in a relatively short period of time.

Challenger Site Approach

After the departure from Site 130 on the Mediterranean Ridge, the *Glomar Challenger* steamed directly southeast toward the new target on the western Nile Cone. The Herodotus Abyssal Plain (Figure 4) was reached at 0920 hours on September 18, 1970, where a water depth of 1635 tau (i.e., 3132 m, corrected for sound velocity) was registered. Another topographic knoll with a subsurface expression of an intruded diapir was then traversed at 1010 hours. This same (or at least very similar) structure had been previously charted at 0335 hours on the *Robert D. Conrad* reflection profile of Figure 2 and lay only about 15 km from the knoll on which the site was targeted.

Sensing, at 1129 hours, a gentle rise in the sea bed diagnostic of this second knoll, a free-floating marker buoy was launched (Figure 5) and the vessel immediately slowed to 4 ks to retrieve the streamed geophysical gear. Since a satellite navigational fix taken just a few minutes earlier had placed the *Challenger* track slightly to the west of the *Robert D. Conrad* profile, a course change to the east was given at 1142 hours when the towed gear was secured. The vessel proceeded eastward for five minutes to bring the two tracks together and then turned back to the north. Following the depth register on the 12 kHz precision echo sounder, we sensed that we had arrived at an optimum location at 1210 hours and gave the order to stop. At 1212 hours, the vessel came still in the water, and at 1216 hours the acoustic positioning beacon was dropped to the sea bed.

A series of satellite fixes obtained while drilling Hole 131 placed the site exactly at 0243 hours on the *Robert D. Conrad* profile of Figure 3, with a velocity-corrected water depth reading of 3038 meters.

OPERATIONS

The *Glomar Challenger* stayed on site for a day and a half between 1210 hours on September 18th and 0001

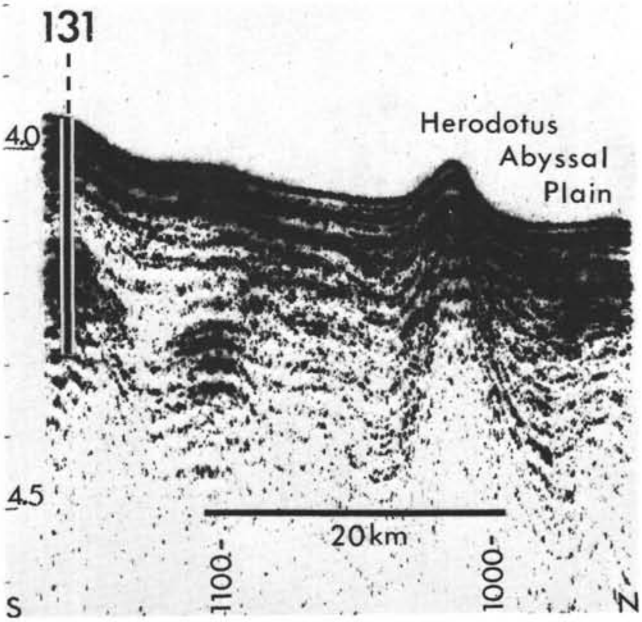

Figure 4. Glomar Challenger *airgun reflection profile on the approach to Site 131, located on the flank of a small knoll whose subsurface expression resembles a diapir. Vertical scale is in seconds of two-way travel time. Vertical exaggeration is ≈60:1.*

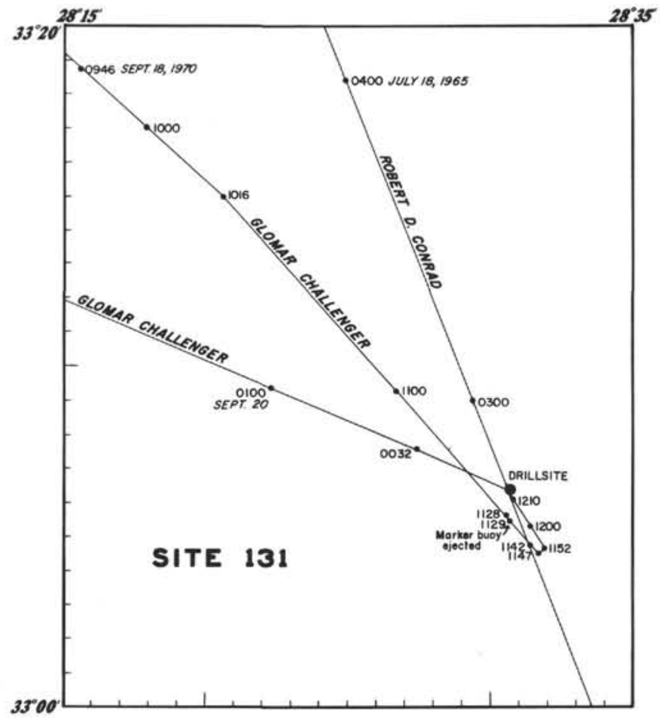

Figure 5. *Details of the site approach of the* Glomar Challenger *showing the location of the seismic profiles of Figures 2 and 4.*

hours on September 20th. Two holes were drilled and six cores were retrieved. The first hole was terminated because of a mechanical failure; the second was terminated and cemented after it was ascertained that the prominent acoustic reflector here is not correlative to the Mediterranean Reflector M as postulated by previous workers. The core inventory of both holes is given in Table 1.

Operations at Hole 131

Hole 131 was spudded in at 3035 meters water depth at 1830 hours on September 19th. The drill string was initially washed down without the core barrel inserted. Some thin resistant intervals were encountered at 7, 8, 19, and 20 meters below bottom. Following a total penetration of some 40 meters, the core barrel was sent down and the cutting of Core 1 was commenced using rotation and minor circulation. When the overshot tool for recovering the core barrel came up empty, a second futile attempt was made to raise the core. Meanwhile, after the pipe joint was remade, circulation was found to be blocked and it was surmised that the bit was plugged, with the core barrel stuck somewhere within the bottom hole assembly. It was decided, therefore, to pull out of the hole.

After the string was raised some 1000 meters above the mudline, the barrel unexpectedly became free and was hauled on deck at 0200 hours on September 19th. It was found to contain several sections of loose coarse sand.

The drilling crew felt that it would be futile to press on and drill through the surficial sand deposits here. However, the prognosis by the Mediterranean Advisory Panel that we should encounter only a relatively thin layer of sandy material above the transparent interval encouraged us to take a calculated risk to at least find out what the transparent material was comprised of. For the second attempt, a 2000 foot (609 m) offset was made to the west of the beacon.

Operations at Hole 131A

Contact with the sea bed at the offset Hole 131A was made at 3037 meters water depth. Again, a firm layer was immediately encountered at 7 meters below bottom. Drilling proceeded smoothly from there, and Core 1 was cut from 47 to 56 meters so as to be a continuous extension of the previous core from Hole 130.

At 74 meters, an abrupt change in formation was noted. First there was a momentary bouncing of the bit on something quite hard. This was followed by considerably stiffer and apparently more physically homogeneous materials. The penetration rate was purposely slowed to allow continuous circulation to pack the walls of the open

TABLE 1
Core Inventory – Site 131

Core	No. Sections	Date	Time	Cored[a] Interval (m)	Cored (m)	Recovered (m)	Subbottom Penetration (m) Top	Bottom	Lithology	Age
Hole 131										
1	6	9/19	0200	3085-3094	9	8.0	40	49	Sand	Quaternary
Hole 131A										
1	2	9/19	0700	3094-3103	9	1.7	47	56	Mud, Sand	Quaternary
2	CC	9/19	0915	3131-3140	9	0.1	84	93	Silty marl	Quaternary
3	1	9/19	1140	3187-3196	9	0.5	140	149	Sandstone, Mud	Quaternary
4	3	9/19	1445	3253-3262	9	3.9	206	215	Sand, Mud	Quaternary
5	2	9/19	1730	3310-3319	9	2.0	263	272	Limestone, Shale, Marl	Quaternary
Drill bit		9/19	2350						Marl	Quaternary
Total					45	8.2		272		
% Cored					16.5%					
% Recovered						18.2%				

[a]Drill pipe measurements from derrick floor.

hole with mud worked loose from expected sandy lithologies, thereby diminishing the likelihood of a second collapse.

Core 2 was cut at 84 to 93 meters, well within the level of the transparent interval[2], and recovered a dark gray marl without coarse clastics.

At about 115 meters the penetration again became rapid; at 130 meters it reached 2.5 m/min. A discernible drilling break was observed at 138 meters with an appreciable increase in resistance (see Figure 5). Core 3 was cut just below the break to examine the new lithology which, if one assumed an interval sound velocity of 1.7 km/sec for the overlying sediment, would be correlatable with the upper surface of the prominent subbottom reflector previously discussed. A well-cemented sandstone was recovered in Core 3, providing a good explanation for the high reflectivity at this level. This rock was interbedded in unconsolidated material of Quaternary age, and allows us to reject the previous identification of the reflecting interfaces as Reflector M or the top of the Late Miocene evaporite layer.

Core 4 was cut from 206 to 216 meters and was found to contain discrete layers of poorly sorted terrigenous sand and silt interbedded with semi-indurated black clay, indicating that there was probably no longer great danger of a cave-in. Since drilling was easy and rapid, and since valuable time had been lost with the mechanical failure of the first hole, it was decided to cut a last core at 263 to 272 meters subbottom to remove all possible contention that the reflector prominent at 0.165 second subbottom could be the M-reflector, and then to terminate the hole. Core 5 was recovered at 1730 hours and contained more Quaternary sand, silt, and mud, along with a piece of indurated foraminiferal ooze (limestone).

By then it was clear that the prognosis by the Panel was wrong and that certainly a great deal of young Nile clastics did not bypass the Nile Cone as had been thought previously. Although an original objective of sampling preevaporitic sediment could not be achieved here, the discovery that the Nile Cone was indeed built up by rapidly accumulating terrigenous sediment was a positive contribution to correct some current misconceptions.

BIOSTRATIGRAPHY

The cores taken from Holes 131 and 131A consist primarily of dark silty muds rich in carbonaceous matter and sands with mainly well-rounded, occasionally frosted and wind polished quartz grains and smaller rock fragments. The fossil content is, generally speaking, not high. The fossils are sorted in part.

No calculations of the sedimentation rate can be made because of the lack of a definite marker point to which reference could be made; the rate, however, probably exceeds 30 $cm/10^3$ y.

The best represented fossil groups are foraminifera, mainly planktonic, diatoms, coccoliths, pteropods, and various fossil debris, including fragments of pelecypods shells, gastropods, otoliths, and fragments of (eroded) bryozoa. No important reworking across stratigraphic levels has been noticed in the foraminifera, but some has been observed in the nannoplankton.

[2]The top of the transparent interval is identified at 0.09 second on Figure 4. Its bottom coincides with the prominent subbottom reflecting horizon at 0.165 second.

Planktonic Foraminifera (M.B.C.)

The distribution of planktonic foraminifera in the Quaternary succession penetrated on the Nile Cone (Holes 131, 131A), resulting from the investigation of 18 selected samples, is indicated in a range chart in Table 2. Also included are data on other fossil remains as well as on some minerals present in the greater than 63 micron fraction.

Following are a few comments:

(1) The sedimentation is mainly terrigenous, however no evidence of extensive reworking of the foraminifera from older deposits has been noticed.

(2) Dominantly pelagic sediments are present in samples 131A-1-1, 138-141 cm; 131A-1-2, 12-15 cm; and 131A-4-1, 110-112 cm. The second sample contains abundant pyrite concretions, indicative of reducing conditions near the sediment-water interface.

(3) Some cold planktonic faunal elements are present in the following samples: 131A-1-2, 12-15 cm; 131A-4-2, 66-69 cm; and 131A-5-1, 110-113 cm. Indications of a cold climate include the (relative) abundance of *Globigerina pachyderma,* always right-coiling, and the absence of definite warm water indicators. These indications are more reliable for the first of the three cited samples, which is a dominantly pelagic sediment.

(4) Scanty tests of *Globigerinoides ruber* (pale) pink in color are present in sample 131A-1-1, 138-141 cm. Their presence suggests a post-Pleistocene age for at least part of Core 1, which was cut from 45 to 54 meters below the sea floor.

Benthonic Foraminifera (W. M.)

Benthonic foraminifera are rare in the Quaternary sections penetrated at Site 131. Their range distribution is given in Table 3. The presence of displaced shallow-water benthonic foraminifera has been noted in the following samples:

Elphidium crispum: 131-1-6, 51-54 cm.

Ammonia beccarii: 131A-1-1, 124-127 cm; 131A-3, CC; 131A-4-1 91-94 cm; 131A-5-1, 110-113 cm.

Quinqueloculina sp: 131A-4-1, 110-112 cm; 131A-5-1, 110-113 cm.

The specimens of shallow water forms are sparse, and often show evidence of abrasion.

Nannofossils (H. S.)

All six cores taken at this site are assigned to the Quaternary because of their nannofossil and diatom contents. The dark silty muds of the drilled section contain excellently preserved diatoms and siliceous sponge spicules. The coccoliths and discoasters, unfortunately are not as well preserved. The best nannofossil assemblages are found in Cores 131-1, 131A-1, and in the thin layer of pelagic sediment between the dark sapropelitic sediments at 131A-4-1, 111-113 cm.

Coccoliths in Selected Samples from Holes 131 and 131A are listed below.

TABLE 2
Distribution of Planktonic Foraminifera and Other Fossil Remains in Quaternary Cores of Holes 131 and 131A from the Western Nile Core

Depth Below Sea Floor (m)	Recovery (m)	Core Number	Section Number	Sample Interval (cm from top)	PLANKTONIC FORAMINIFERA: *Globigerina*						*Globigerinoides*										*Globorotalia*							Others				B.F.[a]		Other Fossils							Various			
					bulbosa	*bulloides*	*eggeri*	*falconensis*	*pachyderma*	*quinqueloba*	*adriaticus*	*conglobatus*	*elongatus*	*helicinus*	*pyramidalis*	*quadrilobatus*	*ruber*	*sacculifer*	*tenellus*	*trilobus*	*acostaensis*	*cf. crassaformis*	*dutertrei*	*inflata*	*scitula*	*truncatulinoides*	*sp.*	*Globigerinita glutinata*	*Hastigerina siphonifera*	*Orbulina bilobata*	*Orbulina universa*	Deep-water	Shallow-water (displaced)	Pteropods	Gastropods	Pelecypod fragments	Siliceous sponge spicules	Echinoid spines	Spores	Organic matter	Pyrite	Glauconite	Quartz	Mica
30			1	40-43																				○									○			○							●	
			3	28-31																		○		○									○	○		○		○					●	
	8	131-1	5	30-33													○					○							○						○						○		●	
			6	51-54																													○	○	○			○					●	○
39			CC	CC																											○			○							○		●	○
47			1	138-140		●	●		●	●	●		●	●	●	●	●			●			●	○	●			●	●		○	○		●							○			
	2.1	131A-1	2	12-15		●	●		●	●	●			●	●		●								●			●				○		○	○						○			
56			CC	CC		●			○		○			○	○		○							○	○							○							○			○	●	○
93	0.1	131A-2	CC	CC						○																										○							●	○
140	0.3	131A-3	1	124-127					○					○		○	○						○					○			○		○									○	●	○
149			CC	CC	○	○	○	○	○							○	○	○		○			○	○		○		○			○	○		○		○				○	○	○	●	
206			1	110-112		●			●	●		●	●		●	●	●	●						●	●	●				●	●		○								○		○	
			2	66-69		○			○								○					○	○	○	○											○					○	○	●	○
	3.9	131A-4	3	91-94		○											○					○		○				○			○	○	○				○					○	●	○
215			CC	CC			○		○																											○					○		●	
263			1	110-113		●		●	●						●		●		●				●	●	●		●	●			●	○	○	○		○					○	○	●	○
	1.4	131A-5	2	9-12	●	●	●		●	●							●		●				●	●			●	●			●											○	●	○
272			CC	CC	●	●	●		●	●											●		●	●			●				●	○											●	

[a]Benthonic foraminifera.

TABLE 3
Range Distribution of Benthonic Foraminifera in Hole 131A on the Western Nile Core

Age	Depth Below Sea Floor (m)	Cores	*Bolivina* cf. *antiqua* d'Orb.	*Valvulineria bradyana* (Forn.)	*Ammonia beccarii* (Linn.)	*Cibicides boueanus* (d'Orb.)	*Bulimina fusiformis-gibba*	*Elphidium macellum* (F. & M.)	*Cassidulina* cf. *laevigata* d'Orb.	*Patellina corrugata* Will.	*Bolivina catanensis* Seg.	*Bolivina* cf. *spathulata* (Will.)	*Uvigerina peregrina-mediterranea*	*Astrononion stelligerum* (d'Orb.)	*Pullenia bulloides* (d'Orb.)
Pleistocene	Sea Floor 3047 m														
	47-56	1	X	X	X	X	X	X	X	X					
	84-93	2			X										
	140-149	3								X	X	X	X		
	206-215	4					X							X	
	263-272	5													X

Quaternary

Samples: 13-131-1-5, 12 cm; 131-1-6, 43 cm; and 131-1, CC:

Ceratolithus cristatus
Coccolithus pelagicus
Cyclococcolithus leptoporus
Gephyrocapsa oceanica
Helicosphaera carteri
Pontosphaera multipora
Pontosphaera scutellum
Schypholithus fossilis
Syracosphaera pulchra

A diatom flora is present in all three samples

Reworked nannofossils: (Upper Cretaceous-Paleocene)

Arkhangelskiella cymbiformis
Cruciplacolithus tenuis
Micula staurophora

Samples 13-131A-1-1, 137 cm and 131A-1-2, 19 cm. (Nannofossil assemblage without diatoms, well preserved):

Coccolithus pelagicus
Cyclococcolithus leptoporus
Gephyrocapsa oceanica
Helicosphaera carteri
Pontosphaera scutellum
Pseudoemiliania lacunosa
Rhabdosphaera stylifera
Scapholithus fossilis
Scyphosphaera apsteini
Syracosphaera pulchra
Thoracosphaera heimi

Reworked: *Micula staurophora* (Upp. Cret.)

Samples: 131A-1-3, 28 cm and 131A-1, CC (Nannofossil assemblage and diatom flora. Nannofossils not so well preserved and less abundant):

Braarudosphaera bigelowi
Coccolithus pelagicus
Gephyrocapsa oceanica
Helicosphaera carteri
Pseudoemiliania lacunosa
Syracosphaera pulchra

Reworked Upper Cretaceous Nannofossils:

Arkhangelskiella cymbiformis
Micula staurophora
Prediscosphaera cretacea
Tetralithus obscurus

Reworked Paleocene Nannofossils:

Braarudosphaera turbinea
Zygolithus junctus

Samples: from 131A-2, CC: barren with respect to nannofossils, only a diatom flora

Samples: 13-131A-3-1, 120 cm and 131A-3, CC: Diatoms and siliceous sponge spicules, some nannofossils of same assemblage as above.

Samples 13-131A-4-1, 112 cm and 131A-4-1, 113 cm (Nanno ooze sediment without siliceous microfossils Coccoliths very abundant and well preserved):

Ceratolithus cristatus
Coccolithus pelagicus
Cyclococcolithus leptoporus
Gephyrocapsa oceanica
Helicosphaera carteri
Pontosphaera japonica
Pseudoemiliania lacunosa
Rhabdosphaera clavigera
Rhabdosphaera stylifera
Scyphosphaera apsteini
Scyphosphaera recurvata
Syracosphaera pulchra
Thoracosphaera heimi
Thoracosphaera imperforata
Umbilicosphaera mirabilis

Samples 131A-4-2, 63 cm; 131A-4-3, 92 cm; and 131A-4, CC: Poorly preserved nannofossils of same assemblage, also diatoms and sponge spicules

Reworked: rare Pliocene discoasters (*D. surculus*)

Samples 131A-5-1, 137 cm; 131A-5-2, 19 cm; and 131A-5, CC (Poorly preserved nannofossil assemblages with diatoms and sponge spicules):

Braarudosphaera bigelowi
Cyclococcolithus leptoporus
Gephyrocapsa oceanica
Helicosphaera carteri
Pontosphaera japonica
Pontosphaera scutellum
Pseudoemiliania lacunosa
Rhabdosphaera stylifera
Syracosphaera pulchra

LITHOSTRATIGRAPHY

The sediments recovered from both holes belong to the same lithologic unit, characterized by numerous sequences of bedded sands, silts, and clays intercalated between very thin intervals of calcareous ooze. The only notable change in sediment type was Core 2, which was cut at 84 to 93 meters below bottom within the acoustically transparent interval on the reflection profile, and which failed to recover coarse material. However, considering the very low amount of material obtained in this coring attempt, we unfortunately cannot place a great deal of emphasis on this.

The sands, silts, and clays are interpreted to have been deposited primarily from turbidity currents and possibly other grain flow processes of uncertain nature. The calcareous oozes, on the other hand, appear to reflect pelagic deposition. They are plastic in nature and rich in microfossils, particularly coccoliths, and have carbonate contents reaching 71.5 per cent. Only three thin light olive gray colored beds of pelagic ooze have been found: at 47.9 to 48.2 meters, 48.5 to 48.8 meters, and 207.1 to 207.15 meters.

In contrast, the inferred turbidite deposits consist largely of terrigenous sands and clays and the calcium carbonate content is exceedingly low (invariably under 7%). Two different facies are distinguished.

Facies A (Sands)

Thick sand beds with thin interbedded clays make up the upper part of the sedimentary column (Cores 1 and 1A).

The sands are medium- to fine-grained and display no particular primary bedding structure. Grading is not visible in the bulk of the beds, but the upper portion is slightly finer. The beds are very thick; up to 2.86 meters. A large amount, perhaps exceeding 20 per cent, of fine-grained matrix is present, particularly in the lower basal intervals of discrete layers. The sand grains are mainly frosted and unfrosted rounded grains of quartz and plagioclase; heavy minerals include hornblende, epidote, and less commonly, clino- and orthopyroxenes (bronzite, hypersthene). Pyrite is a common constituent of the darkest organic-rich intervals. Rare shell fragments, including displaced shallow-water fauna, are also present.

The clay layers on top of the sand beds are dark gray and range in thickness from 2 to 15 cm. They are composed of fine-grained quartz and clay minerals (largely montmorillonite).

Soft clay pebbles (intraclasts) are embedded in the sands at random levels in the sequence; one bed consists almost exclusively of such clasts. They are plastic, rounded, and deformed, and range in size from 2 to 20 mm. Clasts both light and dark gray in color are present, indicating two or more different sources. The light gray intraclasts are nanno oozes, while the dark gray intraclasts are of the same composition as the dark terrigenous clays topping the sand layers.

Facies B (Sandy Clays)

Starting with Core 2 at 84 meters, homogeneous black clays dominate the sequence. Sands are present in Core 3 at 140 meters and below, but they always comprise less than half of the section. In Core 5, believed to be at a level correlatable with the prominent subbottom reflector of Figure 4, thick layers of clean sand occur together with clayey sand, as in Facies A. The passage from clayey sand to silt and clay is gradational, and the clay intervals are laminated. The mineralogical composition of sands and clays is the same as in the overlying Facies A, but in the abundant clay horizon of Facies B two components, pyrite and diatoms, are more commonly present.

We noted a rapid increase in the degree of induration with depth. At 40 meters, some of the clay layers were semi-indurated (Core 1A-1), and at 84 meters they were strongly indurated (Core 2A, CC). At 140 meters, the first pieces of sandstone were found. Finally, at 272 meters, a foraminiferal ooze occurs cemented into limestone (5A, CC and a drill bit sample).

PHYSICAL PROPERTIES

Because recovery was very poor in both holes drilled at Site 131, physical properties were measured only on the first core of each hole.

Core 131-1 comprised six sections of coarse sand with a bulk density of 1.51 gm/cc, a grain density of 2.12 gm/cc, a water content of 37.7 per cent, and a porosity of 54.0 per cent. Core 131A-1 comprised a sequence of nanno oozes with intercalated clayey sands. The oozes have a bulk density of 1.46 gm/cc, a grain density of 2.65 gm/cc, a water content of 49.7 per cent, and a porosity of 72.4 per cent. Corresponding measurements recorded in the clayey sands are 1.82 gm/cc, 2.56 gm/cc, 25.7 per cent, and 47.0 per cent.

SUMMARY AND CONCLUSIONS

Identification of the Prominent Subbottom Reflector

The column that was drilled to a subbottom depth of 272 meters at the second hole at Site 131 most certainly penetrated through the prominent subsurface reflecting horizon discussed in earlier sections of this chapter. This horizon at 0.165 second (two-way reflection time) in the vicinity of the drill site is actually the upper surface of a series of strongly reverberant echo traces that have a span of approximately 0.2 second and can be followed as a group of reflectors seaward beneath the Herodotus Abyssal Plain. The top of this group is believed to coincide with the first contact with indurated sandstone of Quaternary age found in Core 3, cut between 140 and 149 meters below bottom. A noticeable decrease in the drilling rate was observed at 138 meters, just prior to the coring attempt. In fact, Core 3 was taken to learn what the new, more resistant lithology was.

By assigning the top of the reflectors to a subbottom depth of 138 meters, one can calculate an interval sound velocity of $\approx$1.7 km/sec for the overlying sediment layer above the reflectors, a value entirely compatible with calculations at other DSDP holes in the Mediterranean involving sediments of similar lithologies. We can refine this measurement if we assign the abrupt drilling break observed at 74 meters to the contact between the acoustically transparent part of the overlying strata and the uppermost acoustically stratified part. Placing the boundary at 0.09 second, as measured on Figure 4, we can then calculate separate interval velocities of 1.64 km/sec for the superficial stratified zone and 1.74 for the subjacent transparent body (see Figure 6).

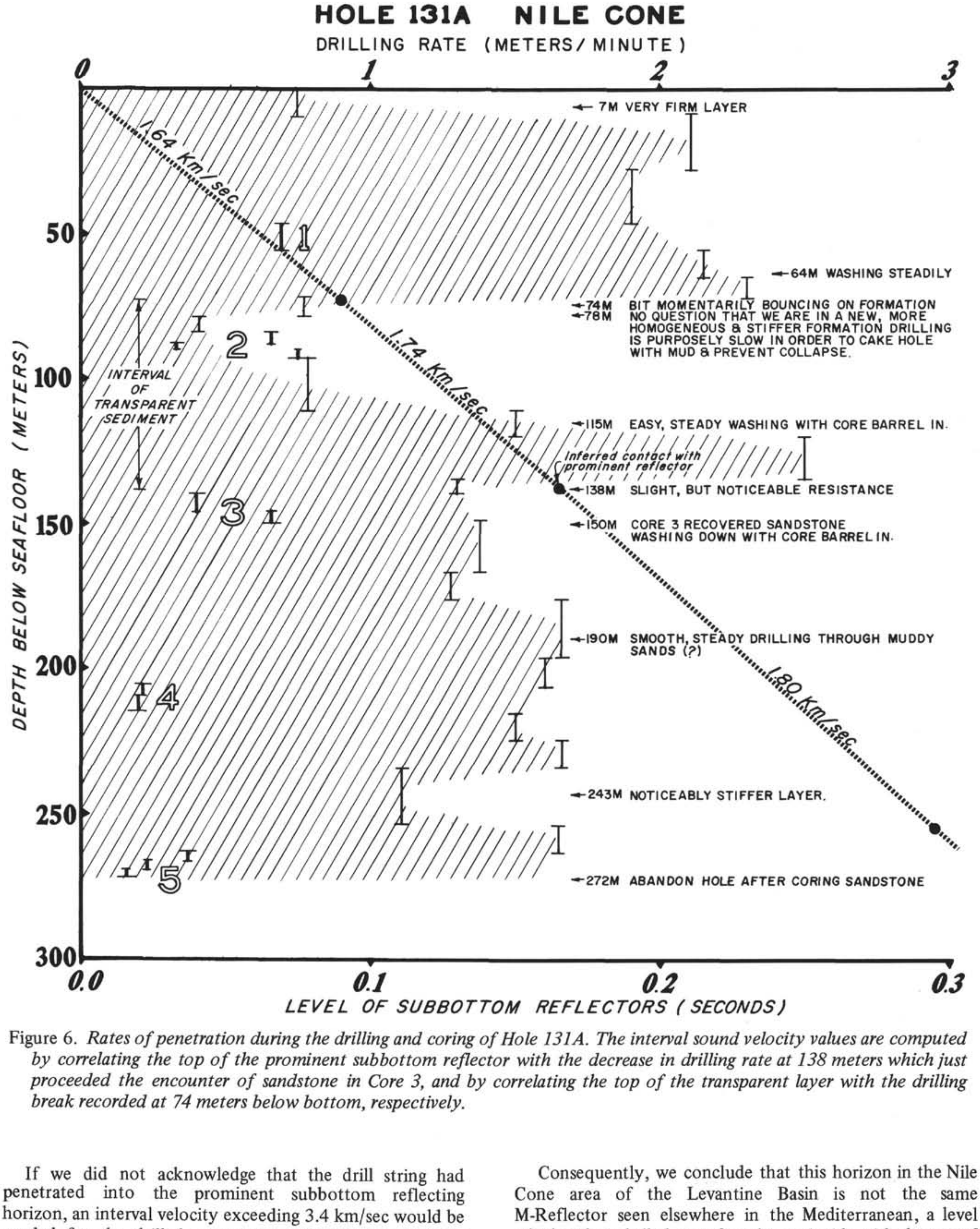

Figure 6. *Rates of penetration during the drilling and coring of Hole 131A. The interval sound velocity values are computed by correlating the top of the prominent subbottom reflector with the decrease in drilling rate at 138 meters which just proceeded the encounter of sandstone in Core 3, and by correlating the top of the transparent layer with the drilling break recorded at 74 meters below bottom, respectively.*

If we did not acknowledge that the drill string had penetrated into the prominent subbottom reflecting horizon, an interval velocity exceeding 3.4 km/sec would be needed for the drilled section; an inferred value entirely unreasonable in light of the types of lithologies recovered in the six cores taken.

Consequently, we conclude that this horizon in the Nile Cone area of the Levantine Basin is not the same M-Reflector seen elsewhere in the Mediterranean, a level which, when drilled, was found to coincide with the top of the Late Miocene deep basin evaporites. Therefore, we are not obliged to assume very low rates of sediment accumulation for the distal cone province, as had been previously suggested by Ryan *et al.* (1971).

Correlation of Sediment Type with Acoustic Properties

At Site 131, the nature of the sediments recovered appears to correlate somewhat satisfactorily with the type of acoustic reflectivity recognized in the seismic profiles. For instance: (1) repeated sequences of sands and clays found in Cores 1 and 1A were retrieved from the level of the superficial stratified zone (i.e., <0.09 second on Figure 4); (2) marls without sand or silt in Core 2A were recovered from the transparent interval; and (3) bedded sandstones, also including loose sand alternating with clays, were encountered in Cores 3A, 4A, and 5A within the interval of subsurface strata observed under the transparent sediments. We surmise that the acoustically stratified intervals occur where there are marked impedance contacts across bedding planes, separating coarse-grained sandy lithologies from fine-grained marls and clays, as would be the case for graded sand-silt-clay turbidites. The transparent intervals would be expected to represent sediments of a more physically homogeneous makeup, and are inferred to be predominantly marls and clays of terrigenous origin. It is quite possible that the homogeneous sediment is also current-transported since it reveals substantial differential thickness across subsurface relief. Perhaps the transparent zone reflects a period of time during the Quaternary when coarse-fraction material was unable to be transported across the shallow-water delta and continental shelf and thus was not capable of being introduced into the deep water distal provinces in discrete strata of turbidity current origin.

Provenance

Analyses of the mineralogy of both the fine-grained and coarse-grained components of representative samples from the Site 131 cores are described in some detail in Chapter 25.2 and are compared and contrasted with numerous piston core samples from the Nile Cone. The dominance of montmorillonite with generally high crystallinity and very high kaolinite/illite ratios in the clay mineral determinations, along with an abundance of hornblende, clinopyroxene, and epidote in the heavy mineral faction of the sands, are strongly diagnostic of a Nile River source for the terrigenous facies of this drill site. Rounded and frosted textures, particularly of the quartz grains, are properties believed to indicate that some of the clastic components resided for a period of time on the North African deserts (Butzer and Gladfelter, 1968).

Other triangular-shaped pits and gouges on the surfaces of the mineral grains suggest high-velocity impacts characteristic of nearshore littoral environments. Pollen from tropical East Africa (see Chapter 35) and brackish water diatoms in silt layers of Site 131 are both considered primarily of fluvial origin. All these components are inferrred to have been displaced to the deep-water area of the Cone in gravity-propelled sediment suspensions.

Transport Processes

As to the dynamics of the transport mechanisms, we note that several of the very thick (3 m) coarse-grained detrital layers contain mud intraclasts and are massively bedded without pronounced grading. Parallel, cross-bedded, and convolute laminations are conspicuously lacking. Sometimes well-rounded mud intraclasts are scattered throughout an entire bed of otherwise very clean coarse sand. Basal contacts are always sharp, and flute depressions were noted. The above textural and structural properties suggest that the emplacing flows were capable of significant erosion.

Ancient marine sediments with remarkably similar sedimentary textures and structures have been recognized in the Numidian Flysch of western North Africa and have been associated with channel environments on what has been inferred by Wezel (1970) to be an Oligocene-Miocene northward facies continental rise. From a sedimentological point of view, the most massive of these clastic beds may be assigned to a class of deposits widely referred to as fluxoturbidites, although we recognize that great confusion exists in the available literature concerning the type of hydrodynamic mechanism forming such deposits and as to whether or not these mechanisms relate to some aspect of turbidity current activity. Some geologists refer to fluxoturbidite deposits as indicating a "proximal" sedimentary environment (e.g., see discussions in Stanley and Unrug, 1972). We, however, point out that bedded units in the Site 131 cores, which are very similar to those characterized as fluxoturbidites, were recovered in Quaternary sequence on the "distal" Nile Cone.

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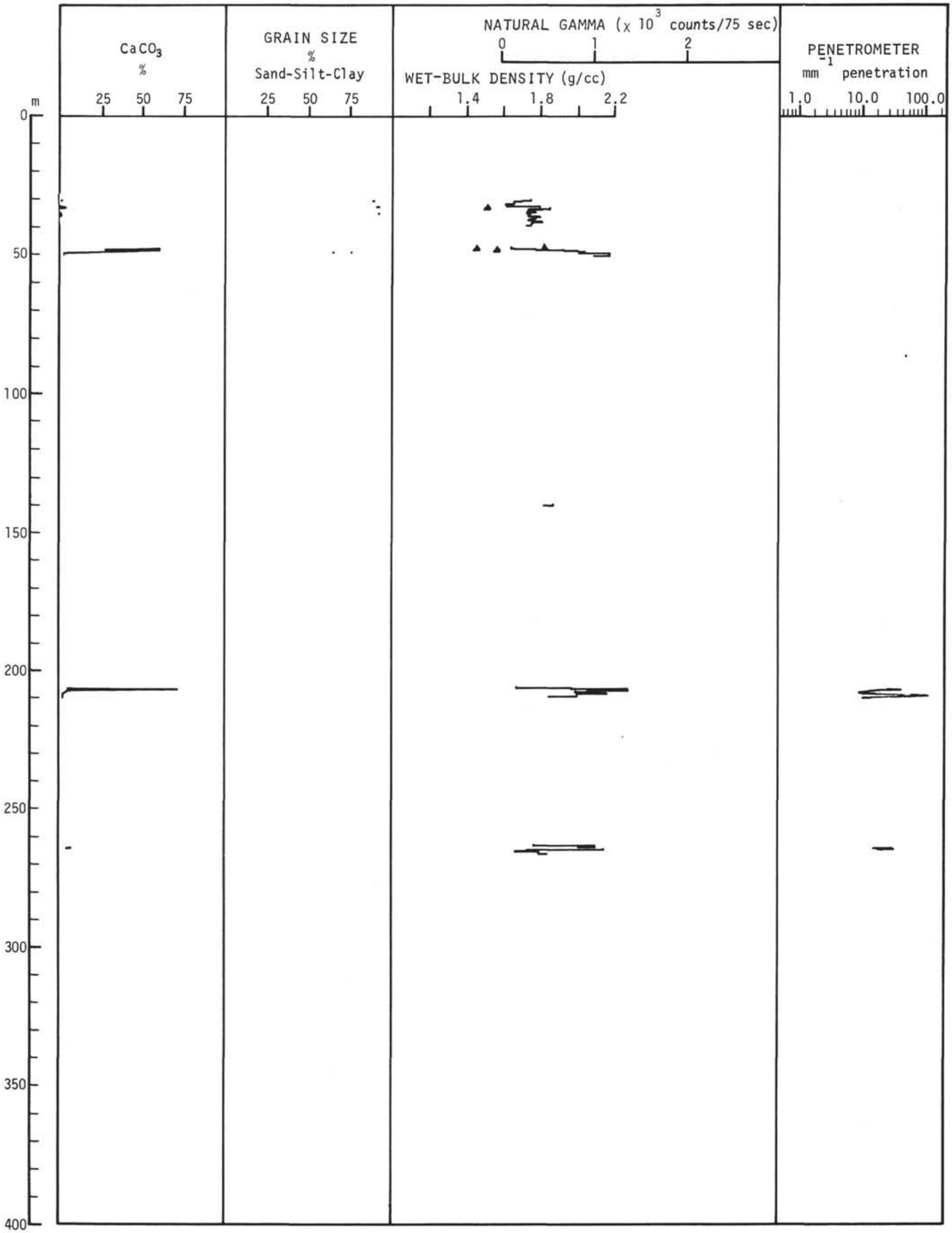
Ryan, W. B. F., Stanley, D. J., Hersey, J. B., Fahlquist, D. A. and Allan, T. D., 1971. The tectonics and Geology of the Mediterranean Sea. **In** *The Sea*. Maxwell, A. (Ed.), John Wiley and Sons, New York. **4**, 387.

Stanley, D. S. and Unrug, R., 1972. Submarine channel deposits, fluxoturbidites and other indicators of slope and base-of-slope environments in modern and ancient basins. **In** *Recognition of Ancient Sedimentary Environments* J. K. Rigby and W. K. Hamblin, (Eds.) Soc. Econ. Paleont. and Mineral. Special Publication #16, 287.

Wezel, F. C., 1970. Numidian Flysch: An Oligocene Early Miocene continental rise deposit off the African Platform. *Nature*. **228**, (5268), 275.

Site Summary 131



AGE	LITHOLOGY AND BIOSTRATIGRAPHY	LITHOLOGY
PLEISTOCENE		

Interbedded TURBIDITES and rare palagic MARL OOZES

SANDS (Nile turbidites)

Sequences, 2 to 3 m thick, of coarse quartzose sand overlain (with a gradational contact) by a thin layer of black clay.
Sharp contacts between sequences.
No apparent grading in the sands.

though the sedimentation is mainly terrigenous, no evidence of reworking of the planktonic foraminifera is noticed.
benthonic fauna is rare, though displacement of shallow-water fauna has been noted.
reworking is present in the nannoplankton

graded SANDS to CLAYS (Nile turbidites)

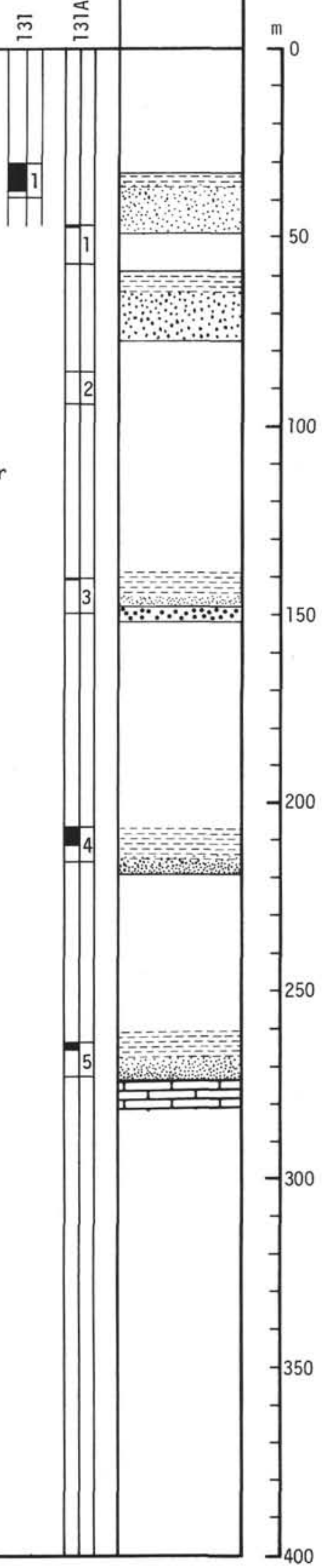
Sequences, 10 to 150 cm thick, of clayey sands (5-10 cm) grading to silts and clays.
Clays: black, plastic, low $CaCO_3$: 2 to 5%

MARL OOZES (pelagics)

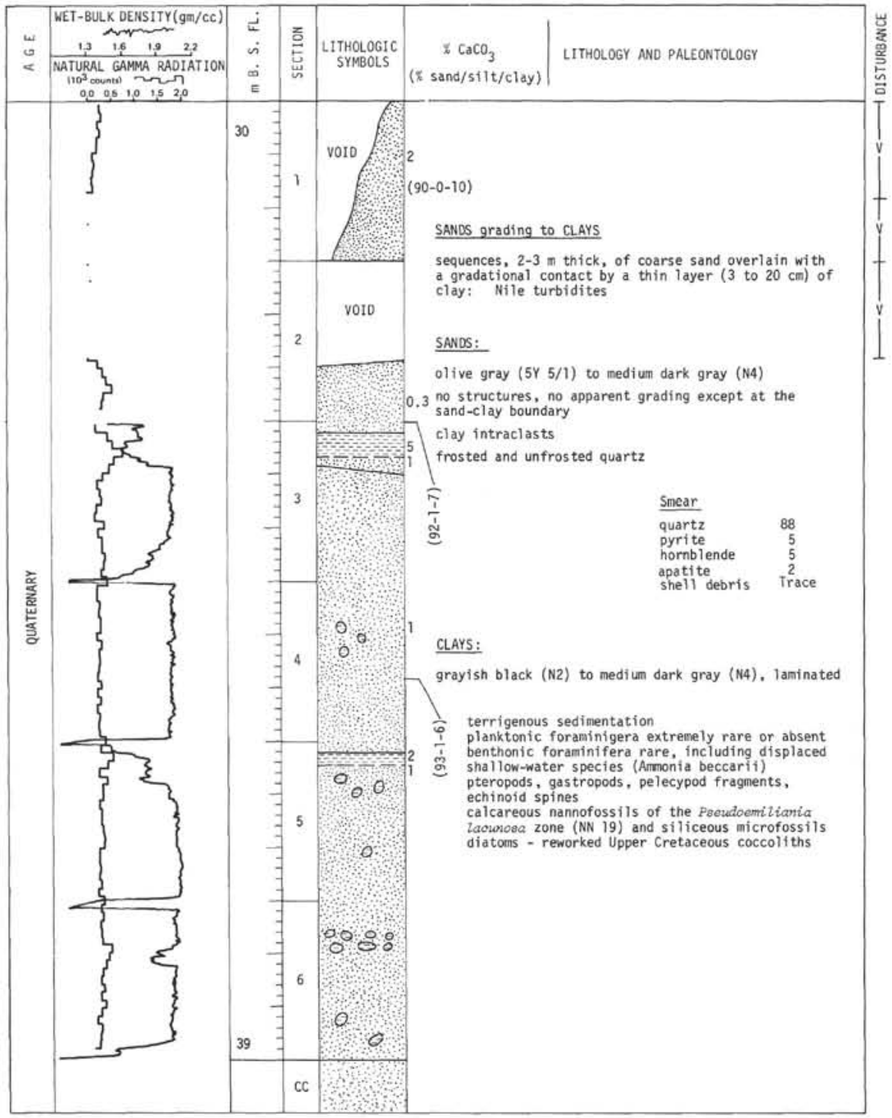
light colored: light brown to light olive gray, plastic, high $CaCO_3$ content: 60%

Note:

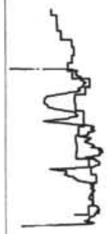
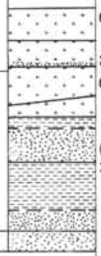
occasional lithification:
quartzose sandstone in core 3A, cemented by fine-grained dolomite
limestone in 5A core-catcher



SITE 131 CORE 1 Cored Interval 30-39 m



SITE 131A CORE 1 Cored Interval 47-56 m

AGE	WET-BULK DENSITY (gm/cc) 1.3 1.6 1.9 2.2 / NATURAL GAMMA RADIATION (10^3 counts) 0.0 0.5 1.0 1.5 2.0	m B. S. FL.	SECTION	LITHOLOGIC SYMBOLS	% $CaCO_3$ (% sand/silt/clay)	LITHOLOGY AND PALEONTOLOGY	DISTURBANCE
QUATERNARY		47	1	VOID			V
					60		
					27		
					61		
			2		(65-12-23)		
					3		
		50	CC				

graded SANDS to CLAYS interbedded w/MARL OOZES

Graded sands to clays

sequences, 50-60 cm thick, of clayey sands grading to clays (Nile turbidites)

dark gray (N3)

plastic except a semi-indurated clay bed in section 2 at 45 cm

sharp contacts between sequences

low $CaCO_3$: 3%

Smear	
quartz	50
plagioclase	5
pyrite	25
hornblende	10
apatite	5
forams	5

Marl Oozes (pelagics)

light yellowish brown (10YR 6/2) to light olive-gray (5Y 6/2)

plastic

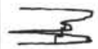
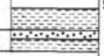
high $CaCO_3$: 60%

Smear	
nannos	60
quartz	10
clays	20
pyrite	5
forams	5

Note: A bed of intermediate mineralogy (27% $CaCO_3$) occurs in section 1 at 120-145 cm, suggesting a redeposited mixture of pelagic and fine Nile material.

planktonic foraminifera either abundant (Section 1, 138-140 cm) or rare (Section 2).
Section 1 also yields abundant pteropod shells
spores of terrestrial plants are recorded in the core catcher, which yields quartz in abundance
nannofossils of the *Pseudoemiliania lacunosa* zone abundant and well preserved (*Gephyrocapsa oceanica* zone)
reworked Upper Cretaceous species

SITE 131A CORE 3 Cored Interval 140-149 m

AGE	WET-BULK DENSITY (gm/cc) 1.3 1.6 1.9 2.2 / NATURAL GAMMA RADIATION (10^3 counts) 0.0 0.5 1.0 1.5 2.0	m B. S. FL.	SECTION	LITHOLOGIC SYMBOLS	% $CaCO_3$ (% sand/silt/clay)	LITHOLOGY AND PALEONTOLOGY	DISTURBANCE
QUATERNARY			1	VOID			V
		141.3			5		
		141.6	CC				

SILTY CLAY (Nile turbidite)

graded from silt to clay
dark gray (N3)
plastic
low $CaCO_3$: 5%

SANDSTONE

dolomite cemented, laminated

X-ray	Smear	
quartz	quartz	80
dolomite	plagioclase	3
feldspar	pyrite	10
	hornblende	5
	apatite	2

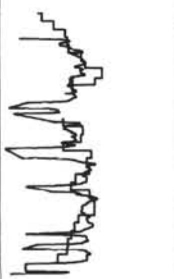
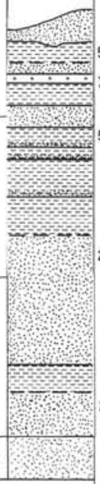
DIATOMACEOUS CLAY

black, underlying the sandstone

Smear	
clays	60
quartz	15
mica	5
feldspar	2
diatoms, etc	5

terrigenous sedimentation
poor foraminiferal fauna
displaced benthonic foraminifera diatoms, siliceous sponge spicules and some calcareous nannofossils of the *Pseudoemiliania lacunosa* zone (NN 19)

SITE 131A CORE 4 Cored Interval 206-215 m

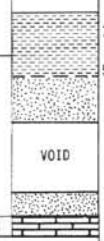
AGE	WET-BULK DENSITY (gm/cc) 1.3 1.6 1.9 2.2 / NATURAL GAMMA RADIATION (10^3 counts) 0.0 0.5 1.0 1.5 2.0	m B. S. FL.	SECTION	LITHOLOGIC SYMBOLS	% $CaCO_3$ (% sand/silt/clay)	LITHOLOGY AND PALEONTOLOGY	DISTURBANCE
QUATERNARY		206.7	1		5, 72	graded SANDS to CLAYS interbedded w/MARL OOZE	V
			2		5, 2	Graded sands to clays (Nile turbidites and contourites): sequences, 10 to 150 cm thick, of clayey sands grading into clays (turbidites) and sand layers with sharp upper and lower contacts: contourites or eroded turbidite sequences; sharp, often eroded contacts between sequences; low $CaCO_3$: 2-5%	
		210.5	3		2	Marl Ooze (pelagic): two thin (2 cm) layers interbedded with sharp contacts in section 1; very light gray; high $CaCO_3$: 72%	
			CC				

Smear (clay)

clays	60
quartz	5
mica	10
pyrtie	15
diatoms, etc.	3

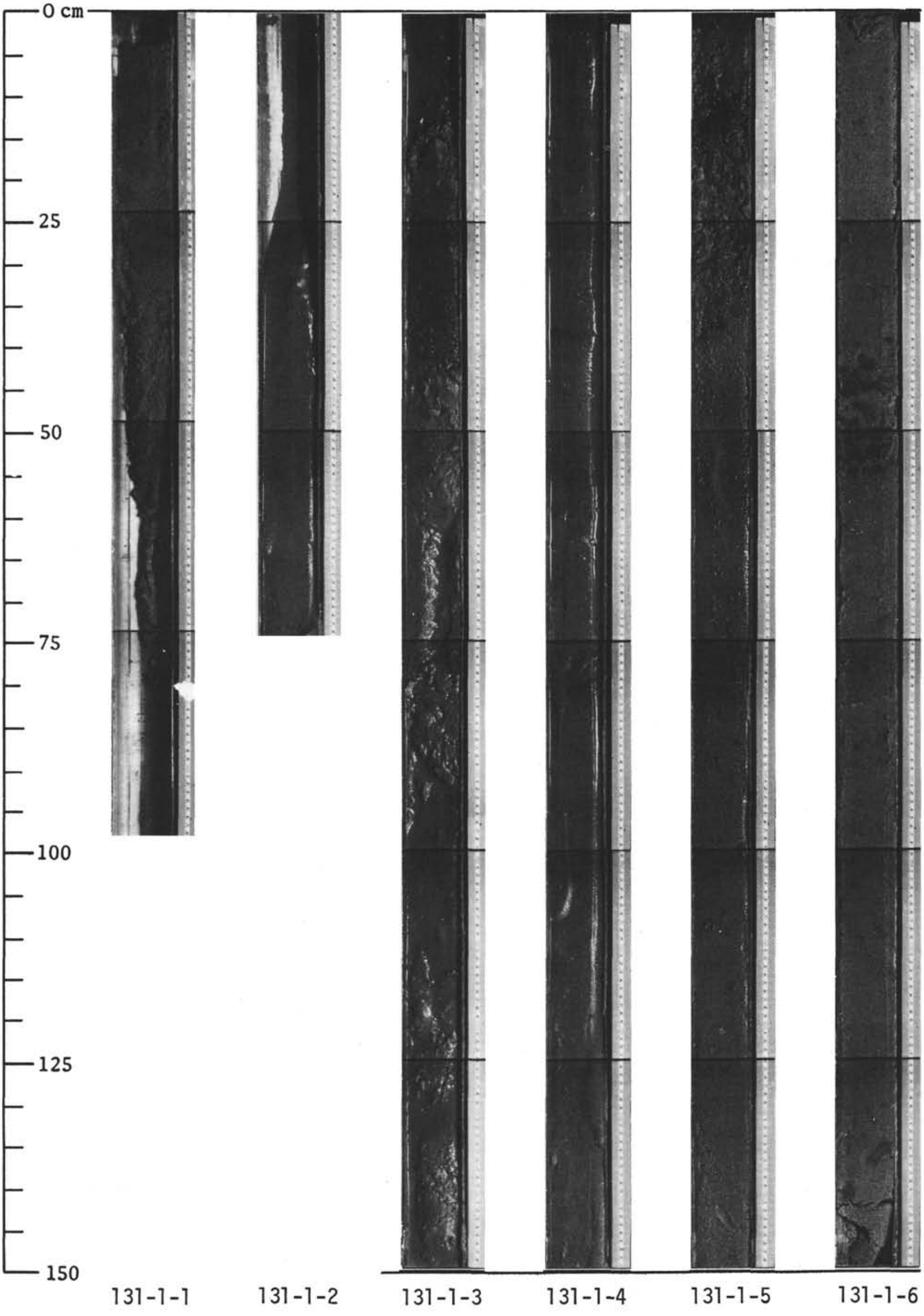
a dominantly pelagic assemblage is present in Section 1 (110-112 cm). Both above and below sedimentation is mainly terrigenous, and foraminifera scarce
benthonic foraminifera include displaced shallow-water species (*Ammonia beccarii* inter alia)
also present are siliceous sponge spicules, organic matter, pelecypod fragments,
calcareous nannofossils of the *Pseudoemiliania lacunosa* zone (NN 19) are abundant and well-preserved in Section 1 (140 cm) and belong to the *Gephyrocapsa oceanica* zone. In Section 2 and in core catcher they are poorly preserved, include reworked species, and are accompanied by diatoms.

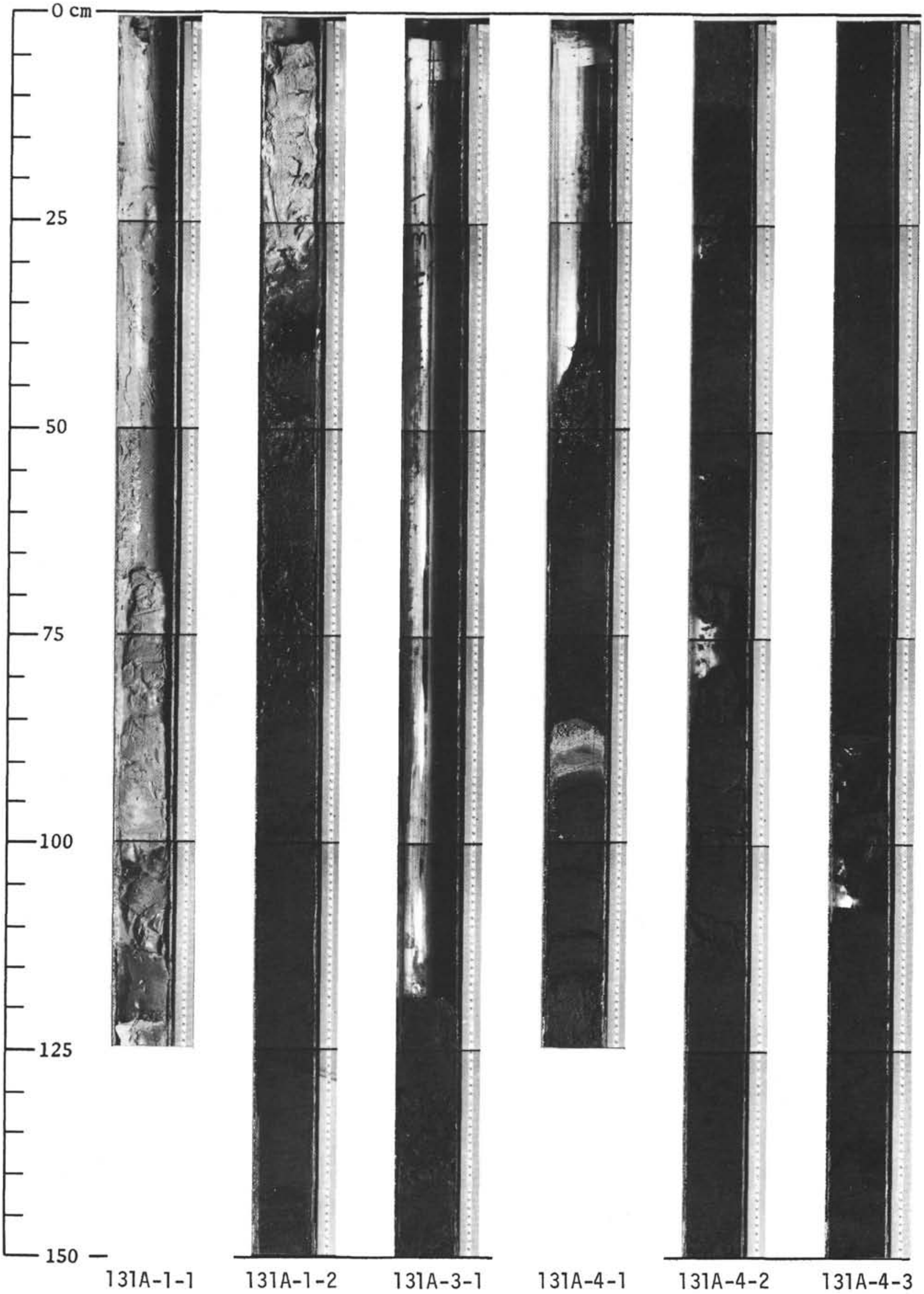
SITE 131A CORE 5 Cored Interval 263-272 m

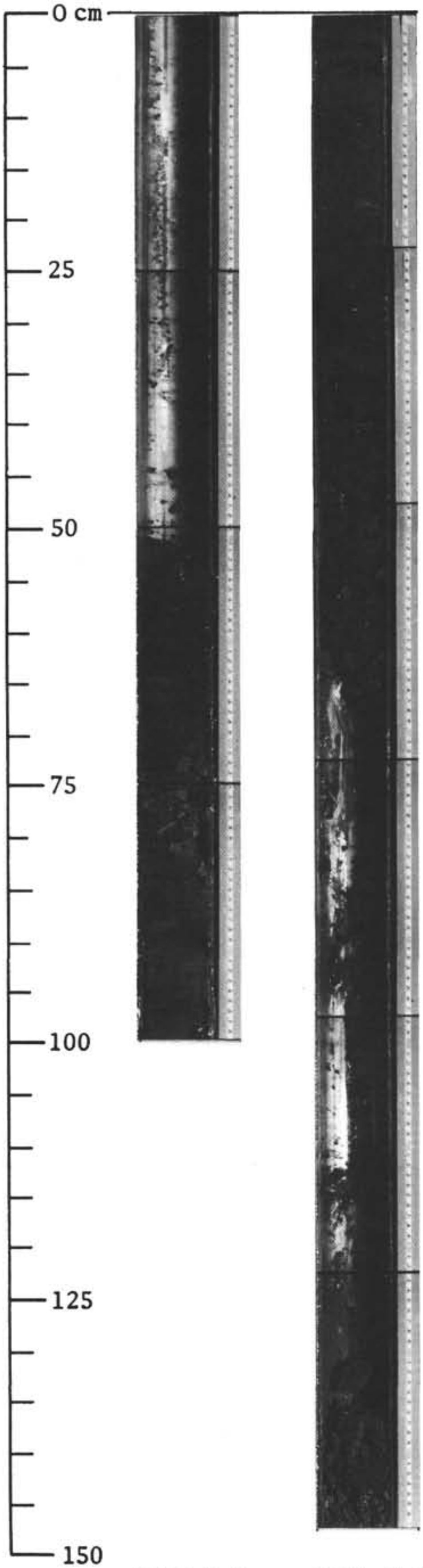
AGE	WET-BULK DENSITY (gm/cc) 1.3 1.6 1.9 2.2 / NATURAL GAMMA RADIATION (10^3 counts) 0.0 0.5 1.0 1.5 2.0	m B. S. FL.	SECTION	LITHOLOGIC SYMBOLS	% $CaCO_3$ (% sand/silt/clay)	LITHOLOGY AND PALEONTOLOGY	DISTURBANCE
QUATERNARY		264.1	1	 VOID	7, 5	graded SAND to CLAY (Nile turbidite): single sequence, broken by drilling, of sand grading to silt and clay; dark gray to grayish black (N2); low $CaCO_3$: 5-7%; plastic clay	V
		266.2	2	VOID		LIMESTONE (in core catcher): indurated foraminiferal marl; light olive gray (5Y 6/1)	V
			CC				

planktonic foraminifera fairly abundant benthonic foraminifera include deep water species and shallow water species as well
sedimentation is mainly terrigenous, with reducing conditions at the bottom (pyrite)
poorly preserved flora of calcareous nannofossils of the *Pseudoemiliania lacunosa* zone (NN 19)

Total Drilling: 272 m in Limestone


0 cm
25
50
75
100
125
150
131-1-1
131-1-2
131-1-3
131-1-4
131-1-5
131-1-6


0 cm
25
50
75
100
125
150
131A-1-1
131A-1-2
131A-3-1
131A-4-1
131A-4-2
131A-4-3



131A-5-1 131A-5-2