5. VALENCIA BASEMENT RIDGE – SITE 123

The Shipboard Scientific Party[1]

SITE DATA

Occupied: August 24-25, 1970.

Position: A basement ridge beneath the axial channel of the Valencia Trough.
Latitude: 40° 37.83′N;
Longitude: 02° 50.27′E.

Water Depth: 2290 meters.

Cores Taken: Six cores.

Total Penetration: 398.2 meters.

Deepest Unit Recovered: Volcanic ash from the acoustic basement (≈21 m.y.).

MAIN RESULTS

The acoustic basement at Site 123 consists of thick ash deposits. Lower Pliocene graded sands lie along an unconformable contact with the basement which has been radiometrically dated at approximately 21 million years.

Current erosion and winnowing on the Pliocene sea floor is indicated by the presence of reworked Miocene faunas and selenite crystals from Messinian evaporites within the younger bedded sand layers and silt laminae.

A greater than 1 million year hiatus exists between the Quaternary and the Upper Pliocene. Large, well-rounded pebbles and shallow-water shell debris at the boundary suggest that the hiatus was probably caused by massive seabed erosion, most likely from channeled turbidity currents.

The conical configuration of the basement high, the recovery of a pure ash deposit without marine fossils over an interval of more than 100 meters beneath the top of the acoustic bedrock, and the presence of hydrothermal veins in the ash body all suggest that the pyroclastic formation is a flank deposit of a composite volcano. This formation and other volcanic cones of calc-alkaline origin appear to be the features which produce the conspicuous magnetic anomalies observed in the Valencia Trough region of the western Mediterranean.

BACKGROUND

When the drilling at Site 122 in the Valencia Trough was prematurely abandoned—because the thick gravel bed encountered at Horizon M posed the prospect of a downhole collapse—it appeared that the chances of recovering autochthonous basement in this region of the western Mediterranean would be thwarted. Furthermore, the unusual composition of the gravel bed led the shipboard scientific party to consider that the unit might not simply be local channel fill, but instead, a regional talus accumulation along the prominent Miocene-Pliocene unconformity seen in the reflection profiles.

In poring over the seismic profiles on the *Challenger* while the drill string was being secured at Site 122, a location was discovered on a *Charcot* Flexotir profile some 25 kilometers to the northeast where the upper surface of the regional unconformity was cut into by the Valencia channel system (see Figures 1, 2 and 3). It was felt that since the channel fill itself had not posed a serious drilling problem at Site 122, it was quite likely that where the channel had cut into the upper surface of the M-Reflectors, the ominous gravel bed would have been removed by erosion. This hunch at least warranted another attempt to reach the basement, so a decision was made to locate the next drilling site there.

In Figures 2 and 3 one can see the *Charcot* crossing of the Valencia Channel, and the targeted location at the point where the uppermost surface of Horizon M is missing. At this point on the profile, the "salt-bed" of Auzende et al., (1971) lies subjacent to the M-Reflectors and overlaps a protruding basement high. The basement ridge had been shown by Vogt *et al.*, (1971) to be associated with another of the characteristic Valencia Trough magnetic anomalies.

Objectives

The principal objective of Site 123, like that of Site 122, was to penetrate and sample the sedimentary layers below Reflector-M and reach the oldest sediment in contact with basement.

Strategy

On the *Charcot* profile, the upper sediments of the channel which cuts into the M Reflectors are very thin. Furthermore, the region where the drill string could penetrate the erosional cut and the subjacent "salt layer," along with the N Reflectors, is less than a kilometer in width. The targeted position was considered well located by a satellite fix on the *Charcot* navigational track; this position is only 14 nautical miles from the abandoned Site 122. A decision was made to proceed directly to the target without streaming the seismic and magnetometer gear; this had the advantage of being able to go immediately into a station-keeping mode upon finding the proper isobath on the channel wall. Furthermore, the satellite-fix alerts indicated that a station fix would be available within minutes of arriving if the vessel could proceed at full speed.

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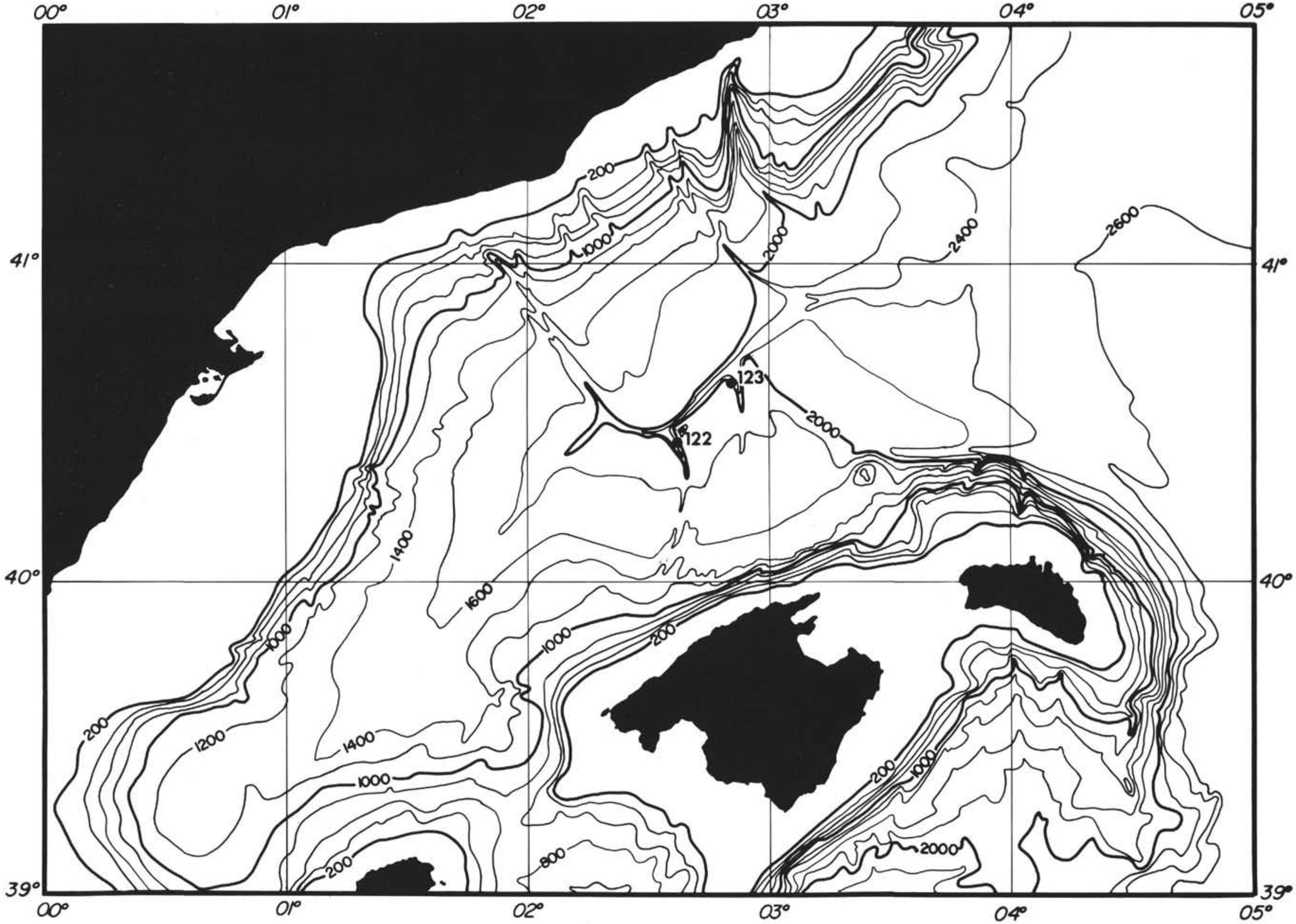

Figure 1. *The Valencia Trough, contours in meters, adapted from Chart 310 of the Defense Mapping Agency Hydrographic Center.*

Challenger Site Approach

The vessel departed for Site 123 at 0620^h August 24, steering a course 042° at 9.5 knots. As the new site was neared, the dead-reckoning plot suggested a course change to 047° which was completed at 0715^h. The *Challenger* crossed over the preselected target (a bench on the southwest channel wall) at 0748^h, where a marker buoy was thrown overboard (Figure 4). The ship slowed immediately and made a Williamson turn at 0751^h to return to the buoy. She stopped on location at 0803^h, waiting for the computation of a satellite fix of our 0800^h position. The results of this fix put us slightly north of the *Charcot* profile. Letting the southerly drift move the vessel back over the shoulder of the channel, the target was reached at 0825^h, and the beacon was dropped.

To the eventual consternation of the shipboard scientists, the drilling location did not offer an opportunity to sample the salt layer where it lapped onto the basement ridge (see remainder of this chapter). After averaging 13 satellite fixes obtained while drilling, we learned that the final site location lay some 700 meters to the northwest of the original target on a similar bench on the channel wall. Because the drilling results showed the Pliocene marine sediments in direct contact with basement, the site is depicted on the *Charcot* profile (Figures 2 and 3) just beyond the pinchout of the salt layer and the underlying N-Reflectors.

OPERATIONS

The *Challenger* stayed on location for a day and half, between 0825^h, 24 August, and 2230^h, 25 August. The hole was terminated at 398.2 m below bottom, after encountering considerable drilling difficulities in penetrating some 130 meters into a volcanic basement. Eight cores were recovered; the inventory is shown in Table 1.

The sedimentary section, represented by the first six cores, was drilled through rapidly (Figure 5). A thin gravel layer in Core 2 caused some concern about a possible cave-in, as the experience at our previous site was still fresh in our memory. However, when we found a predominantly ooze section in the bottom of Core 3, it was decided to continue.

During the early hours of the 25th of August, having penetrated more than 220 meters of the section, we noted an increase in the rate of penetration; the drill string was being washed in at a rate of more than 70 m/hour (exclusive of pipe-connecting time). The next core (6) contained a loosely consolidated volcanic ash deposit, topped by some 60 cm. of sands and oozes. Below this cored interval the drilling became alarmingly rapid. When Core 7 reached the deck at 0415^h, the barrel was empty. This omen of trouble was confirmed when the driller reported shortly afterward that the drill string was stuck again. All attempts to free the pipe during the next few hours proved futile. A decision was reached to blast away the drill string at the mudline. At 1100^h, 25 August, all preparations were completed. As the powersub was raised to increase the tension on the drill pipe, a final preparatory step before dynamiting, the bottom hole assembly unexpectedly pulled free from the formation. It was then decided to keep on drilling, in an effort to determine the thickness of the ash deposits, and, if possible, to determine if this unit was indeed the volcanic rock basement.

After some 80 more meters of easy drilling, Core 8 was cut and was found to contain the same ash deposit as Core 6. It became clear that this thick volcanic deposit was the acoustic basement at this site. Since further drilling might add very little new information about this deposit, but would pose grave danger of catastrophic cave-ins, it was decided to abandon the hole.

Again a Reed PD-2 bit was used. This drill-bit penetrated the sandy and ashy sections very rapidly, but the recovery of 26.5% was far below the DSDP average. The difficulties we encountered in the loosely consolidated ash point to the need of side-wall casing to prevent cave-ins. Aside from the time lost when the pipe was stuck, some three hours were spent testing a beacon-release mechanism and in cementing the hole.

BIOSTRATIGRAPHY

The sediments contained in Cores 1 to 6 yielded abundant and well-preserved foraminiferal and nannofossil assemblages ranging in age from Pleistocene to Lower Pliocene. The lowest core (8) and a part of Core 6 (practically no sediment was recovered from Core 7) are barren of both calcareous and siliceous micro- and nannofossils, and consist entirely of shards of volcanic glass.

The Pliocene/Pleistocene boundary falls between Cores 2 and 3. The very poor core recovery for both cores and the occurrence of a layer of gravels near the base of Core 2 rendered this section unsuitable for detailed investigations.

The latest part of the Pliocene is missing at Site 123, as *Globigerinoides obliquus extremus* is still present in the topmost part of Core 3. This species becomes extinct within the range of *Globorotalia tosaensis* and below the first occurrence of *G. truncatulinoides* (Cita, 1971) or in the later part of Zone N. 21 of Blow's (1969) zonal scheme. The *Globorotalia inflata* Interval-zone (as defined in Chapter 47 of this volume), the topmost foraminiferal zone of the deep-sea Mediterranean Pliocene, was not recorded at Site 123. Apparently, submarine erosion took place after the deposition of the Upper Pliocene recovered from Core 3. The earliest part of the Pleistocene is missing as well. In fact, *Gephyrocapsa oceanica*, the nannofossil marker-fossil of the middle part of the Quaternary, is present here from the base of Core 2, thus indicating a stratigraphic gap which cannot be carefully demonstrated on the basis of the planktonic foraminifera alone. Both the Upper and Lower Pliocene were recognized at Site 123. However, it is difficult to judge on the basis of the available data if sedimentation was continuous during this particular time span.

Paleoenvironment (M.B.C.)

Bottom currents and/or turbidity currents intermittently played an important role in distributing both the clastics and the fossils of the Valencia Ridge sediments. Some samples are typically pelagic, containing besides planktonic foraminifera only a few, deep-living benthonic species; for example, samples 5-1 (108-111 cm) and 5-2 (71-74 cm). Other samples, however, include abundant detrital grains, as

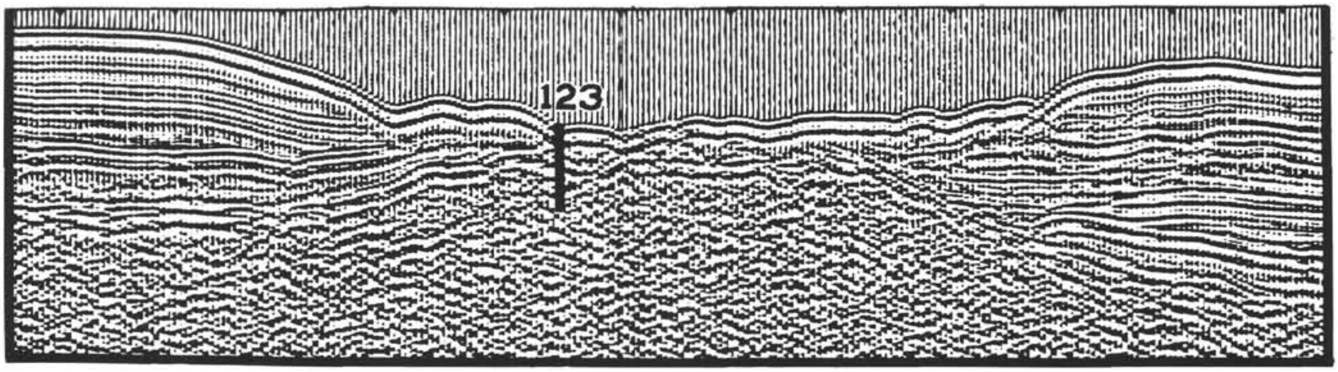

Figure 2. *Seismic reflection profile (Flexotir sound source and variable area recording) across the Valencia Trough channel, showing the basement ridge of Site 123. The profile made by the R/V* Jean Charcot *(Centre Océanologique de Bretagne) has a vertical exaggeration of ≈3:1.*

TABLE 1
Core Inventory – Site 123

Core	No. Sections	Date	Time	Cored[a] Interval (m)	Cored (m)	Recovered (m)	Subbottom Penetration (m) Top	Subbottom Penetration (m) Bottom	Tentative Lithology	Age
1	3	8/24	17:25	2379-2387	8.0	3.5	79	87	Silt and clay	Quaternary
2	1	8/24	18:55	2407.1-2416.2	9.1	1.0	107	116	Gravel and clay	Quaternary
3	1	8/24	20:00	2416-2425	9.0	1.3	116	125	Clay and fine sands	Upper Pliocene
4	3	8/24	22:07	2473.2-2482.2	9.0	4.5	173	182	Sands and Clays	Lower Pliocene
5	2	8/25	00:10	2510-2519.1	9.1	2.5	210	219	Sands and Clays	Lower Pliocene
6	3	8/25	01:38	2567-2576	9.0	5.0	267	276	Nanno-ooze Tephra	Lower Pliocene Lower Miocene
7	0	8/25	04:15	2604-2613.2	9.2	0	304	313.2	Contaminant	–
8	1	8/25	16:10	2689-2098.2	9.2	1.2	389	398.2	Tephra	–
Total					71.6	19.0		398.2		
% Cored					17.9%					
% Recovered						26.5%				

[a]Drill pipe measurements from derrick floor to sea floor.

well as shallow water benthonic foraminifera such as, among others, *Amphistegina lessonii, Elphidium crispum, Ammonia beccarii.* Numerous specimens of *Amphistegina lessonii* exceeding 3 mm in size and obviously displaced, were found in sample 4-CC, associated with a dominantly planktonic assemblage. Abundant detrital materials associated with displaced benthonic foraminifera occur at different levels in Cores 3 and 4 (Upper Pliocene).

The populations of planktonic foraminifera show strong variations both in size and abundance of different taxa. This variation may also indicate sorting in the distribution of the shells of planktonic foraminifera reworked by bottom currents. The existence of anomalous current conditions affecting the deposition of fossils renders the sequence at this site unsuitable for detailed biostratigraphic investigations.

Rates of Sedimentation (M.B.C.)

The sedimentation rates at Site 123 cannot be precisely computed since the section was not continuously cored and recovery was poor. Nevertheless, rough order-of-magnitude calculations were made.

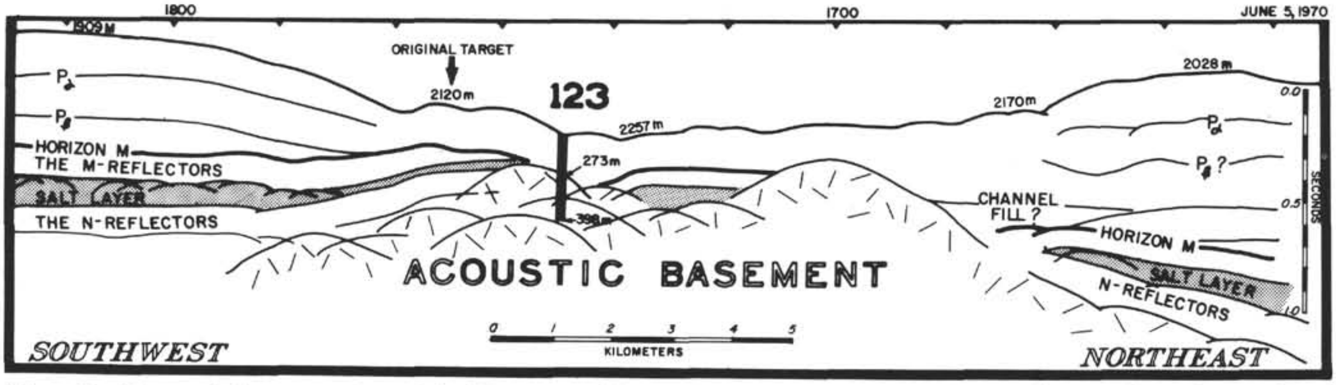

Figure 3. *Schematic interpretation of the* Charcot *profile of Figure 2. The various reflectors illustrated are discussed in the text of this chapter and Chapters 4 and 6. The original target was selected in order to be able to sample the M-Reflectors, the alleged salt-layer, and the N-Reflectors where they on-lap the basement ridge. However, difficulties in positioning the ship placed the eventual site some 700 meters off the profile to the northwest of the target. The site is depicted on the* Charcot *profile where the sedimentary series best matches the drilling record.*

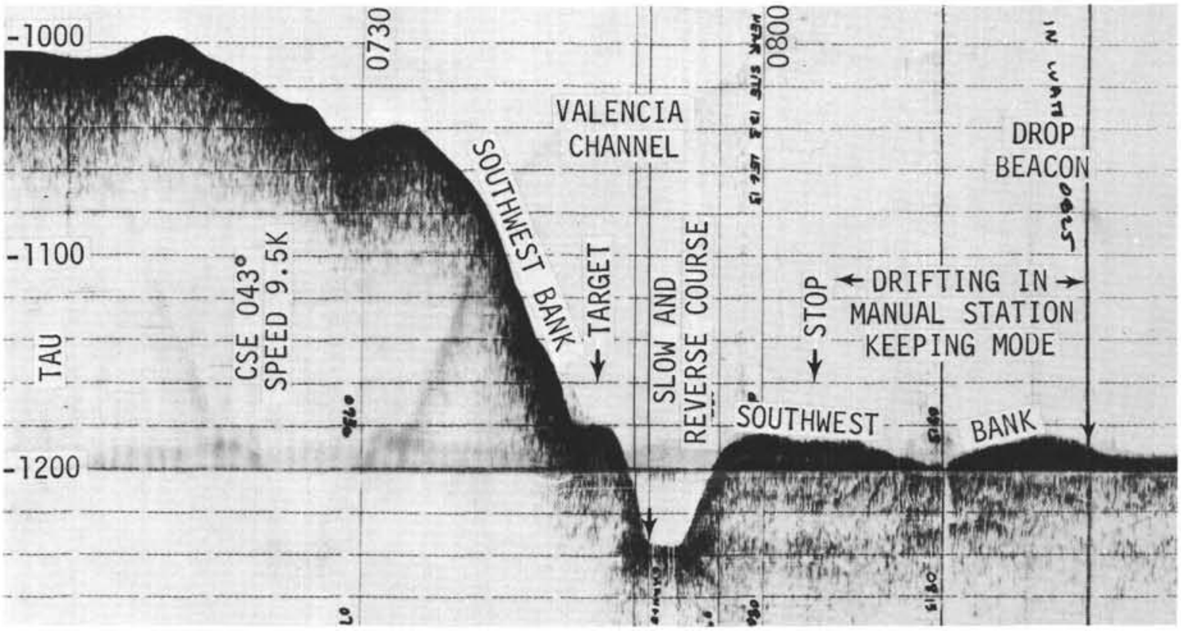

Figure 4. *Details of the* Challenger *site approach. The eventual drilling site was located at 1190 tau (2290 meters, drill-string depth) on a small bench on the southwest band of the Valencia Channel, similar to the terrace observed on the* Charcot *profile. No reflection profile was obtained while approaching the site, however, Figure 9 is an illustration of the profile obtained upon departure.*

Assuming that all of the Quaternary is represented, and that no gaps occur within the stratigraphic record, the resulting sedimentation rate for the Quaternary would be 8 cm/1000 years.

The oldest fossil-bearing sediments are from the top of Core 6 (foraminifera and nannofossils). They indicate an early Pliocene age (*Globorotalia margaritae margaritae* Lineage-zone), slightly above the Miocene/Pliocene boundary, of about 5.4 million years. With this age assigned to the level at 276 meters, and the Pliocene/Pleistocene boundary at 116 meters, the Pliocene sedimentation rate would be about 5 cm/1000 years, if the Pliocene section here were complete.

However, we have clear evidence that at least some of the Upper Pliocene is missing at an apparent hiatus below the *Gephyrocapsa oceanica* Zone of the Middle Pleistocene. Thus, the computed values represent minimum rates of sedimentation, and the actual rates are probably considerably higher.

Planktonic Foraminifera (M.B.C.)

Planktonic foraminifera occur in great abundance through Cores 1 to 6. Their distribution in 17 selected samples from this site is indicated in Table 2, where data on the presence of other fossil remains and the occurrence of

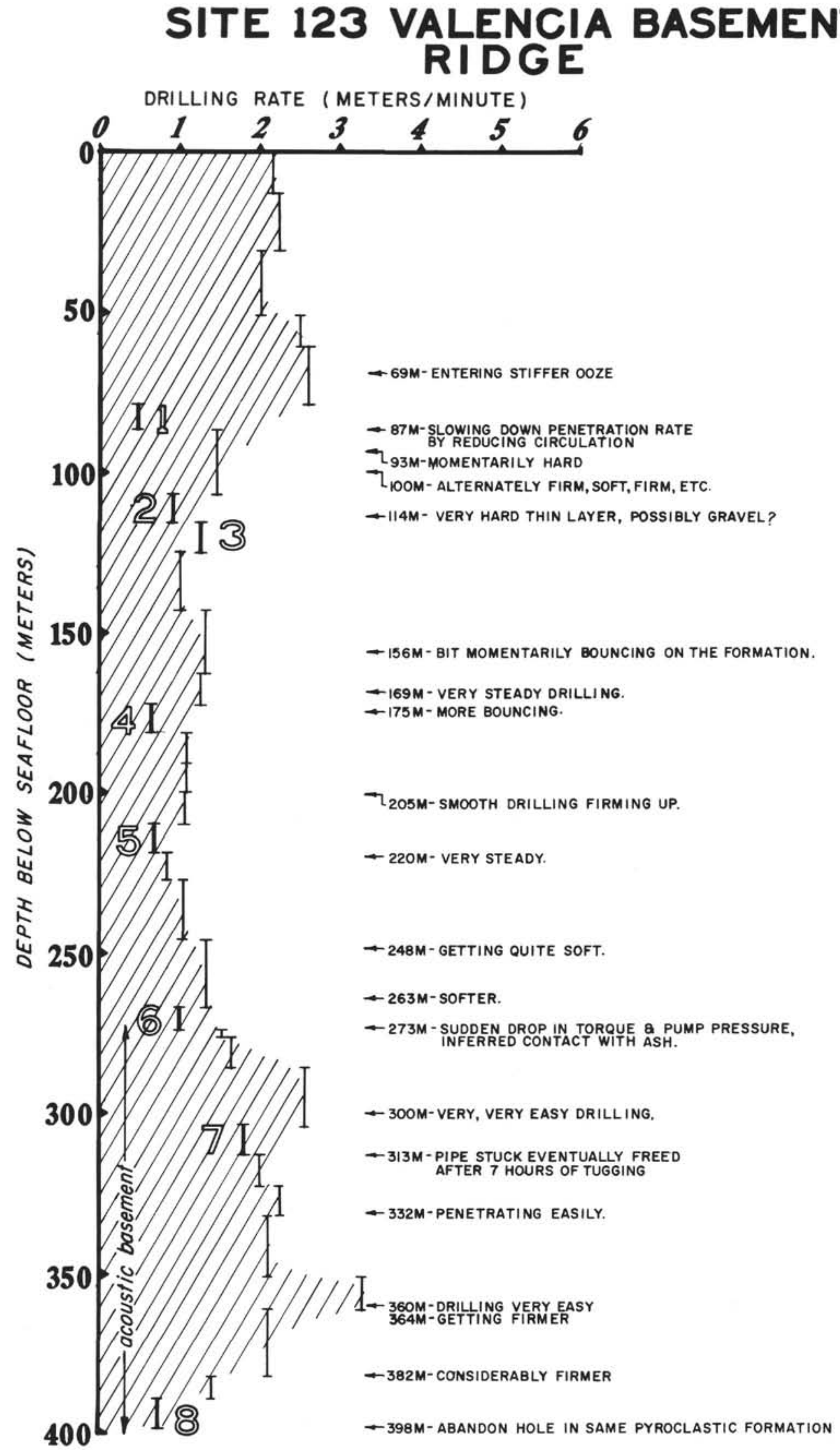

Figure 5. *Drilling rate curve for Site 123. The kicks in the curve at 69, 93 and 114 meters were accompanied by small jumps in the drilling torque. They are believed to represent encounters with thin gravel beds in the channel fill, as evidenced in the recovery of Core 2, from 107 to 114 meters (Figure 6).*

TABLE 2
Range Chart of Planktonic Foraminifera – Site 123

	Depth Below Sea Floor	79		88	107	116	116	125	171			182	210		219	267		276
	Recovery (m)																	
	Core Number	1			2		3		4				5			6		
	Section Number	2	3	CC	1	CC	1	CC	1	2	3	CC	1	2	CC			CC
	Sample Interval (cm from Top)	71-74	104-107		99-101		96-99		136-139	71-74	31-34		108-111	71-74		Top	90-93	
PLANKTONIC FORAMINIFERA – *Globigerina*	*apertura*						•	•	•	•	•	•		•	•	•	•	
	bulbosa	•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	
	bulloides	•	•	•		•	•	•	•		•	•	•	•	•	•	•	
	digitata	•																
	eggeri	•		•			•											
	falconensis			•	•		•	•	•		•	•			•	•	•	
	microstoma						•				•	•	•		•	•		
	cf. nepenthes																•	
	pachyderma	•	•	•	•	•	○			○								
	praedigitata	•				•												
	quinqueloba	•	•	•	•	•	•			•	•	•	•	•		•		
Globigerinoides	*bollii*							•		•			•		•	•	•	
	conglobatus				•		•											
	elongatus		•	•	•	•	•	•	•	•	•	•	•	•	•	•		
	helicinus	•				•	•	•			•	•	•	•	•			
	obliquus extremus						•	○	•	•	•	•	•	•	•	•	•	
	pyramidalis	•			•		•					•	•	•				
	quadrilobatus	•			•		•		•	•	•	•		•	•	•		
	ruber	•	○	•	•	•	•	•			•	•	•	•		•	•	○
	sacculifer	•			•		•	•	•	•	•	•	○	•		•		
	trilobus	•			•		•	•	•	•	•	•		•	•			
Globorotalia	*acostaensis*			•	•	•	•	•	•	•	•	•	•		•	•		
	bononiensis								•	○								
	crassaformis						•		×									
	dutertrei				•		×	×			•							
	inflata	•	•	•	•	•												
	oscitans	•																
	puncticulata								×	×	•	•	•	•	•	•	•	
	scitula		•	•	•	•						•	•	•	•	•	•	
	margaritae margaritae														•	•	•	•
	margaritae praehirsuta														•			
	margaritae primitiva														•	•	•	
Others	*Globigerinita glutinata*	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	
	Globigerinita uvula	•					•				•		•	•			•	
	Hastigerina siphonifera	•			•	•	•	•		•	•		•		•		•	
	Orbulina bilobata														○			
	Orbulina universa	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•	
	Sphaeroroi di nellopsis seminulina											○	•		○			
	Sph. subdehiscens											○	•	•	○			
	Detritus		•	•	•	○	○	•	•	○	○			○	○			
	Displaced shallow water forams		○	•	•		○	○		○	○	○			○			
	Pteropods	•																
	Gastropods	○			○													
	Pellecypods fragments	•		•	•													
	Bryozoa				○							○						
	Ostracods				○			○	○		○	○						
	Otoliths	○							○		○	○						
	Echinoid spines	•		○				○	○	○	○	•		•				
	Organic Matter		○									○						
	Volcanic glass																	•
	Age	Quaternary					Upper Pliocene								Lower Pliocene			
	Zone	*Globorotalia truncatulinoides* Total-range-zone					*Globigerinoides obliquus extremus* Interval-zone					*Sphaeroidinellopsis subdehiscens* Interval-zone			*Globorotalia margaritae* Total-range-zone: *Globorotalia margaritae evoluta* Lineage-zone	*Globorotalia margaritae* Total-range-zone: *Globorotalia margaritae margaritae* Lineage-zone		

detritus in the fraction greater than 63 microns are also shown. Some comments are included here.

QUATERNARY: Cores 1 and 2 represent the lower part of the Middle Quaternary. Sample 1-2 (71-74 cm) yielded an almost purely planktonic fauna, including foraminifera and pteropods. Most of the foraminiferal tests are very small and suggest size sorting. The rare, large forms indicate temperate-warm superficial waters (abundant representatives of the genus *Globigerinoides,* including *G. sacculifer,* and *Globigerina digitata, G. praedigitata*).

Samples 1-3 (104-1-7 cm) and 1 CC yielded fine clastics in abundance, and some benthic foraminifera, including *Bulimina marginata, Bolivina alata* and other cold-water-forms. The planktonic faunas are not highly diversified and indicate a temperate-cold climate. *Globigerina pachyderma* occurs as left-coiling specimens, which indicates cold waters. These assemblages compare well with some of those characterizing the cool intervals penetrated in the Quaternary of the Alboran Basin.

Sample 2-1 (99-101 cm) contains an allochthonous assemblage of abundant detritus, displaced shallow-water benthic forams, fragments of bryozoa, etc.

PLIOCENE: Four foraminiferal zones were recognized in Cores 3 to 6. From top to bottom, they are the *Globigerinoides obliquus extremus* Interval-zone, the *Sphaeroidinellopsis subdehiscens* Interval-zone, the *Globorotalia margaritae evoluta* Lineage-zone (recorded in the core catcher sample of Core 5) and the *Globorotalia margaritae margaritae* Lineage-zone, recorded in Core 6. The thickness of the last two zones (both belonging to the *Globorotalia margaritae* total-range-zone) cannot be precisely determined, because the zonal boundaries were not recovered.

For the definition of the zones used here, which are new, reference is made to Chapter 47.

The *Globorotalia inflata* Interval-zone, the lower boundary of which is defined by the extinction horizon of *Globigerinoides obliquus extremus*, was not recognized. Specimens transitional from *G. puncticulata* to *G. inflata* are present in the samples investigated from Core 3; these two species are here considered as phylogenetically related.

Benthonic Foraminifera (W. M.)

The benthonic foraminifera are represented by rather scattered specimens and cannot be used to distinguish the Pleistocene and Pliocene. The distribution of the major benthonic foraminifera identified from this section is shown in Table 3.

Siphonina reticulata (Czjzek) which in the Mediterranean only very rarely extends into Quaternary deposits, is found at its highest level in Core 3. Another form which does not straddle the Pliocene/Quaternary boundary is *Eponides umbonatus stellatus* (Silv.) which was observed in Core 5. Rare occurrences of the Miocene species *Uvigerina flinti* (Cush.) and *Uvigerian auberiana* (d'Orb.) suggest that components of the sediment resting directly upon acoustic basement are reworked from older sedimentary strata in the region of the drill site.

Nannofossils (H.S.)

The distribution of nannofossils at Site 123 is shown in Table 4. The nannoplankton assemblages of Cores 1 and 2 are typical Quaternary, without discoasters. *Gephyrocapsa oceanica* is the most common species. Cores 3 and 6 contain Pliocene assemblages with abundant discoasters. In Core 3 *Discoaster brouweri* is the dominant species, but there are also some *Discoaster asymmetricus, D. pentaradiatus* and *D. surculus* (Upper Pliocene, NN16-17). Core 4, with *Discoaster asymmetricus* and *D. surculus* more abundant than *D. brouweri*, is assigned to the Lower Pliocene (NN15-16). Cores 5 and 6, with *Ceratolithus tricorniculatus* and *Discoaster surculus*, are also Lower Pliocene. Core 5, with *Discoaster asymmetricus* rather common in Section 1, is assigned to nannoplankton zone NN 14; in the assemblage of Core 6 this species is lacking, so it is assumed that the sediment was deposited before the first occurrence of *Discoaster asymmetricus.* In sample 123-6-1 (102-103 cm) *Discoaster challengeri* is common. *Ceratolithus tricorniculatus* at this site is very rare. Core 6, of nannoplankton zone NN12-14, is either Lower Pliocene or transitional Upper Miocene/Lower Pliocene. The sediment traces in Core 123-7-CC, in the ash layer of the acoustic basement, are of questionable age (contamination?). They contain *Discoaster surculus*, and also *D. brouweri* and *D. pentaradiatus.* Core 8, the lowest Core in the ash, is barren.

The nannofossils in selected samples are shown below:

Quaternary

Samples 13-123-1-2-54-55 cm, 123-1-3-108-109 cm and 123-1-CC:

Braarudosphaera bigelowi
Coccolithus pelagicus
Cyclococcolithus leptoporus
Emiliania huxleyi
Gephyrocapsa oceanica
Helicosphaera carteri
Pontosphaera japonica
Pontosphaera scutellum
Rhabdosphaera clavigera
Rhabdosphaera stylifera
Scypholithus fossilis
Scyphosphaera apsteini
Scyphosphaera campanula
Syracosphaera pulchra
Thoracosphaera heimi

Reworked species: *Nannoconus steinmanni* (Lower Cret.) *Micula staurophora* and other Upper Cret. coccoliths. *Discoaster barbadiensis D. saipanensis,* and *Chiasmolithus grandis* are from Eocene.

Samples 123-2-1-92-95 cm, 123-2-CC:

Braarudosphaera bigelowi
Coccolithus pelagicus
Cyclococcolithus leptoporus
Helicosphaera carteri
Lithostromation perdurum
Pontosphaera japonica
Pontosphaera scutellum
Rhabdosphaera clavigera
Rhabdosphaera stylifera
Scyphosphaera apsteini
Syracosphaera pulchra

Reworked nannofossils from the Lower and Upper Cretaceous

TABLE 3
Range Chart of Benthonic Foraminifera – Site 123

Age	Depth Below Sea Floor (m)	Cores	*Spiroplectammina wrighti* (Silv.)	*Bigenerina nodosaria* d'Orb.	*Spiroloculina depressa* d'Orb.	*Quinqueloculina oblonga* (Mont.)	*Sigmoilina celata* (Costa)	*Guttulina problema* d'Orb.	*Elphidium crispum* (Linn.)	*Uvigerina peregrina-mediterranea*	*Valvulineria bradyana* (Forn.)	*Ammonia beccarii* (Linn.)	*Amphistegina lessonii* d'Orb.	*Planulina ariminensis* (d'Orb.)
	Sea Floor 2290 m													
Pleistocene	79-87	1	x	x	x	x	x	x	x	x	x	x	x	x
Pleistocene	107-116	2									x			x
Pliocene	116-125	3		x			x			x	x	x		x
Pliocene	173-182	4			x	x	x		x				x	x
Pliocene	210-219	5	x				x						x	x
Pliocene	267-276	6												x
Pliocene	304-313.2	7	Void											
Pliocene	389-398.2	8	Tephra											

Age	Depth Below Sea Floor (m)	Cores	*Cibicides* cf. *floridanus* (Cush.)	*Cibicides lobatulus* (Walk. & Jac.)	*Cassidulina carinata* Silv.	*Nonion pompilioides* (F. & M.)	*Astrononion stelligerum* (d'Orb.)	*Articulina tubulosa* (Seg.)	*Dentalina inflexa* Reuss	*Lagena laevis* (Montagu)	*Lagena pseudorbignyana* Buchner	*Nodosaria* cf. *calomorpha* Reuss	*Lagena gracillima* (Seg.)	*Bolivina alata-beyrichi*
Pleistocene	79-87	1	x	x	x	x	x	x	x	x	x			
Pleistocene	107-116	2										x	x	x
Pliocene	116-125	3			x									x
Pliocene	173-182	4	x	x						x	x		x	x
Pliocene	210-219	5	x		x								x	
Pliocene	267-276	6	x											
Pliocene	304-313.2	7												
Pliocene	389-398.2	8												

Age	Depth Below Sea Floor (m)	Cores	*Bolivina dilatata* Reuss	*Bolivina pseudoplicata* Herr. All. & Earl.	*Bolivina punctata* d'Orb.	*Bolivina subspinecens* Cush.	*Bulimina marginata* d'Orb.	*Bulimina ovata* d'Orb.	*Cibicides pseudoungerianus* (Cush.)	*Pleurostomella alternans* Schwag.	*Cassidulina subglobosa* Brady	*Gyroidina soldanii* (d'Orb.)	*Karreriella bradyi* (Cush.)	*Dentalina* cf. *cuvieri* (d'Orb.)
Pleistocene	79-87	1												
Pleistocene	107-116	2	x	x	x	x	x	x	x	x	x	x		
Pliocene	116-125	3					x						x	x
Pliocene	173-182	4	x		x	x		x		x	x	x	x	
Pliocene	210-219	5		x		x	x	x		x			x	
Pliocene	267-276	6				x				x				
Pliocene	304-313.2	7												
Pliocene	389-398.2	8												

Age	Depth Below Sea Floor (m)	Cores	*Orthomorphina stainforthi* Perc.	*Eponides umbonatus* (Reuss)	*Siphonina reticulata* (Czjzek)	*Pullenia bulloides* (d'Orb.)	*Pullenia salisburyi* Stew.	*Hanzawaia boueana* (d'Orb.)	*Lagena orbignyana* (Seg.)	*Dentalina guttifera* d'Orb.	*Dentalina leguminiformis* (Batsch)	*Siphonodosaria consobrina* (d'Orb.)	*Eponides* cf. *haidingeri* (Brady)	*Martinottiella communis* (d'Orb.)
Pleistocene	79-87	1												
Pleistocene	107-116	2												
Pliocene	116-125	3	x	x	x	x	x	x						
Pliocene	173-182	4		x	x		x		x	x	x	x	x	x
Pliocene	210-219	5		x	x	x	x				x			x
Pliocene	267-276	6			x									
Pliocene	304-313.2	7												
Pliocene	389-398.2	8												

Age	Depth Below Sea Floor (m)	Cores	*Spiroloculina excavata* d'Orb.	*Sigmoilina schlumbergeri* (Silv.)	*Sigmoilina tenuis* (Czjzek)	*Robulus cultratus* Montf.	*Globulina* cf. *minuta* (Will.)	*Bolivina spathulata* (Will.)	*Reussella spinulosa* (Reuss)	*Cancris oblongus* (d'Orb.)	*Asterigerina planorbis* (d'Orb.)	*Elphidium macellum* (F. & M.)	*Eponides* cf. *schreibersii* (d'Orb.)	*Planularia insolita-crepidula*
Pleistocene	79-87	1												
Pleistocene	107-116	2												
Pliocene	116-125	3												
Pliocene	173-182	4	x	x	x	x	x	x	x	x	x	x	x	x
Pliocene	210-219	5		x								x	x	
Pliocene	267-276	6												
Pliocene	304-313.2	7												
Pliocene	389-398.2	8												

Age	Depth Below Sea Floor (m)	Cores	*Cibicides* cf. *refulgens* (Montf.)	*Lagena* cf. *acuticosta* Reuss	*Cibicides robertsonianus* (Brady)	*Eponides umbonatus stellatus* (Silv.)	*Nonion padanum-barleeanum*	*Bolivina catanensis* Seg.	*Siphonodosaria monilis* (Silv.)	*Uvigerina auberiana* d'Orb.	*Uvigerina flintii* Cush.
Pleistocene	79-87	1									
Pleistocene	107-116	2									
Pliocene	116-125	3									
Pliocene	173-182	4	x								
Pliocene	210-219	5		x	x	x	x				
Pliocene	267-276	6			x		x	x	x	x	x
Pliocene	304-313.2	7									
Pliocene	389-398.2	8									

TABLE 4
Range Chart of the Nannofossils – Site 123

Age	Zone	Core	Depth Below Sea Level (m)	*Braarudosphaera bigelowi* (Gran & Braarud)	*Coccolithus pelagicus* (Wallich)	*Cyclococcolithus leptoporus* (Murray & Blackman)	*Emiliania huxleyi* (Lohmann)	*Gephyrocapsa oceanica* Kamptner	*Helicosphaera carteri* (Wallich)	*Pontosphaera japonica* Takayama	*Pontosphaera scutellum* (Kamptner)	*Rhabdosphaera clavigera* Murray & Blackman	*Rhabdosphaera stylifera* Lohmann	*Scyphosphaera apsteini* Lohmann	*Scyphosphaera campanula* Deflandre	*Syracosphaera pulchra* Lohmann	*Thoracosphaera heimi* (Lohmann)	*Lithostromation perdurum* Deflandre	*Discoaster asymmetricus* Gartner	*Discoaster brouweri* Tan	*Discoaster pentaradiatus* Tan	*Discoaster surculus* Martini & Bramlette	*Micrantholithus flos* Deflandre	*Pseudoemilia lacunosa* (Kamptner)	*Scyphosphaera intermedia* Deflandre	*Sphenolithus abies* Deflandre	*Discoaster surculus* Martini & Bramlette	*Scyphosphaera pulcherrima* Deflandre	*Scyphosphaera recurvata* Deflandre	*Ceratolithus tricorniculatus*	*Reticulofenestra pseudoumbilica* Gartner	*Discoaster challengeri* Bramlette & Riedel
Pleistocene		1	2379-2387	I	I	I	I	I	I	I	I	I	I	I	I	I	I															
Pleistocene	NN 16-18	2	2407.1-2416.2	I	I	I			I		I	I	I	I				I														
Upper Pliocene	NN 16-18	3	2416-2425		I	I			I	I				I					I	I	I	I	I	I	I	I						
Upper Pliocene	NN 14-16	4	2473.2-2482.2		I	I			I	I				I		I		I	I	I		I						I	I		I	
Upper Pliocene	NN 14	5	2510-2519.1		I	I			I	I				I				I	I	I		I			I	I		I		I		
Lower Pliocene	NN 12-14	6	2567-2576		I	I					I			I				I				I			I	I			I	I	I	I
Lower Miocene																																

PLIOCENE

Samples 123-3-1-99-100 cm, 123-3-CC:

Coccolithus pelagicus
Cyclococcolithus leptoporus
Discoaster asymmetricus
Discoaster brouweri
Discoaster pentaradiatus
Discoaster surculus
Helicosphaera carteri
Micrantholithus flos
Pontosphaera japonica
Pseudoemiliania lacunosa
Scyphosphaera apsteini
Scyphosphaera intermedia
Sphenolithus abies

NN 16-NN 17

Samples 123-4-1-131-132 cm, 123-4-2-75-76 cm, 123-4-3-31-32 cm and 123-4-CC:

Coccolithus pelagicus
Cyclococcolithus leptoporus
Discoaster asymmetricus
Discoaster brouweri
Discoaster surculus
Helicosphaera carteri
Lithostromation perdurum
Pontosphaera japonica
Rhabdosphaera stylifera
Scyphosphaera apsteini
Scyphosphaera pulcherrima
Scyphosphaera recurvata
Syracosphaera pulchra

NN 15-NN 16

Samples 123-5-1-114-115 cm, 123-5-2-36-37 cm and 123-5-CC·

Ceratolithus tricorniculatus
Coccolithus pelagicus
Cyclococcolithus leptoporus
Discoaster asymmetricus
Discoaster brouweri
Discoaster surculus
Helicosphaera carteri

Lithostromation perdurum
Reticulofenestra pseudoumbilica
Scyphosphaera apsteini
Scyphosphaera intermedia
Scyphosphaera pulcherrima
Sphenolithus abies
Discoaster asymmetricus-Zone

NN 14

Reworked: *Discoaster barbadiensis* (rare)

Samples: 123-6-1-1 cm, 123-6-1-102-103 cm and 123-6-CC:
Ceratolithus tricorniculatus
Coccolithus pelagicus
Cyclococcolithus leptoporus
Discoaster challengeri
Discoaster surculus
Lithostromation perdurum
Pontosphaera scutellum
Reticulofenestra pseudoumbilica
Scyphosphaera apsteini
Scyphosphaera intermedia
Scyphosphaera recurvata
Sphenolithus abies

NN 12-NN 14

Sample 123-6-CC: Contains the volcanic ash and only a few nannofossils, which are poorly preserved.

Sample 123-7-CC: Sediment traces found in the core catcher rings are possibly contaminations. They contain a similar assemblage as in 123-6cc, however no *Ceratolithus tricorniculatus* was found.

Sample 123-8-CC: barren.

LITHOSTRATIGRAPHY

A single hole was drilled at Site 123. The drilling was terminated at 398.2 meters in a thick volcanic ash formation, identified as the acoustic basement. Three lithologic units were distinguished, which are, in descending order: 1) Quaternary graded sands and marl oozes with gravels; 2) Pliocene graded sands, silt laminae, marl oozes oozes; 3) volcanic glass of early Miocene age, based on a K/Ar radiometric date.

Table 5
Lithologic Units - Site 123

Unit	Lithology	Age
1	Graded sands, marl oozes with gravels at base; mainly turbidites.	Quaternary
116.6		
2	Graded sands, silt laminae, marl oozes and nanno-oozes; turbidites with contourites	Pliocene
268.5		
3	Volcanic ash deposit (acoustic basement)	Lower Miocene
393.2		

Unit 1 – Graded Sands, Gravels and Marl Oozes

Cores of graded sands and marl oozes were recovered between 79 and 108.5 meters. They are Quaternary in age. Gravel beds were penetrated in the middle of Core 2 and at the top of Core 3. These gravels contain nannofossils of middle Pleistocene age and lie on Upper Pliocene marl oozes. The upper part of the Quaternary sequence is olive gray to grayish brown, with well-developed graded sequences 10 to 40 centimeters thick, starting with sand at the base and grading upward into silt and clay. The lower boundaries are always sharp. The sandy sediments of Unit 1 are interpreted as turbidites deposited within the Valencia Channel. Two thinly laminated layers of silts intercalated in the marl ooze were noted. They may owe their origin to bottom current transport.

Typical minerology for the sands as seen in shipboard smear slides is 70% quartz, 25% mica, and 5% rock fragments. The intercalated layers of Unit 1 are marl oozes composed of 60 to 65% of fine terrigenous clastics – quartz and clay minerals together with nannoplankton and rare foraminifers. Terrigenous gravels were penetrated in Core 2 between 108 and 108.5 meters. They overlie 0.2 meters of dark yellowish brown marl ooze of Pleistocene age.

The 50-centimeter-thick gravel bed contains a small amount of sand. The lower half is well sorted, while the upper part consists of gravels, sands, and silts embedded in a watery clay matrix. The mixing may have been caused by drilling disturbance. Of the pebbles, 40% are 10 to 20 millimeters in diameter and 40% are 2-10 millimeters; the remaining 20% are sand-size particles. Most of the grains are very well rounded (Figure 6A).

The gravels consist of lithic rock fragments (Figure 6D) (usually fine-grained graywackes and arenites), acid to intermediate plutonic rocks (granites etc.) metamorphic rocks, quartzites, limestones (both light and dark colored), and pieces of littoral shells (Figure 6B), particularly valves and hinges (Figure 6C). The abundance of the quartzites and metamorphic rocks is greatest in the large grain-size portion of the bed, and the limestone is usually more prevalent as small fragments. The limestones are the best rounded, the plutonic rocks the least. The shells are always broken and abraded.

In the sand-size fraction the biogenic components are by far the most abundant ($\approx$70%), and include shells of pelecypods, gastrapods, brachyopods, bryozoa, sea-urchin spines, and foraminifera. Quartz and limestone are the dominant terrigenous components of the sand-size fraction. A layer of olive gray to very dark yellowish brown marl ooze separates the gravel bed of Core 2 from that of Core 3. The gravels of Core 3 are similar in composition, texture, and grain size to those of Core 2.

Unit 2 – Graded Sands, Silt Laminae, Marl Oozes and Nanno Ooozes

Alternating layers of Pliocene sand and mud were drilled between 116 and 268.5 meters. The color of Unit 2 grades from olive gray in the clays to very dark yellowish brown in the sand layers.

Microscopic examination of the smear slides of the nanno-ooze beds show that they are composed of 70 to 85%

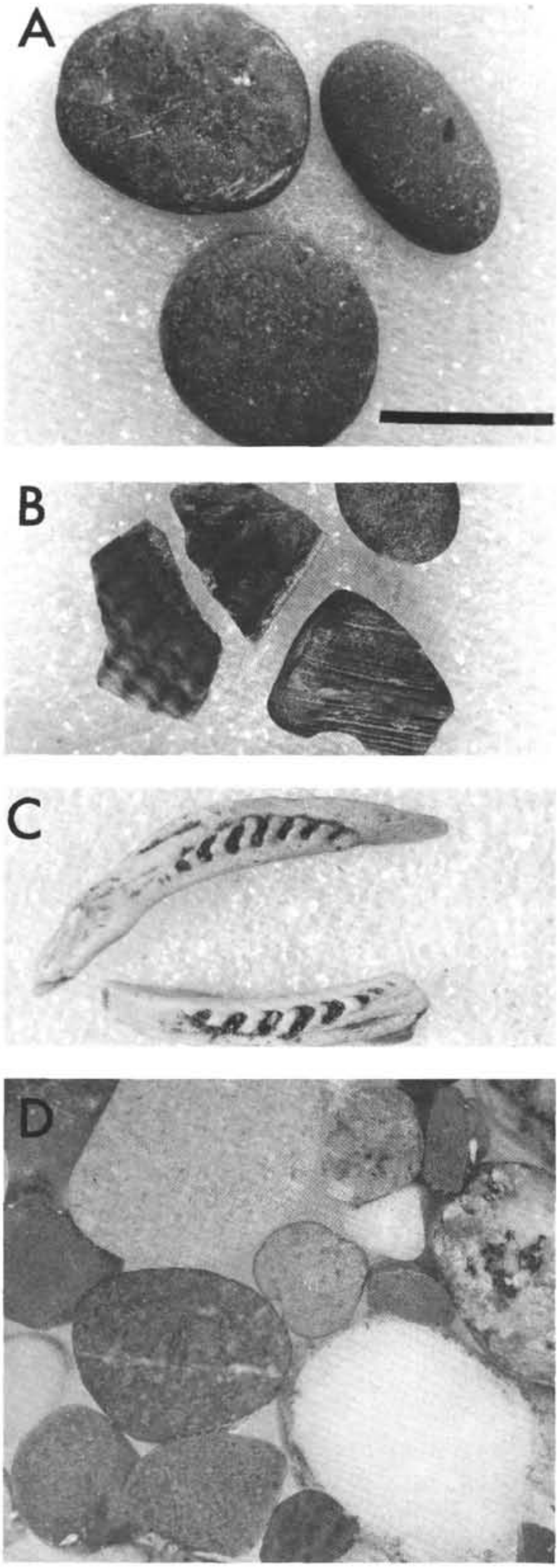

Figure 6. *Quaternary gravels of Unit – 1 (Core 2, Section 1, 130 cm.). This unit, interpreted as a deep-sea channel deposit, contains well-rounded and flattened pebbles of various rock types (A), abraided and broken piece of littoral shells (B), especially hinges and valves (C). The rock types seen in a polished section (D) which include plutonic rocks, quartzites, greywache, schists, and limestones. Scale bar represents one centimeter.*

coccolithophorids, 2 to 4% discoasters, 0 to 1% forams, 10 to 15% mica, 3 to 5% quartz, and 3 to 6% calcite.

The sand layers in the upper part of Cores 3 and 4 are mainly quartzitic – 60% quartz, 15 to 30% micas, 0 to 5% feldspar, 0 to 20% calcite, 2% forams. A layer of particularly fresh sand occurs in Core 5-1 (193 cm); the composition is 30% quartz, 7% chlorite, 12% light mica, 17% dark mica, 15% feldspar, 8% calcite, 5% forams, 2% rock fragments, 2% gypsum, and 2% pyrite.

The graded sand and mud sequences are here interpreted as turbidites. We also recognized numerous closely-spaced silt laminae intercalated in marl-ooze (See Figures 7A, B, C) which we interpret to be a result of traction transport by bottom currents.

In Cores 6-3 and 4-CC, there are beds of clay with abundant reworked *Amphistegina* (a shallow-water benthonic foraminifer), affording further evidence of transport and resedimentaton by currents.

Unit 3 – Volcanic Ash

A thick body of volcanic ash was encountered from 268.5 meters to the bottom of the hole at 398.2 meters. The ash is unfossiliferous. It is composed exclusively of colorless shards of volcanic glass (Figure 8); the larger fragments are up to 0.5 millimeter in length. The index of refraction of the glass of 1.54 corresponds to an andesitic composition. Small amounts of quartz (3%), feldspar (1%), light micas (1%), and clay minerals (5%) are associated with the glass shards. A petrographic description of the volcanic ash is given in Chapter 28.1.

The top 11 centimeters of the unit are lithified. Below, the shards are generally loosely compacted and the deposit crumbles under the fingers. However, additional lithified layers (up to 5 cm. in thickness) are present in Core 8, and several of these fragments show irregular veins (Figure 8a). In thin section, the veins are richer in aggregate polarized grains, clay minerals, and sanidine (Figure 8b). Where the veins cut into the fibrous glass, the contacts are partly devitrified, suggesting the movement of solutions (hydrothermal?) through the pyroclastic deposit.

PHYSICAL PROPERTIES

Because of physical disturbance only some of the cores provided suitable sections for the determination of physical properties.

Penetrometer measurements show a consistent decrease in value towards the bottom of the hole and range from 79 $\times 10^{-1}$ mm in Core 1 at 79 meters below bottom to 33 $\times 10^{-1}$ mm at 213 meters in Core 6. Some physical disturbance in the bedding was noted in Core 3, which produces abnormally high readings of 97 $\times 10^{-1}$ mm.

The wet bulk density, water content and porosity were measured in the sediment only in Cores 1 to 6. No

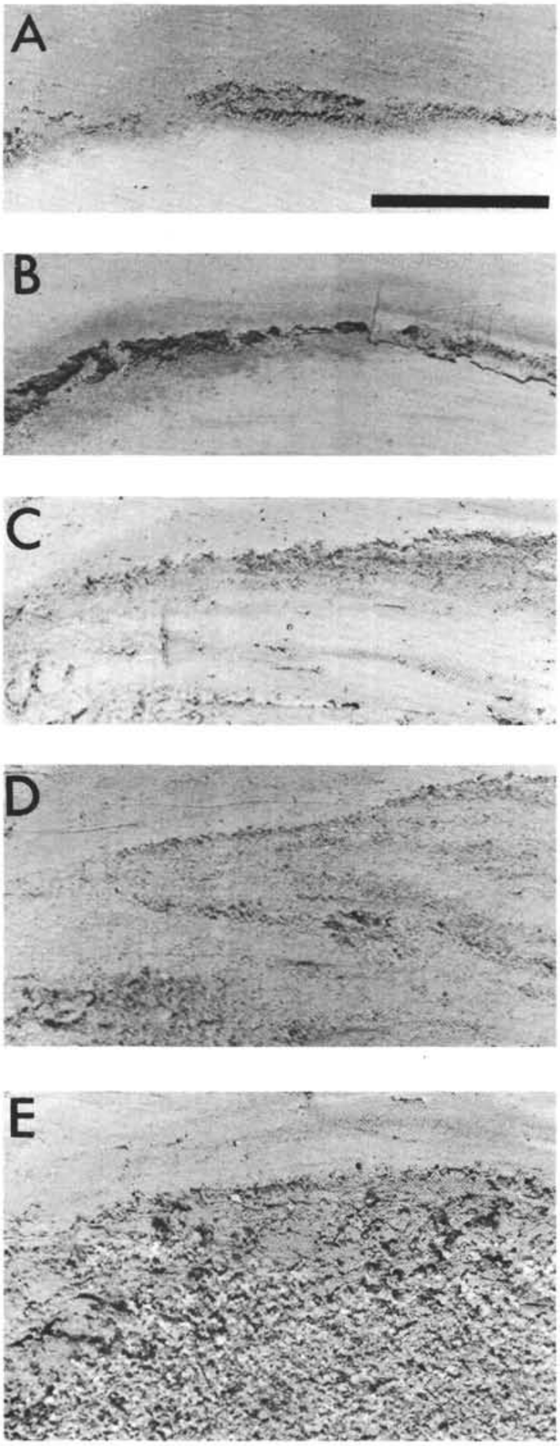

Figure 7. *Examples of bedding structures in Unit 2 – "Graded sands, silt-laminae, and nanno-oozes." A – thin silt layers at basal contact between two different lithologic units, in this case, marl ooze overlying nanno-ooze. B – thin silt-laminae interrupting sequences of marl ooze. C – cross-bedded and truncated lens of poorly-sorted, sandy-silt in nanno-ooze; sand-fraction rich in foraminifera tests. D – cross-bedded (sometimes rippled) silty sand zones interbedded in marl; sand-fraction rich in terrigenous minerals. E – Upper part of a massive graded sand layer showing truncation (?) by a much finer-grained silty-clay laminate. The sand unit from Core 6, Section 1, 146* cm *lies directly on the volcanic basement, and is very rich in detrital gypsum and reworked Miocene foraminifera. The basal part of the sand unit is remarkably clean, whereas the top is very muddy. Scale bar represents one centimeter.*

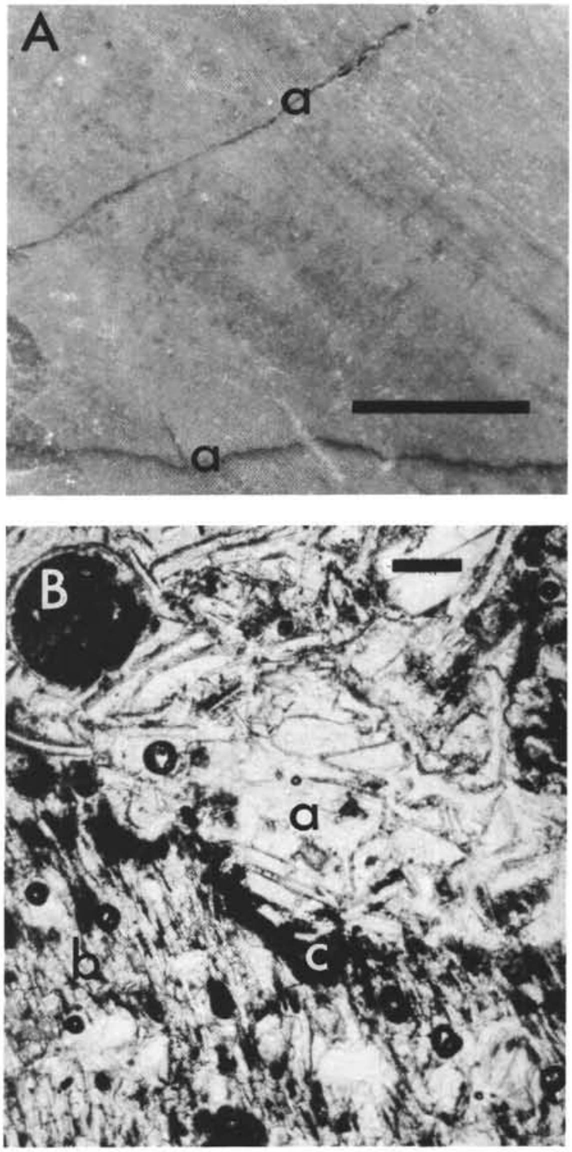

Figure 8. *Volcanic ash (dacite) of Unit – 3 as seen in a polished hand specimen (A), and in thin section (B). Cross-cutting veins (a) rich in clay minerals (c) abut partly devitified fibrous glass and suggest the movement of ground water through this pyroclastic deposit. Note the abundance of large gas inclusions in the vitreous shards. Index of refraction of the glass is ≈1.55. Scale bar in upper figure represents one centimeter, in lower figure, 100 microns.*

measurements were made in the ash deposit. Bulk density increases from 1.55 gm/cc in Core 1 in watery .sands, to 2.03 gm/cc in Core 4, where stiff nanno oozes and marl oozes occur, and decreases to 1.82 in Core 6, again in the sands. The grain density decreases from 2.97 to 2.63 gm/cc through Cores 1 to 6. Water content and porosity decrease progressively with depth from 46.1 to 21.9% and 71.8 to 39.8% respectively.

As observed at Site 122, natural gamma measurements show marked variation where different proportions of calcium carbonate are present. Characteristic results in Cores 3 and 4 show low values in carbonate-rich beds, where counts of around 1950 were recorded. Quartz-rich sands give high readings of around 3400.

SUMMARY AND CONCLUSIONS

The basement ridge (cone?) drilled into at Site 123 was in existence prior to the deposition of the alleged salt-layer seen in the seismic reflection profiles of the Auzende et al., (1971) and Montadert et al., (1970). This conclusion is arrived at by recognizing that both the pre-salt N Reflectors and the post-salt M Reflectors overlap onto the flank of the basement ridge.[2] Thus the radiometric age of 21 million years (see Chapter 28.4) for the dacite deposits on the crest of the ridge predates the evaporite epoch. Since some 0.5 to 0.7 second of stratified sediment can be seen below the N-reflectors on some profiles in the Valencia Trough (based on shipboard examination of the *Charcot* profiles), it seems reasonable to suggest, in light of the drilling results at other Mediterranean locations, that the evaporite rocks here are also Upper Miocene in age.

The volcanic ash of the basement consists of fibrous and vesicular glass shards rich in gaseous and liquid inclusions. This type of pyroclastic material is believed to be produced during violent subaerial eruptions similar to the historical eruptions of Vesuvius and Santorini. Volcanic shards are commonly found in deep-sea sediments from the Mediterranean Sea (Mellis, 1954; Norin, 1958; Ninkovich and Heezen, 1965). Volcanic eruptions of the explosive "Krakatau type" are known to blast large quantities of ash to heights approaching 50 kilometers, where it is then carried out to sea and distributed over large areas by high-altitude winds. Layers of tephra deposited in marine environments are almost invariably interbedded with, and mixed into marine pelagic sediments (Ninkovich et al., 1964).

The presence of vesicular shards deposit that exceeds 120 meters in thickness, the notable absence of marine fossils in the ash—particularly nannofossils[3]—and the welding of glass fragments and associated minerals into large lumps in Cores 6 and 8, are suggestive that the acoustic basement of the Valencia Trough region is not simply a marine tephra layer of unusual proportions, but actually a flank deposit of a once sub-aerial composite volcanic cone. As a flank deposit, the numerous cross-cutting veins seen in the lithified ash units (Figure 8) might be most easily explained by hydrothermal circulation of ground waters, a process unlikely to occur within a deep-sea tephra layer.

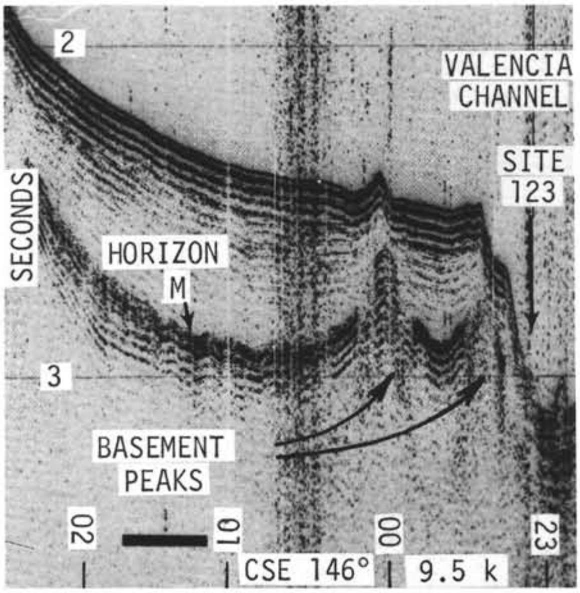

Figure 9. *Seismic reflection profile (airgun) made by the* Challenger *in departing from Site 123. The vessel first proceeded north to stream the seismic gear, then reversed course to the southeast and passed directly over the beacon sitting on a small terrace on the channel wall (marked by the arrow). Note the basement peak beneath the southern bank of the channel and another some 15 kilometers south of the drill site. This and other profiles illustrate how the M-Reflectors abut against elevated ridges and peaks. Note the great thickness of stratified sediment beneath the floor of the channel axis. The vertical scale is in seconds (two-way travel time), and the horizontal scale bar represents 10 kilometers. Exaggeration is ≈50:1.*

It is interesting to note that the reworked foraminifera associated with the detrital gypsum in certain sand and silt layers in Cores 5 and 6 are all of Miocene age. We recall that the limestone fragments recovered from the basal gravel on the M-Horizon at Site 122, again in the Valencia Trough, were also of Miocene age. Thus, the accumulated evidence points to an initiation of marine conditions here, sometime in the Miocene, following sub-aerial volcanic eruptions around 21 million years ago.

The biogenic marl oozes of Core 6 which accumulated during the early Pliocene afford further evidence that the Valencia Trough was a deep-sea basin at that time. The shallow-water benthonic foraminifera and fragments of bryozoa are considered allochthonous, as they are found exclusively in graded sand layers, rich in terrigenous clastics, and in current-bedded silt laminae.

The unconformities seen at Horizon M and within the overlying Pliocene and Pleistocene section are manifestations of the major role played by a vigorous deep-sea circulation (and probably turbidity currents) in sedimentation. The occurrence in Cores 5 and 6 of considerable amounts of detrital gypsum in some of the bedded sand and silt layers is a demonstration that the ocean-floor currents during the Lower Pliocene were of sufficient strength to

[2] The salt-layer refers to an interval in the reflection profiles with a characteristic acoustic signature which is shown to have flowed to form diapirs in the area of the Rhone Cone and Balearic Abyssal Plain.

[3] The traces of ooze in Core 7cc are considered as downhole contaminants, since they include Pliocene assemblages of nannofossils very much younger than the radiometric age of the pyroclastic deposits.

have eroded into the subjacent Upper Miocene evaporite rocks. In fact, we suspect that these currents were responsible for the absence of the M-Reflectors (series) and the salt layer on the crest of the basement volcano,

Although we cannot rule out the possibility of some initial channel cutting during the Pliocene, the major incisement of the Valencia Channel system appears to have occurred in the Quaternary[4]. In fact the marked one million year hiatus directly below the gravels in Cores 2 and 3 is readily explained by postulating that the gravels were deposited contemporaneously with the removal of perhaps fifty meters[5] of the Lower Quaternary and Uppermost Pliocene sediment sequence (i.e., by turbidity currents which became channelized upon cutting into the seabed along the axis of the trough).

The volcanic basement peak drilled into at Site 123 lies on the margin of a negative depression in the residual magnetic field of about 200 gammas amplitude (see Figure 10 and the *Challenger* underway magnetic measurements in Chapter 16 of Part II of this volume). The negative depression itself lies directly to the northeast of one of the large (>300 gammas) circular magnetic anomalies of the Valencia Trough region of the western Mediterranean.

The offset of the center of the positive anomaly to the south of the magnetic body can be explained by postulating that this volcanic cone in the northern hemisphere is normally magnetized (Vacquier, 1962; Francheteau *et al.*, 1970). An oriented sample of the dacite from Core 6, Section 2, 5 cm. has a remnant inclination of +55 degrees, a weak remanent magnitization of 0.8×10^{-6} emu/cm^3 and a susceptibility of 0.5×10^{-4} emu/cm^3. It is interesting to note that 21 million years on the geomagnetic time scale (Heirtzler *et al.*, 1968) corresponds to a relatively broad period of normal polarity (Anomaly 6). Since several of the other magnetic anomalies in the Valencia Trough also have negative depressions on their northern margins, it seems reasonable to speculate that these magnetic bodies owe their presence to an episode of calc-alkaline volcanism in the early Miocene.

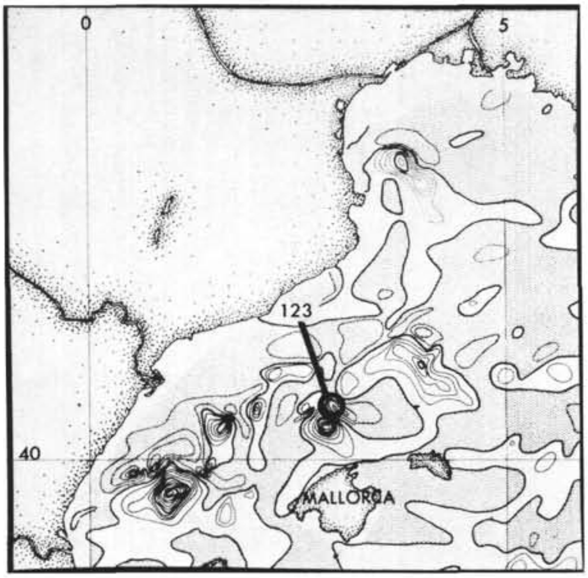

Figure 10. *Residual magnetic-field anomaly map of the Valencia Trough region of the western Mediterranean (from Vogt* et al., *1971). The data are from primarily north-south aeromagnetic flight lines at a spacing of approximately 18 km. and elevation of 300 meters. The contour interval is 50 gammas; the shaded areas are negative anomalies.*

[4]Youthful cutting of the channel is supported in a reflection profile of Mauffret (1970) (Plate 3, page 38, where his Reflector B is correlatable with Horizon M.)

[5]The mean sedimentation rate for the Quaternary and Pliocene is estimated at 5 cm/1000 years. Thus a 1 million year accumulation comprises approximately 50 meters.

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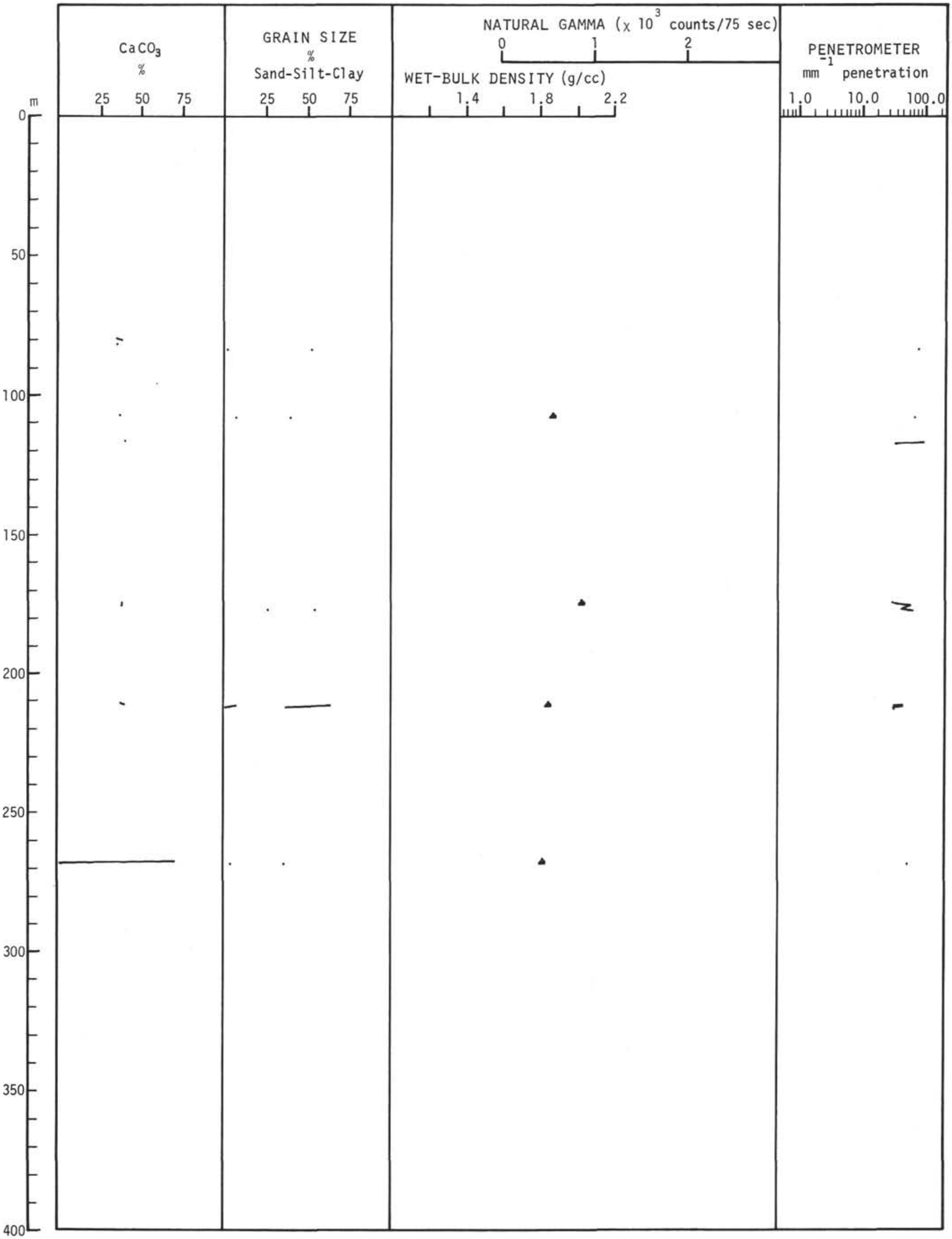
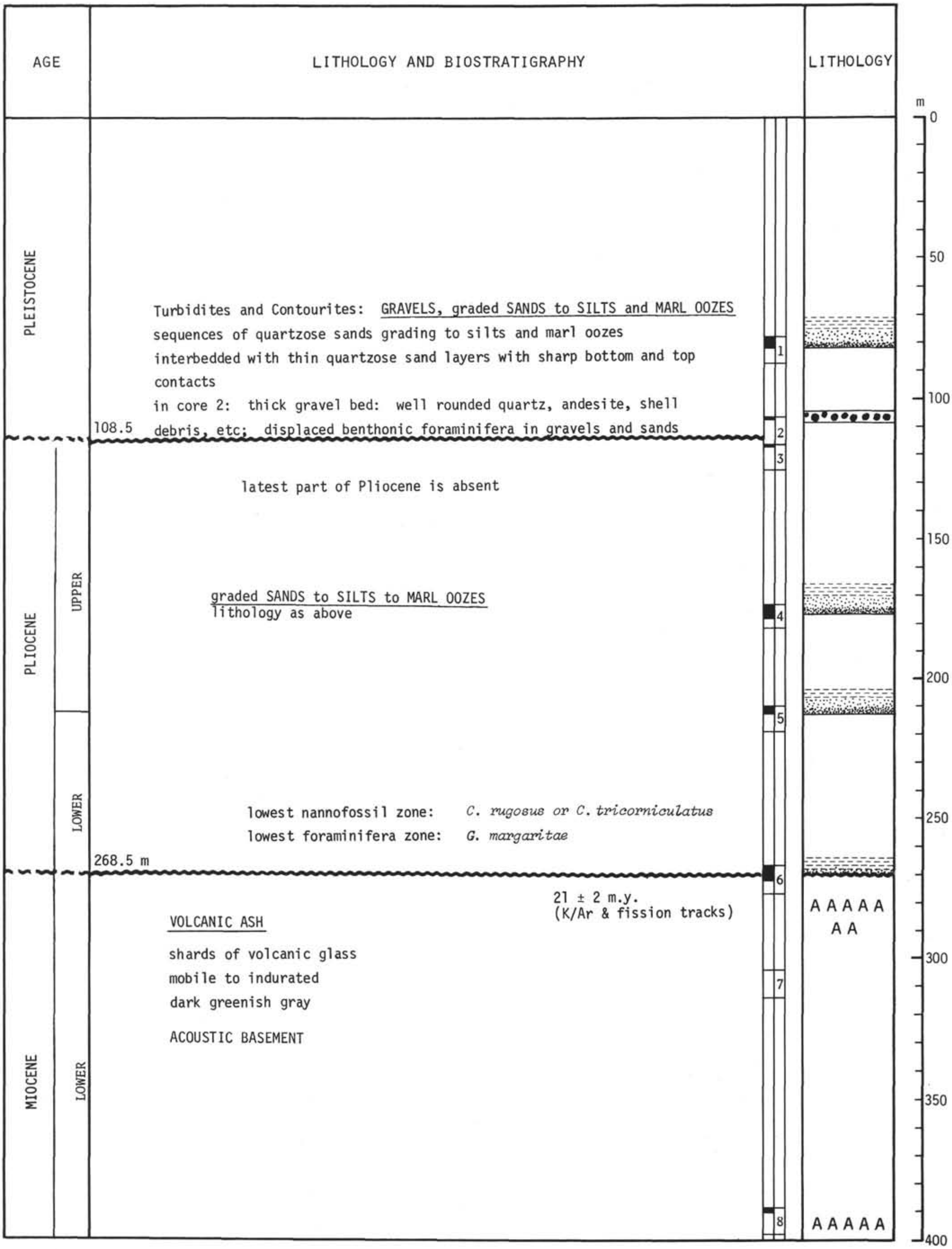
Site Summary 123




AGE
LITHOLOGY AND BIOSTRATIGRAPHY
LITHOLOGY
m
0
50
100
150
200
250
300
350
400
PLEISTOCENE
Turbidites and Contourites: GRAVELS, graded SANDS to SILTS and MARL OOZES
sequences of quartzose sands grading to silts and marl oozes
interbedded with thin quartzose sand layers with sharp bottom and top contacts
in core 2: thick gravel bed: well rounded quartz, andesite, shell
108.5
debris, etc; displaced benthonic foraminifera in gravels and sands
PLIOCENE
UPPER
latest part of Pliocene is absent
graded SANDS to SILTS to MARL OOZES
lithology as above
LOWER
lowest nannofossil zone: C. rugosus or C. tricorniculatus
lowest foraminifera zone: G. margaritae
268.5 m
MIOCENE
LOWER
21 ± 2 m.y.
(K/Ar & fission tracks)
VOLCANIC ASH
shards of volcanic glass
mobile to indurated
dark greenish gray
ACOUSTIC BASEMENT
1
2
3
4
5
6
7
8
A A A A A
A A
A A A A A

SITE 123 CORE 1 Cored Interval 79-87 m

AGE: QUATERNARY — *Globorotalia truncatulinoides* Total-range-zone

Columns: 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

m B. S. FL.: 79 – 83.5

Sections: 1, 2, 3, CC

Section 1: VOID

$CaCO_3$: 35, 39, 36, (3-51-46)

graded SANDS and MARL OOZES

sequences of sands grading to silts and marl oozes: turbidite structures

sequences 10 to 180 cm thick

sand layers graded, 5 cm thick, sharp bottom contact, gradational top

marl oozes plastic, olive gray (5Y 4/1)

Smear (marl ooze)	
nannos	40
quartz	25
mica	35

displaced shallow-water foraminifera in the coarser layers.
almost purely planktonic fauna in Section 2 including foraminifera and pteropods, indicating temperate-warm surficial water
(abundant *Globigerinoides* spp., *Globigerina digitata-praedigitata*)
section 3 and the core catcher sample give indications of colder climate (less diversified fauna, scantiness of *Globigerinoides*, lack of *Globigerina digitata*, occurrence of left-coiling *Globigerina pachyderma*)
nannofossils characteristic of the *Gephyrocapsa oceanica* zone.

SITE 123 CORE 2 Cored Interval 107-116 m

AGE: QUATERNARY — *Globorotalia truncatulinoides* Total-range-zone

Columns: 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

m B. S. FL.: 107.7, 108, 108.5, 108.7

Sections: 1, CC

Section 1: VOID

$CaCO_3$: 38 (8-33-59)

107.7-108 MARL OOZE
olive gray (5Y 4/1)
plastic to stiff
moderate mottling

108-108.5 GRAVEL
well rounded, 2-20 mm in size
no grading
quartz, andesite, shell debris, limestone

108.5-108.7 MARL OOZE
dark yellowish brown (10YR 4/2)
plastic

Smear (nanno ooze)	
nannos	40
discoaster	3
calcite	2
quartz	25
micas	30

abundant detritus in the sand-fraction
sediment-recorded fossils include displaced shallow-water benthonic foraminifera fragments of bryozoa, pelecypod fragments, ostracods, etc.
planktonic foraminifera without *Globorotalia truncatulinoides*
nannofossils characteristic of the Lower Pleistocene

SITE 123 CORE 3 Cored Interval 116-125 m

AGE: UPPER PLIOCENE — *Globigerinoides obliquus extremus* Interval-zone

Columns: 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

m B. S. FL.: 116.6, 117.5

Sections: 1, CC

Section 1: VOID

$CaCO_3$: 41

graded SANDS and MARL OOZES

sequences of sands and silts interbedded with marl oozes: contourite structures

sequences 5 to 30 cm thick

sand layers graded, 1 to 3 cm thick, sharp bottom and top contacts

marl oozes plastic, dark yellowish brown (10YR 4/2), moderately burrowed

Smear (sand)		(nanno ooze)	
quartz	60	nannos	40
micas	15	discoasters	4
feldspars	5	quartz	26
calcite	20	micas	30

rich and diversified planktonic foraminiferal assemblage with *Globigerinoides obliquus extremus* and primitive forms of *Globorotalia inflata*
benthonic foraminifera including displaced, shallow-water forms
ostracods, echinoid spines
nannofossils including *Discoaster brouweri* and *D. asymmetricus*

SITE 123 CORE 4 Cored Interval 173-182 m

AGE: UPPER PLIOCENE — *Globigerinoides obliquus extremus* Interval-range-zone; *Sphaeroidinellopsis subdehiscens* Interval-range-zone

Columns: 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

m B. S. FL.: 174.2, 176.3, 178, 178.3

Sections: 1, 2, 3, CC

Section 1: VOID; Section 2: VOID; Section 3: VOID

$CaCO_3$: 38, 38, (27-28-45)

graded SANDS and MARL OOZES

sequences of sands grading to silts and marl oozes: turbidite with occasional contourite structures

sequences 10 to 55 cm thick

sand layers graded, 1 to 50 cm thick, dark grayish brown (10YR 4/2), sharp bottom contact, gradational top, occasionally sharp top

marl oozes plastic, olive gray (5Y 4/1). Between 176 and 178 m the oozes are loaded with Amphistegines and urchin spicules

Smear (sand)		(marl ooze)	
nannos	3	nannos	40
forams	2	discoaster	2
quartz	60	quartz	23
micas	35	micas	35

planktonic foraminifera of the *Sphaeroidinellopsis subdehiscens* partial-range zone in the core catcher; of the *Globigerinoides obliquus* Interval-range zone in sections 1 and 2
displaced benthonic foraminifera; nannofossils include *Discoaster brouweri*, *D. surculus*, *D. asymmetricus*, etc.
ostracods
pelecypod fragments
echinoid spines
large size *Amphistegina* in the core catcher

SITE 123 CORE 5 Cored Interval 210-219 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
UPPER PLIOCENE *Sphaeroidinellopsis subdehiscens* Interval-range-zone			1	VOID			V
		211			37 (7-57-36)		
			2		40 (1-36-63)		
LOWER PLIOCENE *Globorotalia margaritae* total-range-zone		213.4	CC				

SANDS, SILTS and MARL OOZES

sequences of sands grading to silts and marl oozes: turbidite structures with contourites.

sequences 10 to 35 cm thick.

sand & silt layers thin: mainly 1 cm, bottom contact sharp, top gradational except in section 1 and core catcher where it is also sharp.

marl oozes plastic, gray (5Y 5/1), olive gray (5Y 4/1) and brown (10YR 5/3)

Smear (sand)		(Marl ooze)	
quartz	50	nannos	40
micas	20	quartz	30
feldspars	15	mica	30
rock fragments	15		

planktonic foraminifera abundant and well diversified belonging to the *Globorotalia margaritae* total-range-zone (in the core catcher sample) and to the *Sphaeroidinellopsis subdehiscens* Interval-range zone (Sections 1 and 2)
displaced shallow-water foraminifers in 5 core catchers with *Amphistegina lessoni*, *Ammonia beccarii*, *Elphidium*
nannofossils include *Reticulofenestra pseudoumbilica*, *Discoaster asymmetricus*, etc.

SITE 123 CORE 6 Cored Interval 267-276 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
LOWER PLIOCENE *Globorotalia margaritae* total-range-zone			1	VOID			V
		267.9			70 (4-33-63)		
		268.5		A A A A A	0.7		
			2	A A A A A			
			3	A A A A A			
		271.5	CC	A A A A A			

267.9-268.5 - graded SANDS and MARL OOZES

sequences of sands grading to silts and marl oozes: turbidite structures.

mineralogy and structures as in core 5.

268.5-271.5 - ASH

shards of volcanic glass

mobile to indurated, top 10 cm and random horizons below, consolidated in tuffs

dark greenish gray (5G 4/1)

Smear	
glass shards	94
quartz	3
feldspar	1
mica	1
calcite	1

planktonic foraminifera of the *Globorotalia margaritae margaritae* lineage zone and nannofossils of the *Ceratolithus tricorniculatus* zone in Section 1

SITE 123 CORE 8 Cored Interval 389-398.2 m

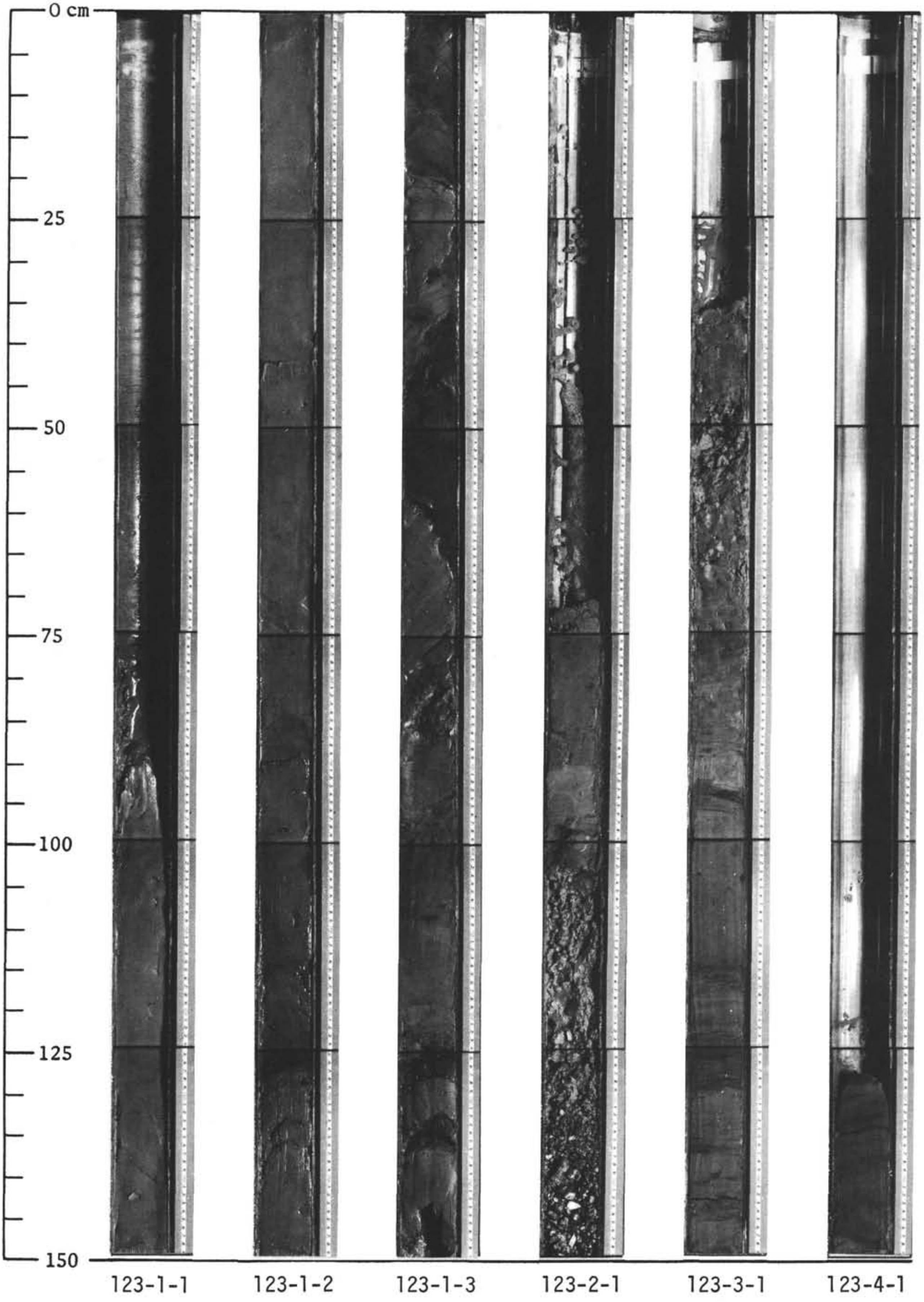
AGE	WET-BULK DENSITY (gm/cc) 1.3 1.6 1.9 2.2 / NATURAL GAMMA RADIATION (10^3 counts) 0.0 0.5 1.0 1.5 2.0	m B. S. FL.	SECTION	LITHOLOGIC SYMBOLS	% $CaCO_3$ (% sand/silt/clay)	LITHOLOGY AND PALEONTOLOGY	DISTURBANCE
				VOID			V
		389.3	1	A A A A A			
		390.5	CC	A A A A A			

ASH

dark greenish gray (5G 4/1)

mobile to indurated at random horizons

Total Drilling: 398.2 m in ash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0 cm
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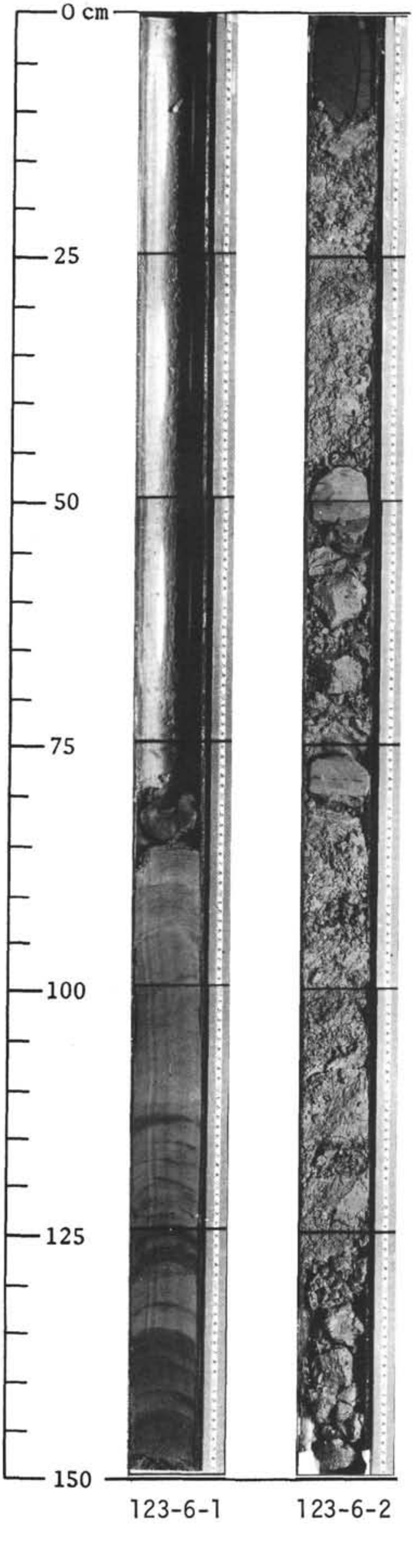
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