OCEAN DRILLING PROGRAM

LEG 149 PRELIMINARY REPORT

OCEAN-CONTINENT TRANSITION IN THE IBERIA ABYSSAL PLAIN

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ABSTRACT

The principal objective of Leg 149 was to drill a transect of holes across the ocean-continent transition (OCT) off western Iberia to determine the changes in the petrologic and physical nature of the acoustic basement (Fig. 1). Three main sites (Sites 897, 898, and 900, originally designated IAP-4, IAP-2, and IAP-5, respectively) were chosen on basement highs to enable penetration of basement to several hundred meters. The catastrophic loss of 3500 m of drill string at Site 898 led to the abandonment of that site and the occupation of a nearby alternate site (Site 899), discovered during the leg, where basement was within reach of the remaining drill string. Site 901 was drilled in the last 2 days of the leg over a tilted basement fault block the top of which is within 200 m of the seabed.

The west Iberia margin is an excellent example of a nonvolcanic rifted or passive continental margin. The OCT in the central Iberia Abyssal Plain segment of the margin has been located by seismic reflection and refraction profiles and by magnetic and gravity modeling. These independent measurements all support a single conceptual model of the crust and upper mantle within the OCT of the Iberia Abyssal Plain. In part, Leg 149 confirmed this model by finding serpentinized peridotite acoustic basement at Site 897 and pre-rift sediments and therefore thinned continental crust at Site 901 (Fig. 2). However, the presence and unusual mode of emplacement of the serpentinite breccias over serpentinized peridotite at Site 899, 19 km east of Site 897, and the metagabbros drilled at Site 900, 122 km east of Site 897, were unexpected. The geophysical and tectonic models of rifted margin formation will need revision to explain these new observations.

Secondary objectives of the leg, to be concluded in some cases with shore-based studies, included studies of the late Cenozoic turbidite succession, with a view to testing whether turbidites and debris flows are triggered by changes in sealevel and hence climate; the history of sediment deformation in the Cenozoic; a comparison of downhole and earlier seismically predicted depths of the ooze/chalk transition and the post-rift subsidence history.

INTRODUCTION

The North Atlantic Rifted Margins Detailed Planning Group (NARM DPG) met in 1991 to plan a program of drilling to study the problems of rifted-margin formation and evolution. They identified two important classes of rifted margin to be studied: margins in which magmatism has dominated the rifting process (volcanic margins) and margins in which magmatism seems to have been absent or incidental to the rifting process (nonvolcanic margins). The DPG recommended that ODP focus on one margin transect of each type and that each transect include the conjugate margin.

Leg 149 represented the first part of a program proposed by the DPG for the study of nonvolcanic margins that includes drilling multiple sites in both the Iberia Abyssal Plain and the conjugate Newfoundland Basin. Drilling on each of the margins will include sites, like those of Leg 149, that would sample significant sections of basement with minimum sediment penetration and other sites that would sample thicker and stratigraphically more complete sequences of syn- and post-rift sediment.

Leg 149 drilled five sites (Sites 897 through 901) on the Iberia Abyssal Plain with the principal objective of constraining the nature and age of the crust under the OCT (Fig. 1). Each of the Leg 149 sites is over a basement high (Fig. 2). Before the leg we believed that these highs were produced late in the rifting process, principally by rotation of faulted blocks of basement, and hence would be representative of the adjacent but deeper basement rocks. The advantage of drilling basement at these sites was that we had a realistic chance of penetrating several hundred meters into basement. The disadvantage was that we were not likely to sample the syn- or early post-rift sediments. We expect that a later leg will be scheduled to drill IAP-1, a site that is along our transect, and will focus on sampling the complete sedimentary section (and possibly basement) between the basement highs.

Scientific Objectives

Ocean-Continent Transition

The principal objective of Leg 149 was to establish the nature of the OCT beneath the Iberia Abyssal Plain by drilling a transect of holes. Identification of crustal type within a wide zone of thinned continental or thin oceanic crust (Whitmarsh et al., 1990, in press) and the position and nature of the OCT were important drilling targets. Geophysical data suggest that seafloor exposures of mantle peridotite on the western margin of Galicia Bank, to the north of our transect, extend southward beneath the sediments of the Iberia Abyssal Plain (Fig. 1) (Beslier et al., 1993). If Leg 149 proved this hypothesis correct, then clearly the peridotite is of more than local significance. The objectives of establishing the nature of the upper crust and testing some of the predictions, made largely on the basis of geophysical observations, had to be tempered by the accessibility of the crust to the drill bit. Therefore, to achieve significant progress within a single leg, sites were drilled that lie on basement highs that are situated at critical points within the OCT (Fig. 2). The detailed objectives of each site are outlined below. The general aim was to penetrate several hundred meters into the acoustic basement and to obtain cores and downhole logs in the basement to determine its origin and history. This was to be done by petrologic and chemical analysis, by microstructural examination, by examination of the mineralogy, by apatite fission track analysis and/or isotope dating of suitable core material, by velocity and magnetic measurements, by analysis of geochemical logs, by interpretation of the formation microscanner logs and other logs, and by whatever other means seemed appropriate.

Secondary Objectives

One aim was to discover the history of turbidite sedimentation in the Iberia Abyssal Plain. Work done in the Madeira Abyssal Plain indicates that, in general, a single turbidite was deposited each time sea level was changing between a glacial and an interglacial period or vice versa (Weaver and Kuijpers, 1986). We also expected to determine to what extent the age and frequency of turbidites relate to past climatic change.

Another objective was to date the deformation of the sediments and to compare this with the Miocene phase of compressional deformation in the Rif-Betic mountains of southern Spain and north Africa.

We planned to test estimates of the depth of the ooze/chalk transition made on the basis of seismic refraction measurements in the Iberia Abyssal Plain (Whitmarsh et al., 1989) and to relate the velocity logs to these predictions.

We planned to measure heat flow at each of the Leg 149 sites, using temperature data from the ADARA, WSTP, and Lamont temperature logging tools and thermal conductivity measured on cores.

We expected to acquire data that can be used to estimate the late post-rift subsidence history of the Iberia Abyssal Plain, including the depth, age, environment of deposition, and physical properties of each sedimentary unit. We did not expect to be able to deduce the syn- and early post-rift subsidence history, because we were unlikely to encounter sediments of that age.

RESULTS

The Cenozoic sediment-accumulation history for all sites are shown together in Figure 3.

Site 897

Site 897 is situated in the Iberia Abyssal Plain over a north-south basement ridge within the OCT zone (Fig. 4). Geophysical modeling had predicted that the ridge lay at, or close to, the ocean-continent boundary and might consist of serpentinized peridotite. Cores were obtained from three holes that penetrated up to 694 m of Pleistocene to Lower Cretaceous sediments and from two holes that penetrated up to 153 m of basement.

The basement is composed of serpentinized, relatively undepleted peridotite that originated in the upper mantle and was exposed at the seafloor during, or somewhat after, the time of continental breakup.

A debris-flow unit containing early late Hauterivian to early Aptian sediments immediately overlies basement and contains fragments of peridotite and continental basement rocks. The unit could have been deposited in a single event or as multiple events. The sediments suggest that continental basement rocks and a source of land-plant debris were located upslope of the site.

A significant depositional hiatus starting in the middle Miocene, correlatable with a regional angular unconformity on seismic reflection profiles, may be related to northwest-southeast compression on this margin during a compressional phase in the Betic Mountains in southern Spain.

Four lithologic units are identified at Site 897 (Figure 5):

1. Unit I (0-292.0 mbsf) is a Pleistocene to lower Pliocene silty clay to clayey silt with nannofossil clay with graded silt and fine sand beds. The unit consists mainly of terrigenous turbidites.

2. Subunit IIA (292.0 -301.2 mbsf) is an upper Miocene nannofossil claystone with claystone and nannofossil silty claystone. The subunit consists mainly of terrigenous turbidites.

   Subunit IIB (301.2-359.8 mbsf) is an upper to lower Miocene calcareous claystone and claystone with silty claystone and clayey siltstone. The subunit consists mainly of calcareous turbidites.

   Subunit IIC (359.8-619.7 mbsf in Hole C; base at 622.4 mbsf in Hole D) is an upper Oligocene to middle Eocene silty claystone to clayey siltstone with calcareous claystone. The subunit consists mainly of calcareous turbidites.

3. Subunit IIIA (619.7-639.4 mbsf in Hole C; 622.4-645.2 mbsf in Hole D) is an unfossiliferous claystone that extends back in age to the Paleocene/Cretaceous. The subunit consists of a pelagic/hemipelagic facies deposited below the CCD.

   Subunit IIIB (639.4-648.7 mbsf in Hole C; 645.2-655.2 mbsf in Hole D) is an unfossiliferous Cretaceous clayey conglomerate and sandy silty claystone with clayey sandstone.

4. Unit IV (648.7-677.5 mbsf in Hole C; 655.2-693.8 mbsf in Hole D) consists of post-Aptian(?) sandstone, dolomite, limestone, and calcareous claystone with peridotite clasts and megaclasts. The unit is a mass-flow deposit.

The sedimentary section provided a discontinuous fossil record from the Pleistocene through Early Cretaceous. Calcareous nannofossils are generally present, except in Unit IIIA. Planktonic and benthic foraminifers are abundant to common in the Pleistocene and upper Pliocene deposits, but rare to absent throughout most of the remaining cored interval. Two unconformities in the Miocene together represent a 12-Ma hiatus from middle Miocene to early Pliocene time. An earlier hiatus in deposition occurred from Early Cretaceous to middle to late Eocene time.

The mass-flow deposit immediately above the basement, containing basement blocks and a variety of sediments of early late Hauterivian to early Aptian age, has several implications for the history of the peridotite ridge. The peridotite was exposed at the seafloor and contributed clasts to the debris flow(s) some time between the early late Hauterivian and the Paleocene. Either the ridge existed when the debris flow(s) occurred, and material was transported from the north along the north-south ridge itself, or the peridotite had not yet been fully uplifted to form a ridge when the debris flow(s) occurred and the non-peridotite material was transported from the north, east, or even west.

Holes 897C and 897D penetrated 95 and 153 m, respectively, of basement rock. The entire basement section consists of peridotite that has been almost completely serpentinized and partially brecciated during and after serpentinization. About 90% of the peridotite is undifferentiated harzburgite or lherzolite whose original composition was 70%-80% olivine, 15%-20% pyroxene, and 1%-2% spinel. These rocks are heterogeneous, ranging from pyroxene-rich peridotite to dunite. The remaining 10% of the peridotite is plagioclase- and spinel-bearing and was originally composed of 50%-70% olivine, 20%-30% pyroxene, 15% plagioclase, and 1%-5% spinel. The coexistence of plagioclase and spinel suggests that these rocks last equilibrated at a low pressure, 900-1000 MPa (about 30 km depth). The wide variety of peridotite types and the locally high proportion of plagioclase (up to 40%), suggest that the peridotite may have experienced some melting and even magma mobility. The brecciation ranges from pervasive fracturing and serpentine and carbonate veining to the formation of gravel-sized serpentinized peridotite clasts embedded in a carbonate and serpentine matrix. Some brecciation shows a well-developed foliation associated with a late-stage shear deformation event. While the peridotites have experienced late, low-temperature deformation, they show no signs of high-temperature ductile deformation.

Acoustic formations 1A, 1B, and 2 have been widely recognized on multichannel seismic reflection profiles on the west Iberia margin and locally dated by previous drilling (Mauffret and Montadert, 1988). At Site 897, acoustic formation boundaries 1A/1B and 1B/2 correlate with the middle to late Miocene hiatus at 315 mbsf and with the top of a middle Eocene claystone and chalk at 590 mbsf, respectively.

Several tentative magnetostratigraphic correlations have been identified in the Pliocene, and one each in the middle Oligocene and Maastrichtian. Magnetic susceptibility correlates particularly well on a fine scale with the alternating sand and clay units of the terrigenous turbidite sequences in Unit I. In the serpentinized peridotite basement, magnetic susceptibility is generally higher than in the sediments, but it decreases with increasing peridotite alteration.

In-situ temperature measurements indicate that the vertical temperature gradient between the seafloor and 215 mbsf is about 44°C/km, and the vertical conductive heat flow is about 56 mW/m^2.

Physical-property measurements on the sediments show a steady increase in density, seismic velocity, formation factor, and thermal conductivity, and a concomitant decrease in porosity, with depth, except for a high-porosity anomaly associated with the claystone, siltstone, and chalk between 600 and 650 mbsf. In the serpentinized peridotite, density and velocity vary according to the degree of alteration visible in hand specimens and range from 2.3 to 2.5 g/cm^3 and 2.8 to 7.1 km/s. Logging at this site was prevented by bad hole conditions.

Interstitial water samples were obtained from Units I to IIIB (26 to 636 mbsf). The pore water chemistry (sulfate, alkalinity, ammonia, iron, manganese, calcium, magnesium, strontium, potassium, silica, chloride, and sodium) reflects the rapid deposition of the Pliocene-Pleistocene turbidites and the relatively slower deposition of the earlier sediments. The principal result is the surprisingly high sulfate concentration (up to 18 mM) in the sediments below Units I and IIA. This is attributed to a low sedimentation rate, low permeability, and a lack of reactive carbon.

Profiles of carbonate content against depth reflect a history of generally low biological productivity, and deposition of hemipelagic sediment below the CCD, combined with delivery by turbidites of carbonate-rich material initially deposited above the CCD. Elevated organic carbon is found in Units I and IV (0.6% and 0.9% respectively); Unit IV appears to contain organic material mostly derived from land-plant detritus. Relatively high concentrations of biogenic methane were encountered in headspace gas analyses of lithostratigraphic Unit I but were essentially absent from all deeper sections.

Site 898

Site 898 is situated in the Iberia Abyssal Plain over a semi-elliptical basement ridge within the OCT zone (Fig. 6). Geophysical modeling had predicted that the ridge lay within a part of the OCT, intermediate between thin oceanic crust to the west and thinned continental crust to the east, in which there is a large magnetic anomaly that cannot be modeled by seafloor spreading. APC and XCB cores were obtained from a single hole that penetrated 342 m of Pleistocene to upper Oligocene sediments. Coring and logging plans were terminated by the loss of 3500 m of drill pipe, which prevented us from reaching basement at this site.

Unit I contains approximately 260 turbidites that were deposited in the last 1.1 Ma; on average one turbidite was deposited every 4000 years.

A significant depositional hiatus starting in the middle Miocene, correlatable with a regional angular unconformity on seismic reflection profiles, may be related to northwest-southeast compression on this margin during a compressional phase in the Betic Mountains in southern Spain.

Two lithologic units are identified at Site 898 (Fig. 7):

1. Unit I (0-161.9 mbsf) is a Pleistocene to Pliocene silty clay to clayey silt, silt and fine sand with nannofossil clay. The unit consists mainly of terrigenous turbidites.

2. Subunit IIA (161.9 -172.2 mbsf) is a Pliocene to Miocene silty clay to clayey silt with nannofossil clay and clay. The subunit consists mainly of pelagic/hemipelagic sediments.

Subunit IIB (172.2-341.5 mbsf) is a Miocene to Oligocene silty claystone to clayey siltstone and nannofossil claystone with claystone. The subunit consists mainly of calcareous contourites and terrigenous turbidites.

The sedimentary section provided a discontinuous fossil record of the Pleistocene through the late Oligocene. Calcareous nannofossils are generally present. Planktonic and benthic foraminifers are abundant to common in the Pleistocene and upper Pliocene deposits but are less common below. An unconformity in the Miocene represents a 10-m.y. hiatus from middle Miocene to late Pliocene time.

Acoustic formations 1A and 1B have been widely recognized on multichannel seismic reflection profiles on the west Iberia margin and locally dated by previous drilling. At Site 898, acoustic formation boundary 1A/1B correlates with the middle Miocene to late Pliocene hiatus at 162 mbsf and with the top of Unit IIA. Shipboard interpretation of seismic profiles around the Leg 149 drill sites has discovered a layer of westward/southwestward-prograding reflectors within acoustic formation IB. The shape and extent of this layer suggest that it represents an abyssal fan lobe or a contourite drift the top of which may have been cored in the base of Hole 898A.

Many potential magnetic reversals were observed in the almost complete sequence of APC/XCB cores from 0 to 177 mbsf. At greater depths the cores were too weakly magnetized for definite interpretation. The Brunhes to Gauss sequence of chrons has been tentatively identified in the APC cores (0-133 mbsf). At the centimeter scale, peaks in magnetic-susceptibility values are associated with the terrigenous sandy layers in the turbidites of Unit I.

In-situ temperature measurements indicate that the vertical temperature gradient between the seafloor and 176 mbsf is about 41°C/km, and the vertical conductive heat flow is about 61 mW/m^2.

Physical-property measurements on the sediments show a small but steady increase in density, seismic velocity, formation factor, and thermal conductivity, and a concomitant decrease in porosity, with depth.

Interstitial-water samples were obtained from Units I to IIB (3 to 336 mbsf). The pore-water chemistry (sulfate, alkalinity, ammonia, iron, manganese, calcium, magnesium, strontium, potassium, silica, chloride, and sodium) reflects the rapid deposition of the Pliocene-Pleistocene turbidites and the relatively slower deposition of the earlier sediments. The principal result is the surprisingly high sulfate concentration (up to 16 mM) in Unit IIB. This is attributed to a low sedimentation rate in the Miocene and Oligocene, low permeability, and a lack of reactive carbon. Sulfate concentrations decrease rapidly from 3 to 50 mbsf as sulfate is consumed by reaction with organic carbon in Unit I.

Profiles of carbonate content against depth reflect a history of generally low biological productivity, and deposition of hemipelagic sediment below the CCD, combined with delivery by turbidites of carbonate-rich material initially deposited above the CCD. Elevated organic carbon is found in Unit I (mean value 0.5%), whereas Unit II has much lower organic carbon. Relatively high concentrations of biogenic methane were encountered in headspace-gas analyses of lithostratigraphic Units I and IIA, but methane was essentially absent from all deeper sections.

Site 899

Site 899 is situated in the Iberia Abyssal Plain within the OCT zone over a semi-elliptical basement ridge with a steep southern flank (Fig. 8). Geophysical modeling had predicted that the ridge lay within a part of the OCT, intermediate between thin oceanic crust to the west and thinned continental crust to the east, in which there is a large positive magnetic anomaly that cannot be modeled by seafloor spreading. Rotary cores were obtained from two holes that penetrated 562.5 m of upper Pliocene to Upper Cretaceous sediment overlying an unusual serpentinite breccia and serpentinized peridotite with interbedded lower Aptian to upper Hauterivian claystone and siltstone. Coring was terminated when the drill string became temporarily trapped near the bottom of hole. Downhole logs were acquired from within acoustic basement in the interval 395 to 430 mbsf; deeper logging was prevented by bridges, and, when we tried to log from the base of the casing to the top of basement, bridges stopped the logging tools in that interval, too.

A 2.9-m.y. hiatus in the middle/late Miocene, correlatable with a regional angular unconformity on seismic reflection profiles, may be related to northwest-southeast compression on this margin during a compressional phase in the Betic Mountains in southern Spain. In addition, there is a major hiatus represents most of the Paleogene.

Acoustic basement is composed of a thick series of three serpentinite breccias overlying discrete sections of serpentinite, serpentinized peridotite, gabbro, and intercalated Lower Cretaceous claystones and siltstones with associated non-MORB basalts.

Four lithologic units are identified at Site 899 (Fig. 9):

1. Unit I (81.5-131.65 mbsf) is Pleistocene to Pliocene silty clay to clayey silt, nannofossil clay with clay, silt and fine sand with minor nannofossil ooze. The unit consists mainly of terrigenous turbidites.

2. Subunit IIA (131.65-206.6 mbsf) is a Pliocene to Miocene bioturbated nannofossil claystone and claystone with minor silty claystone. The subunit consists mainly of pelagic/hemipelagic sediments with scattered turbidites.

   Subunit IIB (206.6-228.6 mbsf in Hole 899A, 230.5-360.2 mbsf in Hole 899B) is a Miocene to Oligocene bioturbated silty claystone to clayey siltstone with calcareous claystone and minor claystone, siltstone, and sandstone. The subunit was probably deposited above the CCD by contour currents and occasional mud turbidites.

3. Subunit IIIA (360.2-364.61 mbsf in Hole 899B) is an upper Eocene claystone deposited below the CCD.

   Subunit IIIB (364.61-369.8 mbsf in Hole 899B) is an Upper Cretaceous sandy silty claystone with clayey conglomerate and clayey sandstone. It was deposited by a combination of hemipelagic and pelagic settling and by high density turbidites or sand-silt-clay debris flows.

4. Subunit IVA (369.8-484.2 mbsf in Hole 899B) contains three Cretaceous serpentinite breccias, 10 to 95 m thick, with minor calcareous claystone and claystone. The two lowermost breccias are Aptian in age.

Subunit IVB (484.2-549.9 mbsf in Hole 899B) was poorly recovered and includes serpentinite, basalt, gabbro, and claystone and minor siltstone of early Aptian to late Hauterivian age.

A most unusual aspect of the sequence of rocks recovered is the three lithologies in Unit IV (Fig. 10) which consist of (a) serpentinite breccia units up to 95 m thick; (b) unbrecciated serpentinite, serpentinized peridotite, and gabbro; and (c) intercalated claystone, unconsolidated altered serpentinite, and minor siltstone associated with basalt fragments as individual pieces in the cores or as clasts within the sediment. The clasts in the breccia units are up to 1 m thick. At least 90% of these clasts are serpentinized peridotite, many of which display a fabric indicative of moderate temperature-high pressure ductile deformation, and the remainder are fragments of metamorphosed magnesium-rich igneous rock. The breccia units are structureless and unsorted. Rarely, flow structures and the sediment/breccia contact are seen near the bases of the breccia units. The matrix has a texture that, in a tectonic setting, indicates shear deformation under low normal stress typically due to high fluid pressures. Clasts of continental basement rocks, basalt, sediment, and gabbro are entirely absent. Below the breccia units, Subunit IVB is composed principally of unbrecciated boulder-sized blocks of serpentinite, but it also contains intercalated siltstones and claystones and intercalated clasts of basalt, microgabbro, and mylonite. Both subunits contain intercalated Lower Cretaceous sediments that suggest a normal stratigraphic upward-younging sequence.

The cores at Site 899 provide a discontinuous fossil record from the late Pliocene through the Late Cretaceous. Calcareous nannofossils are generally present but sometimes rare in the Cretaceous. Planktonic foraminifers are abundant to common in the upper Pliocene to upper lower Miocene deposits but are less common or absent below. A hiatus representing at least 2.9 m.y. lasted from middle to late Miocene time. A major hiatus representing most of the Paleogene is represented within Core 899B-15R. The presence of the Early Cretaceous nannoflora is especially important in providing a tentative stratigraphy for the serpentinite breccias.

Acoustic formations 1A and 1B have been widely recognized on multichannel seismic reflection profiles of the west Iberia margin and locally dated by previous drilling. At Site 899, acoustic formation boundary 1A/1B correlates with the middle/late Miocene hiatus at 170 mbsf.

A few potential paleomagnetic reversals were observed in the sedimentary section. Sediment NRM intensities range from 0.1 to 1.0 mA/m. Within Unit IV the serpentinite breccias have a very stable normal magnetization, which may correspond to a period within the Cretaceous Long Normal Superchron. Between 470 and 520 mbsf a possible pattern of reversals was observed. Magnetic susceptibility was moderately high in Unit I (3 x 10^{-4} SI units), low in Unit IIB (about 10^{-4} SI units), and very high within Unit IV (about 10^{-2} SI units).

Physical-property measurements on the sediments show a small but steady increase in bulk density, seismic velocity, formation factor, shear strength, and thermal conductivity, and a concomitant decrease in porosity, with depth. Within the acoustic basement the altered ultramafic rocks have higher densities but relatively low grain densities (both about 2.5 g/cm^3). Electrical resistivity is particularly high in parts of the serpentinite breccia (up to 800 ohm-m), as are seismic velocity (4.2 to 6.9 km/s) and thermal conductivity (1.4 to 2.5 W/mK).

Downhole logs were obtained from only the thick serpentinite breccia unit in the top of Unit IVA (395 to 430 mbsf). These showed a very low natural-gamma count (5-10 API units), low aluminum (1%-1.5 wt %), a high resistivity (mean 150 and maximum 1000 ohm-m), low porosity (0%-10%), and compressional and shear wave velocities of 3.81-4.85 and about 2.3 km/s respectively. Locally higher velocities, resistivities, and densities appear to correlate with blocks of serpentinized peridotite.

Interstitial-water samples were obtained from within Units I to IIB (81.5 to 350 mbsf). The sulfate concentration is almost constant (18.5-19.9 mM) in most of the hole, with a steady decrease within the lower half of lithostratigraphic Unit IIB to a minimum of 15.5 mM. Sulfate is depleted with respect to seawater, indicating that sulfate reduction has probably occurred in the unsampled section from 0 to 81.5 mbsf.

Profiles of carbonate content against depth reflect a history of generally low biological productivity, and deposition of hemipelagic sediment below the CCD, combined with delivery by turbidites of carbonate-rich material initially deposited above the CCD. Unit I contains 0.3% organic carbon, which is much less than at Sites 897 and 898. Organic C/N ratios from Unit I and the upper part of Unit IIB are variable; a few values are anomalously low. Concentrations of biogenic methane encountered in headspace-gas analyses of lithostratigraphic Units I to IIIB are generally low. Methanogenesis may have been inhibited by the generally high sulfate concentrations.

Site 900

Site 900 is situated in the Iberia Abyssal Plain within the OCT zone over an angular basement high that appears to be a tilted fault block (Fig. 11). Geophysical modeling had indicated that this basement high lay within a part of the OCT with a very weak magnetization and therefore is probably thinned continental crust. Cores were obtained from a hole that penetrated 748.9 m of Pleistocene to Paleocene sediment, and 57.1 m of basement composed of mafic igneous rock. Coring was terminated when the rate of penetration came close to 1 m/hr and bit failure was imminent. A total of 385 m of sonic, resistivity, and FMS logs was acquired from three separate intervals in the sediments and basement.

Basement is composed of amphibolite-grade mafic igneous rocks. The history of these rocks is unclear at present, and they may have originated as Paleozoic basalt, cumulate gabbro from the lower crust, or pre-Mesozoic subcontinental mantle invaded by gabbro. In any case they were exposed at the seafloor prior to the late Paleocene, probably by the Early Cretaceous rifting.

A 4-m.y. hiatus in the middle/late Miocene, which began at 11.7 Ma, is correlatable with a regional angular unconformity on seismic reflection profiles and may be related to northwest-southeast compression on this margin during a compressional phase in the Betic Mountains in southern Spain.

Two lithostratigraphic units are identified at Site 900 (Fig. 12):

1. Subunit IA (0.0-67.2 mbsf) is a Pleistocene to upper Pliocene nannofossil clay, clay, and nannofossil ooze. The subunit consists mainly of mud-dominated turbidites and hemipelagic/pelagic sediment.

Subunit IB (67.2-96.0 mbsf) is an upper Pliocene to upper Miocene nannofossil claystone and nannofossil chalk. The subunit consists mainly of hemipelagic/pelagic sediment.

Subunit IC (96.0-181.5 mbsf) is an upper Miocene to upper lower Miocene nannofossil claystone, claystone, and nannofossil chalk with minor siltstone and fine sandstone. The subunit consists mainly of mud-dominated turbidites and hemipelagic/pelagic sediment.

2. Subunit IIA (181.5-234.3 mbsf) is a lower Miocene nannofossil claystone and chalk, with claystone and minor silty claystone to fine sandstone. The subunit consists mainly of contourites and turbidites with pelagic/hemipelagic sediments.

Subunit IIB (234.3-748.9 mbsf) is a lower Miocene to Paleocene silty claystone to clayey siltstone, nannofossil claystone, and claystone with calcareous silty claystone to clayey siltstone, siltstone, and fine sandstone. The subunit consists mainly of sediments, possibly including turbidites, reworked by contour currents.

The sediments at this site reveal the history of development of the lower continental rise adjacent to the Iberia Abyssal Plain during the Cenozoic. The cores chronicle the deposition of silt and clay layers with laminated bases under the influence of bottom currents, which were probably contour-following currents and part of the general oceanic circulation. Mud turbidites were occasionally seen, too. These sediments were succeeded by carbonate-rich turbidites and then by mud-dominated turbidites as the abyssal-plain sediments built upward and sideways onto the rise.

The cores provide a discontinuous fossil record from the Pleistocene through the late Paleocene. Calcareous nannofossils are generally abundant to very abundant. Planktonic foraminifers are generally common to abundant in the upper section of the hole, but samples from the deeper sections contained fewer specimens. Two major hiatuses, representing the early late Miocene and the early Eocene, as well as several minor hiatuses, are identified.

The Matuyama, Gauss, and Gilbert Chrons are tentatively identified from paleomagnetic measurements on the sediments above 145 mbsf. Below that depth, the sediments are weakly magnetized, and no chrons have been identified. The metagabbro basement rocks do not provide any reliable magnetic results, mainly due to weak magnetization. Magnetic-susceptibility values generally follow the pattern of remanent magnetization values in both sediments and basement.

Fifty-seven meters of fine- to coarse-grained metamorphosed mafic rocks was drilled in the basement. The rocks are highly deformed and brecciated and veined by later calcite, epidote, and clinozoisite. A porphyroclastic texture, with large porphyroclasts of plagioclase and clinopyroxene, is seen in thin section. Chemical analyses suggest that the rocks are relatively depleted in large ionic lithophile elements. These rocks may be (a) Paleozoic basalts that were accreted onto continental basement during the Hercynian orogeny, (b) cumulate gabbro from the lower crust, or (c) pre-Mesozoic subcontinental mantle invaded initially by a hot gabbroic component, stretched during the Mesozoic crustal extension and then retrogressively metamorphosed. In any case they were exposed at the seafloor prior to the late Paleocene, probably by the Early Cretaceous rifting.

The sonic, resistivity, and FMS logging strings were run over three separate parts of the hole, including 36 m of basement. Hole conditions made logging difficult and forced us to use the conical side-entry sub. Eventually, logging had to be abandoned due to persistent obstructions in the hole and damage to the logging cable and FMS tool. The most valuable data are likely to be the FMS images from the sediments at the base of the hole. They show clear evidence of dip within those sediments that correlate with the observation of dip within the cores. The FMS data will allow the azimuth of the dip to be determined.

Physical-property measurements on the sediments show a small but steady increase in bulk density, seismic velocity, formation factor, shear strength, and thermal conductivity, and a concomitant decrease in porosity, with depth. Slight variations in the trends of the physical properties are related to the degree of lithification of the sediment. The clay-rich sediments were notable for their significant seismic anisotropy in places (over 7%) and relatively strong vertical velocity gradient (1 sec^{-1}) compared to Sites 897, 898, and 899. The density of the basement rocks is about 2.6-2.9 g/cm^3, and their velocity ranges from 3.7 to 7.5 km/s with a cluster of observations at 5.7 km/s.

Interstitial-water samples were obtained from Units I to IIB (13 to 722 mbsf). The principal result is the steady downward decrease in sulfate concentration throughout the hole from a value close to the seawater concentration at 13 mbsf to a minimum of 1.9 mM at 702 mbsf. The profile is slightly convex upward, suggesting that some sulfate reduction occurs within the sedimentary column. Ammonia concentrations are consistent with this interpretation. A similarly shaped magnesium profile may result from clay-mineral alteration. Calcium and strontium concentrations suggest carbonate recrystallization at around 300 mbsf and below 630 mbsf.

Profiles of carbonate content against depth reflect a history of generally low biological productivity, and deposition of hemipelagic sediment below the CCD, combined with delivery by turbidites of carbonate-rich material initially deposited above the CCD. An average 0.3% organic carbon is found in Unit I ; this is much less than at Sites 897 and 898. Variable organic C/N ratios from Unit I indicate the fluctuating predominance of marine or terrigenous sources of organic matter. Concentrations of biogenic methane encountered in headspace-gas analyses of lithostratigraphic Units I to IIB are generally low, as at Site 899. Methanogenesis may have been inhibited by interstitial sulfate as indicated by the generally high sulfate concentrations in the pore waters.

Site 901

Site 901 is situated in the Iberia Abyssal Plain within the OCT zone over a basement high that has an angular shape on a single east-west seismic reflection profile and that appears to be a tilted fault block (Fig. 13). The block has a west-dipping fault scarp and is capped by an acoustically transparent layer, clearly visible on a pre-stack migrated version of the seismic profile, several hundred meters thick. Geophysical modeling had indicated that this basement high lay within a part of the OCT with a weak magnetization and therefore is probably underlain by thinned continental crust. Site 901 was drilled during the last 48 hr of the leg. We drilled and washed down to 182.0 mbsf and cored intermittently down to 247.8 mbsf. Coring was terminated when we had to depart for Lisbon.

We obtained Upper Jurassic (Tithonian) black mud and sandstone containing significant terrestrial plant debris from the acoustically transparent layer capping the tilted fault block. This is the oldest sediment acquired during Leg 149, and it is from the pre- or syn-rift period.

We recovered a section of Pliocene nannofossil clay or ooze, apparently unconformably overlying a thin film of Lower Cretaceous clay. The section below is apparently Tithonian and consists of black clay, silt, and sand. There are intervals of sandstone that make up about 10%-20% of the section. The sediments are black because they contain significant pieces of land-plant debris (some are as large as 1 cm) and pyrite.

The Tithonian, 152-146 Ma, is older than the time of initiation of seafloor spreading on this margin, 130 Ma. We do not know the time at which rifting began here, so this sediment could have been pre-rift or syn-rift. In either case, we conclude that this part of the margin is underlain by extended continental crust.

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FIGURES

Figure 1. Bathymetry of the west Iberian margin (contours in meters; bold lines are at 1000-m intervals). Leg 149 sites are 897-901; other numbers are sites drilled during Legs 13, 47B, and 103. The bold dashed line is the predicted location of the peridotite ridge (Beslier et al., 1993). The map at the top shows the location (solid lines) of the seismic profiles used to construct the composite structural section in Figure 2.. Labels are: IB, Galicia Interior Basin; VDGS, Vasco da Gama Seamount; VS, Vigo Seamount; PS, Porto Seamount; LB, Lusitanian Basin; ES, Estremadura Spur.

Figure 2. Composite east-west sediment and basement section through the Leg 149 sites. The composite section was assembled from parts of three seismic sections (see Fig. 1 inset for locations of seismic lines). The magnetic profile is a composite from two tracks projected onto an east-west line (Whitmarsh et al., 1990). East of Site 897, which is over the peridotite ridge, the magnetic anomalies cannot be explained by seafloor spreading. Drilling results show that Sites 897 and 899 are underlain by serpentinized peridotite, which was part of the upper mantle exposed at the seafloor during rifting. Site 900 is underlain by amphibolite-grade metagabbro, possibly continental crust or syn-rift lower oceanic crust. Site 901 is underlain by Jurassic pre- or syn-rift sediments over extended continental crust. The crust under the J magnetic anomaly is considered to be unambiguous oceanic crust.

Figure 3. Summary sediment-accumulation-rate diagram for Leg 149 sites. Dates were obtained from calcareous nannofossils and planktonic foraminifers. The boxes with diagonal lines indicate hiatuses in deposition that can be correlated between all the sites. The shaded boxes indicate hiatuses that can be correlated between at least two or more sites.

Figure 4. Seismic reflection profile across Site 897. The location and approximate penetration of the site are shown by the vertical line. Data provided by K. Hinz.

Figure 5. Lithostratigraphic summary of Site 897.

Figure 6. Seismic reflection profile across Site 898. The location and approximate penetration of the site are shown by the thick vertical line. Layers 1A, 1B, 2, and 3 are acoustic formations recognized off western Iberia (Mauffret and Montadert, 1988). Data provided by G. Boillot.

Figure 7. Lithostratigraphic summary of Site 898.

Figure 8. Seismic reflection profile across Site 899. The location and approximate penetration of the site are shown by the vertical line. Layers 1A, 1B, 2, and 3 are acoustic formations recognized off western Iberia (Mauffret and Montadert, 1988).

Figure 9. Lithostratigraphic summary of Site 899.

Figure 10. Lithologic summary of the cores obtained from the basement section (Unit IV) at Hole 899B.

Figure 11. Seismic reflection profile across Site 900. The location and approximate penetration of the site are shown by the vertical line. Data provided by G. Boillot.

Figure 12. Lithostratigraphic summary of Site 900.

Figure 13. Seismic reflection profile across Site 901. The location and approximate penetration of the site are shown by the vertical line. Data provided by G. Boillot.

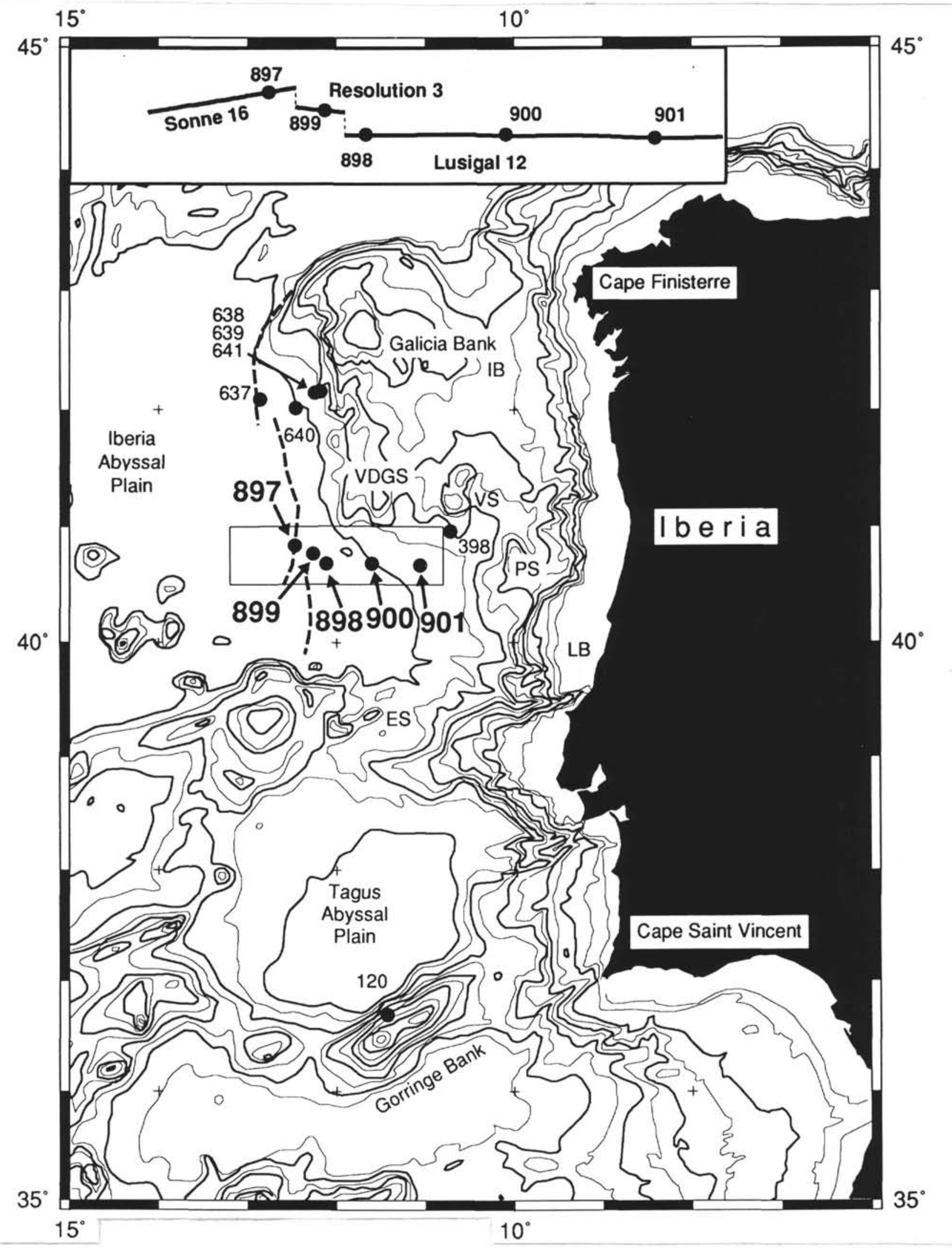

15°
10°
45°
40°
35°
897
Resolution 3
Sonne 16
899
900
901
898
Lusigal 12
Cape Finisterre
638
639
641
637
640
Galicia Bank
IB
Iberia
Abyssal
Plain
VDGS
VS
897
398
PS
Iberia
899
898
900
901
LB
ES
Tagus
Abyssal
Plain
Cape Saint Vincent
120
Gorringe Bank

Figure 1

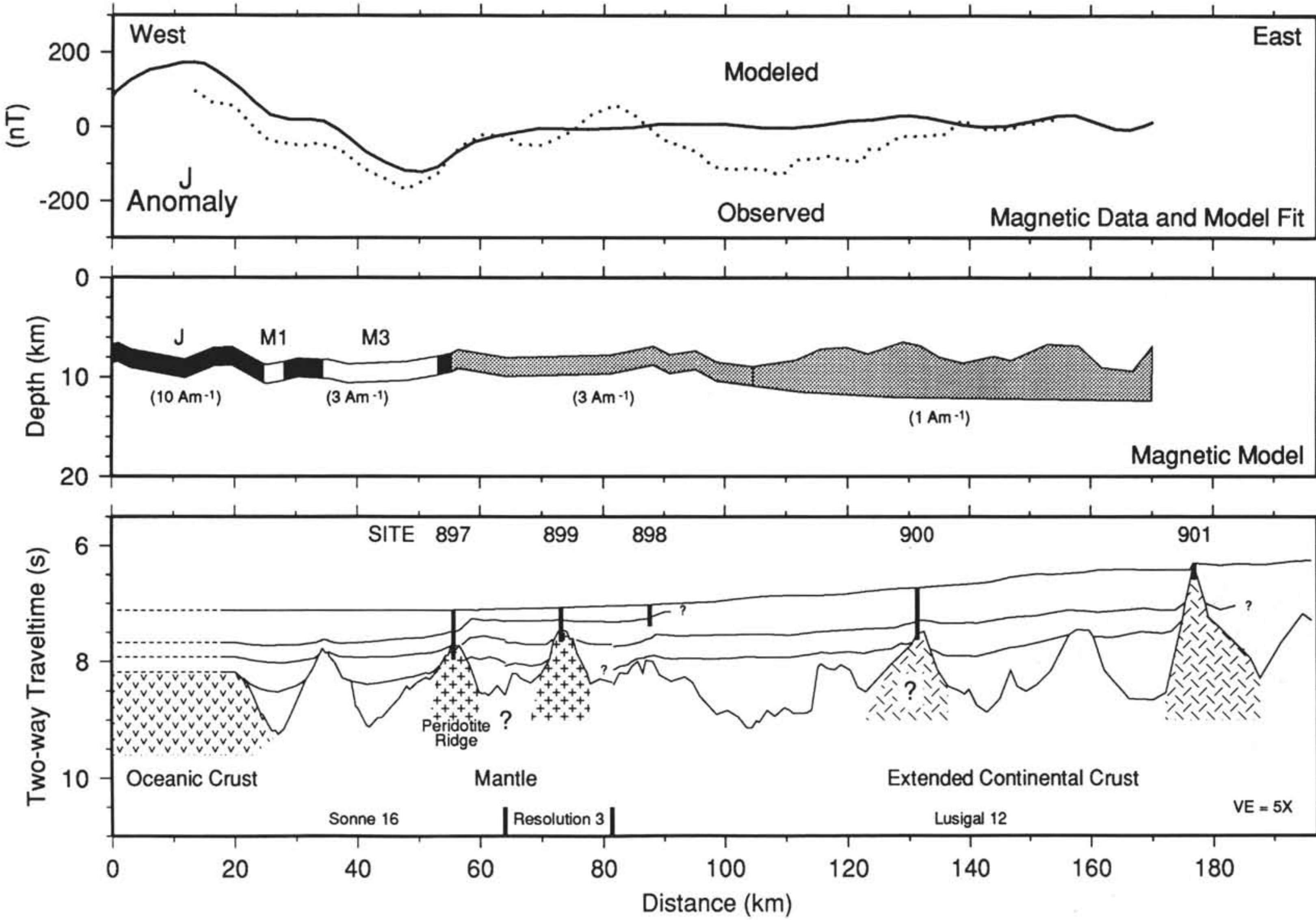

West
East
Modeled
Observed
J
Anomaly
Magnetic Data and Model Fit
(nT)
200
0
-200
Depth (km)
0
10
20
J
M1
M3
(10 Am-1)
(3 Am-1)
(3 Am-1)
(1 Am-1)
Magnetic Model
Two-way Traveltime (s)
6
8
10
SITE 897
899
898
900
901
?
Peridotite Ridge
Oceanic Crust
Mantle
Extended Continental Crust
VE = 5X
Sonne 16
Resolution 3
Lusigal 12
0
20
40
60
80
100
120
140
160
180
Distance (km)

Figure 2

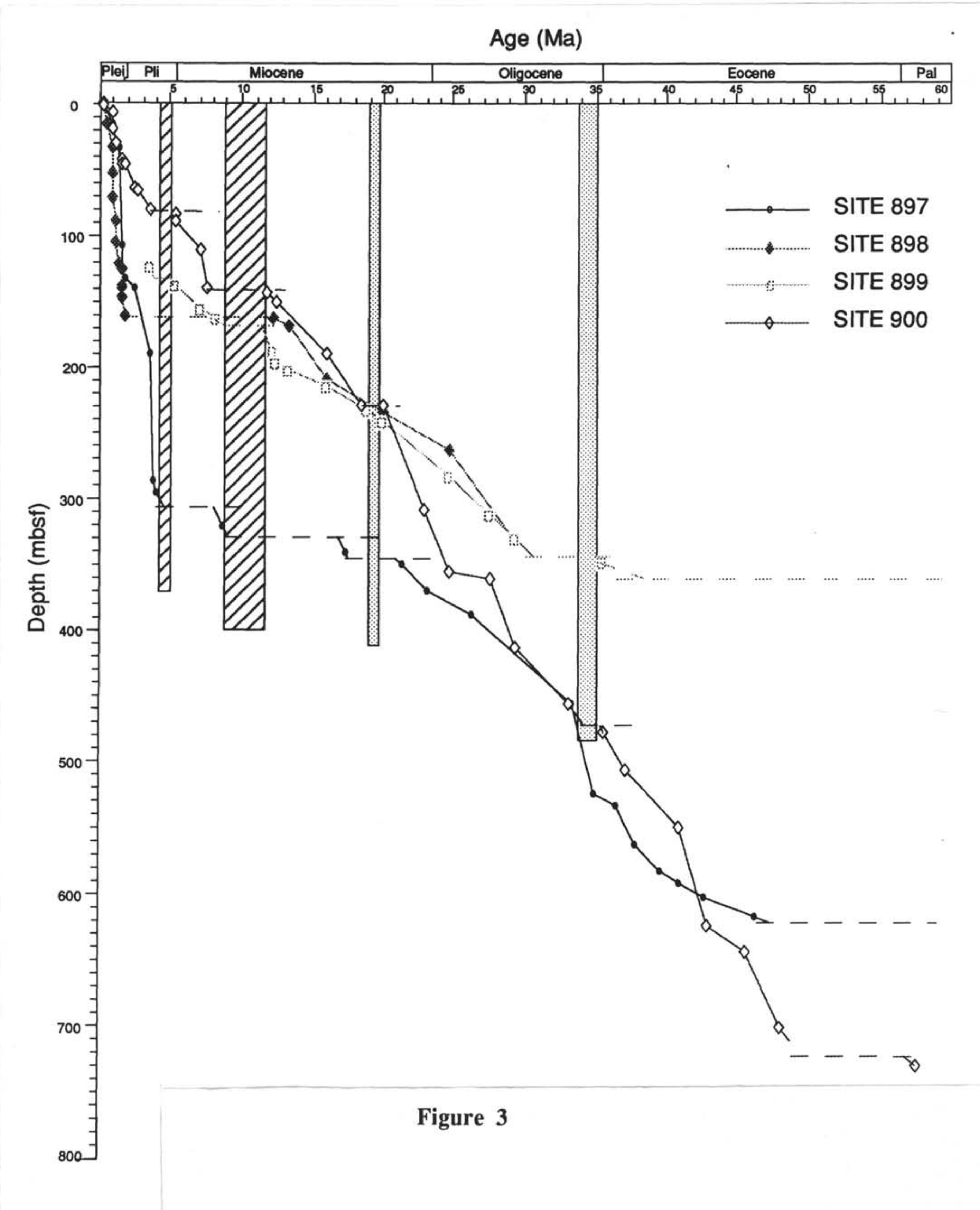
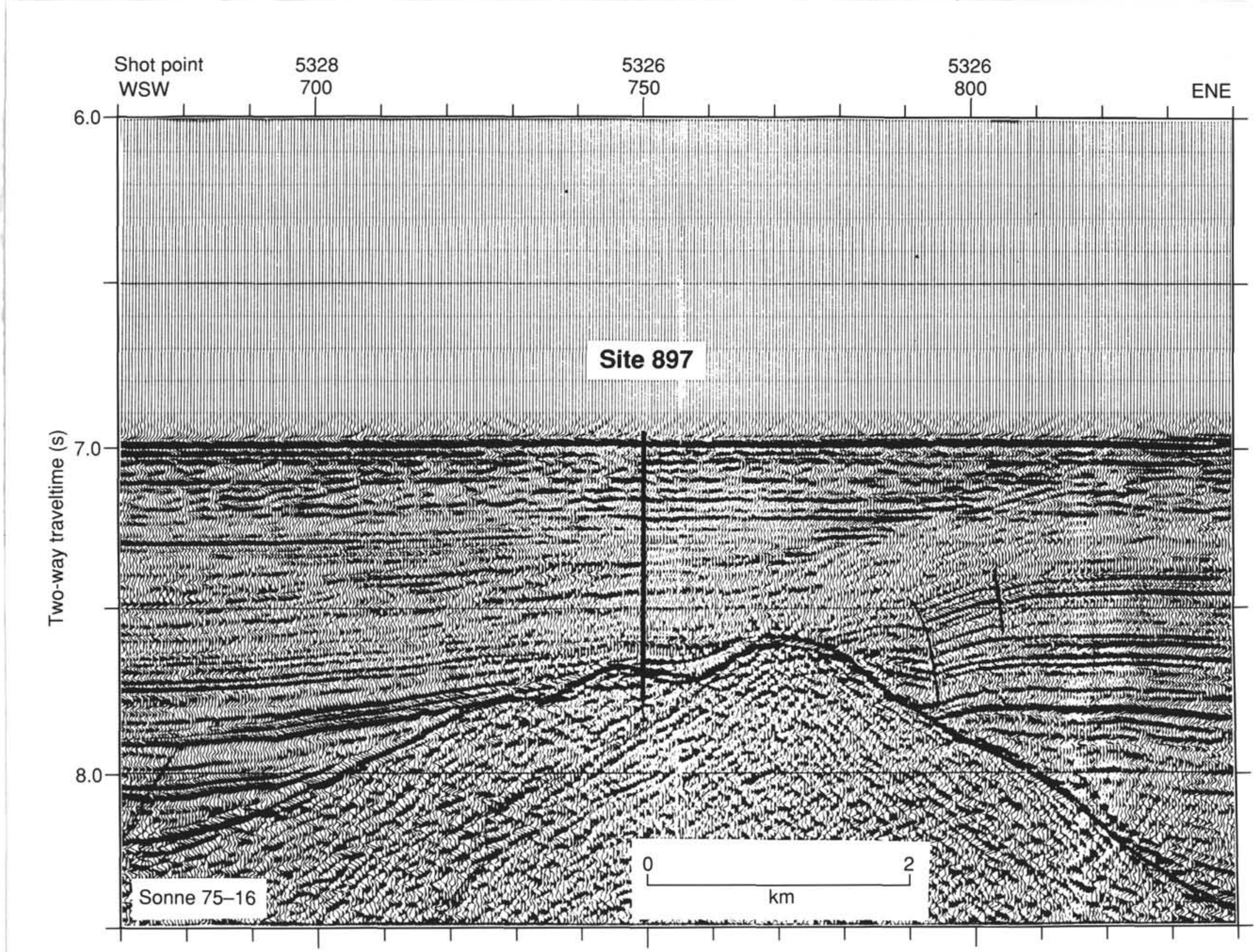

Age (Ma)
Plei
Pli
Miocene
Oligocene
Eocene
Pal
5
10
15
20
25
30
35
40
45
50
55
60
0
100
200
300
400
500
600
700
800
Depth (mbsf)
SITE 897
SITE 898
SITE 899
SITE 900

Figure 3



Shot point
WSW
5328
700
5326
750
5326
800
ENE
6.0
7.0
8.0
Two-way traveltime (s)
Site 897
0
2
km
Sonne 75–16

Figure 4

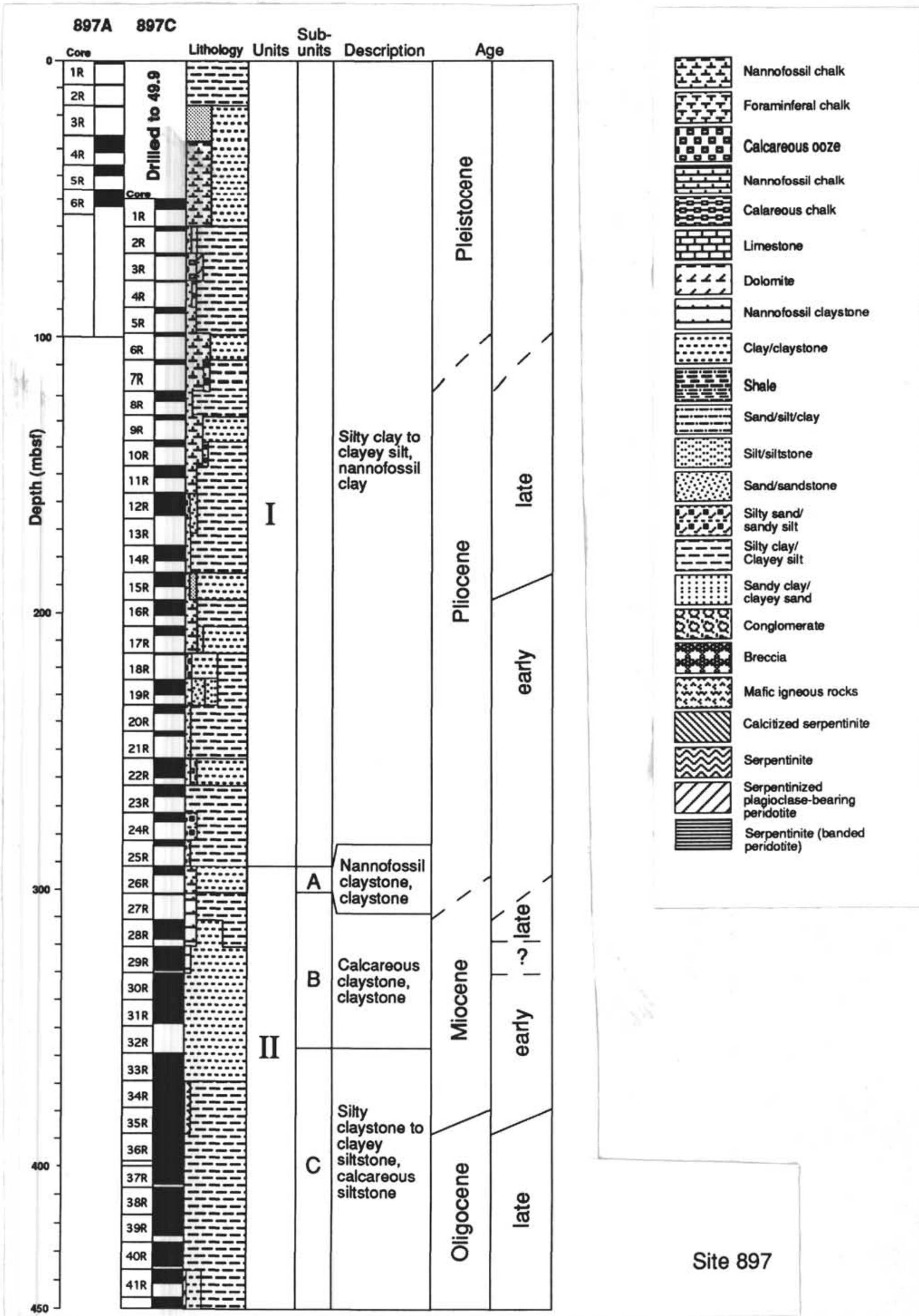
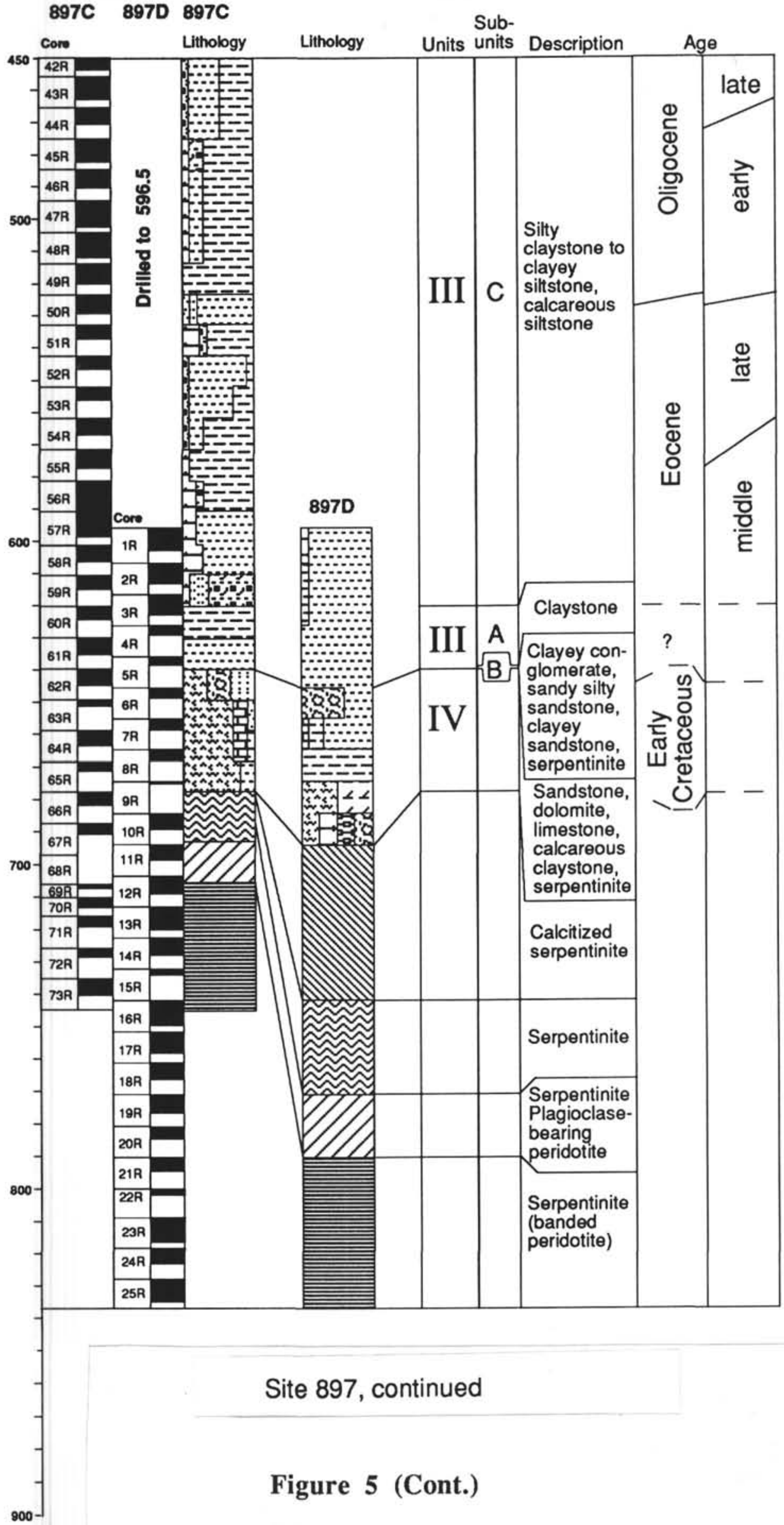

897A
897C
Core
Drilled to 49.9
Lithology
Units
Sub-units
Description
Age
Depth (mbsf)
0
100
200
300
400
450
1R
2R
3R
4R
5R
6R
7R
8R
9R
10R
11R
12R
13R
14R
15R
16R
17R
18R
19R
20R
21R
22R
23R
24R
25R
26R
27R
28R
29R
30R
31R
32R
33R
34R
35R
36R
37R
38R
39R
40R
41R
I
II
A
B
C
Silty clay to clayey silt, nannofossil clay
Nannofossil claystone, claystone
Calcareous claystone, claystone
Silty claystone to clayey siltstone, calcareous siltstone
Pleistocene
Pliocene
Miocene
Oligocene
late
early
late
?
early
late
Nannofossil chalk
Foraminferal chalk
Calcareous ooze
Nannofossil chalk
Calareous chalk
Limestone
Dolomite
Nannofossil claystone
Clay/claystone
Shale
Sand/silt/clay
Silt/siltstone
Sand/sandstone
Silty sand/ sandy silt
Silty clay/ Clayey silt
Sandy clay/ clayey sand
Conglomerate
Breccia
Mafic igneous rocks
Calcitized serpentinite
Serpentinite
Serpentinized plagioclase-bearing peridotite
Serpentinite (banded peridotite)
Site 897

Figure 5



Site 897, continued

Figure 5 (Cont.)

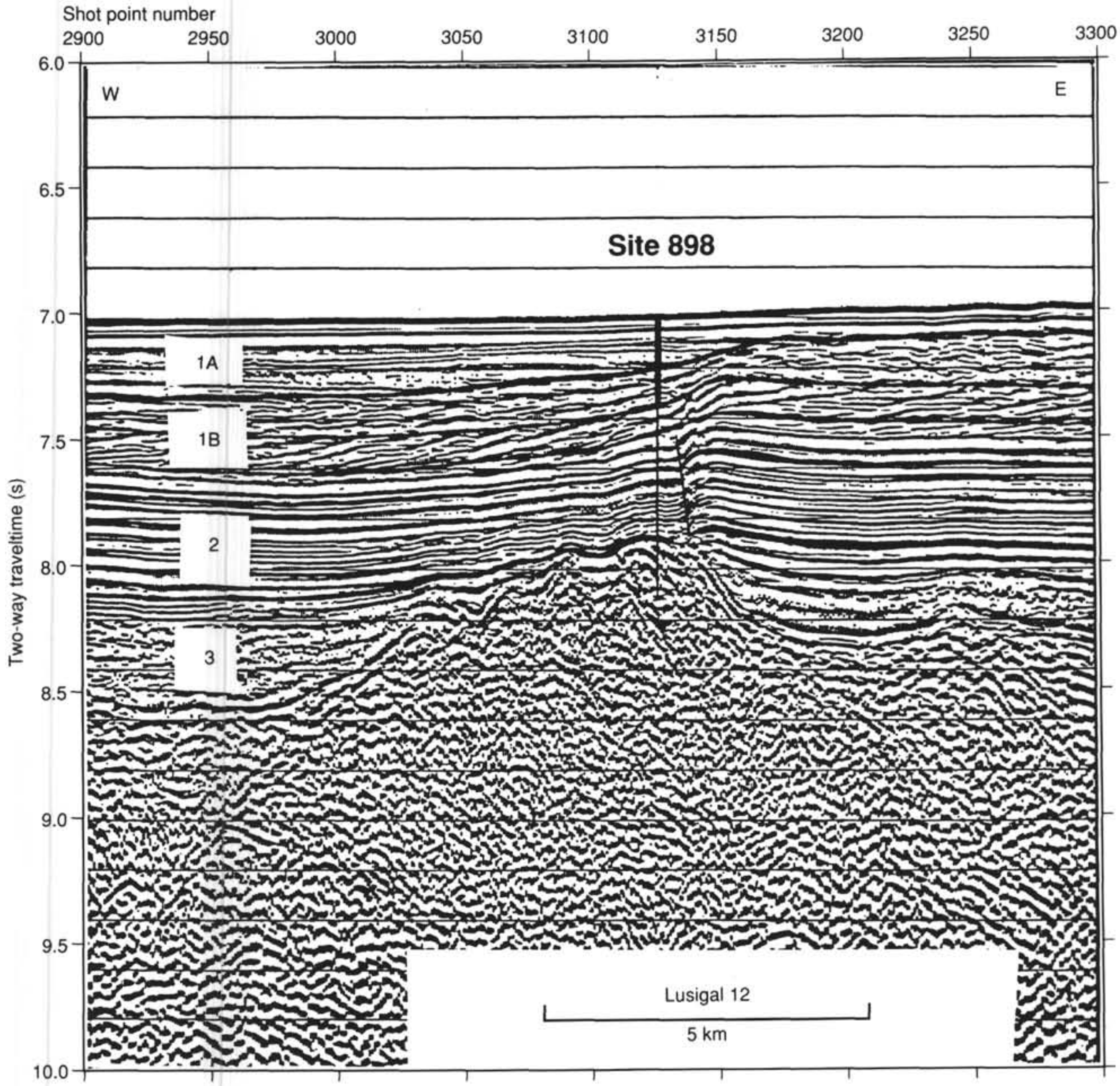
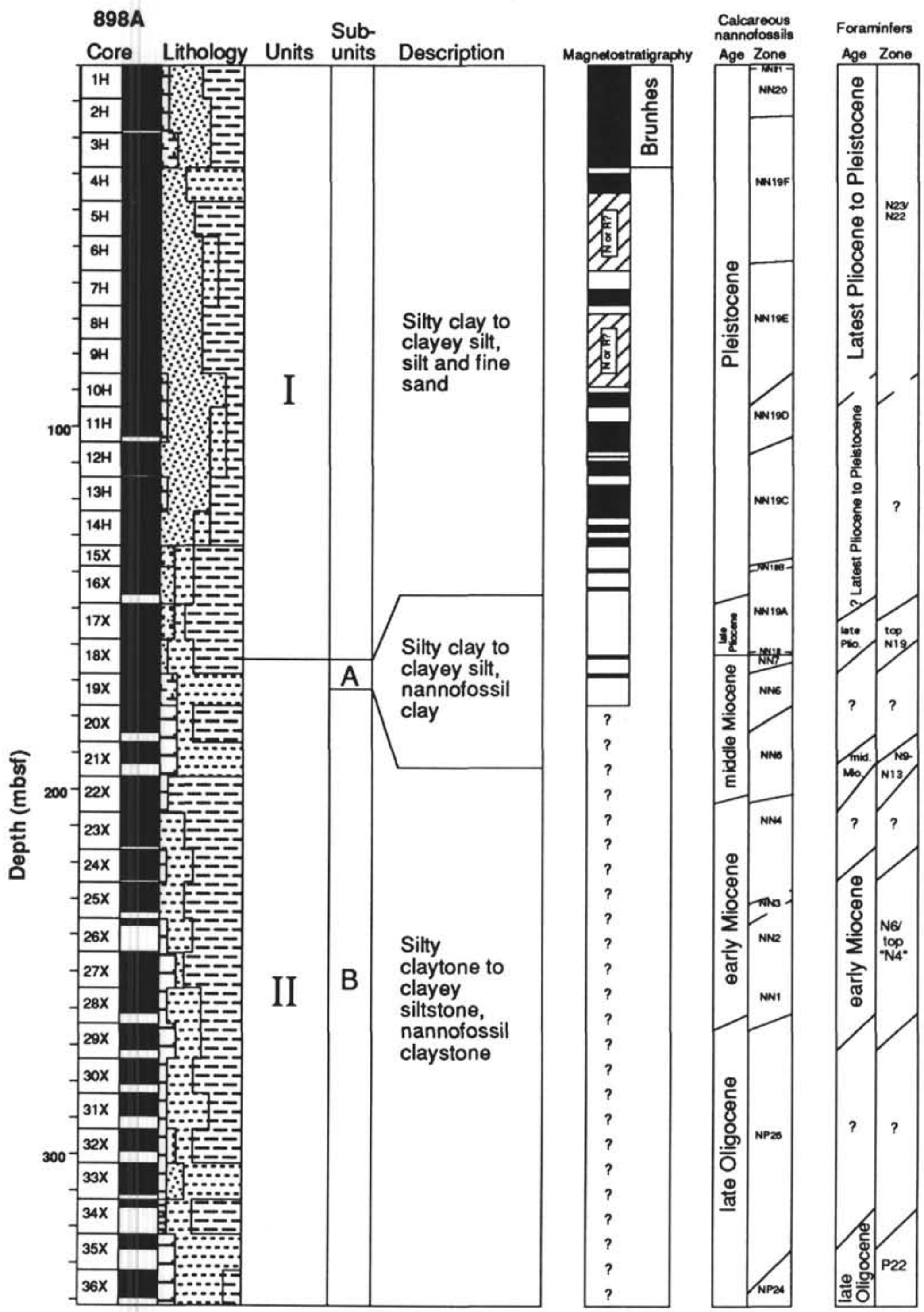

Shot point number
2900
2950
3000
3050
3100
3150
3200
3250
3300
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
Two-way traveltime (s)
W
E
Site 898
1A
1B
2
3
Lusigal 12
5 km

Figure 6



Site 898

Figure 7

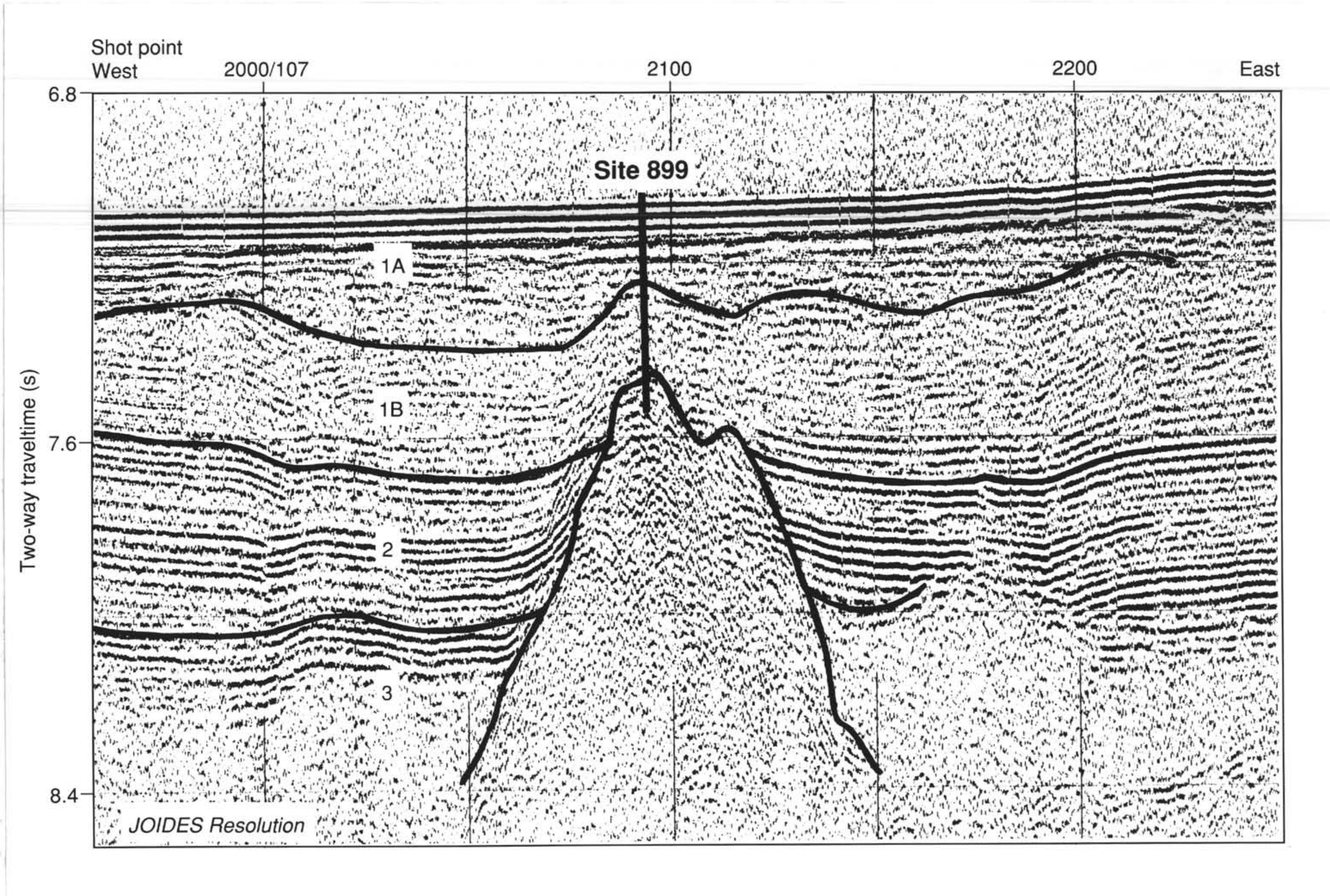

Shot point
West
2000/107
2100
2200
East
6.8
7.6
8.4
Two-way traveltime (s)
Site 899
1A
1B
2
3
JOIDES Resolution

Figure 8

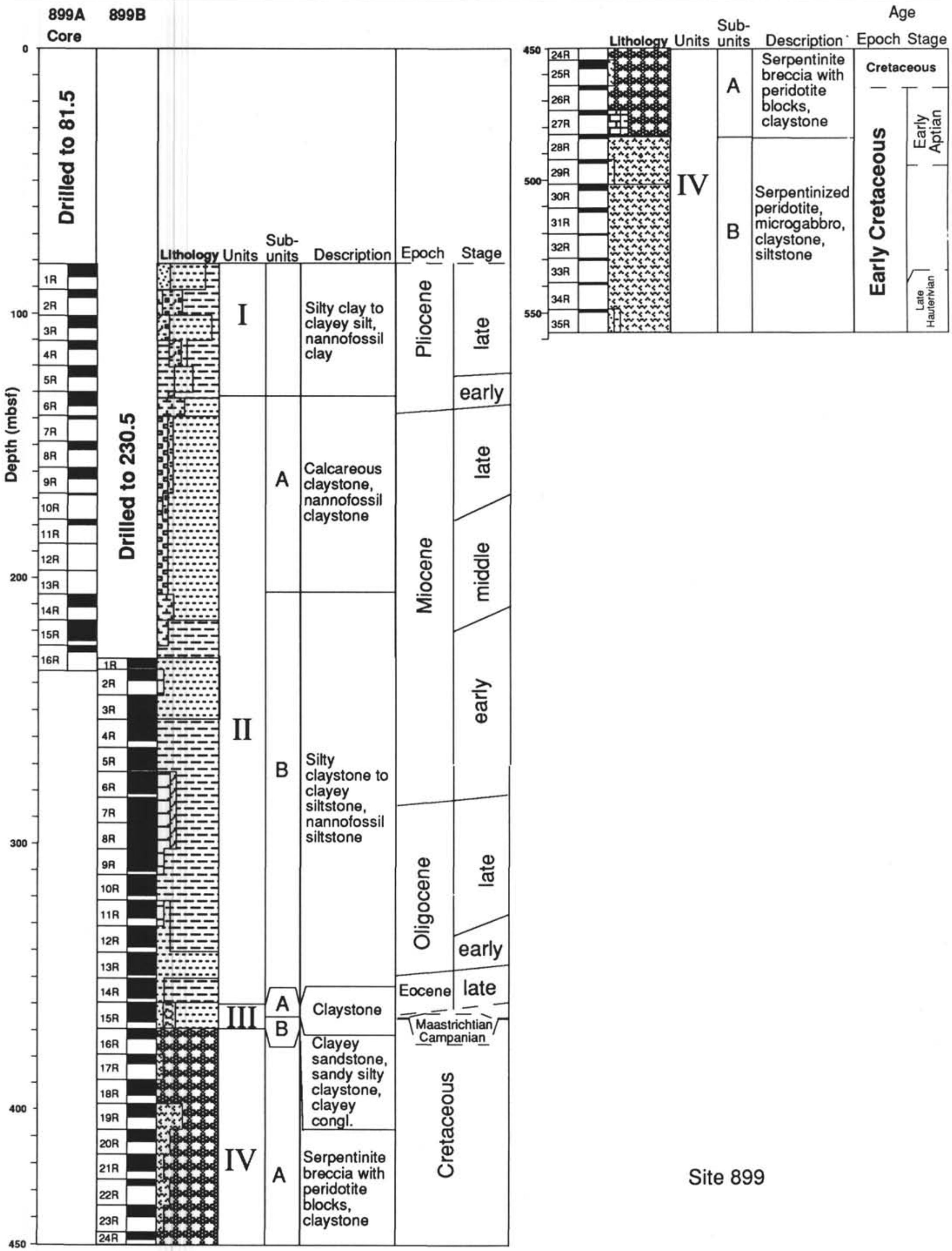
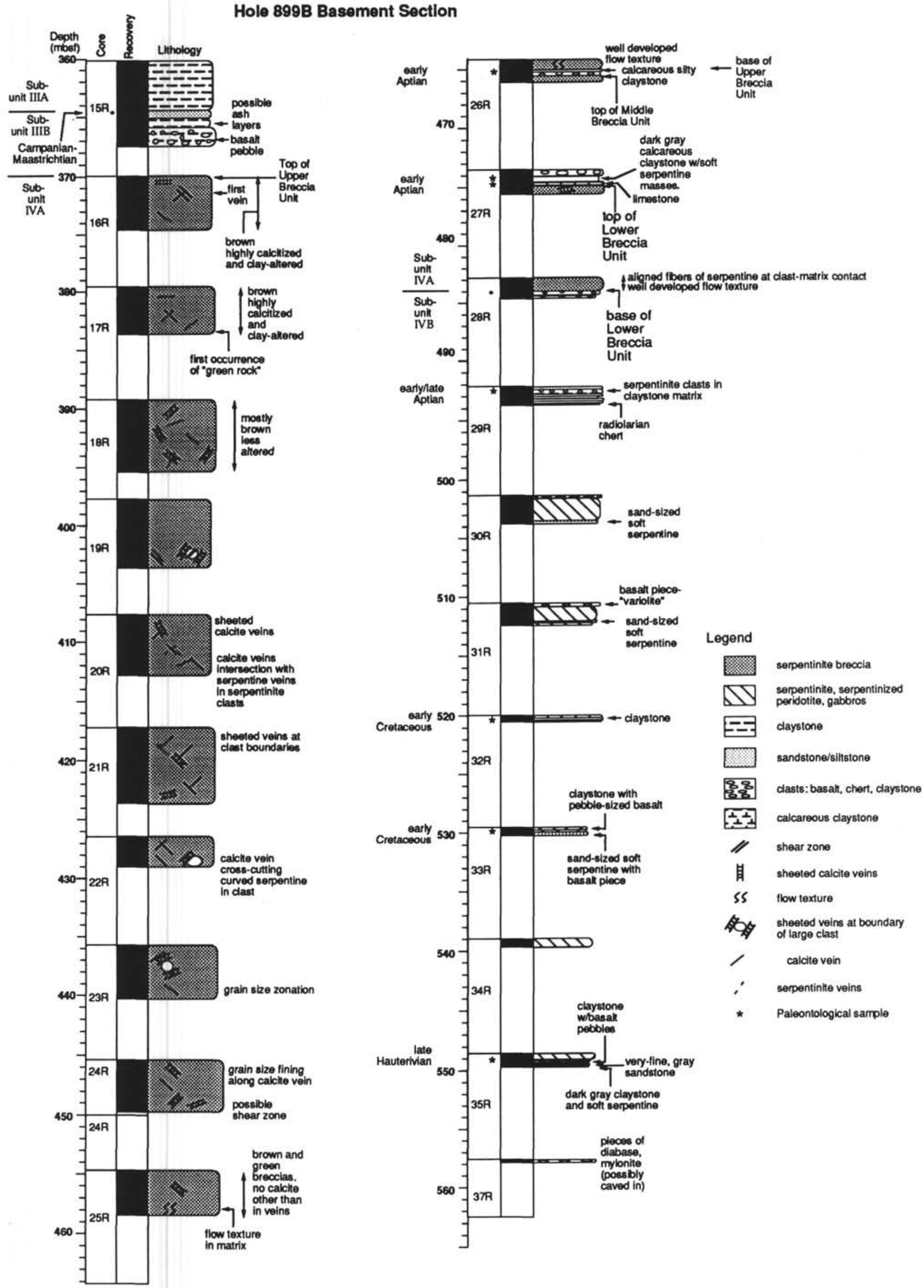
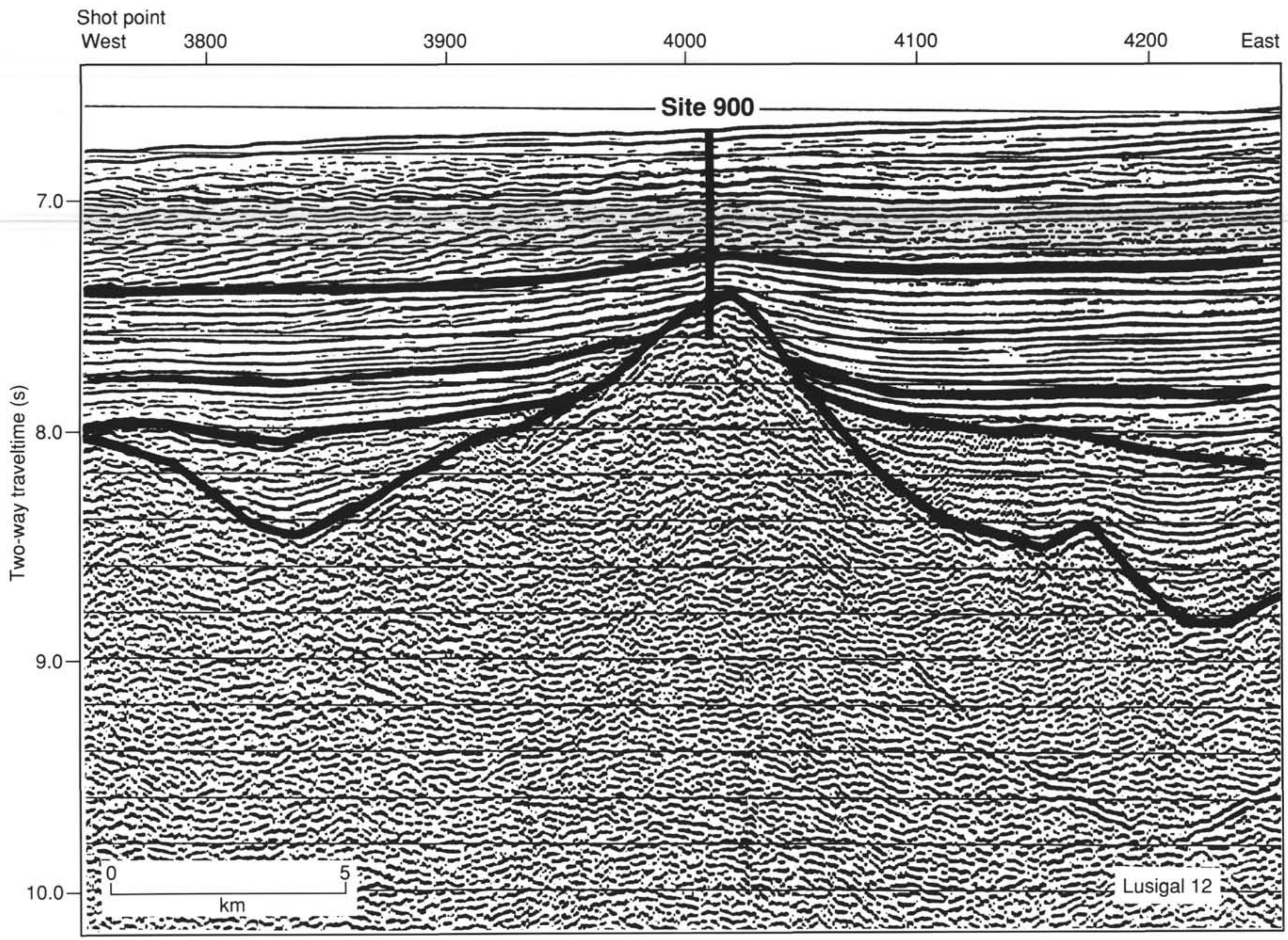

899A
899B
Core
Depth (mbsf)
Drilled to 81.5
Drilled to 230.5
Lithology
Units
Sub-units
Description
Epoch
Stage
Age
I
II
III
IV
A
B
Silty clay to clayey silt, nannofossil clay
Calcareous claystone, nannofossil claystone
Silty claystone to clayey siltstone, nannofossil siltstone
Claystone
Clayey sandstone, sandy silty claystone, clayey congl.
Serpentinite breccia with peridotite blocks, claystone
Serpentinized peridotite, microgabbro, claystone, siltstone
Pliocene
Miocene
Oligocene
Eocene
Maastrichtian
Campanian
Cretaceous
Early Cretaceous
late
early
middle
Early Aptian
Late Hauterivian
Site 899

Figure 9



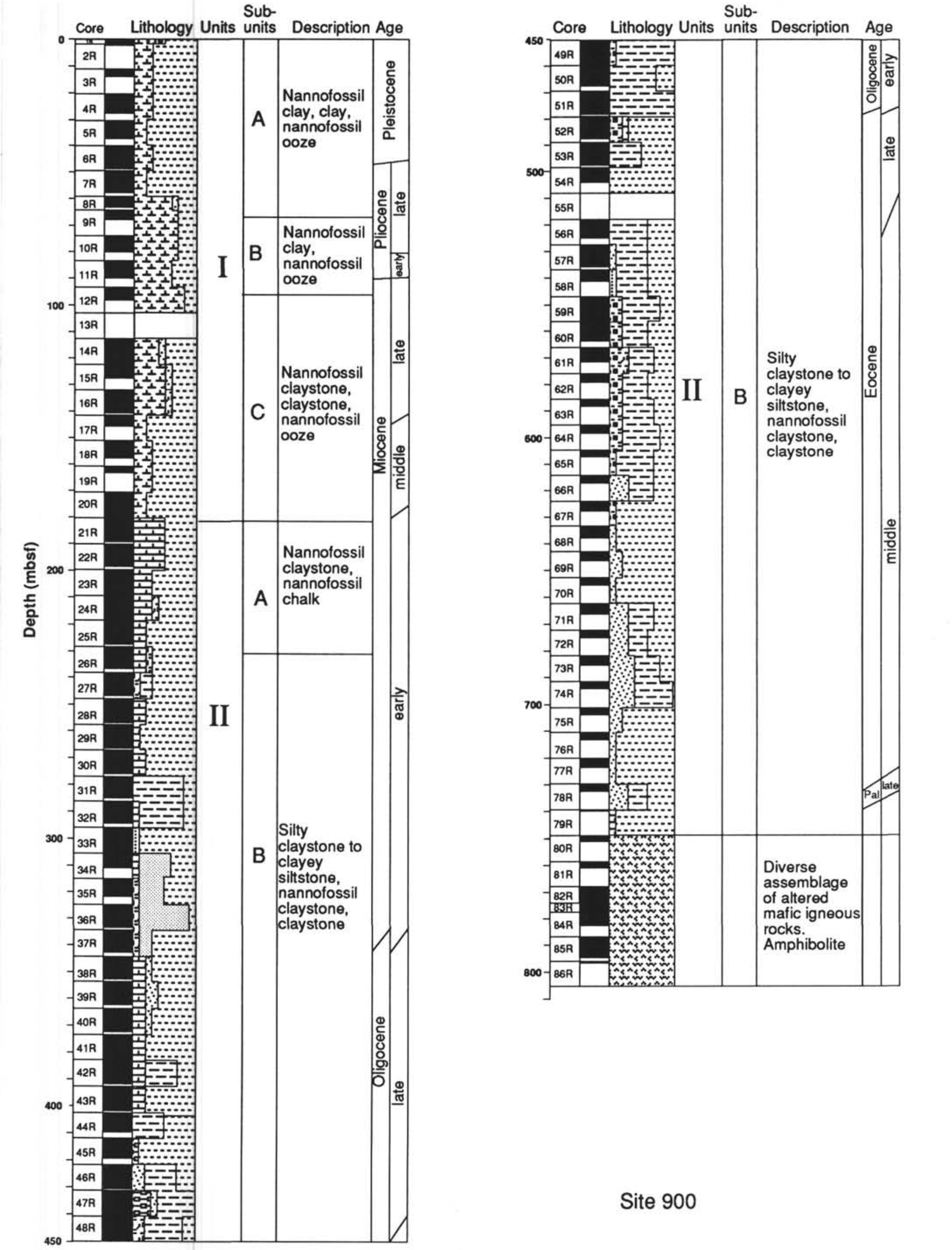
Hole 899B Basement Section
Depth (mbsf)
Core
Recovery
Lithology
Sub-unit IIIA
Sub-unit IIIB
Campanian-Maastrichtian
Sub-unit IVA
possible ash layers
basalt pebble
Top of Upper Breccia Unit
first vein
brown highly calcitized and clay-altered
brown highly calcitized and clay-altered
first occurrence of "green rock"
mostly brown less altered
sheeted calcite veins
calcite veins intersection with serpentine veins in serpentinite clasts
sheeted veins at clast boundaries
calcite vein cross-cutting curved serpentine in clast
grain size zonation
grain size fining along calcite vein
possible shear zone
brown and green breccias, no calcite other than in veins
flow texture in matrix
early Aptian
well developed flow texture
calcareous silty claystone
base of Upper Breccia Unit
top of Middle Breccia Unit
dark gray calcareous claystone w/soft serpentine masses.
limestone
top of Lower Breccia Unit
Sub-unit IVA
Sub-unit IVB
aligned fibers of serpentine at clast-matrix contact
well developed flow texture
base of Lower Breccia Unit
early/late Aptian
serpentinite clasts in claystone matrix
radiolarian chert
sand-sized soft serpentine
basalt piece-"variolite"
sand-sized soft serpentine
early Cretaceous
claystone
claystone with pebble-sized basalt
sand-sized soft serpentine with basalt piece
claystone w/basalt pebbles
late Hauterivian
very-fine, gray sandstone
dark gray claystone and soft serpentine
pieces of diabase, mylonite (possibly caved in)
Legend
serpentinite breccia
serpentinite, serpentinized peridotite, gabbros
claystone
sandstone/siltstone
clasts: basalt, chert, claystone
calcareous claystone
shear zone
sheeted calcite veins
flow texture
sheeted veins at boundary of large clast
calcite vein
serpentinite veins
Paleontological sample

Figure 10



Shot point
West
3800
3900
4000
4100
4200
East
Site 900
7.0
8.0
9.0
10.0
Two-way traveltime (s)
0
5
km
Lusigal 12

Figure 11



Core
Lithology
Units
Sub-units
Description
Age
Depth (mbsf)
Nannofossil clay, clay, nannofossil ooze
Nannofossil clay, nannofossil ooze
Nannofossil claystone, claystone, nannofossil ooze
Nannofossil claystone, nannofossil chalk
Silty claystone to clayey siltstone, nannofossil claystone, claystone
Diverse assemblage of altered mafic igneous rocks. Amphibolite
Pleistocene
Pliocene
Miocene
Oligocene
Eocene
Pal
late
early
middle
I
II
A
B
C
Site 900

Figure 12

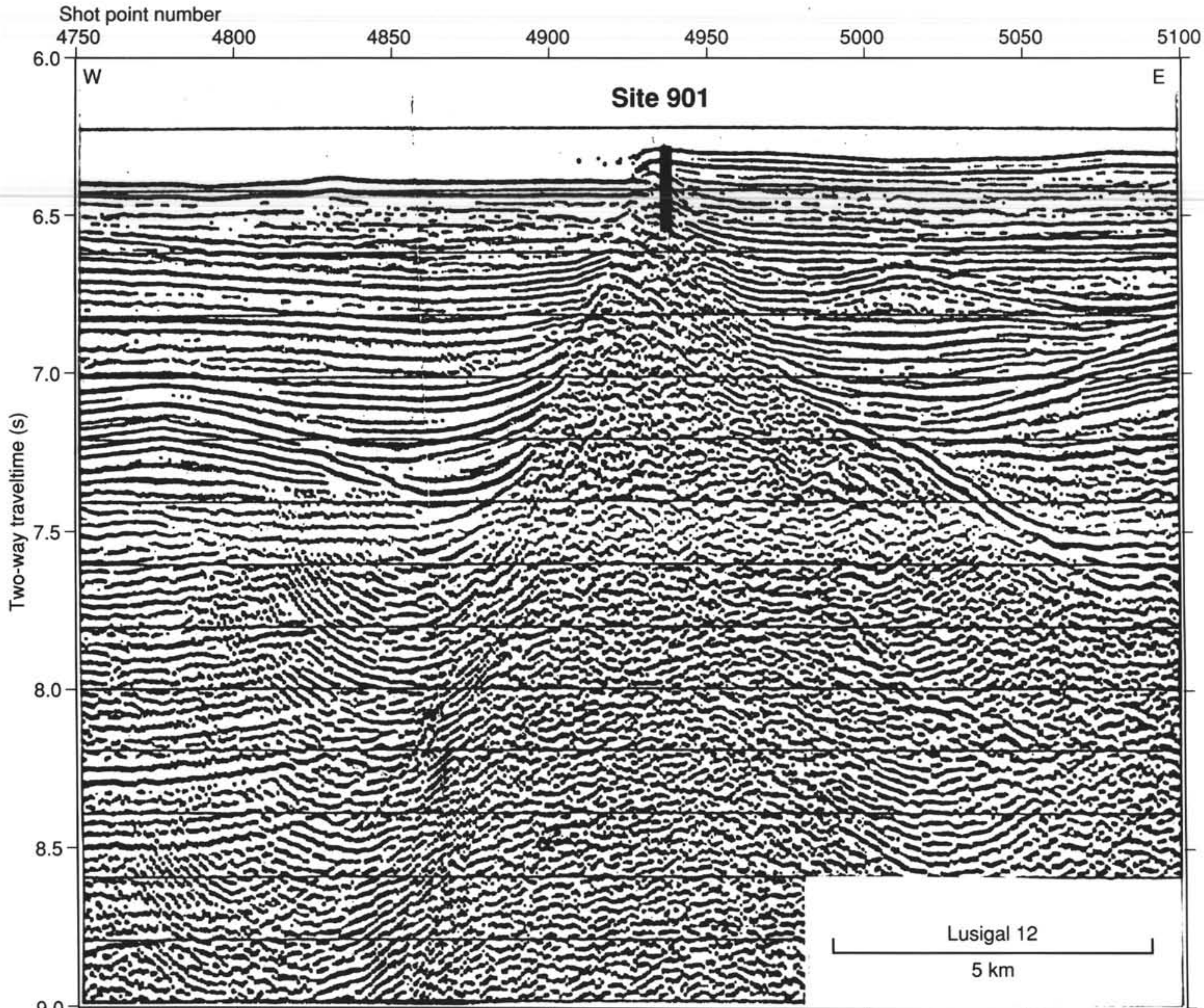

Shot point number
4750
4800
4850
4900
4950
5000
5050
5100
W
E
Site 901
Two-way traveltime (s)
6.0
6.5
7.0
7.5
8.0
8.5
9.0
Lusigal 12
5 km

Figure 13

OPERATIONS REPORT

The ODP Operations and Engineering personnel aboard *JOIDES Resolution* for Leg 149 were:

Operations Superintendent:	Gene Pollard
Development Engineer:	Scott McGrath
Schlumberger Engineer:	Pablo Saldungaray (Leg 149B)
	Steven Kittredge (Leg 149C)

TRANSIT FROM PANAMA TO PONTA DELGADA, AZORES

The *JOIDES Resolution* departed Balboa, Panama, at 0730 hr (all times are given in UTC) on 14 March 1993. We then transited to Ponta Delgada, Azores. We arrived in Ponta Delgada at 1300 hr on 28 March 1993 to take aboard the Leg 149 shipboard scientists.

SITE 897

The *JOIDES Resolution* departed Ponta Delgada, Azores, at 1615 hr on 28 March 1993. We transited the 631 nmi to Site 897 in 51.25 hr. We started a single-channel seismic reflection and magnetic survey over proposed site IAP-4 at 2130 hr on 30 March to confirm its location. During this site survey, a navigation computer program (AGCNAV) proved extremely helpful in providing a real-time display of the ship's track. The seismic survey was completed at 0052 hr, 31 March, and the ship returned to the chosen site location. A Datasonics beacon was deployed at 0145 hr at 40° 50.37'N, 12° 28.37'W. After the ship was in dynamic positioning (DP) mode, a backup Datasonics beacon was dropped and turned off. The site location had been offset 200 m east-northeast of the approved location in order to penetrate a thin layer of possible syn-rift sediment above basement. The precision depth recorder (PDR) indicated a water depth of 5330.2 meters below rig floor (mbrf; the rig floor is approximately 11.05 m above sea level).

Hole 897A

Beginning at 0400 hr, 31 March, a rotary core barrel (RCB) bottom-hole assembly (BHA) with a mechanical bit release (MBR) was assembled and run to the seafloor. The bit tagged bottom at 5331.0 mbrf. Hole 897A was spudded at 1845 hr, 31 March. Cores 149-897A-1R through -6R were cut from 0.0 to 55.2 meters below seafloor (mbsf) and 17.01 m was recovered. A water sampler and temperature probe (WSTP) measurement was taken at 55.2 mbsf.

The drawworks brakes were not holding, and several attempts to adjust them were unsuccessful. Sea conditions were causing an occasional 3-m heave and +/-40Klb fluctuations in the 580Klb hanging weight of the drill string. The silty/sandy top of the hole was potentially unstable, and the hole was only 55 m deep; therefore, it was judged best to terminate operations in Hole 897. The bit was pulled above the seafloor, and the drawworks brake pads were replaced.

Hole 897B

The ship was not moved, and Hole 897B was spudded at 1320 hr, 1 April. The mud line was encountered at 5331.0 mbrf, and the hole was drilled from 0.0 to 52.0 mbsf. Erratic torque was observed in the first 30 m and assumed to be unstable seafloor sediments caving into the hole. A 10.0-m core was cut from 5383.0 to 5393.0 mbrf. Several attempts to retrieve the core barrel were unsuccessful. We pulled the drill pipe out of the hole and found that part of the BHA had been lost.

Hole 897C

A new RCB-BHA with a MBR was assembled, and the ship was moved 20 m north. Hole 897C was spudded at 1745 hr, 2 April. The PDR indicated a water depth of 5329.4 mbrf, and the bit encountered the seafloor at 5326.3 mbrf. Cores 149-897C-1R through -73R were cut from 49.9 through 744.9 mbsf. A total of 695.0 m was cored with 352.9 m of material recovered. WSTP temperature measurements were taken at 117.9, 166.1, and 214.4 mbsf.

After coring Hole 897C to 774.9 mbsf, the hole appeared to be in good condition, and it was judged to be prudent to change the bit. Since a primary objective of Site 897 was significant basement penetration, and the first bit could not complete the hole, we decided to deploy a Free-Fall Funnel (FFF) and retrieve the pipe to replace the bit.

The bit was pulled to 74 mbsf, and a FFF was deployed. The vibration-isolation tool (VIT) was deployed with a television and a sonar. The FFF and floats were not visible on the seafloor, but the VIT sonar indicated that the funnel was 4 mbsf. No flow was visible exiting the crater during circulation. The hole was too valuable to risk losing on a blind reentry, and additional basement penetration and logging were considered important; therefore, we decided to go back to bottom and continue coring for the remaining life of the bit. At this point, however, the drill pipe became stuck. In the process of attempting to free it and continue drilling, the BHA broke off. Hole 897C was terminated, and the drill string pulled out of the hole.

Hole 897D

We decided to drill Hole 897D to acquire additional basement and deep sediment cores and to obtain downhole logs. The ship was offset 100 m west-southwest of Hole 897C to obtain information on the lateral variability within the deep sediments and basement rocks. The PDR indicated a water depth of 5330.2 mbrf. A RCB-BHA with a MBR was deployed, and the seafloor was encountered at 5327.0 mbrf. Hole 897D was spudded at 0600 hr, 10 April. We drilled from 78.0 to 596.0 mbsf. The core barrel was recovered at 200-m intervals as a precaution against its becoming stuck by cuttings that might circulate above it. Cores 149-897D-1R to -25R were cut from 596.0 to 837.9 mbsf, an interval of 241.9 m in which we recovered 117.94 m of material.

After coring, the hole was then flushed, the basement/sediment contact from 5982 to 6164 mbrf was reamed clear, and a short pipe trip was made to 120 mbsf. The bit was dropped, and the pipe was pulled to 120 mbsf again for logging.

A 41-m-long quad combo logging tool was run. The tool encountered a bridge at 228 mbsf and became stuck. The pipe also became stuck and was freed by circulating seawater at high pressure. The open BHA was carefully washed down over the logging tool from 5447 to 5557 m to recover it. The logging tool became unstuck when we had washed to within 3 m of the bottom of the tool. After recovering the logging tool, the drill string was stuck. The drill string was freed again by using the pumps to liquefy the formation. Hole 897D and Site 897 ended at 1515 hr, 17 April, when the BHA was on deck.

PORT CALL, LISBON

After completing Site 897, we conducted a single-channel seismic reflection and magnetic survey of proposed sites IAP-2 and IAP-3C to confirm their locations.We then transited to Lisbon, Portugal, to exchange crews. This marked the end of Leg 149B. Leg 149C began at 0700 hr, 19 April, with the first line ashore. We departed Lisbon at 1702 hr, 19 April and sailed to Site 898.

SITE 898

We deployed a Datasonics beacon at 40° 31.934'N, 11° 57.316'W. This location had been confirmed during the geophysical survey prior to the end of Leg 149B. After the ship was stabilized in dynamic positioning mode over the primary beacon, a second backup Datasonics beacon was deployed.

Hole 898A

An advanced hydraulic piston core (APC)/extended core barrel (XCB) bottom-hole assembly (BHA) was assembled and run to the seafloor. The PDR indicated a water depth of 5294.4 mbrf. Core 149-898A-1H was taken with the bit at 5290.0 mbrf. The recovery was 9.25 m, and the liner had split. We continued coring despite the possibility of having missed the mud line. The water depth was taken to be 5290.3 mbrf. APC Cores 149-898A-1H to -14H were taken from 5290.3 to 5423.0 mbrf (0.0-132.7 mbsf), with 132.7 m cored and 133.38 m recovered (100.5% recovery). Cores were oriented from Core 149-898A-4H on, using the Tensor orientation tool. The Adara temperature shoe was run on Core 149-898A-12H. After Core 149-898A-14H, the core barrel became stuck, and we had to drill down around it; therefore, we switched to an XCB.

XCB Cores 149-898A-15X to -36X were taken from 5423.0 to 5631.8 mbrf (132.7 to 341.5 mbsf), with 208.8 m cored and 155.38 m recovered (74.4% recovery). WSTP temperature measurements and water samples were taken at 5467.7 mbrf (177.4 mbsf) and 5515.9 mbrf (225.6 mbsf). XCB coring was terminated when the time per core had increased unduly and recovery had begun to decrease. At this site, we anticipated deploying a reentry cone, setting casing, and coring to basement. Hole 898A ended when the bit cleared the seafloor at 0845 hr on 24 April.

Hole 898B

The ship was offset 10 m to the north for a jet-in test and to obtain a mudline core. The jet-in test, however, had to be abandoned due to severe weather. We were experiencing a heave of 14 ft (4.3 m) and large drill string weight fluctuations. Hole 898B was intended to obtain a complete mudline core and only one additional APC core. Attempting the mud-line APC core was considered safe, since the bit could stay above the seafloor. The bit was positioned at 5285.0 mbrf, and Hole 898B was spudded at 120 hr on 24 April. The core barrel recovered 5.42 m of sediment. The seafloor was, therefore, at 5289.1 mbrf. Core 149-898B-1H was taken from 5289.1 to 5294.5 mbrf (0.0-5.4 mbsf).

The weather conditions deteriorated (Force 9 gale, 25-ft swells) as we began pulling out of the hole to begin reentry cone/casing operations. The APC/XCB-BHA had been pulled to 3455 mbrf, when the drill string broke at the rig floor at 1730 hr on 24 April. We lost approximately 3.34 km of drill string. The two Datasonics beacons were recovered. We began inspecting all the joints in the recovered sections of the drill string, began assessing the total amount of usable drill pipe remaining aboard the ship, and waited for the weather to improve.

The site was abandoned when it became clear that insufficient usable drill pipe remained on board to penetrate a significant basement section, which was the primary objective at this site.

SITE 899

Hole 899A

After completing drilling at Site 898, the ship was moved 8 nmi northwest to Site 899. We deployed a Datasonics beacon at 40° 46.34' N, 12° 16.07' W. This location had been confirmed during the geophysical survey prior to the mid-leg Lisbon port call (end of Leg 149B). After the ship was stabilized in dynamic positioning mode over the primary beacon, a second backup Datasonics beacon was deployed.

A RCB-BHA was assembled and run to the seafloor. The VIT was lowered, and the seafloor was observed at 5302.5 mbrf. A jet-in test was conducted from the seafloor to 5366.5 mbrf (0.0 to 64.0 mbsf) beyond which depth we were unable to penetrate. We then drilled from 5366.5 to 5384.0 mbrf (64.0 to 81.5 mbsf). Cores 149-899A-1R to -16R were taken from 5384.0 to 5538.0 mbrf (81.5 to 235.5 mbsf). Well-compacted clay was cored at 5512.5 mbrf (210 mbsf), and we stopped coring at 5538.0 mbrf (235.5 mbsf) to set a reentry cone and casing.

Hole 899B

The ship was moved 20 m north to 40° 46.347' N, 12° 16.063' W. We assembled three joints of 16-in. casing (49.62 m), with a 3-cone drill bit inside the casing about 0.15 m above the shoe, and attached it to a reentry cone. The reentry cone and casing were run to the seafloor, and the casing was jetted-in to 5352.1 mbrf (49.6 mbsf), placing the reentry cone on the seafloor. The drill bit was disconnected from the casing, and we drilled to 5529.5 mbrf (227.0 mbsf). The hole was filled with a mixture of sepiolite clay and seawater, and we pulled out of the hole.

We assembled 216 m of 11-3/4-in. casing and lowered it to 5518.9 mbrf (216.4 mbsf). The casing was cemented in place. After pulling out of the hole, we assembled a RCB-BHA with a chisel-point center bit and MBR and lowered it to the seafloor. We reentered the hole, encountered cement at 5508.0 mbrf (205.5 mbsf), and drilled through the cement and the 11-3/4-in. casing shoe. A 4.5-m section of new hole was drilled to 5533.0 mbrf (230.5 mbsf) to completely break down pieces of the shoe.

Cores 149-899B-1R to -37R were taken from 5533.0 to 5865.0 mbrf (230.5 to 562.5 mbsf), with 332.0 m cored and 173.31 m recovered. Hard rock (acoustic basement) was encountered at 369.8 mbsf. Below Core 149-899B-26R (464 mbsf), recovery decreased (to less than 20%), and hole conditions deteriorated. We discontinued coring due to high torque, overpull, and continuous sloughing of material into the bottom of the hole.

The hole was reamed from 5764.0 to 5860.1 mbrf, and Core 149-899B-37R was taken from 5860.1 to 5865.0 mbrf (557.6-562.5 mbsf), with 4.9 m cored and 0.19 m recovered. Hole conditions remained poor, and we made another attempt to ream and wash the hole from 5505.0 to 5865.0 mbrf (202.5 to 562.5 mbsf). We encountered several bridges that had to be drilled through (a wash barrel was recovered from this section). Finally, the pipe became stuck at 5852.0 mbrf (549.5 mbsf), and after pulling free with difficulty, we decided to terminate coring at Hole 899B.

The original plan for logging at Hole 899B was to drop the bit on the seafloor. Due to the unstable hole conditions, the importance of logging the peridotite basement, the risk of the hole collapsing if the drill string was pulled out of the hole to drop the bit, and the probability that an open-ended drill string could not be worked back down below the top of basement to obtain logs in the basement, we decided to release the bit in the hole.

The bit was released, using the MBR at 5841.6 mbrf (539.1 mbsf). The open drill string was pulled to 5696.3 mbrf (393.8 mbsf), which was just below the top of the peridotite breccia at 369.8 mbsf. The first two logging runs (Run 1-dual induction tool [DIT], caliper tool [MCD], dipole shear imager [DSI], natural gamma spectrometry tool [NGT-C], and the Lamont temperature logging tool [TLT]; Run 2- slim hole lithodensity logging tool [HLDT], dual porosity compensated neutron tool [CNT-G], sonic digital logging tool [SDTC], NGT-C, and TLT) were successfully run to 5757.0 mbrf (454.5 mbsf) and 5747.0 mbrf (444.5 mbsf), respectively. The induced gamma-ray spectrometry tool (GST-A) neutron source malfunctioned during the initial attempt at the third logging run (GST-A, aluminum activation clay tool [ACTC], CNT-G, NGT-C, and TLT). After the GST-A source was replaced, we began logging again. Although the neutron source failed again, we continued logging with the remaining tools in this combination to 5737.0 mbrf (434.5 mbsf). During this run, sediment had accumulated in the bottom of the hole, decreasing the amount of section possible to log, and we decided to discontinue logging this interval.

The drill string was then pulled up to 5496.5 mbrf (194 mbsf), inside the casing, and the fourth logging run was made with the formation microscanner (FMS)/NGT-C/TLT combination. The tool was unable to penetrate more than 4 m below the end of the casing, and logging was terminated. The drill pipe was pulled out of the hole, and the two beacons recalled and recovered.

SITE 900

Hole 900A

After completing drilling at Site 899, we moved the ship to 40° 41.00' N, 11° 36.25' W, Site 900 (proposed site IAP-5) and deployed a Datasonics beacon. The precision depth recorder indicated a water depth of 5045.4 mbsl. After the ship was stabilized in dynamic positioning mode over the primary beacon, a second backup Datasonics beacon was deployed.

A RCB-BHA with an MBR was assembled and run to the seafloor. The bit was positioned at 5048.5 mbrf, and Hole 900A was spudded at 0605 on 11 May 11 1993 by advancing 1.5 m. Core 149-900A-1R recovered 1.36 m; therefore, the seafloor was assigned a depth of 5048.5 mbrf. Cores 149-900A-1R to -86R were taken from 5048.5 to 5853.5 mbrf (0.0-805.0 mbsf), with 805.0 m cored and 519.80 m recovered (65% recovery). The first three cores were taken without rotating or pumping seawater; the weight-on-bit, rotation speed, and pump rate were gradually increased in response to increasing formation hardness and to maintain good hole conditions and core recovery. The WSTP was successfully run at 5170.9 mbrf (122.4 mbsf), 5219.1 mbrf (170.6 mbsf), and 5267.3 mbrf (218.8 mbsf).

We conducted two wiper trips in the sedimentary section. The first was after Core 149-900A-39R when we moved the pipe between 5412.0 and 5196.6 mbrf (363.7-148.1 mbsf). A second wiper trip was made after Core 149-900A-75R, when we moved the pipe between 5758.8 and 5600.0 mbrf (710.3-551.5 mbsf). We encountered a bridge at 5747.0 mbrf and washed and rotated the bit past it to total depth and found no fill in the bottom of the hole.

Basement rocks were encountered at 748.9 mbsf. After Core 149-900A-86R (805.5 mbsf), suspecting imminent bit failure, we decided to stop coring and prepare for logging. The hole was circulated clean, and a short trip was made to 5187 mbrf. Minor overpull was observed while pulling up, and the tight sections were reamed out while moving the pipe down. We then circulated clean the 10 m of fill at the bottom of the hole. The bit was released, and the end of the pipe was pulled to 5185.4 mbrf (136.9 mbsf) for logging.

Two logging runs were made. During the first run (DIT, MCD, DSI, and NGT-C) the tool would not pass 5286 mbrf (237.5 mbsf). The drill pipe was repositioned at 5378.5 mbrf (330.0 mbsf). No obstructions or drag were noted while running the drill string further into the hole. The first logging combination was rerun; however, it would not pass 5500 mbrf (451.5 mbsf). After the logs were run, we pulled the drill pipe up to 5244 mbrf (195.5 mbsf) and picked up the Conical Side Entry Sub (CSES).

A tool combination including the FMS and NGT-C was loaded into the CSES, and the drill string was run to 5802.2 mbrf (753.7 mbsf); however, the tool would not pass 5837 mbrf (788.5 mbsf).

The pipe was pulled up to 5742 mbrf (693.5 mbsf) in an effort to get above the obstructed hole. The combination was rerun from 5837 to 5695 mbrf (788.5-646.5 mbsf). The tool became stuck at 5695 mbrf (646.5 mbsf). The drill string was washed down to 5698 mbrf (649.5 mbsf) over the stuck tool. The logging tool came free, and the drill string and tool were pulled to 5528.9 mbrf (480.4 mbsf). This combination was run again and became stuck at 5613 mbrf (564.5 mbsf). We washed the drill pipe over the tool from 5528 to 5614 mbrf (478.5-565.5 mbsf). At this point, we abandoned logging due to poor hole conditions and damage to the logging cable and FMS tool. We recovered the drill string, recalled the two beacons, and terminated operations at Site 900 at 1518 hr on 22 May 22 1993.

SITE 901

Hole 901A

We moved the ship to 40° 40.48' N, 11° 3.59' W, Site 901, and deployed a Datasonics beacon. The precision depth recorder indicated a water depth of 4726.4 mbsl. An RCB-BHA was assembled and run to the seafloor. The seafloor was encountered at 4730.0 mbrf, and Hole 901A was spudded at 0325 hr on 23 May 23 1993. We washed from the seafloor to 4912.0 mbrf (0 to 182.0 mbsf; Core 149-901A-1W), cored from 4912.0 to 4930.8 mbrf (182.0 to 200.8 mbsf; Cores 149-901A-2R to -3R), washed from 4930.8 to 4949.8 mbrf (200.8 to 219.8 mbsf; Core 149-901A-4W), and cored from 4949.8 to 4968.1 mbrf (219.8 to 247.8 mbsf; Cores 149-901A-5R to -7R). We stopped coring to retrieve the drill string so that we could return on time to Lisbon for the end of Leg 149. Leg 149 ended with the first line ashore at 0700 hr 25 May 1993.

OPERATIONS SUMMARY

LEG 149 A/B/C

Total Days (10 March 1993 to 25 May 1993)	75.8
Total Days in Port	4.6
Total Days Underway	20.0
Total Days on Site	51.2

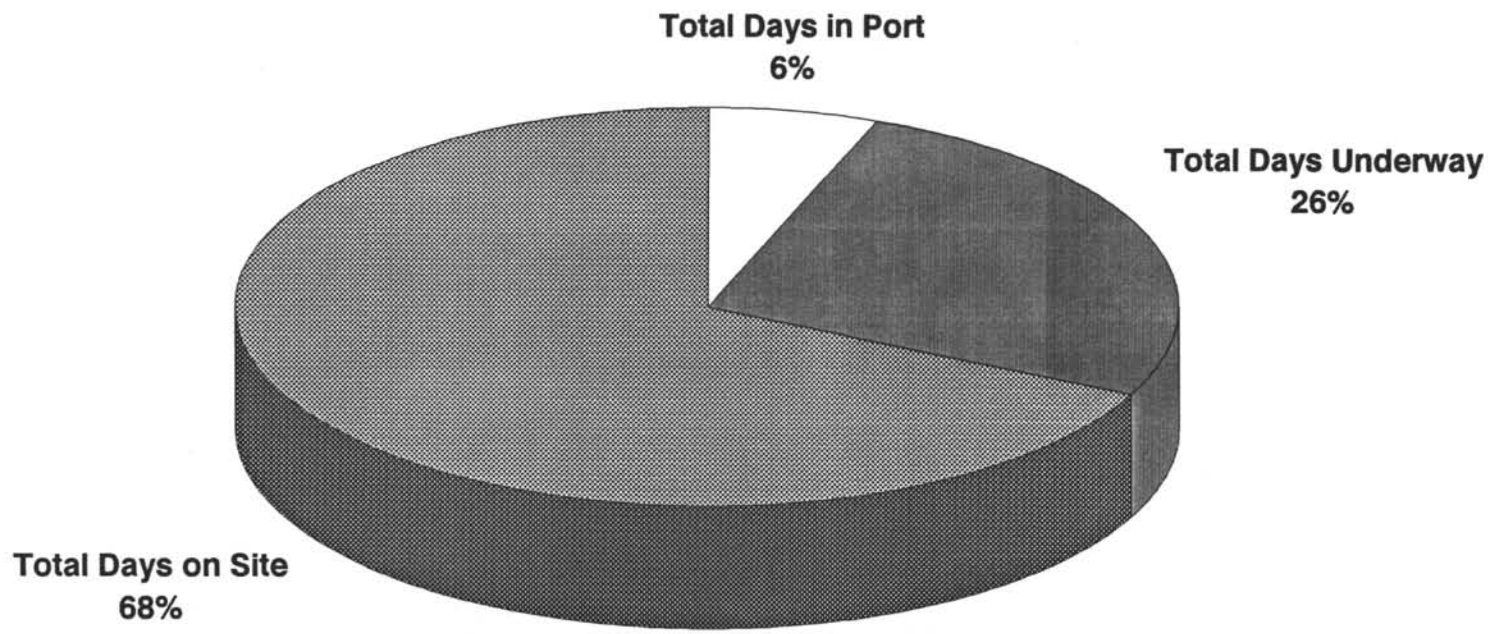
Stuck Pipe/Downhole Trouble	0.6
Tripping	10.3
Other	1.6
Drilling	2.0
Coring	28.3
Re-Entry	1.0
Logging/Downhole Science	5.0
Casing and Cementing	1.4
Repair Time (ODP)	0.9
Fshing & Remedial	0.0
Development Engineering	0.0
Repair Time (Contractor)	0.2
W.O.W.	0.0

Total Distance Traveled (nmi)	4834.0
Total Miles Transited:	4708.0
Average Speed Transit (kts):	10.5
Total Miles Surveyed:	126.0
Average Speed Survey (kts):	24.1
Number of Sites	5.0
Number of Holes	10.0
Total Interval Cored (m)	2640.0
Total Core Recovery (m)	1532.0
% Core Recovery	57.8
Total Interval Drilled (m)	1009.9
Total Penetration	3649.9
Maximum Penetration (m)	837.9
Maximum Water Depth (m from drilling datum)	5331.0
Minimum Water Depth (m from drilling datum)	4730.0

SITE SUMMARY : LEG 149

HOLE	LATITUDE	LONGITUDE	WATER DEPTH (meters)	NUMBER OF CORES	INTERVAL CORED (meters)	CORE RECOVERED (meters)	PERCENT RECOVERED (percent)	DRILLED (meters)	TOTAL PENETRATION (meters)	TIME ON HOLE (hours)	TIME ON SITE (days)
897A	40°50.320'N	12°28.440'W	5331.0	6	55.2	17.37	31.5	0.0	55.2	29.75	1.2
897B	40°50.315'N	12°28.439'W	5331.0	1	10.0	0.00	0.0	52.0	62.0	19.00	0.8
897C	40°50.331'N	12°28.444'W	5326.3	73	695.0	352.90	50.8	49.9	744.9	176.50	7.4
897D	40°50.308'N	12°28.505'W	5327.0	25	241.9	117.94	48.8	596.0	837.9	191.25	8.0
		Site 897 TOTALS:		**105**	**1002.1**	**488.21**	**48.7**	**697.9**	**1700.0**	**416.50**	**17.4**
898A	40°41.104'N	12°07.429'W	5290.3	36	341.5	288.76	84.6	0.0	341.5	92.75	3.9
898B	40°41.106'N	12°07.415'W	5289.1	1	5.4	5.42	100.4	0.0	5.4	8.75	0.4
		Site 898 TOTALS:		**37**	**346.9**	**294.18**	**84.8**	**0.0**	**346.9**	**101.50**	**4.2**
899A	40°46.335'N	12°16.062'W	5302.5	16	154.0	51.45	33.4	81.5	235.5	59.00	2.5
899B	40°46.347'N	12°16.063'W	5302.5	37	332.0	173.31	52.2	230.5	562.5	278.25	11.6
		Site 899 TOTALS:		**53**	**486.0**	**224.76**	**46.2**	**312.0**	**798.0**	**337.25**	**14.1**
900A	40°40.992'N	11°36.270'W	5048.5	86	805.0	519.80	64.6	0.0	805.0	283.25	11.8
		Site 900 TOTALS:		**86**	**805.0**	**519.80**	**64.6**	**0.0**	**805.0**	**283.25**	**11.8**
901A	40°40.477'N	11°03.587'W	4730.0	7	46.8	4.86	10.4	201.0	247.8	42.25	1.8
		Site 901 TOTALS:		**7**	**46.8**	**4.86**	**10.4**	**201.0**	**247.8**	**42.25**	**1.8**
		LEG TOTALS:		**288**	**2686.8**	**1531.81**	**57.0**	**1210.9**	**3897.7**	**1180.75**	**49.2**

LEG 149
TOTAL TIME DISTRIBUTION



Total days of leg =75.7 days

TECHNICAL REPORT

The following ODP Technical and Logistics personnel were aboard *JOIDES Resolution* for Leg 149 of the Ocean Drilling Program:

Leg 149B

Laboratory Officer:	Brad Julson
Senior Marine Laboratory Specialist/X-Ray:	Don Sims
Marine Computer Specialist/System Manager:	John Eastlund
Marine Computer Specialist/System Manager and Underway:	Barry Weber
Marine Electronics and Downhole Tool Specialist:	Roger Ball
Marine Electronics Specialist and Underway:	Eric Meissner
Marine Laboratory Specialist/Photography:	Brad Cook
Marine Laboratory Specialist/Curatorial Representative:	Lorraine Southey
Marine Laboratory Specialist/Yeoperson:	Michiko Hitchcox
Marine Laboratory Specialist/Chemistry:	Chieh Peng, Philip Rumford
Marine Laboratory Specialist/Thin Section:	"Gus" Gustafson
Marine Laboratory Specialist/Physical Properties:	Claudia Müller
Marine Laboratory Specialist/Paleomagnetics:	Monica Sweitzer
Marine Laboratory Specialist/Storekeeper:	Robert Olivas
Marine Laboratory Specialist:	Johanna Adams
Marine Laboratory Specialist:	Andrea Leader
Marine Laboratory Specialist/Downhole Laboratory:	Jaque Ledbetter
Database Supervisor:	John Coyne

Leg 149C

Laboratory Officer:	Brad Julson
Senior Marine Laboratory Specialist/X-Ray:	Wendy Autio, Kuro Kuroki
Marine Computer Specialists/System Managers:	John Eastlund, Barry Weber
Marine Electronics and Downhole Tool Specialists:	Bill Stevens, Mark Watson
Marine Laboratory Specialist/Photography:	Brad Cook
Marine Laboratory Specialist/Curatorial Representative:	Erinn McCarty
Marine Laboratory Specialist/Yeoperson:	Jo Claesgens
Marine Laboratory Specialist/Chemistry:	Dennis Graham, Anne Pimmel
Marine Laboratory Specialist/Thin Section:	Tim Bronk
Marine Laboratory Specialist/Physical Properties:	Jon Lloyd
Marine Laboratory Specialist/Paleomagnetics:	Margaret Hastedt
Marine Laboratory Specialist/Storekeeper:	Robert Olivas
Marine Laboratory Specialist/Underway:	Dwight Mossman
Marine Laboratory Specialist/Core Laboratory:	Mary Reagan
Marine Laboratory Specialist/Downhole Laboratory:	Jaque Ledbetter

INTRODUCTION

Leg 149 was an experimental leg in a number of ways. This is the first leg that had a complete change out of both technical and SEDCO personnel midway through the cruise. The ship went in to Lisbon from Site 897, exchanged crews, and went back to Site 898. The scientific party boarded the ship in Ponta Delgada and worked with both crews during the leg. We were also fortunate to have two of the ODP managers sail on one of the sublegs to view the operations firsthand.

PORT CALL, PANAMA

The ship arrived at Pier 18 in Balboa, Panama, about 1200 hr on 10 March 1993. The oncoming technical staff arrived just as the gangway was being laid out. Crossover commenced the first day. The second day the offgoing air freight and surface freight were transferred off the ship. The surface shipment was large and consisted of, among other things, some drill pipe and the old Schlumberger winch cab and CSU cab. During the port call, the skid where the CSU had been was lowered about 2 ft so the third crane would have a greater span to pick up items on the helipad. The Schlumberger CSU unit that arrived had both its air conditioning units damaged in transit. A large amount of cement, barite, and bentonite was also loaded during the port call. The Fisons XRF representative was present the entire port call, as the operating system for the XRF was upgraded from a PDP-11 to a PC.

TRANSIT FROM PANAMA TO PONTA DELGADA (LEG 149A)

The ship left Balboa on the morning of 14 March and transited through the Panama Canal. A number of people stayed aboard for the transit and got off on the pilot boat just before we passed Cristobal.

The transit had several large projects assigned to it.

(1) The natural gamma unit was installed. The MST track and surrounding area were modified to incorporate the 3000-lb instrument. The electronics were mounted on the

shelves, and the initial testing started. It will take some testing to get an idea of how long it will take to measure and collect counts from each section of the core.

(2) Training and use of the new PC XRF operating system, which includes recalibrating the XRF.

(3) Extension of the Ethernet system throughout the hotel to the offices on the bridge deck, including the radio room and the Operations Superintendent's stateroom. The cable was also pulled through the foc'sle deck to several staterooms and the library. Aft, a hub was attached to the cable in the underway laboratory that would allow computers in that laboratory to connect to the LAN. The aft ethernet line was connected to the existing ethernet in the physical properties laboratory with an intelligent bridge. Lamont and Schlumberger are also going to connect to the ethernet, and the intelligent bridge will give us the capability to isolate their heavy traffic from the rest of the network.

(4) Discussion of the ship's drilling and science operation with four representatives from two of the companies that were bidding on the new database system. This consisted of going through each laboratory and familiarizing this group with the equipment and the output from each instrument. Kate Moran, representing the Shipboard Measurements Panel, was also aboard to work with these representatives.

(5) Removal of the Schlumberger winch cab and CSU cab. This was accomplished during the port call. Another Schlumberger combination winch and CSU unit were installed during the port call and transit. This unit was in bad shape and even older then the CSU van taken off. The air conditioning units on the roof of the cab were ripped off, and the van damaged during transport to the ship. The new MAXIS unit was also installed during the transit.

(6) Demonstration and testing of the AGC real-time navigation software.This software was loaned to the ODP for a trial use during the transit, and this trial was extended for the rest of the leg. The software worked well.

(7) Wanda Johnson from the computer group sailed in order to do an inventory of the computer software aboard the ship. She looked at individual software on each machine for software revisions or version numbers, licenses, documentation, etc.

The ship pulled into Ponta Delgada, Azores Islands on 28 March 1993 for a 2.5-hr port call. Transit-only personnel disembarked, and the scientists and some additional technical people joined the ship. The ship pulled away at about 1700 hr to begin part B of Leg 149, and on to Site 897 (proposed site IAP-4).

LABORATORY OPERATIONS (LEG 149B AND LEG 149C)

Underway Laboratory

The 3.5- and 12-kHz PDRs and the magnetometer were run between Panama and the first site. There were two site surveys using twin 200-in.^{3} water guns. The second survey was conducted

before going into Lisbon the first time, and it was during this survey that we discovered a basement high that ultimately became Site 899. The magnetometer fish was rebuilt and, unexpectedly, had to be reterminated. The preamp card in the receiver was also rebuilt. A new AGC real-time navigation software package was borrowed from the Canadians for testing and trial during the leg. The PC that runs the program was connected to the bridge GPS. The display is distributed over the LAN network and can be viewed by any PC. The display was set up in the underway laboratory and used during the site surveys as well as on the transits. A Sun workstation was also installed this leg that has a public-domain software program called Generic Mapping Tools (GMT). This program allows the user to produce plots easily in different formats to meet the cruise and scientists' needs.

Bridge Deck

Physical-Properties Laboratory

Claudia Müller, the new technician in the laboratory, received a tremendous amount of training in preparation for this leg. Jon Lloyd, the other technician, worked with her during the Panama port call. Kate Moran and Brad Cook, a former Phys Props technician, worked with her all during the 13-day transit.

The natural gamma instrument was installed during the transit and briefly tested during the leg. The software to run the instrument and incorporate it into the rest of the MST was not finished in time for the leg. Consequently, the only software available was that written by the vendor for the sensors. This software will do manual counts for a spectrum. Times can be set for the counts, and widths can be set for the amount of the spectrum to monitor. The software also allows the user to search a library to identify the energy peak. During the testing the joystick was used to push the core through the sensors while the software was operated manually. Initial tests were not promising. The goal, to incorporate the sensor into the MST program, has problems due to the weak signal generated by the sample and the associated long count times needed to obtain statistically significant numbers of counts. The long count times would slow down the core flow to the point at which it would not be feasible to use the natural gamma device continuously for an entire stratigraphic sequence. More testing will be done on the Leg 150 transit.

Magnetics Laboratory

This laboratory was heavily used during the leg. We had one episode in which the controller ramped up the Z-axis coil in the cryomagnetometer on its own. The coil became hot enough to smoke but fortunately was turned off before there was any damage done. It appears to be working fine again, and there were no further incidents.

The cryomagnetometer and the GSD-1 degaussing coils were calibrated with the Hall probe. The X and Y coils had changed little from age and use, but the Z coil's fields were significantly different than what was calculated, being off by 2.5 times. This means that we have been degaussing 2.5 times as much as we thought we were on that coil, and this unequal degaussing might be giving the appearance of the suspected ARM. We are waiting for word from the beach to change the constants in the program.

A new Molspin program was used this leg. It is an alpha version of a Labview program that is being developed.

Core Laboratory

The modified Faxitron with the horizontal lead tubes was installed during the transit. This will allow the user to use a whole section of core rather than having to remove sections of core to X-ray. It takes up a significant amount of the limited bench space and was used sparingly during the cruise.

Foc'sle Deck

Chemistry Laboratory

The chemistry laboratory was used throughout the leg. A new manifold was installed in the freeze drier. The manifold attaches to three vacuum desiccators, which increases our capacity to dry samples. The freeze drier vacuum is also able to develop a faster and better vacuum with the new manifold.

A new air compressor and filter were installed to produce "FID" quality laboratory air. It provides the air to all of the flame ionization detectors on the different instruments. The system has a water filter, a catalytic converter, and a molecular sieve filter to clean the air. The baseline background signals on the "FID's" have been noticeably lower with the new air compressor in line.

The Chemstations, a new LaserWriter, and a PC486 were installed for the Geofina Hydrocarbon Meter and the Rock-Eval. The "Analog to Digital" converters were connected to the GHM and the Rock-Eval, and methods were developed to allow the signals from the instruments to be quantified and calibrated. Common standards were run on the GHM and the Rock-Eval, and the results from the Rock-Eval and the Chemstations were compared. The results were favorable and indicate that the Chemstations produce the same results as the Rock-Eval. Quite often the Rock-Eval's data system may be broken, but as long as the instrument is running we can still gather good data on the Chemstations. The GHM also produces analogous data to the Rock-Eval, and if the Rock-Eval is broken altogether, good data for safety hydrocarbon monitoring will be produced by the GHM.

The Dionex continued to produce quality data this leg. The hydrocarbon "Publish and Subscribe" template for the Operations Office was also used again this leg. This allows the Operations

Superintendent to receive the methane/ethane ratio on a spreadsheet that is shared across the network as soon as the numbers are produced in the chemistry laboratory. This proved very useful.

X-ray Laboratory

This laboratory was very busy during this leg. The original PDP-11 computer was replaced with a 486PC and the new operating software, XRF386. A service representative worked through the port call installing the system and working on the XRF. He got off after passing through the Panama Canal and Don Sims calibrated the instrument during the transit. The major elements are measured directly by the instrument, and the traces are now also analyzed using the online ARL software rather than our previous offline program.

The first site recovered ultramafic rocks, and additional standards were sent out to the first port call to check the calibration. Later in the leg a short program was written to do chlorine, potassium, iron, titanium, and calcium determinations on trace element pellets, and the scientists were pleased with the results.

We did have one problem when the Cyberex power conditioner was knocked offline and switched over to the auxiliary backup unit, the motor generator set. At the same time the XRF suddenly shut off. This was traced to a blown X-ray tube, though it is not completely clear which caused which. Did the Cyberex switch over, which caused the tube to blow, or did the tube blow, which caused the Cyberex to switch over to auxiliary power? A new tube was installed, and the drift correction of the new software was able to correct for the new tube. We were able to run the rest of the leg with the old calibration. We again had problems with scientists requesting non-SMP-approved crushing methods (agate) to allow better analysis of certain elements and to run the samples on their own instruments. The policy was formulated to prevent the technical staff from spending extra time prepping samples for shore-based analysis.

The XRD was used extensively during the leg both for clay studies and bulk analysis of some of the serpentinite-rich rocks.

Thin-Section/Paleontology Laboratory

The thin-section laboratory produced thin sections of both sediments and the basement materials for all the sites. Over 200 thin sections were made.

The paleontology laboratory was used by both paleontologists and petrologists. Clay samples were prepared in the sample prep area using the sonic dismembrator and centrifuge for the clay separation study. We had one problem with the one of the filters. It became stuck and would not move in the analyzer slot on the new Axioplan microscope.

Main Deck

Computers

A number of new computers were installed, including a SUN workstation. To make room for these we had to ship home a lot of obsolete parts. The SUN was connected to the Ethernet. It has an application that allows it to print to the laser writers on the network. It came loaded with two data-analysis software packages from PV-WAVE, which should prove helpful in future analyses.

Major changes were made in the VAX cluster configuration in preparation for removing the VAX-11/750's. We also added two new APS 1.2 GB drives to the cluster. Due to the lack of serial ports on the VAX, approximately 20 copies of ST420 terminal emulation software were installed on PC's, which allowed these users to log onto the VAX via the ethernet.

Print spoolers were started for a number of the printers to speed up the transfer of data to the printers and free-up the computer applications. Two new PC's were installed in the Operations Office.

The thinnet ethernet was extended forward to the offices, some of the staterooms, and the library. The aft thicknet ethernet was activated via a bridge to the rest of the network. A hub was installed in the underway laboratory to allow computers back there to connect to the network. We also tested a new version of E-mail, which allows official telexes to be sent through regular E-mail. By sending this as E-mail, the telexes would arrive as normal mail on the VAX and could be stored on the VAX.

Curation

The archive halves of the sediment cores from the top of each hole were run through the cryomagnetometer before the working half was sampled. The paleomagnetist was looking for a magnetic reversal in the cores in order to take a U channel. This procedure did slow the core flow but fortunately was restricted to the top 15 cores or so. A geochemist brought out a pore-water squeezer to squeeze water in an inert environment for trace-metal analysis. Additional samples were taken for his thorium study.

This leg was difficult because we recovered large amounts of sediment and hard rock. Core-handling procedures were affected by the difference in material and by trying to have enough space and microscopes to accommodate both the sedimentologists and the petrologists at the same time in the core laboratory.

We had problems with expanding clays "growing" out of the liners after the cores were split at a couple of sites. The modified Faxitron was reinstalled this leg. A lead tube and the associated interlock were added to each side of the instrument so that full-length sections of core can be passed through the instrument. Unfortunately the instrument takes up a tremendous amount of valuable benchtop space for the small amount of time that it was used.

A checkout procedure has been developed so that individuals can borrow some of the thin sections without one person monopolizing the entire shipboard thin-section collection.

Downhole Tools

The WSTP tools were run nine times. Pore-water collection was attempted six times, and temperature measurements were attempted on all the runs. There were some problems with the filters due to the clays and the extreme pressure change difference when the valve is opened at over 5000 m water depth. A "noise" problem on the DCDL recorder was alleviated with the addition of a capacitor to the board.

The ADARA tool was deployed once and collected good data. A new-style soldered battery pack was used, and after some further modifications it appeared to be eliminating the problem of distorted, dented batteries.

Miscellaneous

The METS met weekly for emergency training with the ship's crew.

Due to the type of material that was drilled, there were a lot of logging problems and not many successful logs. There was an attempt to try and receive training on the new FMS software. This did not work well, and the older system was used. Now that the Schlumberger MAXIS computer is connected to the network, the Schlumberger engineer can send the FMS data directly to the FMS directory rather than copying tapes from one system to another. We are trying to free-up more continuous space on the disc for the large files.

The Cyberex regulated power unit had the usual problems this leg. It was involved in the loss of the X-ray tube in the XRF.

LEG 149 LABORATORY STATISTICS

GENERAL

Sites:	5
Holes:	10
Cored Interval (meters):	2640.0
Core Recovered (meters):	1526.95
Total Penetration (meters):	3649.90
Time on Site (days):	48.8
Number of Cores:	281
Number of Samples:	8800

Analyses

Inorganic Carbon($CaCO_3$):	662
Total Carbon (NCHS):	400
Water Chemistry (the suite includes pH, Alkalinity, Sulfate, Calcium, Magnesium, Chlorinity, Potassium, Silica, Lithium):	98
Pyrolysis Evaluation (Rock-Eval and GHM):	104
Gas Samples:	196
Thin Sections:	200
XRF:	105
XRD:	267
MST Runs:	521
Cryomagnetometer Runs:	1850
Cubes:	500
Oriented Runs:	12
Physical Properties Velocity:	243
Thermal Conductivity:	358
Index Properties:	699

Underway Geophysics

Bathymetry (nmi):	3650
Magnetics (nmi):	3000
Seismic Survey (nmi):	110
XBT's launched:	85

Downhole Tools

WSTP	9
ADARA	1