5. VALENCIA BASEMENT RIDGE – SITE 123

The Shipboard Scientific Party

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 channelled 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.

1W. B. F. Ryan, Lamont-Doherty Geological Observatory; K. J. Hsu, Eidg. Technische Hochschule; M. B. Cita, Universita degli Studi di Milano; Paulian Dumitrica, Geological Institute, Bucharest; Jennifer Lort, University of Cambridge; Wolf Mayne, Geological Consulting Service, Berne, Switzerland; W. D. Nesteroff, University of Paris; Guy Pautot, Centre Oceanologique de Bretagne; Herbert Stradner, Geologische Bundesanstalt, Vienna; F. C. Wezel, Universita di Catania.

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Figure 1. The Valencia Trough, contours in meters, adapted from Chart 310 of the Defense Mapping Agency Hydrographic Center.
Because the drilling results showed the Pliocene marine final site location lay some 700 meters to the northwest of ridge (see remainder of this chapter). After averaging 13 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 difficulties 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 50 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 core 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 upper 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

<table>
<thead>
<tr>
<th>Core</th>
<th>No. Sections</th>
<th>Date</th>
<th>Time</th>
<th>Cored&lt;sup&gt;a&lt;/sup&gt; Interval (m)</th>
<th>Cored (m)</th>
<th>Recovered (m)</th>
<th>Subbottom Penetration (m)</th>
<th>Tentative Lithology</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>8/24</td>
<td>17:25</td>
<td>2379-2387</td>
<td>8.0</td>
<td>3.5</td>
<td>79</td>
<td>Silt and clay</td>
<td>Quaternary</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>8/24</td>
<td>18:55</td>
<td>2407.1-2416.2</td>
<td>9.1</td>
<td>1.0</td>
<td>107</td>
<td>Gravel and clay</td>
<td>Quaternary</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>8/24</td>
<td>20:00</td>
<td>2416-2425</td>
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<td>1.3</td>
<td>116</td>
<td>Clay and fine sands</td>
<td>Upper Pliocene</td>
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<tr>
<td>4</td>
<td>3</td>
<td>8/24</td>
<td>22:07</td>
<td>2473.2-2482.2</td>
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<td>4.5</td>
<td>173</td>
<td>Sands and Clays</td>
<td>Lower Pliocene</td>
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<td>5</td>
<td>2</td>
<td>8/25</td>
<td>00:10</td>
<td>2510-2519.1</td>
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<td>2.5</td>
<td>210</td>
<td>Sands and Clays</td>
<td>Lower Pliocene</td>
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<tr>
<td>6</td>
<td>3</td>
<td>8/25</td>
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<td>2567-2576</td>
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<td>5.0</td>
<td>267</td>
<td>Nanno-ooze Tephra</td>
<td>Lower Pliocene</td>
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<tr>
<td>7</td>
<td>0</td>
<td>8/25</td>
<td>04:15</td>
<td>2604-2613.2</td>
<td>9.2</td>
<td>0</td>
<td>304</td>
<td>Tephra</td>
<td>Lower Pliocene</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>8/25</td>
<td>16:10</td>
<td>2689-2098.2</td>
<td>9.2</td>
<td>1.2</td>
<td>389</td>
<td>Tephra</td>
<td>Lower Pliocene</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>71.6</td>
<td>19.0</td>
<td>398.2</td>
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<td></td>
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<td>% Cored</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Recovered</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26.5%</td>
</tr>
</tbody>
</table>

<sup>a</sup>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.
5. SITE 123

JUNE 5, 1970

SOUTHWEST

NORTHEAST

ACOUSTIC BASEMENT

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 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

<table>
<thead>
<tr>
<th>Depth Below Sea Floor</th>
<th>Recovery (m)</th>
<th>Core Number</th>
<th>Section Number</th>
<th>Sample Interval (cm from Top)</th>
<th>Others</th>
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</thead>
<tbody>
<tr>
<td>Lower Pliocene</td>
<td>90-93</td>
<td>6</td>
<td>276</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>207</td>
<td>270</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upper Pliocene</td>
<td>106-109</td>
<td>111</td>
<td>123</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>116</td>
<td>116</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quaternary</td>
<td>101-104</td>
<td>102</td>
<td>116</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>104-107</td>
<td>103</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Zone

- Lower Pliocene
- Upper Pliocene
- Quaternary

### Species

- *Globorotalia margaritae* margaritae
- *Globorotalia margaritae* praehirsuta
- *Globorotalia margaritae* primitiva
- *Sphaerolites subdehiscens*
- *Sphaerolites seminulina*
- *Sphaerolites in*...
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 digitiata, G. praedigita).

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 inflata 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. pucticulata 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 Epinides umbonatus stellatus (Silv.) which was observed in Core 5. Rare occurrences of the Miocene species Uvigerina flinti (Cush.) and Uvigerina 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 nanoplanckton 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 nanoplanckton zone NN14; 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 nanoplanckton 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
Pontosphera japonica
Pontosphera scutellum
Rhabdosphaera clavigera
Rhabdosphaera stylifera
Scypholithus fossils
Scyphosphaera apsteinii
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 perdnurn
Pontosphera japonica
Pontosphera scutellum
Rhabdosphaera clavigera
Rhabdosphaera stylifera
Scyphosphaera apsteinii
Syracosphaera pulchra

Reworked nannofossils from the Lower and Upper Cretaceous
<table>
<thead>
<tr>
<th>Depth Below Sea Floor (m)</th>
<th>Cores</th>
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</thead>
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<td>Sea Floor 2290 m</td>
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<tr>
<td>79-87</td>
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<tr>
<td>107-116</td>
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<td>116-125</td>
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<td>173-182</td>
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<td>210-219</td>
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<td>267-276</td>
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</tr>
<tr>
<td>304-313.2</td>
<td>7</td>
</tr>
<tr>
<td>389-398.2</td>
<td>8</td>
</tr>
</tbody>
</table>

**TABLE 3**

Range Chart of Benthonic Foraminifera — Site 123

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<th>Age</th>
<th>Depth Below Sea Floor (m)</th>
<th>Cores</th>
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<td>Pliocene</td>
<td>Sea Floor 2290 m</td>
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<td>107-116</td>
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<td>304-313.2</td>
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</tr>
<tr>
<td>389-398.2</td>
<td>8</td>
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## TABLE 4
Range Chart of the Nannofossils - Site 123

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<thead>
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<th>Age</th>
<th>Zone</th>
<th>Core</th>
<th>Depth Below Sea Level (m)</th>
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<th>Upper Pliocene</th>
<th>Lower Pliocene</th>
<th>Lower Miocene</th>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Pleistocene</td>
<td>NN 16-18</td>
<td>2</td>
<td>2407.1-2416.2</td>
<td>Braarudosphaera bigelowi (Gran &amp; Braarud)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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**PLIOCENE**

Samples 123-3-1-99-100 cm, 123-3-CC:
- Coccolithus pelagicus
- Cyclococcolithus leptoporus
- Discoaster asymmetricus
- Discoaster brouweri
- Discoaster surculus
- Helicosphaera carteri
- Lithostromation perdurum
- Micrantholithus flos
- Pontosphaera japonica
- Rhabdosphaera stylifera
- Scyphosphaera apsteini
- Scyphosphaera pulcherrima
- Scyphosphaera recurvata
- Syracosphaera pulchra

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

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
Discosta asymmetricus

Reworked: Discoaster barbadiensis (rare)

Samples: 123-6-1-1 cm, 123-6-1-102-103 cm and 123-6-CC:

- Ceratolithus tricomiculatus
- Coccolithus pelagicus
- Cyclococcolithus leptopoma
- Discoaster challengeri
- Discoaster surculus
- Lithostromation perdurum
- Pontosphaera scutellum
- Reticulofenestra pseudoumbilica
- Scyphosphaera apsteini
- Scyphosphaera intermedia
- Scyphosphaera recurvata
- Sphenolithus abies

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 and nanno-oozes; 3) volcanic glass of early Miocene age, based on a K/Ar radiometric date.

<table>
<thead>
<tr>
<th>Table 5</th>
<th>Lithologic Units - Site 123</th>
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<tbody>
<tr>
<td>Unit</td>
<td>Lithology Detail</td>
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<tr>
<td>1</td>
<td>Graded sands, marl oozes with gravels at base; mainly turbidites.</td>
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<tr>
<td>2</td>
<td>Graded sands, silt laminae, marl oozes and nanno-oozes; turbidites with contortures</td>
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<tr>
<td>3</td>
<td>Volcanic ash deposit (acoustic basement)</td>
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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 (~70%), and include shells of pelecypods, gastropods, brachyopods, bryoza, sea-urchin spines, and foraminifers. 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 Oozes

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), abraded and broken pieces of littoral shells (B), especially hinges and valves (C). The rock types seen in a polished section (D) which include phaneritic 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 reedsedimentation 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 X 10^{-1} mm in Core 1 at 79 meters below bottom to 33 X 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 X 10^{-1} mm.

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

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 devitrified 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 Charecot 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. Vesuvius 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 nanofossils³ 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 deposit of a once sub-aerial composite volcanic cone. As a 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.

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 bryozoan are considered allochthonous, as they are found exclusively in graded sand layers, rich in terrigenous clastics, and in current-bedded silt laminas.

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

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²The 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.

³The traces of ooze in Core 7cc are considered as downhole contaminants, since they include Pliocene assemblages of nanofossils 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 incision of the Valencia Channel system appears to have occurred in the Quaternary. 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 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 magnetization of 0.8 X 10^-6 emu/cm^3 and a susceptibility of 0.5 X 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.

REFERENCES


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.
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 debris, etc; displaced benthonic foraminifera in gravels and sands

latest part of Pliocene is absent

graded SANDS to SILTS to MARL Oozes
lithology as above

lowest nannofossil zone: C. rugosus or C. trioorniculatus
lowest foraminifera zone: G. margaritae

VOLCANIC ASH
shards of volcanic glass
mobile to indurated
dark greenish gray
ACOUSTIC BASEMENT

21 ± 2 m.y.
(K/Ar & fission track)
graded SANDS and MARL OOZES
sequences of sands grading to silts and marl ooze
sequences 10 to 80 cm thick
sand layers graded, 5 cm thick, sharp bottom contact, gradational top
marl ooze plastic, olive gray (5Y 4/1)

Smear (marl ooze)

nannos 40
discoasters 2
calclite 35

nannos 40
discoasters 2
calclite 35

rich and diversified planktonic foraminiferal assemblage with Globigerinoides obliquus, Globorotalia inflata
benthonic foraminifera including displaced, shallow-water forms, echinoderm spines
nannofossils including Discoaster brouweri and D. asymmetricus

planktonic foraminifera of the Sphaeroidinellopsis subdehiscens partial-range zone in the core catcher; of Globigerinoides obliquus interval-range zone in sections 1 and 2

planktonic foraminifera without Globorotalia inflata, nannofossils without Discoaster brouweri, B. asymmetricus, etc.
WET-BULK DENSITY (g/cm³)

NATURAL GAMMA RADIATION

LITHOLOGIC SYMBOLS

% CaCO₃

LITHOLOGY AND PALEONTOLOGY

SANDS, SILTS and MARL OOKES

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

% CaCO₃

sand/silt/clay)

SANDS, SILTS and MARL OOKES

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

planktonic foraminifera abundant and well diversified belonging to the Globorotalia margaritae total-range-zone (in the core catcher sample) and to the Globorotalia menardii pseudostellata Interval-range zone. (Sections 1 and 2)

diatomic shallow-water foraminifera in 5 core catchers with A. lessoni, A. bechieri, Elphidium nannofossils include Reticulofenestra pseudowrigili, Discosower segonzaci,

ASH

shards of volcanic glass

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

dark greenish gray (5G 4/1)

planktonic foraminifera of the Globorotalia margaritae pseudostellata lineage zone and nannofossils of the Ceratolithus tricornioulatus zone in Section 1

ASH

dark greenish gray (5G 4/1)

mobile to indurated at random horizons

Total Drilling: 390.2 m in ash