8. SITE 901[1]

Shipboard Scientific Party[2]

HOLE 901A

Date occupied: 22 May 1993

Date departed: 24 May 1993

Time on hole: 1 day, 18 hr, 14 min

Position: 40°40.477'N, 11°3.587'W

Bottom felt (drill-pipe measurement at rig floor, m): 4730.0

Distance between rig floor and sea level (m): 11.54

Water depth (drill-pipe measurement from sea level, m): 4718.5

Total depth (rig floor, m): 4977.80

Total Penetration (m): 247.80

Number of cores (including cores with no recovery): 7

Total length of cored section (m): 46.8

Total length of washed section (m): 201.0

Total recovery while coring (m): 4.89

Total recovery while washing (m): 2.78

Core recovery while coring (%): 10

Total core recovered (m): 7.67

Principal results: Site 901 is situated in the Iberia Abyssal Plain within the ocean/continent transition (OCT) zone over a basement high that has an angular shape in a single east-west seismic-reflection profile and that appears to be a tilted fault block. The block has a west-dipping fault scarp and is capped by an acoustically transparent layer, several hundred meters thick. Geophysical modeling had indicated that this basement high lay within a part of the OCT having no linear magnetic anomalies and a weak magnetization and that therefore it probably is underlain by thinned continental crust. The site was one of a transect of sites across the OCT designed to study the petrologic changes in the basement rocks within the OCT to identify the processes that accompanied continental breakup and the onset of steady-state seafloor spreading. Site 901 was drilled quickly during the last 48 hr of the leg. We drilled and washed down to 182.0 mbsf and then cored intermittently down to 247.8 mbsf. Coring was terminated when we had to depart for Lisbon.

We recovered (1) a section of Pliocene nannofossil clay or ooze, apparently unconformably overlying (2) a thin film of Early Cretaceous clay, and (3) early Tithonian black clay, silt, and sandstone containing significant terrestrial plant debris. Intervals of sandstone make up about 10% of the early Tithonian section, and the sediments are black, probably because they contain a significant amount of organic carbon.

The Tithonian (152-146 Ma) is substantially older than the time Whitmarsh, Miles, and Mauffret (1990) have interpreted for the initiation of seafloor spreading on this margin (130 Ma). If this interpretation is correct, and because we do not know the time at which rifting began here, the Tithonian sediments would have been deposited over extended or extending continental crust. These sediments could only have been deposited over oceanic crust if seafloor spreading had begun during or before the Tithonian, as proposed in the Tagus Abyssal Plain (Mauffret et al., 1989) and proceeded very slowly (about a factor of 10 slower than later spreading) until 130 Ma. Furthermore, the magnetic anomaly pattern around Site 901 shows neither lineated nor large anomalies, such as those found over oceanic crust (although very slow spreading might also explain these observations), and the crustal velocity structure there is unlike oceanic crust (Whitmarsh, Miles, and Mauffret, 1990). We conclude that Site 901 probably lies over extended continental crust but could possibly lie over oceanic crust formed at a very slow spreading rate.

BACKGROUND AND SCIENTIFIC OBJECTIVES

Site 901 (Fig. 1) was one of a series of sites drilled during Leg 149 to elucidate the nature of the top of the crust (acoustic basement) within the ocean/continent transition (OCT) beneath the Iberia Abyssal Plain. The regional background of this and the other Leg 149 sites is presented elsewhere (see "Introduction" chapter, this volume; Whitmarsh, Miles, and Mauffret, 1990; Whitmarsh et al., 1993). Site 901 was a new site, not included in the Leg 149 Prospectus, that was chosen at sea when only 36 hr remained for drilling at the end of the leg. Site 901 is located about 45 km east of Site 900 and 40 km southwest of Site 398 on the lower continental rise in multichannel seismic-reflection profile Lusigal Line 12 (Fig. 2; also see "Site Geophysics" section, this chapter). The site is 500 m east of an 80-m-high seafloor fault scarp that appears to represent the surface expression of a reactivated deep normal fault. This fault forms the western side of an asymmetric basement fault block that tilts about 13° to the east. The north-south shape of the block in cross section is unknown. On a pre-stack, depth-migrated seismic section, the fault block appears to consist of a transparent (sediment?) layer 500 to 600 m thick overlying a strong basement reflector (Fig. 3). The sediments overlying acoustic basement thicken to about 2.25 s two-way traveltime (2.8 km) in the basin west of the site and to at least 1.9 s two-way traveltime (2.25 km) to the east.

The objective at this site was to drill into the shallow upper surface of the transparent layer on the fault block that we estimated as being about 100 m below the seabed. We had interpreted the high to be a fault block of continental crust. Should the acoustic basement under the site prove to be continental, then the almost 110-km-wide region of crust between the site and the base of the Portuguese continental slope might logically be assigned a continental origin also. Furthermore, it could be argued that a wide area of thinned continental crust might also exist under the conjugate Newfoundland margin, where conflicting views exist regarding the extent of thinned continental crust (Keen and de Voogd, 1988; Tucholke et al., 1989).

OPERATIONS

Hole 901A

After completing drilling at Site 900, we moved the ship to 40°40.48'N, 11°3.59'W for Site 901 and deployed a Datasonics beacon. The precision depth recorder indicated a water depth of 4726.4 mbsl. A rotary core barrel (RCB) bottom-hole assembly (BHA) was assembled and run to the seafloor. The seafloor was encountered at 4730.0 mbrf, and Hole 901A was spudded at 0325UTC, 23 May 1993. We washed the hole from the seafloor to 4912.0 mbrf (0-182.0 mbsf;

[1] Sawyer, D.S., Whitmarsh, R.B., Klaus, A., et al, 1994. *Proc. ODP, Init. Repts.,* 149: College Station, TX (Ocean Drilling Program).
[2] Shipboard Scientific Party is as given in list of participants preceding the contents.

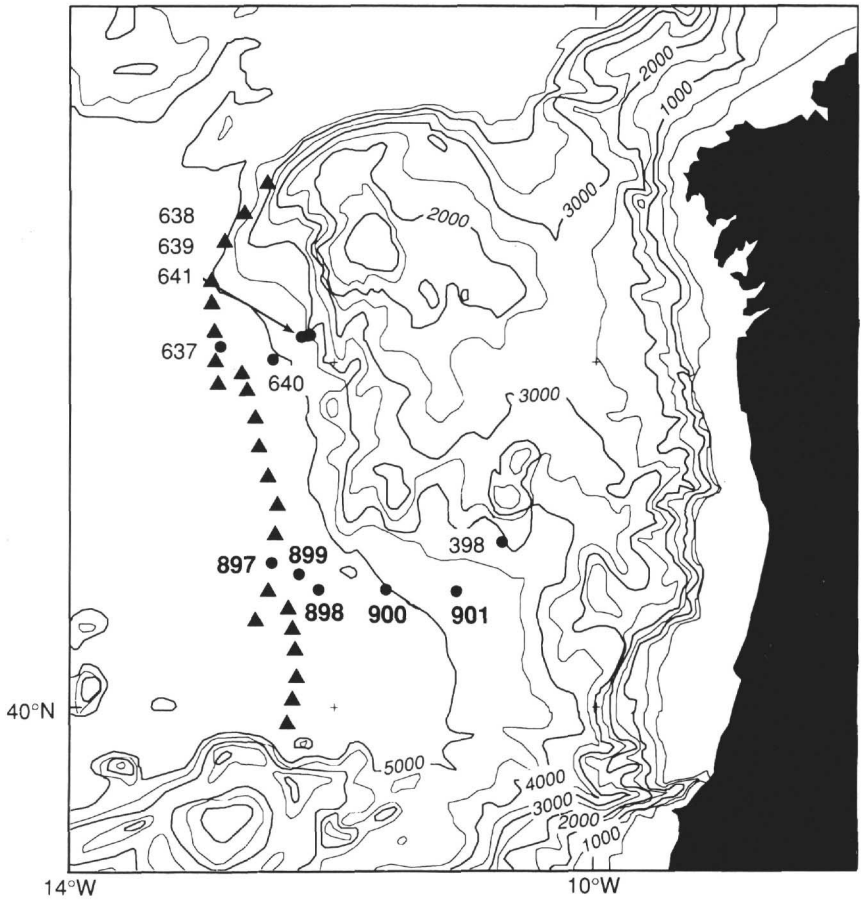

Figure 1. Bathymetric chart of the Iberia Abyssal Plain showing the location of Site 90l and other DSDP and ODP drill sites. Contours are in meters.

Core 149-901A-1W), cored from 4912.0 to 4930.8 mbrf (182.0-200.8 mbsf; Cores 149-901A-2R to -3R), washed from 4930.8 to 4949.8 mbrf (200.8-219.8 mbsf; Core 149-901A-4W), and cored from 4949.8 to 4968.1 mbrf (219.8-247.8 mbsf; Cores 149-901A-5R to -7R; Table 1). We stopped coring after Core 149-901A-7R to retrieve the drill string so that we could return on time to Lisbon for the end of Leg 149.

SITE GEOPHYSICS

Geophysical Data near Site 901

Only one multichannel seismic-reflection profile passes through Site 901 (Fig. 4). It is the east-west Lusigal Line 12 (see "Background and Scientific Objectives" section, Figs. 2 and 3, this chapter). Site 901 is located over a basement high that is 15 km wide on Lusigal Line 12 (west to east). The high is triangular in west-east cross section (Fig. 2). Site 901 is located over the top of the high. Basement was estimated to lie about 110 ms two-way traveltime below the seafloor or 100 mbsf at its shallowest known point. An 80-m seafloor fault scarp (Fig. 5) is located over the basement high. This steps down to the west and is almost certainly related to recent fault movement along the western side of the high. Site 901 is located about 500 m to the east of the fault scarp. Beslier et al. (1993) and Whitmarsh, Miles, and Mauffret (1990) interpreted regional seismic and magnetic data, respectively, to indicate that Site 901 is located over extended continental crust.

Table 1. Coring summary for Site 901.

Core	Date (May 1993)	Time (UTC)	Depth (mbsf)	Length cored (m)	Length recovered (m)	Recovery (%)
1W	23	0920	0–182.0	182.0	2.46	(wash core)
2R	23	1130	182.0–191.3	9.3	0.00	0.0
3R	23	1350	191.3–200.8	9.5	1.05	11.0
4W	23	1710	200.8–219.8	19.0	0.32	(wash core)
5R	23	1935	219.8–229.4	9.6	1.90	19.8
6R	23	2135	229.4–238.1	8.7	1.51	17.3
7R	23	2340	238.1–247.8	9.7	0.43	4.4
Coring totals:				46.8	4.89	10.5
Washing totals:				201.0	2.78	
Combined totals:				247.8	7.67	

LITHOSTRATIGRAPHY

Introduction

Two lithostratigraphic units are recognized in Hole 901 A. Unit I was recovered only in a wash core (149-901A-1W) and consists of nannofossil clays and clays with silt yielding late Aptian, middle Miocene, and late Pliocene ages. As the hole was washed down to 182 m, the depth of the boundary between Units I and II has been constrained to lie only between 0 and 182 mbsf. The wash core barrel was recovered after the drilling rate slowed, indicating that the bit had encountered harder rocks. This suggests that the Unit I rocks cored probably came from just above 181 mbsf. Unit II was cored discontinuously over an interval of about 57 m and consists of olive black clays and parallel-laminated calcareous sandstones of early Tithonian age. The ages, lithologic composition, colors, facies and depositional environment, and cored intervals for Units I and II are summarized in Table 2.

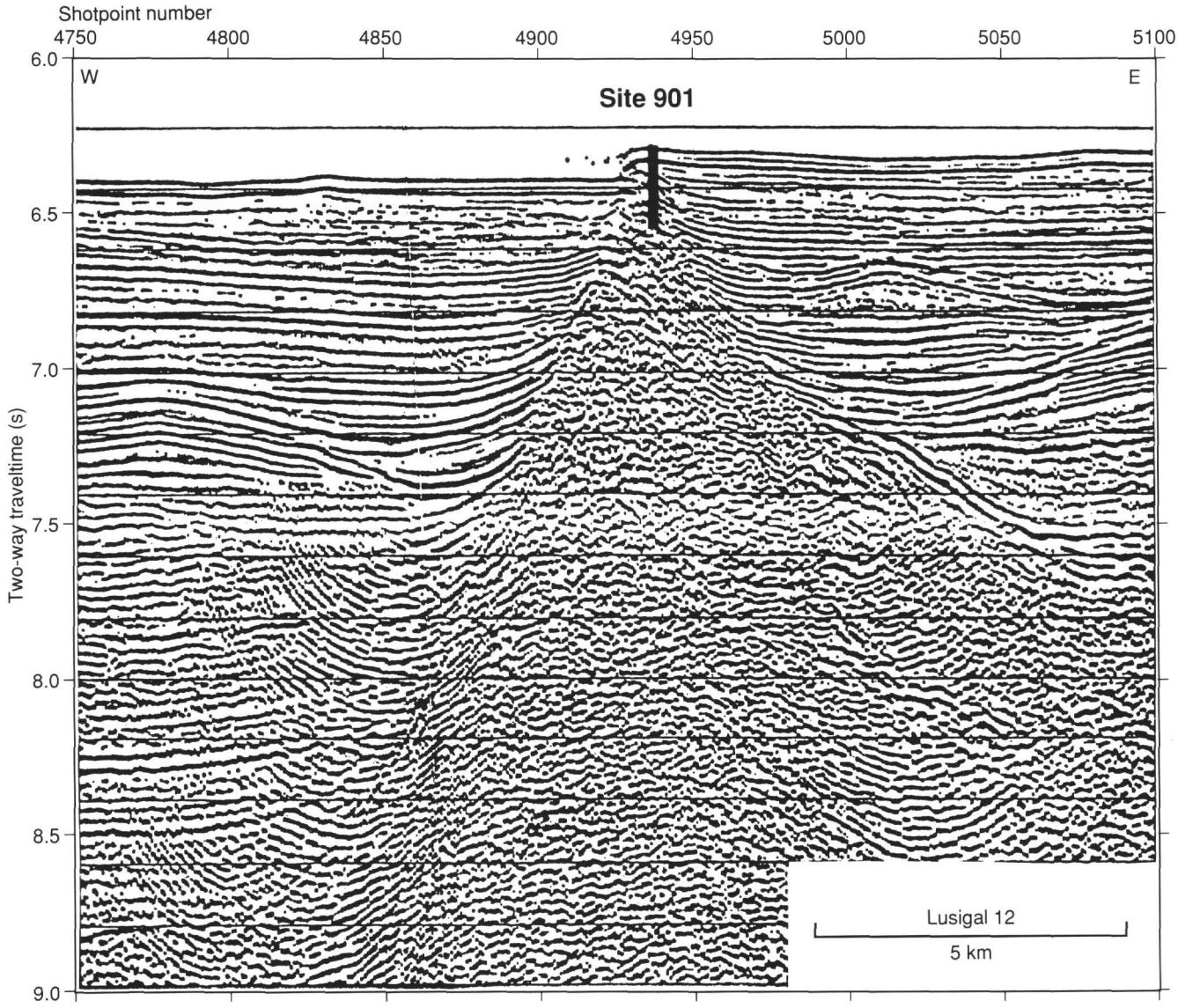

Figure 2. East-west Lusigal 12 multichannel seismic reflection profile across Site 901 (See Fig. 4 for location). Thick vertical line indicates penetration of the borehole. Vertical exaggeration is about 5:1.

Unit I

Seafloor to Core 149-901 A-1W-2, 50 cm
Depth: 0(?) to about 182(?) mbsf
Age: Pleistocene(?) to late Aptian

General Description

This unit was recovered in a single washed core that contains pinkish gray (5YR 8/1), yellowish gray (5YR 8/1), and moderate yellowish brown (5YR 6/2) nannofossil clay and clay with silt. The massive, structureless appearance of the sediments may result from extreme core disturbance and/or bioturbation. A thin (5 mm) layer of gray clay at Sample 149-901 A-1W-2, 50 cm, yielded nannofossils indicating a late Aptian age; the overlying lighter-colored clays gave middle Miocene and late Pliocene ages (for details, see "Biostratigraphy" section, this chapter). The Pleistocene age for the top of the unit is not proven biostratigraphically, but assumed by comparison with other Leg 149 sites.

Depositional Processes

The sediments recovered from Unit I are broadly comparable to those in Subunits IB and IC at Site 900 and are probably pelagic and/or hemipelagic, although a contribution from muddy turbidity flows cannot be ruled out. The absence of siliciclastic silts and sands is consistent with a continental-rise setting where bypassing of coarser sediment would have occurred.

Unit II

Cores 149-901 A-1W-2, 50 cm, to 149-901A-7R-1, 41 cm
Depth: 182(?) to 247.8 mbsf
Age: early Tithonian

General Description

Core recovery for Unit II totaled 4.9 m (excluding wash cores) and ranged from 0% to almost 20%. About 90% of the total section recovered consists of olive black (5Y 2/1) clay or clay with silt, which

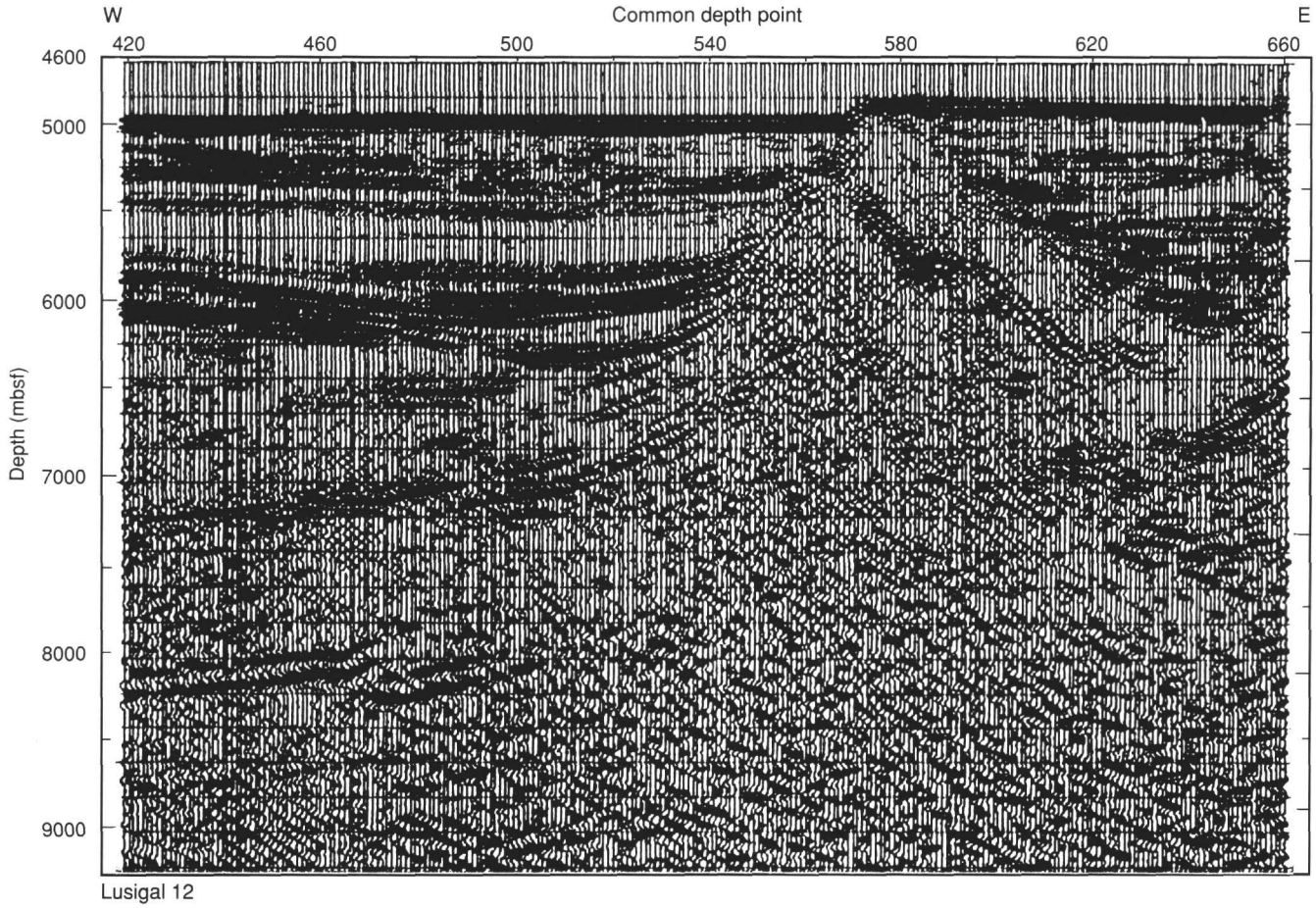

Figure 3. Pre-stack depth-migrated version of part of the Lusigal Line 12 multichannel seismic-reflection profile shown in Figure 2. The figure clearly shows the transparent layer at the top of the tilted fault block (common depth points 570 to 620; A. Bitri, unpubl. data).

Table 2. Lithostratigraphic summary for Site 901.

Unit	Age	Thickness (m)	Lithology	Color	Facies and environment [total m described]	Interval (mbsf)	Occurrence
I	Pleistocene(?) late Aptian	181(?)	Nannofossil clay and clay with silt	Pinkish gray, yellowish gray and moderate yellowish brown	Pelagites/hemipelagites continental rise [1.5]	0–182(?)	1W-1, 0 cm–1W-2, 50 cm
II	early Tithonian	>57	Clay with silt/silty clay with plant debris, calcareous sandstone and minor dolomite with calcite	Dark gray, greenish gray	Uncertain [5.2]	182(?)–47.8	1W-2, 50 cm–7R-1, 41 cm

in places contains thin laminae of silt and black plant debris. The dark color of the clays is probably the result of a high content of organic matter. Intervals showing color banding (up to 1 cm thick) in shades of gray show no signs of bioturbation.

Greenish gray (5GY 6/1) and light olive gray (5Y 6/1) parallel laminated calcareous sandstone forms about 10% of the unit. Many laminae are formed of black plant debris. The sandstone intervals range in thickness between 10 and 20 cm and often are fractured along laminae. Apparent dips of up to 10° probably result from tilting of the core pieces during coring.

Occasional pieces of thick (up to 10 cm), very fine-grained, olive gray (5Y 4/1) dolomite with calcite occurs within the dark colored clays.

Depositional Processes

In the absence of any diagnostic structures or facies sequences, no precise interpretation of the depositional environment of Unit II can be given. The presence of black, presumably organic-rich claystones, the common occurrence of plant debris, the apparent lack of bioturbation, and the abundance of calcareous nannofossils in some intervals indicate that deposition took place in a relatively deep marine basin with anoxic bottom conditions and that was fringed by well-vegetated areas. Influxes of terrigenous sands were frequent, but the processes of transportation and deposition are not clear.

The early Tithonian sedimentary assemblage characteristic of Unit II is unknown elsewhere in the North Atlantic. Pre-rift sediments over-

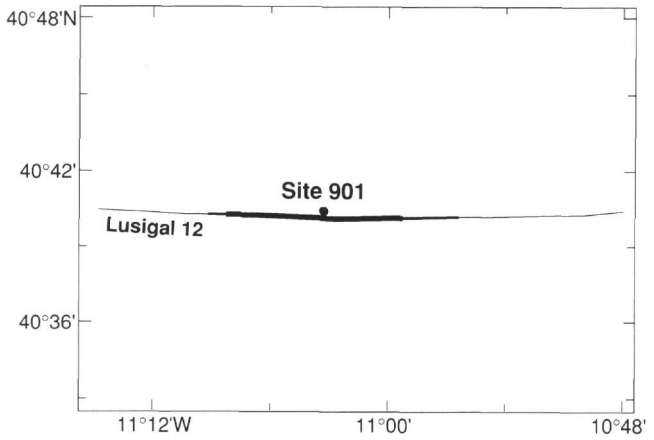

Figure 4. Multichannel seismic-reflection profile track chart. The boldest line indicates the portion of Lusigal Line 12 shown in Figure 3. The less bold line shows the location of the portion of Lusigal Line 12 shown in Figure 2.

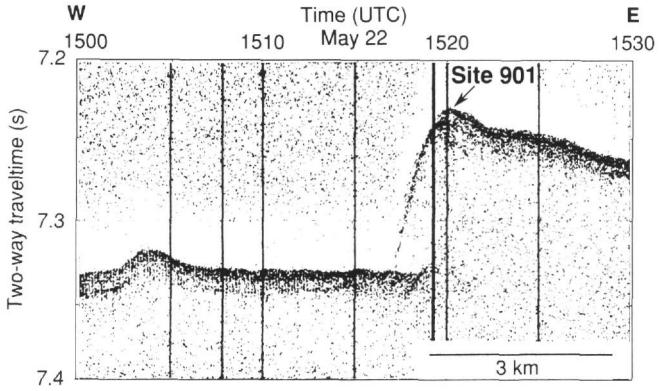

Figure 5. Profile of 12-kHz echo-sounder data across Site 901, obtained on board *JOIDES Resolution* prior to dropping a beacon. The track is the same as Lusigal Line 12 (see Fig. 4).

lying continental basement drilled on the Galicia margin during ODP Leg 103 consist of Tithonian and lowermost Cretaceous neritic limestones and dolomites, essentially devoid of nannofossils (Boillot, Winterer, Meyer, et al., 1987). In the western North Atlantic, the equivalent formation of the same age is the Cat Gap Formation, drilled in the Blake-Bahamas Basin at Site 534 (DSDP Leg 76) (Sheridan, Gradstein, et al., 1983) is Kimmeridgian to upper Tithonian in age. It is composed mostly of reddish gray and dark green to gray calcareous claystones interbedded with micritic and bioclastic limestones.

BIOSTRATIGRAPHY

Calcareous Nannofossils

Site 901 is located in the eastern part of the Iberia Abyssal Plain at a water depth of 4726 m. Hole 901A was drilled to a depth of 248 m. The upper part of the hole was washed to a depth of 182 m and is estimated to represent an interval from the early late Pliocene to the late Pleistocene (about 3.0 Ma). The relatively high sedimentation rate calculated for this period, 61 m/m.y., corresponds to the development of turbidite sequences of Unit I observed at Sites 897 and 899.

Seven cores were drilled at Site 901 to recover 7.67 m of sediment. Calcareous nannofossils define a discontinuous stratigraphic succession from the upper Pliocene to the Upper Jurassic (lower Tithonian), which is divided into three parts: Cenozoic, Cretaceous, and Upper Jurassic.

The interval from the top of Core 149-901 A-1W-1 (lower upper Pliocene) to Sample 149-901 A- 1W-2, 13 cm (middle Miocene) contains a significant amount of nannofossil ooze with abundant and well-preserved calcareous nannofossils. Sample 149-901 A-1W-2,49 cm, is barren of nannofossils but the reddish color of the clay may correspond to the red clay formation of the lithostratigraphic Unit III that was defined at Site 897 and is of middle Eocene to Late Cretaceous in age. Sample 149-901 A- 1W-2, 55 cm, has the same red brown color and contains very rare *Tribrachiatus orthostylus,* which indicates an early Eocene age. However, the position of this sample is suspect because of drilling disturbance.

Sample 149-901 A- 1W-2, 50 cm, contains common and moderately preserved nannofossils from the upper Aptian, as indicated by the presence of *Eprolithus floralis, Rucinolithus irregularis, Micula infracretacea, Lucianorhabdus carniolensis, Manivitella pemmatoidea, Zeugrhabdotus embergeri,* and *Watznaueria barnesae.* The Lower Cretaceous layers, composed of only 5 mm of gray clay, lie directly below and in conformable contact with the reddish brown claystone, which has been placed in the Cretaceous at Site 899. The Paleocene and probably the earliest Eocene sequences are missing.

No sediment was recovered from Core 149-901A-2R. Cores 149-901A-3R to -7R, which represent 56.50 m, had a recovery of 5.21 m of Upper Jurassic black shales. The presence of black clay and the abundance and highly diversified calcareous nannofossils in some intervals indicate that the deposition took place in a relatively large and deep marine basin (see "Lithostratigraphy" section, this chapter).

The interval from Cores 149-901A-3R to -6R has been placed in the Upper Jurassic-early Tithonian stage. Sample 149-901A-3R-1, 1 cm, contains common and moderately well-preserved calcareous nannofossils from the early Tithonian, as indicated by the presence of *Stephanolithion bigotii, Conusphaera mexicana minor, Cyclagelosphaera brezae, Faviconus multicolumnatus, Biscutum rotatorium, Watznaueria manivitae, Discorhabdus patulus, Watznaueria fossacincta, Cyclagelosphaera margerelii, Zengrhabdotus erectus, Pichelhaube furtiva, Diazomatholithus lehmanii, Zengrhabdotus fissus, Ethmorhabdus gallicus, Ellipsagelesphaera communis, Markalius ellipticus, Microstaurus quadratus, Polypodorhabdus madingleyensis, Stradnerlithus tortuosus, Ausulosphaera bownii, Zeugrhabdotus noeliae,* and *Retecapsa catheta.*

Sample 149-901A-4W-1, 6 cm, is barren of calcareous nannofossils. Sample 149-901A-4W-1, 31 cm, contains rare and moderately preserved nannofossils. The presence of *Stephanolithion bigotii* and *Conusphaera mexicana minor* indicate an early Tithonian age. Sample 149-901A-5R-CC contains few and moderately preserved nannofossils from the middle Tithonian. Sample 149-901A-6R-1, 41 cm, contains *Stephanolithus bigotii, Conusphaera mexicana minor, Ellipsagelosphaera reinhardtii, Zeugrhabdotus fissus, Axopodorhabdus cylindratus,* and *Polypodorhabdus madingleyensis.* Sample 149-901A-6R-CC contains common and moderately well-preserved nannofossils from the lower Tithonian, as indicated by the presence of *Stephanolithion bigotii, Conusphaera mexicana minor, Hexalithus noelia, Ethmorhabdus* spp., *Cyclagelosphaera margerelii, Zeugrhabdotus erectus, Watznaueria barnesae,* and *Microstaurus quadratus.* Sample 149-901A-7R-CC is barren of calcareous nannofossils.

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* Abbreviations for names of organizations and publication titles in ODP reference lists follow the style given in *Chemical Abstracts Service Source Index* (published by American Chemical Society).

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Ms 149-108

NOTE: For all sites drilled, core-description forms ("barrel sheets") and core photographs have been reproduced on coated paper and can be found in Section 3, beginning on page 271. GRAPE and MAGSUS data are presented on CD-ROM (back pocket).