OCEAN DRILLING PROGRAM

LEG 107 PRELIMINARY REPORT

TYRRHENIAN SEA

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SCIENTIFIC REPORT

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INTRODUCTION

The Tyrrhenian Sea is the small triangular sea surrounded by peninsular Italy, Sicily, Sardinia and Corsica (Figure 1). Drilling objectives for Leg 107 of the Ocean Drilling Program considered the Tyrrhenian Sea from three different perspectives: (1) as a land-locked backarc basin, (2) as a young, passive margin, and (3) as a stratigraphic type locality.

In common with other backarc basins, the Tyrrhenian Sea exhibits a Benioff zone (Gasparini et al., 1982), a calc-alkaline volcanic belt (Barberi et al., 1974; Selli et al., 1977), thinned crust on the margins (Panza et al., 1980), tholeiitic (MORB) volcanism (Barberi et al., 1978; Dietrich et al., 1978) high heat flow (Della Vedova et al., 1984; Hutchinson et al., 1985), and high-amplitude magnetic anomalies (Bolis et al., 1981). The Tyrrhenian Sea contains two small southeast deep basins: The Vavilov Basin and the Marsili Basin (southeasternmost), both floored with thin crust (Steinmetz et al., 1983; Recq et al., 1984; Duschenes et al., in press). It has been suggested that the two basins differ in age (Moussat, 1983); thus the Tyrrhenian Sea offers a field area in which to test the hypothesis of expansion of a backarc basin through seaward migration of the arc and subduction zone (Boccaletti et al., 1976; Moussat et al., 1985; Malinverno and Ryan, 1986). Furthermore, because the Tyrrhenian is bounded to the northeast and southeast by orogenic belts, interactions between extension and collision could be explored and the basin itself may be regarded as a model for land-locked backarc basin evolution.

In common with other passive margins, the western Tyrrhenian Sea is floored by continental crust which has been stretched and thinned by listric faulting (Fabbri et al., 1981; Malinverno et al., 1981; Rehault et al., in press). A principal goal of drilling on the Tyrrhenian margin was to determine the timing and rate of extension and subsidence during the stretching phase as well as during the stage of oceanic crust emplacement. These questions are more easily addressed in the Tyrrhenian than elsewhere because the passive margin here adjoins a young oceanic basin and has a relatively low sedimentation rate; the pre-rift, syn-rift and post-rift sediment sections are thus easily accessible to drilling.

Another goal of Leg 107 was to obtain a near-continuous Plio-Pleistocene sequence of pelagic sediments. Such a stratigraphic sequence would serve as a deep-sea type section with which biostratigraphy, magnetostratigraphy, tephrachronology and stable isotope stratigraphies could be correlated. Such a comparative study is essential because the Plio-Pleistocene stages were originally defined in land sections around the Tyrrhenian Sea; stratigraphic correlations between Mediterranean and open-ocean records remain somewhat ambiguous.

To meet these objectives, the D/V Joides Resolution drilled a NNW/SSE transect of seven sites across the passive margin and two deep oceanic type basins (Figure 1). More than 3500 meters of sediments and hard rocks were drilled, in a total of 11 holes. The cruise comprised 45 operational days and 5 days of transit, between 30 December 1985 and 18 February 1986, beginning in Malaga, Spain, and ending in Marseilles, France.

PRINCIPAL RESULTS

The seven sites drilled are discussed bellow in chronological order; Sites 652, 654 and 656 were primarily concerned with the passive margin of the western Tyrrhenian Sea; Sites 650, 651 and 655 considered the Tyrrhenian Sea as a backarc basin and Site 653 was targeted at recovering a Plio-Pleistocene stratigraphic reference section.

SITE 650 (MARSILI BASIN)

Site 650 is located near the western rim of the Marsili Basin (Figures 1 and 2), which is the southeastern of two deep basins in the Tyrrhenian Sea. Two major sedimentary units were recovered between the seafloor and 602 meters below sea floor (m BSF), and basalt was recovered between 602 m BSF and 634 m BSF (Figures 3 and 4). The lithologic units are as follows:

Sedimentary Unit 1: (0-354 m BSF; age: <0.45 Ma; NN20/NN21) Normally graded thin sequences of gravel-to sand-sized clastics with low carbonate content, interbeded with mud. The normally graded sequences are interpreted as turbidites. Coarse basal portions of the turbidites are dominated by volcanoclastic components (glass and pumice fragments). The fine-grained upper portion of each turbidite is a calcareous mud, occasionally containing volcanic ash.

Sedimentary Unit 2: (354-602 m BSF; age: upper Pleistocene to upper Pliocene: 0.45-"2.0 Ma; NN18/NN19) The upper part of unit 2 (354-546 m BSF) is predominantly calcareous mud and mudstone, interbedded with thin normally graded clastic sequences interpreted as volcanoclastic turbidites. The lower part (546-602 m BSF) consists of nannofossil ooze, calcareous muds, pebbly mudstone, thin sapropels, and slump deposits. A ten-m thick basal unit of red-brown to greyish green nannofossil ooze, possibly a metalliferous facies, lies in contact with basalt.

Vesicular Basalt: (602-634 m BSF) The top part of the basalt unit consists of strongly altered glass containing a few scattered skeletal Ca-plagioclase crystals and pseudomorphs after olivine. Further down in the section, the crystallinity increases and the basalt shows intersertal to intergranular texture. Vesicles are large (up to 2 or 3 mm diameter) and abundant (about 20% of rock volume).

Downhole Measurements: Three successful heat flow measurements gave a linear thermal gradient of 14 degrees/hundred meters, implying a heat flow of approximately 4 HFU. No logging was attempted because of the premature hole termination caused by a stuck core barrel.

Significance:

The acoustic basement in the western Marsili Basin is identified as highly vesicular basalt, overlain by an unexpectedly young sedimentary section. Textural evidence within the basalt suggests that it was emplaced as a flow, rather than as a sill. The contact between the basalt and the sediment was recovered intact, and has been dated as uppermost Pliocene (within the Olduvai magnetic event, i.e., 1.67-1.87 Ma). The top of the basalt now lies at 4100 m BSL. The high vesicularity of the basalt suggests it may have been emplaced significantly shallower depths and that the basin has undergone rapid subsidence. A 10-m thick zone above the basalt has been altered by hydrothermal circulation or by halmirolysis. Slumps and debris flows are found in the lowest 40 m overlying the basal altered zone, and are interpreted as evidence of tectonic instability, possibly accompanying the formation of the basement relief.

The Pleistocene sequence shows an upward-increasing sedimentation rate, caused by an increasing influx of volcanoclastic turbidites. The coarse-grained component of these turbidites is principally pumice and glass. Preliminary determinations of glass chemistry by refractive index suggest a provenance from the Eolian Islands. The increase in rate of turbidite deposition could thus be related to a volcano-tectonic pulse. In addition, sea-level fluctuations during the glacial Pleistocene could have triggered more frequent and/or larger turbidity currents.

Because of the high sedimentation rate and the high concentration of magnetic minerals in the volcanoclastic turbidites, it has been possible to establish a high-resolution paleomagnetic chronology down to the top of the Olduvai epoch, and to tie this magnetostratigraphy to biostratigraphic datums (Figure 4). Site 650 will thus provide a calibration point between western Mediterranean stratigraphy and open ocean records.

SITE 651 (VAVILOV BASIN)

This site was located on the eastern flank of a basement swell that lies at the axis of the Vavilov Basin (Figures 1 and 5). Drilling established the presence of a basement complex consisting predominantly of basalts overlying serpentinized peridotite. The sedimentary cover is of upper Pliocene to Pleistocene age and includes abundant volcanoclastics in the upper section (Figures 6 and 7).

Two major sedimentary units were recovered between the seafloor and 388 m BSF, and three basement units were recovered between 388 and 551 m BSF. These lithologic units are as follows:

Sedimentary Unit 1: (0-136 m BSF; age: upper Pleistocene) Unit 1 consists mostly of volcanogenic sediments interbedded with volumetrically subordinate (<15%) marly, nannofossil-rich mud. Beneath the superficial muds, the succession is dominated by pumaceous sand and gravel. Cemented pumice breccia increases in average grain-size and abundance downhole.

Sedimentary Unit 2: (136-388 m BSF; age: upper Pliocene to upper Pleistocene) Unit 2 is composed of nannofossil chalk with very subordinate volcanogenic claystone and siltstone turbidites. The upper part of this unit (136-309 m BSF) is lithologically very heterogeneous and includes volcanoclastic siltstone and sandstone, whereas the lower part (309-348 m BSF) is more uniform and dominated by nannofossil chalk. A 40-m thick section immediately above basement (348-388 m BSF) comprises brilliantly colored dolomite-rich sediment, relatively enriched in Fe and Mn. No microfossils were detected in the lower 39 m of this dolomitic section;

the fauna in the top meter are from the base of biostratigraphic zone MP16/ NN18 (upper Pliocene, 2 Ma).

Basement Unit 1: (388-464 m BSF) The upper part of the basement section consists of basalt with carbonate veins which decrease in abondance downhole, plus carbonate-opal cemented basaltic breccias. The basalt is aphanitic, highly altered, and of low vesicularity. Several distinct flows were recognized by the presence of altered glassy chilled margins.

Basement Unit 2: (464-492 m BSF) Basement unit 1 grades into basement unit 4 through a complex transition zone. The upper part of the transition zone comprises highly altered peridotite, dolerites and metadolerites, dolomitic chalk, alkali-feldspar-rich leucocratic rocks. The deepest occurrence of planktonic foraminifers was in a dolomite breccia at 465 m BSF; a very tentative date of lower Pliocene has been assigned to this assemblage.

Basement Unit 3: (492-522 m BSF) The lower part of the transition zone includes carbonate-cemented basaltic breccias, a very-coarse-sand to fine-gravel graded layer (possible drilling disturbance), and a few rounded loose pebbles of metabasalt. The breccia could represent tectonic and/or talus basaltic breccia which have been cemented by carbonate sediment infilling and by carbonate precipitation from circulating sea water.

Basement Unit 4: (522-551 m BSF) Highly serpentinized peridotites showing a tectonite fabric. Relict mineralogy suggests that these peridotites are prevalently lherzolitic.

Downhole Measurements: Standard downhole measurements (DIL-LSS-GR-CAL and LDT-CNL-NGS) were made from 119 m BSF to approximately 325 m BSF. The logs agree well with the laboratory physical properties measurements and lithostratigraphy in intervals of good core recovery. In intervals of poor recovery, the logs indicate that volcanoclastics were dominant (Fig 23), and suggest that the coring process preferentially sampled the carbonate-rich and fine-grained sediment sections. High values of Thorium and Uranium in tephra-layers seem to indicate the Roman volcanic province as source for the volcanogenic sediments (Locardi, 1967).

Significance:

The upper part of the sedimentary section is of mostly pyroclastic origin and has been extensively reworked by gravitational processes from subaerial source areas including the Roman volcanic province. The lower part of the section records a more normal hemipelagic sedimentary regime, with only minor volcanoclastic input. Towards igneous basement there is evidence of minor tectonic instability in the form of microfaults, slumps, dewatering structures and high-angle dipping strata. The rather thick (40-m) dolomitic, red-brown, Fe-Mn-rich basal sediments may be in part hydrothermal precipitates, overprinted by post-depositional chemical interactions across the sediment/ basalt contact.

The basalts of basement unit 1 probably have tholeiitic to transitional affinity similar to the basalt drilled at DSDP Site 373 (Barberi et al., 1978). The peridotites may represent a fragment of pre-Cenozoic ophiolite (Appenine or Alpine). More likely, they may represent a younger upper mantle protrusion related to the stretching and rifting of the Tyrrhenian basement.

SITE 652 (LOWER SARDINIAN CONTINENTAL MARGIN)

Site 652 (Figures 1 and 8) is situated on a small tilted block of the lower Sardinian Margin. The sediments recovered can be divided into two major divisions (Figures 9 and 10): Plio/Pleistocene hemipelagic marine sediments from 0 to 188 m BSF, underlain by barren, gypsiferous, calcareous sandy mud and mudstone interbedded with minor chemical sediments from 188 to 721 m BSF. The Plio/Pleistocene hemipelagic sediments are divided into two units primarily based on their calcium carbonate content; the pre-Pliocene sediments are divided in two units based on sedimentary structures and the abundance of chemical sediments. A 40-cm thick transition zone divides the Plio/Pleistocene hemipelagic sediments from the pre-Pliocene barren sediments. In more detail, the sedimentary units are described as follows:

Sedimentary Unit 1: (0-55 m BSF; age: Pleistocene) This unit consists mainly of gray calcareous mud and gray mud, with volcanic glass as a common minor constituent. Carbonate content averages 22%. The succession includes four distinct sapropel layers; preliminary geochemical data suggest that these sapropels contain a mixture of marine and continental organic lipids.

Sedimentary Unit 2: (55-188.2 m BSF; age: lower Pleistocene-Pliocene) Sedimentary unit 2 consists of marly nannofossil oozes with higher carbonate content (average 48%) than the sediment of unit 1. Four sapropel layers were found in the upper 22 m of this unit. The interval between 65-113 m BSF contains relatively abundant volcanic glass. From 176 to 180 m BSF, the dominant olive-gray color grades downsection into yellowish red and brownish yellow tones, followed by intense reds and browns directly above the Mio/Pliocene boundary. The boundary was determined by the last appearance of in situ planktonic foraminifers at 188.2 m BSF.

Sedimentary Unit 3: (188.2-188.6 m BSF; age: uppermost Messinian) This unit is a transitional interval between the normal marine Pliocene and the barren Messinian sediments. The unit is composed of a succession of cm-thick layers of strongly colored clay and mud. The deepest occurrence of rare in situ nannofossils occurs at 188.4 m BSF.

Sedimentary Unit 4: (188.6-345 m BSF; age: probable upper Messinian) The interval 18.6-286 m BSF is dominated by gray, thinly bedded, normally graded, gypsum- and carbonate-bearing sandy mud, interpreted as turbidites. From 286 to 335 m BSF the lithologic components are the same but the sedimentary structures differ in that there are reversely graded sequences, frequent water escape structures, syn-sedimentary microfaults, and microbreccias; the shallowest occurrence of authigenic calcium sulfate and halite-dissolution molds occurs here. The lowest core of the unit (335-345 m BSF) recovered only fourteen smooth, rounded pebbles of sedimentary and low-grade metamorphic origin. The collection of varied lithologies represented by these pebbles occurs in the southern Apenneninic and/or the Sicilian Maghrebide mountain chains; this suite of rocks is unknown in Sardinia, Calabria, or on de Marchi Seamount. The unit was barren except for three specimens of Ammonia becarii tepida and two fragments which may be from the brackish water ostracod Cyprideis, all found at 277 m BSF.

Sedimentary Unit 5: (345-721 m BSF; age: undetermined, probable Messinian) The interval 345-684 m BSF is characterized by a succession of dark gray, well-graded and cross-bedded, gypsum- and carbonate-bearing sandy muds, with several cyclic zones containing up to 5-cm thick crystalline anhydrite showing "chicken-wire" texture. Rare scattered plant debris, one algae-rich layer, thin finely-laminated organic carbon-rich layers, and numerous bright red (hematite?) and yellow (limonite?) millimetric horizons of inferred continental derivation are locally present. Within the interstitial waters, $Ca^{2+}$, $Mg^{2+}$, sulfate, and chlorinity reach a maximum at about 500 m BSF; this suggests that the pore water chemistry of the entire sediment column is dominated by dissolution of evaporites in this unit. From 684 to 721 m BSF, sedimentary unit 5 is very indurated and consists mainly of dark gray calcareous siltstones, sandstones and claystones containing highly-variable detrital elements, including pelagic micrite, platform carbonates, metamorphic rocks and minerals, and detrital dolomite, calcite and gypsum.

Downhole Measurements: Five successful heat flow measurements gave a thermal gradient of $14^{\circ}/100$ m, for an average heat flow of about 4 HFU. The hole was logged between 72.5 and 365 m BSF with a DIL/LSS/GR/CALI combination and a GST/NGT/CNTG combination. The logging results are difficult to interpret because of the extreme variability of the borehole diameter. However, preliminary analisis of GST data suggests that ciclic alternation of smectite- and carbonate- rich sediments can be identified in Unit 4.

Significance:

The pre-Pliocene sequence at Site 652 is characterized by a thick sequence of subaqueously deposited, clastic sediments. The environment of deposition seems to have been highly variable through time: frequent, thin evaporite interbeds indicate periods of higher salinity; algae- and organic- rich beds suggest periods of higher productivity. The pebble horizon may indicate a temporary fluviatile or beach environment. Other than the isolated pebble horizon, we found no direct evidence of subaerial exposure. However, significant input of iron-oxide-rich continentally derived sediments suggests nearby subaerial exposure. We consider that the most probable sedimentary environment for the pre-Pliocene units is lacustrine.

The strong red-brown coloration around the Miocene/Pliocene boundary is attributed to iron oxides suggesting that sediments which had been subaerially weathered during the Messinian drawdown were reworked during the terminal Messinian transgression. The Plio-Pleistocene sediments are characterized by open marine conditions, with a small volcanic influx. Interbedded sapropels reflect the recurrence of anoxic conditions during the late Pliocene and Pleistocene.

A comparison between lithostratigraphic and seismic reflection data indicates the following:

(1) The uppermost pre-rift sequence coincides with the highly-indurated lowest 30 or 40 m of sedimentary unit 5. We cannot exclude the possibility that these barren sediments were deposited in a pre-Messinian continental environment. However, we consider it more likely that the pre-rift to syn-rift transition occurred during the Messinian.

(2) Most of the pre-Pliocene section (sedimentary units 3-5), presumably of Messinian age, are interpreted as syn-rift deposits. We speculate that the pebble horizon between 335 and 345 m BSF may coincide with the intra-Messinian erosional event which is represented elsewhere in the Mediterranean by an unconformable contact between the lower and upper evaporites.

(3) The transition from syn-rift to post-rift sedimentation occurred during Pliocene time. However, minor tectonic activity persisted into the Pleistocene.

SITE 653 (RE-OCCUPATION OF DSDP SITE 132)

This site was located one-half mile northeast of DSDP Site 132 (Figures 1 and 11), on the eastern rim of the Cornaglia Basin in the western Tyrrhenian Sea. Two major sedimentary units were recovered (Figures 12 and 13):

Sedimentary Unit 1: (Hole 653A: 0-220 m BSF; Hole 653B: 0-216 m BSF; age: Pliocene-Quaternary) In general, unit 1 represents an interval of open-marine hemipelagic to pelagic sedimentation; the sediments are dominantly gray and brown nannofossil ooze and foraminiferal nannofossil ooze with minor mud. Carbonate content ranges from 12 to 90%, averaging 50%. The unit can be further divided into: (1) Subunit 1A, characterized by a lower carbonate content and the occurrence of sapropels (maximum organic carbon concentration = 4.2%), clastic layers and volcanic ash layers; (2) Subunit 1B, characterized by a higher carbonate content and the absence of sapropels, clastic layers and volcanic ash layers; (3) Subunit 1C, characterized by a reddish and yellowish coloration attributed to iron oxides. Site 653 unit 1 correlates with units 1 and 2 of DSDP Site 132.

Sedimentary Unit 2: (Hole 653A: 220-240.7 m BSF; Hole 653B: 216- 264.3 m BSF; age: Messinian) Unit 2 includes sediments deposited in restricted marine to evaporitic and subaerial environments. Carbonate content is low (0-20%). Lithologies present in the two holes include: biotite- and gypsum-bearing sand, calcite-cemented siltstone, nannofossil mud dolomitic nannofossil mud, calcareous mud nannofossil and foraminifer-bearing marly calcareous (dolomitic?) mud, and brilliant yellow and red mud and silt containing hematite, limonite, sulfur and sulfates. Gypsum is present as very friable gypsum with wavy laminations, balantino-type laminated gypsum, powdery white gypsum interbedded within dull-red muds, and as centimeter thick layers of lenticular and nodular gypsum interbeded within calcareous dolomitic(?) nannofossil mud. Correlation of the Messinian sediments in Holes 132, 653A and 653B is not straightforward due to a poor recovery of the Messinian sediments in these three holes (25%, 36% and 31% respectively) and to possible lateral facies variability.

Downhole Measurements: Neither hole was logged. Five heat flow measurements on

Hole 653A revealed a thermal gradient which decreases steeply downsection from 12.9°/100 m in the top of the hole to 5.04°/100 m near the base of the hole.

Significance:

The Messinian-Pliocene boundary (separating units 1 and 2) has been defined by the recognition of the base of foraminiferal zone MPl-1 (Sphaeroidinellopsis acme zone) which occurs at approximately 230 m BSF in Hole 653A and 225 m BSF in Hole 653B. Zone MPl-1 is underlain by a 10-m-thick "non-distinctive" biozone (Iaccarino and Salvatorini, 1982) which lacks age-diagnostic species of planktonic foraminifers. Nannoplankton of smaller size, indicating somewhat restricted marine conditions, are few to common down to the base of Hole 653A (240 m BSF; within lithologic unit 2) and down to 245 m BSF in Hole 653B.

The section at Site 653 is very similar to that recovered at DSDP Site 132. The quality and quantity of core recovered seem suitable for the high-resolution shore-based stratigraphic studies which were the main objective of this site. An exception may be magnetostratigraphy, as the natural remanent magnetization in the upper 165 m of both holes of Site 653 is too weak to identify geomagnetic reversals.

SITE 654 (UPPER SARDINIAN MARGIN)

This site is located on a fault-bounded, tilted block on the upper margin of Sardinia (Figures 1 and 14). Seismic lines across Site 654 exhibit a geometry suggestive of pre-rift, syn-rift and post-rift sequences. Hole 654A penetrated the wedging seismic unit interpreted as the syn-rift sequence, but was terminated in coarse conglomerate before reaching the subparallel dipping reflectors interpreted as the pre-rift sequence. Six major sedimentary units have been identified in the recovered Pleistocene to Tortonian (and possibly older) section (Figures 15 and 16).

Sedimentary Unit 1: (0-242.7 m BSF; age: Pleistocene and Pliocene) Unit 1 consists of nannofossil ooze with subordinate calcareous mud, with minor terrigenous clastics, volcanic ashes and probable sapropels. An interval of non-vesicular, aphanitic, olivine-phyric basalt was encountered between 71 and 73 m BSF, within a few meters of the Pliocene-Pleistocene boundary.

Sedimentary Unit 2: (242.7-312.6 m BSF; age: Messinian) Unit 2 comprises gypsum interbedded with calcareous clay, mudstone, minor sandstone, breccia, dolostone, anhydrite and very rare nannofossil chalk. Numerous discrete intercalations of laminated, balatino-type gypsum were penetrated, ranging in thickness from 0.15 to 7 m, which cumulatively account for approximately one-third of the total sediment thickness. Structures indicative of current activity (ripples, microcross-laminations and small scours) are common in the intra-gypsum clastic layers. Evidence of sedimentary instability is sparse.

Sedimentary Unit 3: (312.6-348.9 m BSF; age: inferred lower to middle Messinian) Unit 3 is dominated by dark-colored, finely laminated, organic carbon-rich claystone and dolomitic/calcareous siltstone, with minor volcanic ash. A sparse biota comprises radiolarians, diatoms, sponge spicules and fish teeth. Syn-sedimentary debris-flows, convolute-laminations and micro-faults are common.

Sedimentary Unit 4: (348.9-403.9 m BSF; age: upper Tortonian to lowermost Messinian) Unit 4 comprises homogeneous, highly burrowed nannofossil ooze. The benthic foraminfer assemblages are interpreted as suggesting a slight shoaling of the water depth downsection, while the nannofossil assemblages suggest a downsection trend from open marine to more restricted marine environment. Trace quantities of asphaltine hydrocarbons were found in the upper part of this unit.

Sedimentary Unit 5: (403.9-415.7 m BSF; age: not determined) This unit comprises polymict glauconitic sandstone and marly calcareous chalk with large forams and fragments of molluscs and echinoderms. The base of the unit is marked by large, thick-walled oyster shells.

Sedimentary Unit 6: (415.7-473.8 m BSF; age: indeterminate) Unit 6 comprises reddish-colored gravel-bearing calcareous mudstones, underlain by matrix-supported conglomerate, gravel and gravelly mudstone. The pebbles consist mostly of limestone, marble, dolostone and quartzitic rocks, and are subrounded. (Note: Core 654A-53R, drilled from 473.8 m BSF to 483.4 m BSF, was empty).

Downhole Measurements: Hole 654A was not logged because the bit failed to release. A series of four heatflow measurements gave an average thermal gradient of $4.2^{\circ}C/100$ m or approximately 1.20 HFU (50 $mW/m^2$-sec).

Significance:

The Plio-Pleistocene section (unit 1) was deposited under open marine conditions. The basalt interval is interpreted as a flow rather than a sill, based on textural evidence in the basalt and overlying sediments. The position of the basalt in the sediment is near the Plio/Pleistocene boundary. Alkaline basaltic volcanism of this age is known in western Sardinia.

The sediments deposited during the latter part of the Messinian salinity crisis (unit 2) represent an alteration between intervals of hypersaline conditions during which chemical sedimentation dominated, and intervals of less saline conditions during which the clastic sediments and rare chalks were deposited. Unit 3, deposited during the earlier part of the Messinian drawdown, is thought to have accumulated in an organically productive sea, possibly in a barred basin analogous to the Black Sea. Unit 3 may be a basinal equivalent of the diatomites of the Tripoli Formation in Sicily.

The lowermost 140 m of Hole 654 contain a textbook example of a transgressive sequence. Unit 6 is interpreted as an alluvial fan deposit; the shallow-water macrofauna of unit 5 suggest a coastal marine environment; and the nannofossil oozes of unit 4 suggest a gradually deepening, fertile, open marine sea. We attribute this transgressive sequence to rapid subsidence of the continental crust during the rifting stage of the Tyrrhenian Basin.

The pebbles in the unit 6 conglomerate are inferred to be derived from an erosional unconformity which is observed on seismic reflection profiles up-dip (i.e., east) of the site. The lithologies recovered suggest that the pre-rift unit of the tilted block comprises a deformed and metamorphosed carbonate platform and its underlying quartzitic basement.

SITE 655 (WESTERN RIDGE OF VAVILOV BASIN)

This site was located near the crest of a north-south trending ridge which lies near the inferred contact between oceanic and continental crust at the western rim of the Vavilov Basin (Figures 1 and 17). One sedimentary unit was recovered between the seafloor and 79.9 m BSF in Hole 655A. Basaltic basement was recovered between 79.9 m BSF and 196.1 m BSF in Hole 655B (Figures 18 and 19).

Sedimentary unit: (Hole 655A: 0-79.9 m BSF; age: upper Pliocene (MPl-4) to Quaternary) The dominant sedimentary lithology is a marly nannofossil ooze, with occasional volcanoclastic layers and detrital sand layers. Six sapropels and/or sapropelic layers occur in the Pleistocene sequence. The Pliocene-Pleistocene boundary occurs at 29 meters BSF, with no lithologic expression. The lower 6 meters overlying basement exhibit a downsection color change from pale yellow to brown.

Basement unit: (Hole 655B: 79.9-196.1 m BSF; age: inferred 3.4-3.6 Ma) The basement at Site 655 consists of basalt, with little obvious vertical variability in modal composition or structure. The basalt is generally aphanitic, but with occasional large (up to 2-3 mm) phenocrysts of plagioclase. Chilled glass margins were observed throughout the basalt unit, spaced an average of 2 meters apart. The entire basalt section is reversely magnetized, with an inclination of $50^{\circ}$ to $60^{\circ}$; the intensity of natural remanent magnetization is high ($3x10^{-2}$ to $10^{-3}$ G/cc).

Sediment within the basalt: Throughout the basalt unit, but particularly in the upper 30 m, veins and fractures were filled with indurated limestones. Planktonic foraminifers of biozone MPl-4 and nannofossils of biozone NN15 are present in these carbonates.

Downhole Measurements: Three heat flow measurements in Hole 655A yielded a mean heat flow value of approximately 2 HFU. One logging run was completed in Hole 655B with a DIL-LSS-GR-CALI combination. A scheduled borehole televiewer run was cancelled when the cable head flooded.

Significance:

Site 655 was designed to identify the nature of basement of a linear ridge located near the transition between stretched continental and inferred oceanic crust; it had been suggested that this ridge was a protrusion of upper mantle material. Although we have not conclusively ruled out the possibility that the ridge may have a core of serpentinite/peridotite under a carapace of basalt, the recovery of 120 m of basalt makes this hypothesis increasingly untenable.

Instead, the curved, glassy rims of the basalts suggest that the ridge is constructed of pillow basalts. The magnetic inclination values of 50-60 degrees are close to those expected, indicating that the pillow stack has not been tectonically disrupted.

The age of the basalts is constrained by the observation of reversed magnetic remanence throughout the basalt column, and by the identification of biozones MPl-4/NN15 in carbonates infilling cracks in the basalt. Together, these observations suggest that the basalt was erupted during the latest part of the reversed polarity event at the end of the Gilbert magnetic epoch, i.e., 3.4-3.6 Ma.

The location of Site 655 on a topographic high, well above the turbidite pond, offered an opportunity to recover a relatively undisturbed, undiluted pelagic Plio-Quaternary sequence to address stratigraphic questions left unanswered at Site 653. However, the sediment turned out to be thinner than predicted and also younger and less continuous than we had hoped. Nonetheless, the short sequence recovered contains a set of well-developed Pleistocene sapropels or sapropelic layers, which will be used to constrain the depth range and lateral extent of episodes of anoxic bottom water in the Mediterranean Sea, as well as a set of volcanic ash layers that will contribute to assessments of the regional tephrachonology.

SITE 656 (LAST TILTED BOCK OF THE SARDINIAN MARGIN: DE MARCHI SEAMOUNT)

Site 656 is located on the westward flank of de Marchi seamount, which is the easternmost continental fault-bounded tilted block on the lower Sardinian margin (Figures 1 and 20). This site was attempted to date the pre-rift/syn-rift contact and if possible to recover the pre-rift sediments. Two holes were rotary drilled, Hole 656A was located slightly downdip from the apparent pinchout of a thin wedge of inferred pre-rift sediments. The upper 102 m of Pleistocene turbidites were not cored. Hole 656A was abandoned prematurely when the pipe got stuck in syn-rift sand and gravel. The ship was offset to drill Hole 656B just updip of the apparent pinchout of the syn-rift wedge. The upper 55 m of Pleistocene turbidites were not cored. Hole 656B was terminated before to sample the pre-rift sediments to leave for Marseilles. Neither hole was logged and no heat flow measurements were made. Four sedimentary units were recovered (Figure 21):

Sedimentary Unit 1: (Hole 656A: 102.8-131.3 m BSF; Hole 656B: 55.5-83.9 m BSF; age: upper Pleistocene) Unit 1 contains detrital and volcanogenic sediments, mostly fine-grained, with a subordinate fraction of biogenic carbonates. The detrital component includes zircon, pyroxene and blue amphibole; the latter suggests a high pressure/low temperature metamorphic source terrain.

Sedimentary Unit 2: (Hole 656A: 131.3-169.7 m BSF; Hole 656B: 83.9-93.3 m BSF; age: middle Pleistocene to lower Pliocene) Unit 2 consists of nannofossil ooze and less abundant foraminifer-nannofossil ooze, with minor zeolite-bearing sandy mud layers, volcanic glass, and micrite. Significant hiatuses occur within this unit in the lower Pleistocene (within nannofossil zone NN19) and in the lower Pliocene (between nannofossil zones NN12 and NN16). The hiatuses are more pronounced in Hole 653B than in Hole 653A.

Sedimentary Unit 3: (Hole 656A: 169.7-179.1 m BSF; Hole 656B: 93.3-105.6 m

BSF age: Hole 656A: undetermined; Hole 656B: lower Pliocene) Unit 3 is mostly homogeneous, structureless calcareous dolomitic mud. In Hole 656A, biogenic components are either absent or extremely scarce and reworked; in Hole 656B some minor intervals of nannofossil ooze or calcareous ooze were dated as lower Pliocene (biozone NN12).

Sedimentary Unit 4: (Hole 656A: 179.1-236.4 m BSF; Hole 656B: 105.6-121.8 m BSF; age: pre-Pliocene, possibly Messinian) The major lithology of unit 4 is a conglomerate containing clasts of the following lithologies in one or both holes: greenish siltstone and fine-grained sandstone, altered greenstone, red chert, white chert, silicified micritic limestone, limonitic clay, pyrite, chalcophyrite, galena, amphibole-rich rocks, mudstones, altered metagabbro (tremolite-rich), amphibolite, metadolerite, chloritic marble, and metaquartzite. The assembly of pebble lithologies at Hole 656B is less diverse than in Hole 656A. In both holes the matrix is a red carbonate mud.

Significance:

Units 1 and 2 were deposited in a normal open marine environment, however part of unit 2 (from lower Pliocene to lower Pleistocene) is very condensed and contains at least two major hiatuses (in NN19 and between NN12 and NN16 zones). Unit 3 represents a transition in age from lower Pliocene to probable Miocene and in facies from open marine to continental environment. This observation verifies that the lower Sardinian continental margin was not a lowstanding evaporitic-collecting basin during the Messinian. Unit 4 includes numerous basement rock types of alpine orogenic units, confirming the continental affinity of this thin crust.

## CONCLUSIONS

Simplified stratigraphic columns from each site drilled during Leg 107 are shown in Figure 22 along a NNW-SSE bathymetric and crustal transect from a young passive continental margin (Sardinia margin) to even younger oceanic basin (Marsili Basin).

Leg 107 has investigated a wide range of geologic questions including passive margin and backarc basin evolution, crustal heterogeneity and protrusion of upper mantle material to the seafloor, chronology of circum-Tyrrhenian eruptive volcanism, cyclic evaporite deposition, origin of sapropels, origin of metalliferous "basal" sediments, as well as definition of the Miocene/Pliocene boundary. In this very preliminary report, we choose to emphasize two outstanding results. First, the Tyrrhenian Sea is very young and has evolved extremely quickly. Second, the locus of intense tectonic activity and of oceanic crust formation has migrated through time from northwest to southeast, i.e., towards the subduction zone.

On the upper Sardinian margin (Site 654), rifting began in the upper Tortonian and slowed significantly or stopped in the upper Messinian. In contrast, on the lower Sardinian margin (Sites 652 and 656), rifting was apparently initiated during the Messinian and probably ended in the lower Pliocene. Rifting and subsidence thus appear to be diachronous across the continental margin.

By the Messinian, rifting and subsidence of what is now the upper and middle Sardinian margin were sufficiently advanced to allow deposition of basinal evaporites at Sites 654 and 653. Rifting and subsidence on what is now the lower Sardinian margin was apparently less advanced; thus the Messinian facies at Sites 652 and 656 are lacustrine and subaerial, respectively. Since the water depth at Site 654 is now 1.3 km shallower than at Site 652, a drastic reorganization of the morphology of the ancestral Tyrrhenian basin must have occurred during and since the Messinian; we attribute this reorganization to progressive rifting.

Neither Vavilov nor Marsili Basins seem to have existed as deep oceanic basins during the Messinian. Just as the locus of intense rifting migrated from northwest to southeast, a comparable shift in the location of crustal accretion occurred from the northwestern deep basin (Vavilov) to the southeastern deep basin (Marsili). Basalts cored in the Vavilov Basin (Sites 655 and 651) are inferred to be approximately 3.5 million years old, based on biostratigraphically controlled dating of sediment overlying and filling cracks in the basalt. Seismic reflection data imply that we did not sample the oldest basement of Vavilov Basin. In contrast, in the Marsili basin, Site 650 was located in the area of thickest sediment cover, and thus probably did sample basalt which was among the oldest in the basin. Age of the basalt at the Site 650 sediment/basalt contact is biostratigraphically and magnetostratigraphically constrained at 1.6-1.9 Ma. Therefore, injection of basaltic crust began at least 1.5 million years later in Marsili Basin than in Vavilov Basin.

In summary, Leg 107 has clearly demonstrated that rifting and basin formation within the Tyrrhenian Sea have migrated southeastward towards the subducting plate. Furthermore, the process is very recent: the present phase of rifting began as recently as upper Tortonian, and the younger of the deep basins is apparently less than 2 million years old.

FIGURE CAPTIONS

Figure 1: Locations of Leg 107 drillsites 650 to 656. Note: The sites are located along a NW-SE transect across the entire Tyrrhenian Sea from North Eastern Sardinia to the toes of Italy. The line indicates the bathymetric and crustal section shown on Figure 22 (simplified from Steimetz et al., 1983).

Figure 2: Location of Site 650 on multichannel seismic line ST16 IFREMER-IFP-CNRS.

Figure 3: Synthetic lithologic column and drilling recovery at Site 650 (see legend on caption of Figure 22).

Figure 4: Site 650 summary of measurements.

Figure 5: Location of Site 651 on multichannel seismic line ST12 IFREMER-IFP-CNRS.

Figure 6: Synthetic lithologic column and drilling recovery at Site 651 (see legend on caption of Figure 22).

Figure 7: Site 651 summary of measurements.

Figure 8: Location of Site 652 on multichannel seismic line ST01 IFREMER-IFP-CNRS.

Figure 9: Synthetic lithologic column and drilling recovery at Site 652 (see legend on caption of Figure 22).

Figure 10: Site 652 summary of measurements.

Figure 11: Location of Site 653 on D/V Joides Resolution site survey seismic line.

Figure 12: Synthetic lithologic columns and drilling recovery at Site 653 (see legend on caption of Figure 22).

Figure 13: Site 653 summary of measurements.

Figure 14: Location of Site 654 on multichannel seismic line ST06 IFREMER-IFP-CNRS.

Figure 15: Synthetic lithologic column and drilling recovery at Site 654 (see legend on caption of Figure 22).

Figure 16: Site 654 summary of measurements.

Figure 17: Location of Site 655 on multichannel seismic line ST12 IFREMER-IFP-CNRS.

Figure 18: Synthetic lithologic column and drilling recovery at Site 655 (see legend on caption of Figure 22).

Figure 19: Site 655 summary of measurements.

Figure 20: Location of Site 656 on multichannel seismic line ST12 IFREMER-IFP-CNRS.

Figure 21: Synthetic lithologic column and drilling recovery at Site 656 (see legend on caption of Figure 22).

Figure 22: Simplified bathymetric and crustal section across a NW-SE direction the Tyrrhenian Sea (see location in insert). Simplified stratigraphic column of Leg 107 drillsites are projected along the transect. Graphic symbols for lithologic columns of Sites 650 to 656: 1) Calcareous Biogenic; 2) Terrigeneous; 3) volcanic; 4) Conglomerate; 5) Dolomite; 6) Evaporites; 7) Basalt; 8) Serpentinite and Peridotite.

Figure 23: Logging data and log-stratigraphic interprertation as a fonction of depth at Hole 651A. Gamma Ray (GR, GAPI units), Caliper (CALI, in), Deep and Medium Resistivity (ILD and ILM, ohlm*m), Spherically Focused Resistivity (SFLU, ohm*m), Compressional Sonic Velocity ($V_p$, km/s), Neutron Porosity (NPHI, %), Bulk Density (RHOB, g/cm$^3$), U (URAN, ppm), Th (THOR, ppm), K (POTA, %). Calculated percentages of volcanogenic and pelagic sediments are least squares estimates computed from gamma ray and velocity data. The logs suggest that the volcanoclastic levels have been undersampled in the recovered sediments.

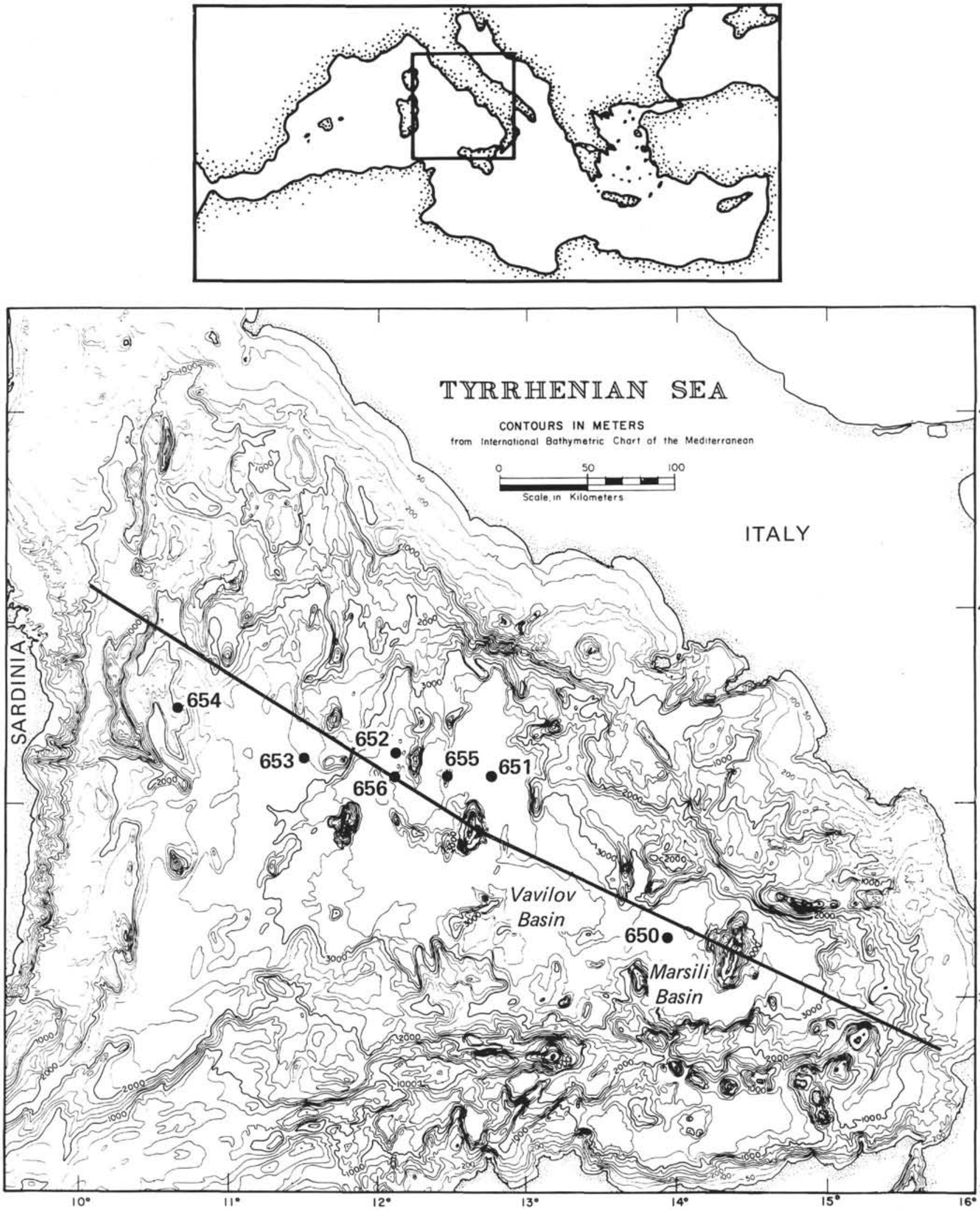



Figure 1: Locations of Leg 107 drillsites 650 to 656. (simplified from International Bathymetric Chart of the Mediterranean Sea, GEPCO-UNESCO, 1981).

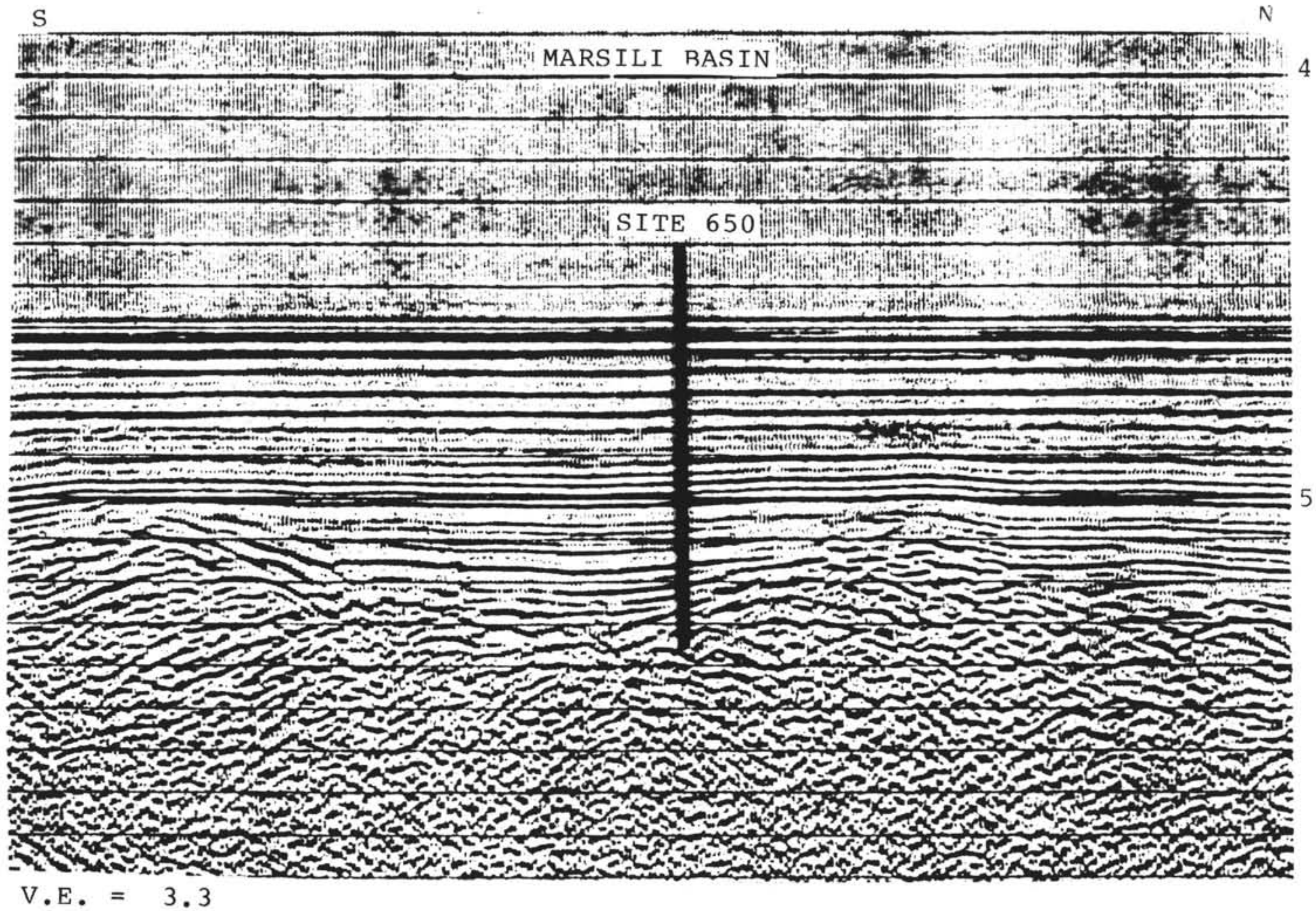



Figure 2: Location of Site 650 on multichannel seismic line ST16 IFREMER-IFP-CNRS.

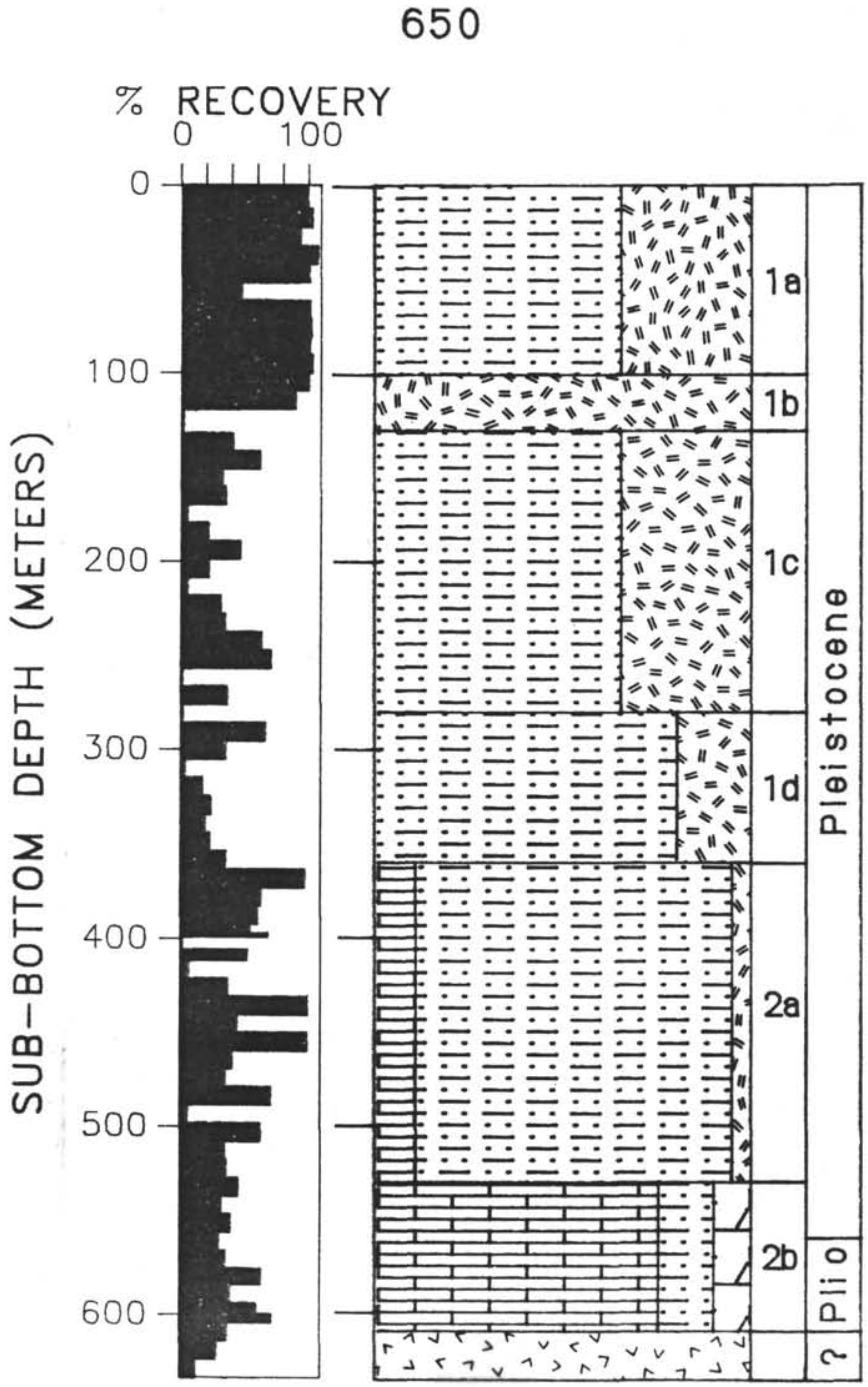



Figure 3: Synthetic lithologic column and drilling recovery at Site 650.

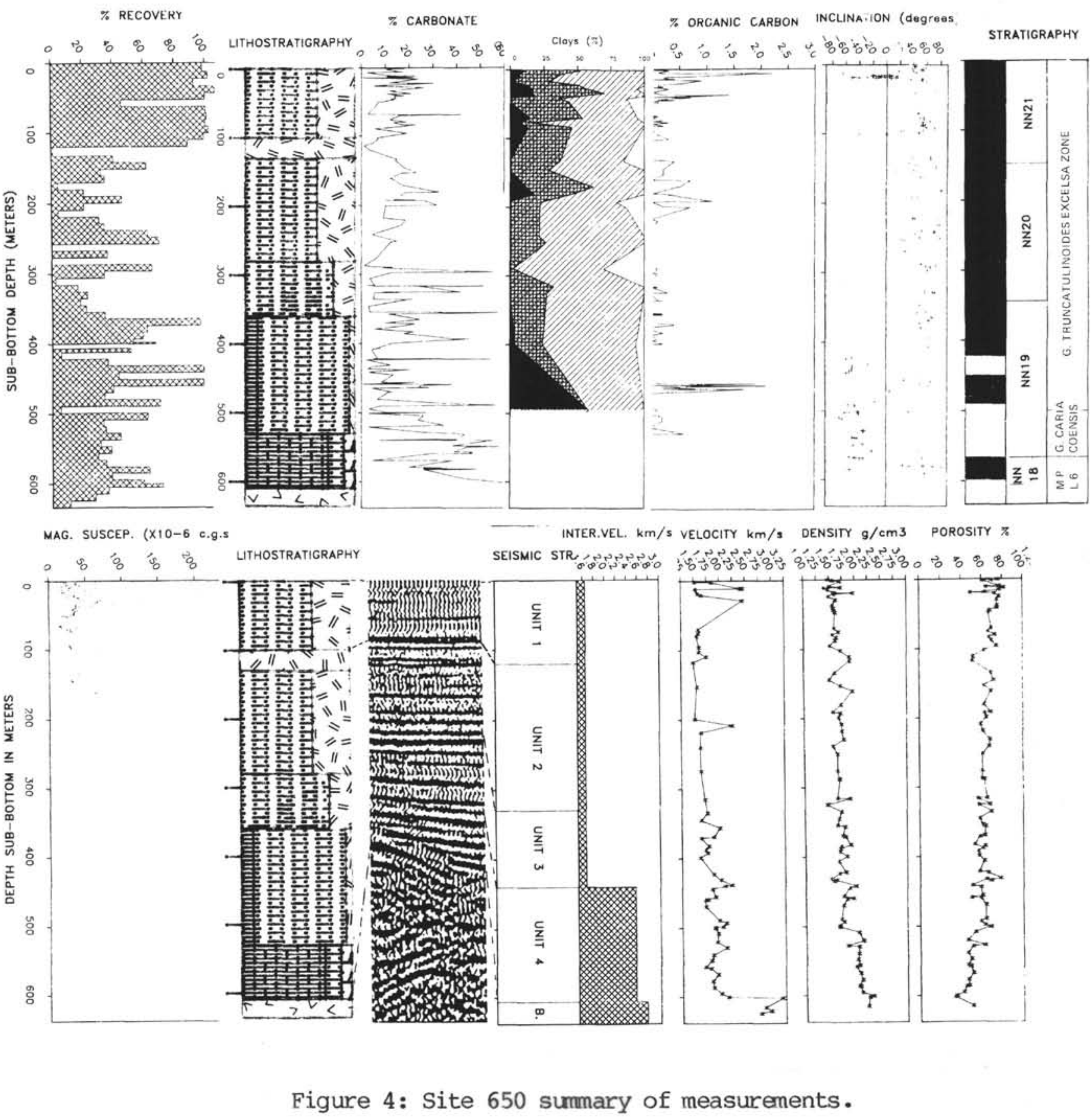
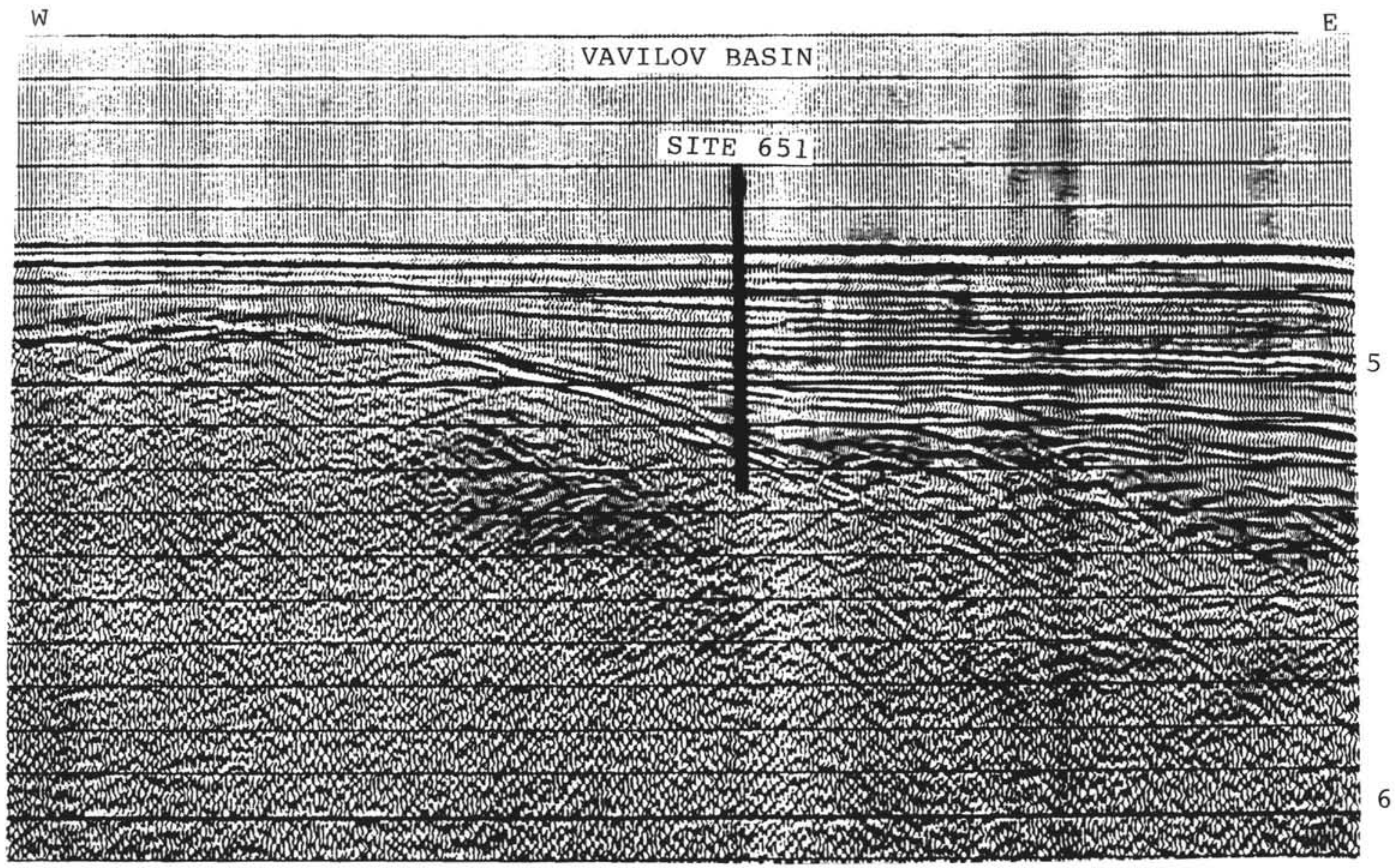



Figure 4: Site 650 summary of measurements.




V.E. = 3.3

Figure 5: Location of Site 651 on multichannel seismic line ST12 IFREMER-IFP-CNRS.

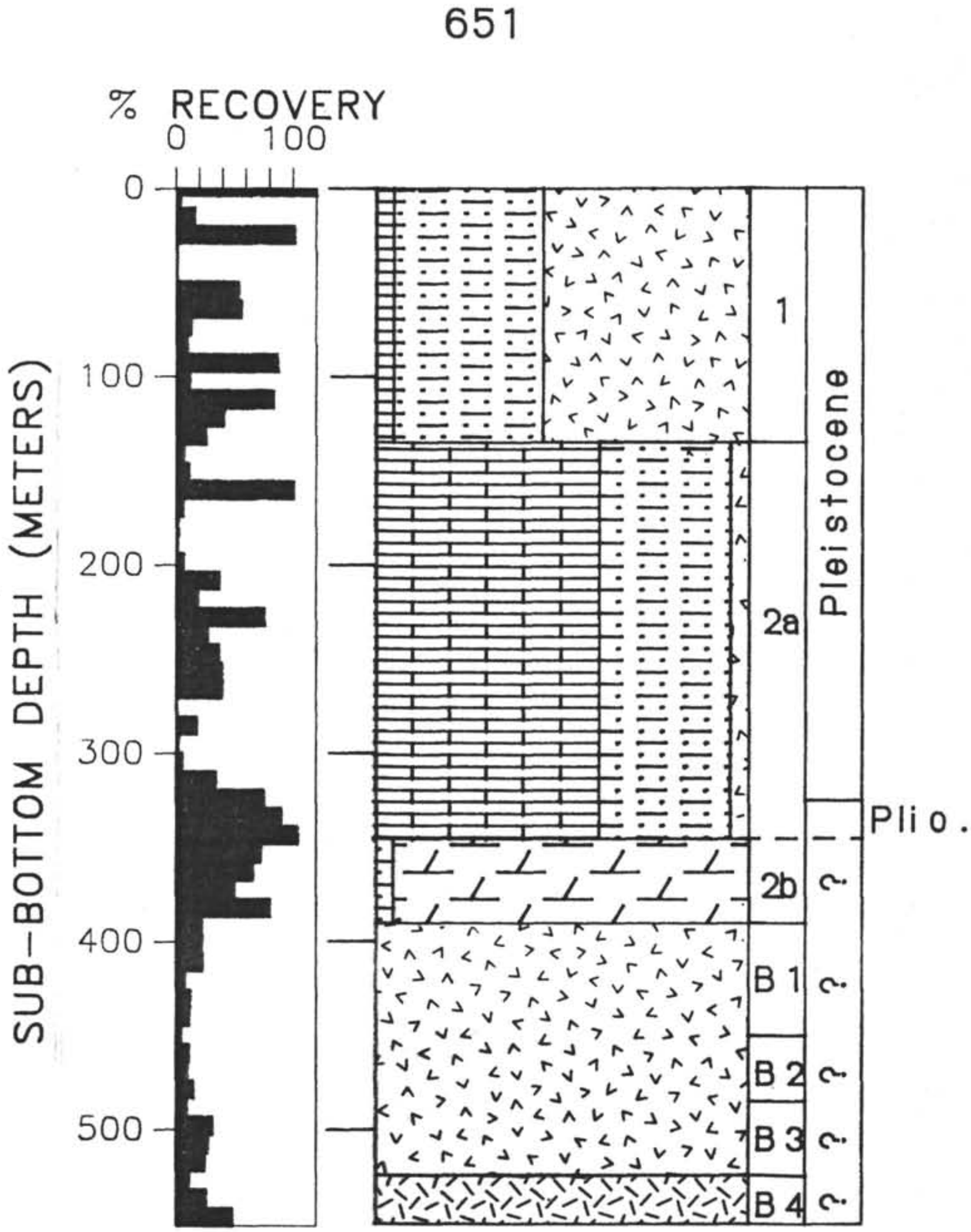



Figure 6: Synthetic lithologic column and drilling recovery at Site 651.

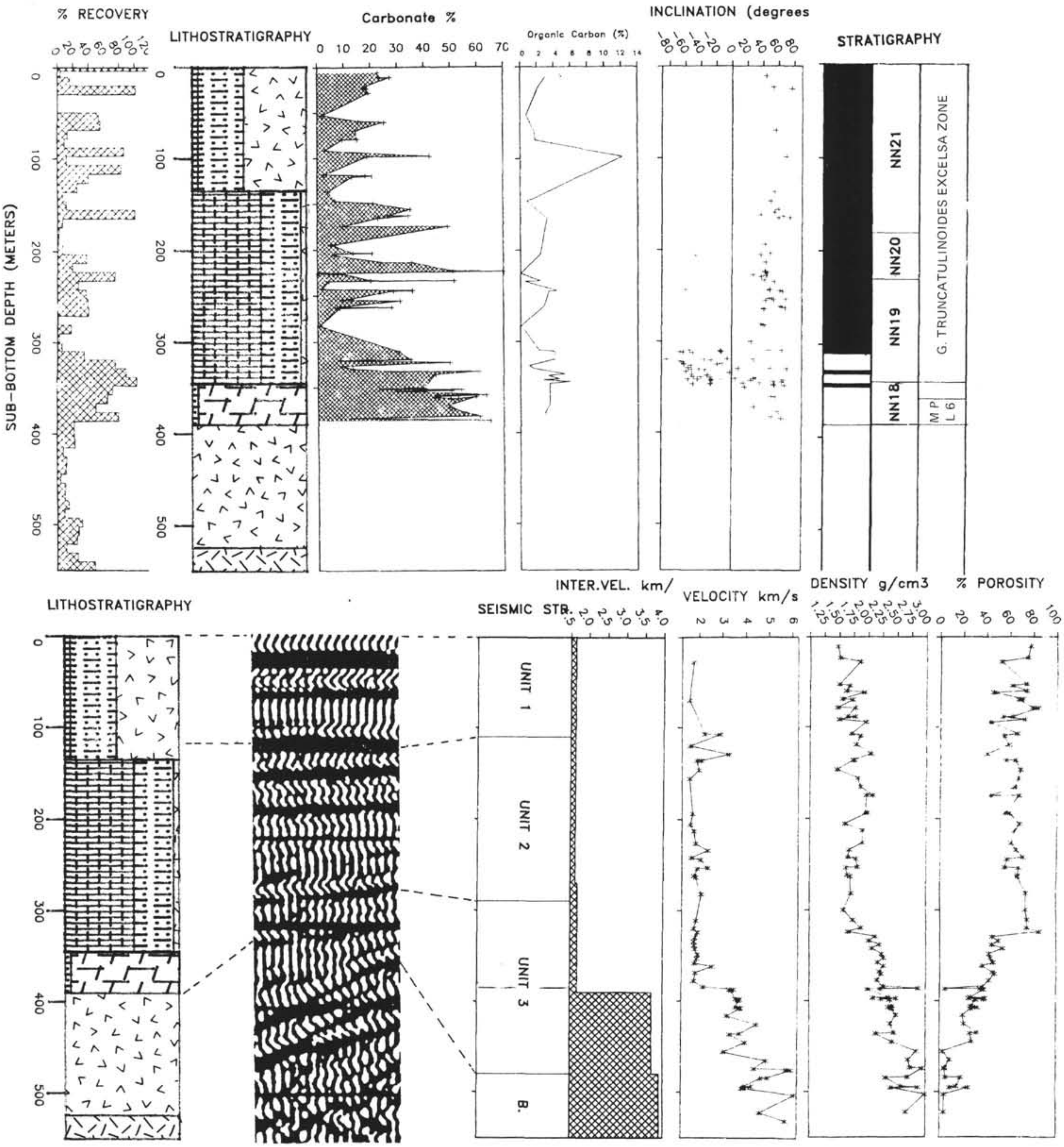



Figure 7: Site 651 summary of measurements.

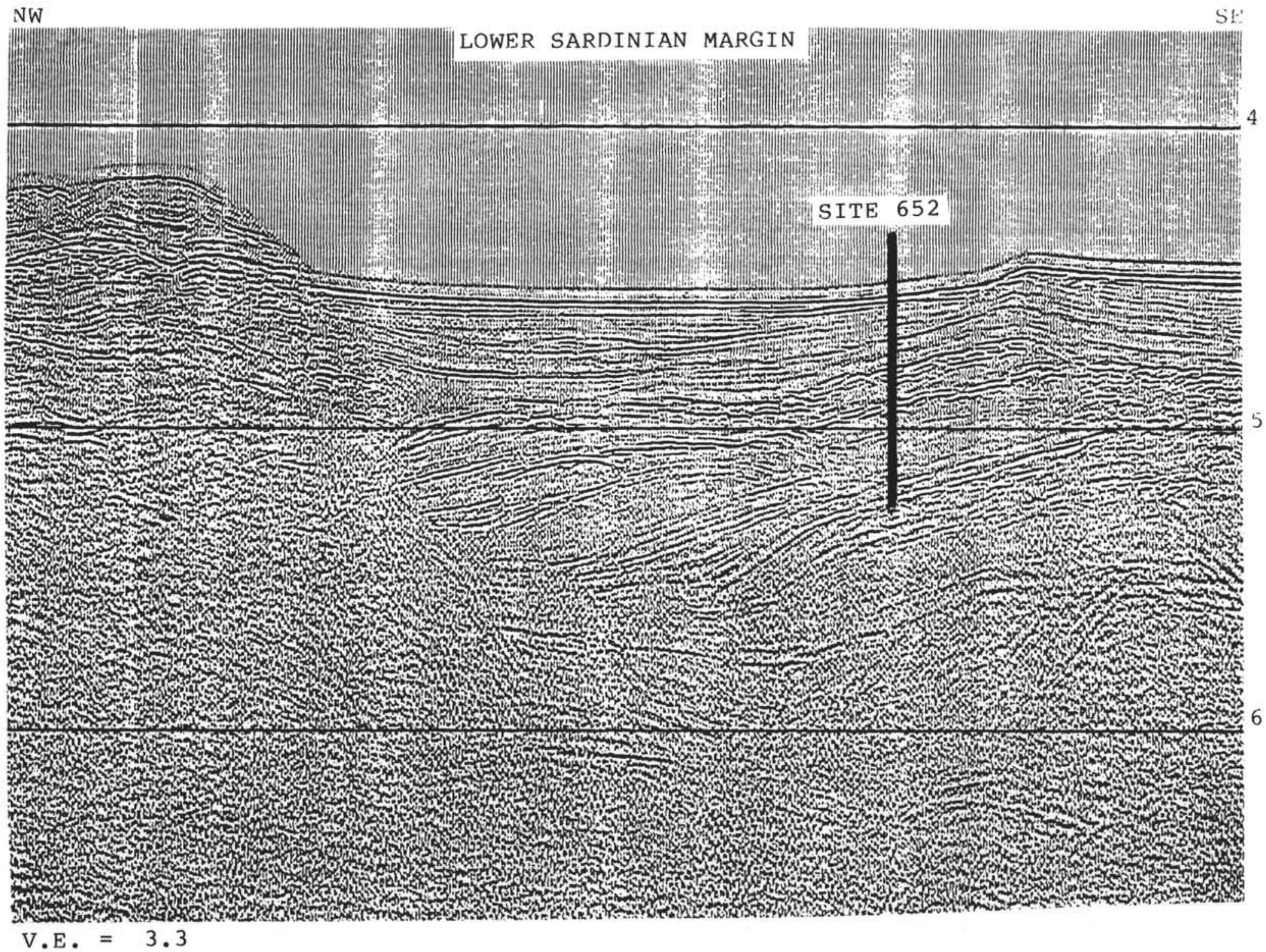



Figure 8: Location of Site 652 on multichannel seismic line ST01 IFREMER-IFP-CNRS.

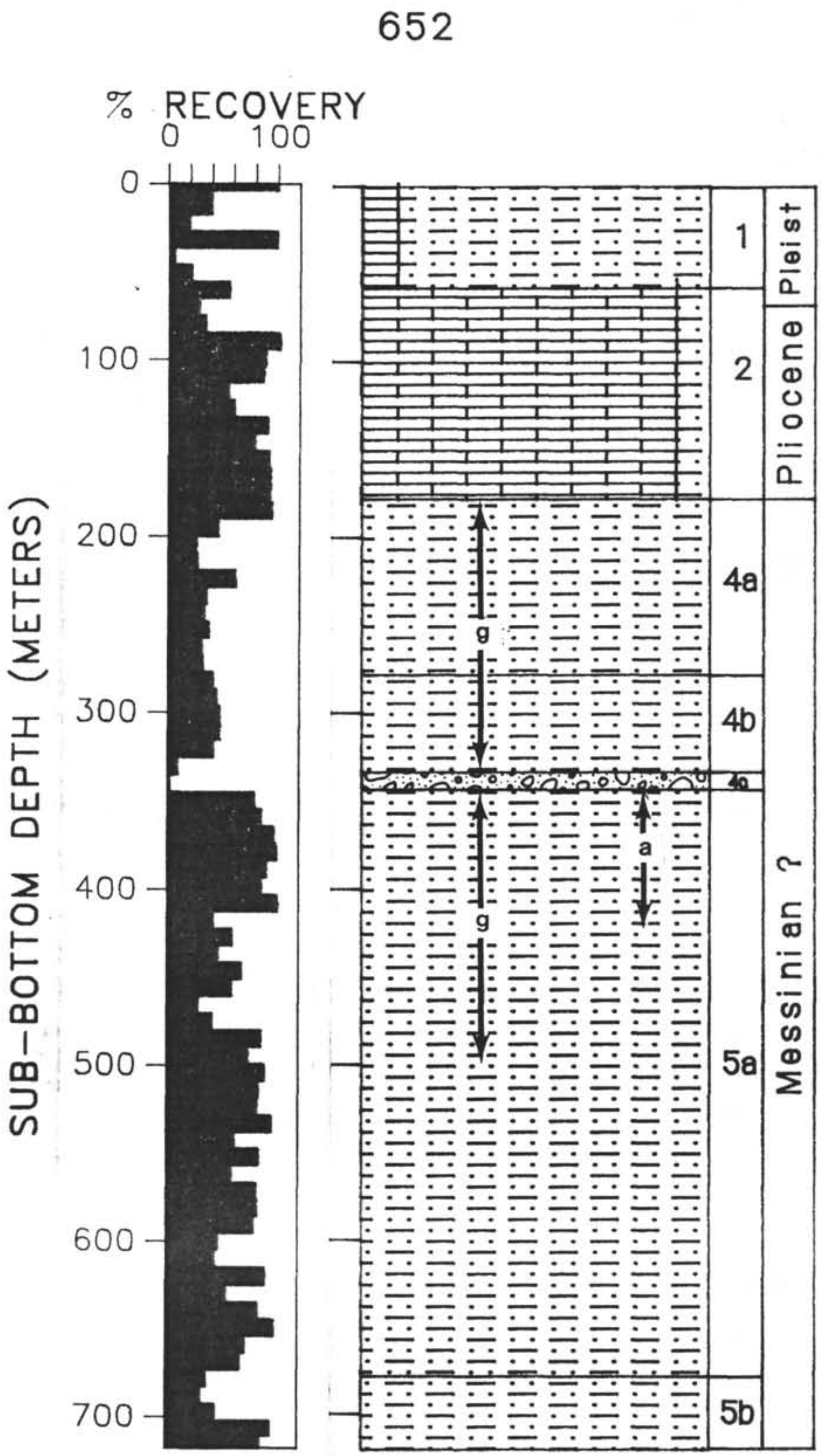



Figure 9: Synthetic lithologic column and drilling recovery at Site 652.

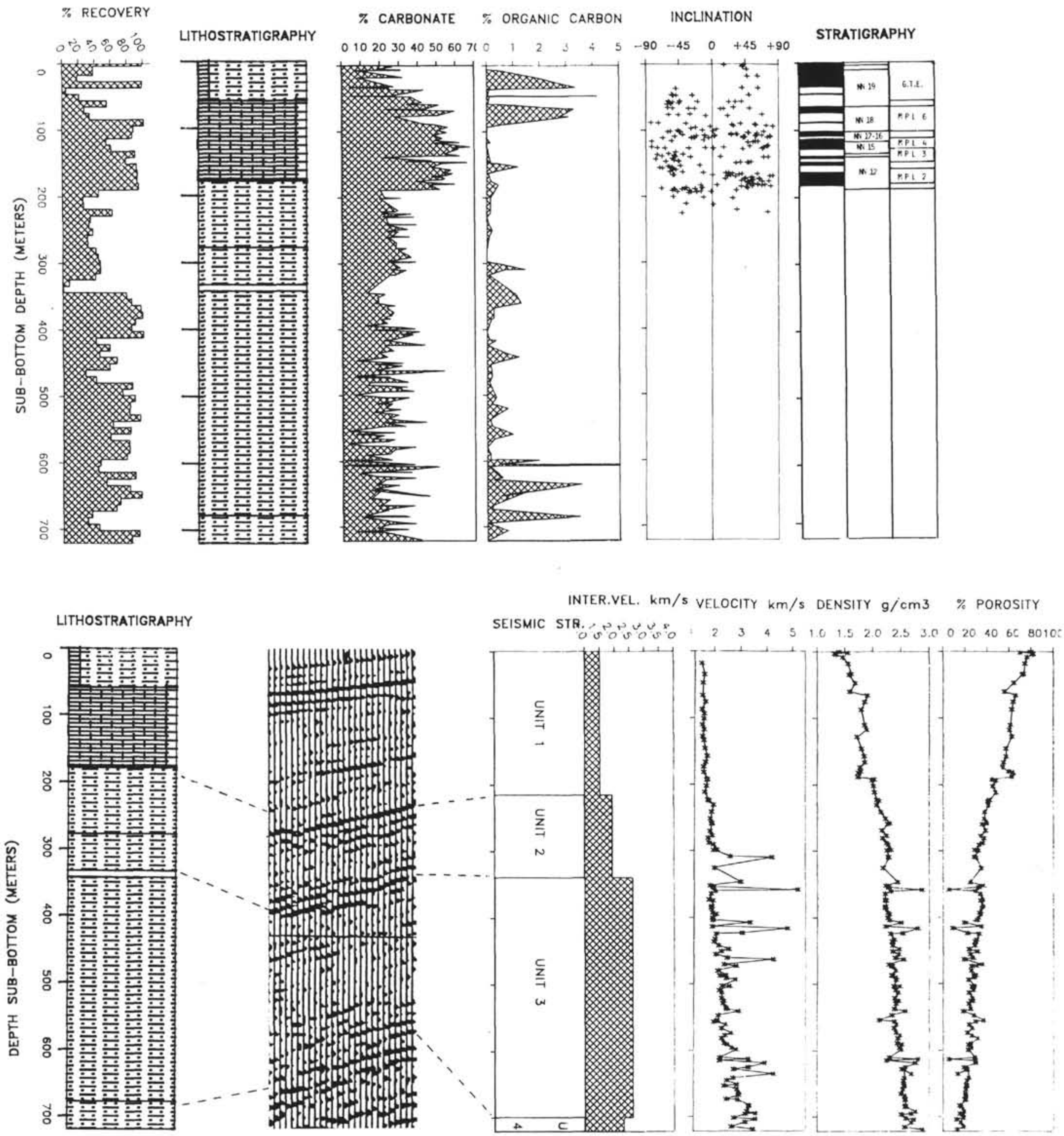



Figure 10: Site 652 summary of measurements.

CORNAGLIA BASIN

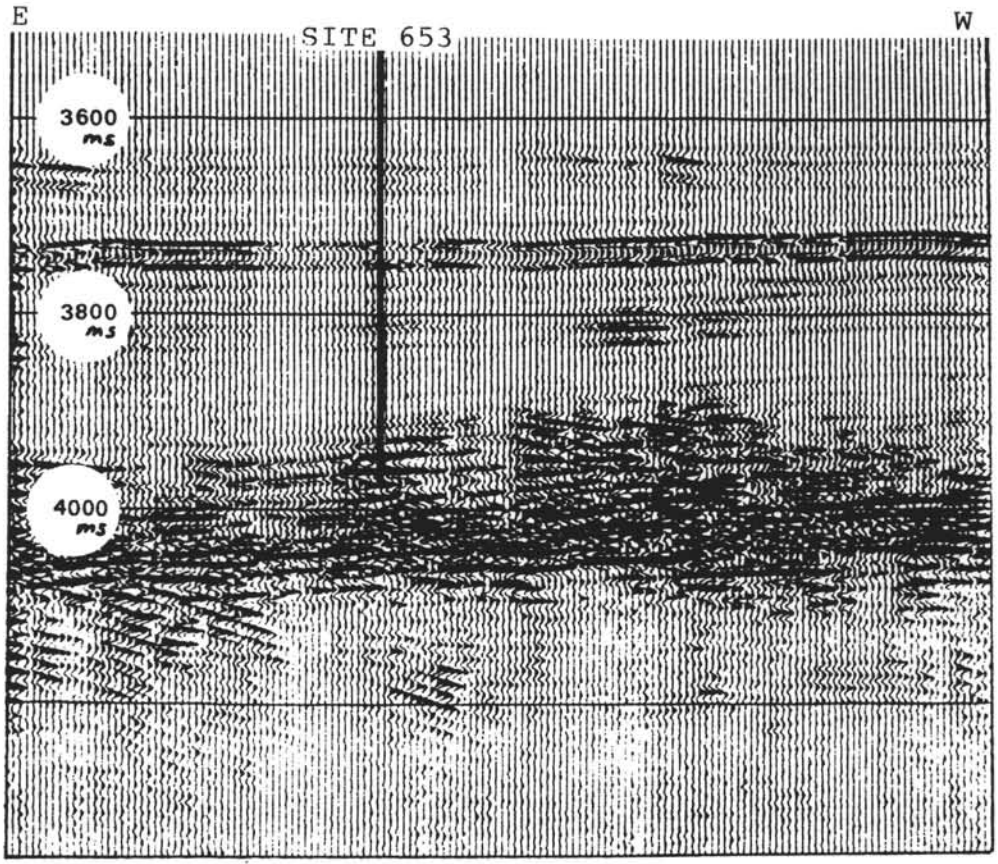



Figure 11: Location of Site 653 on D/V Joides Resolution site survey seismic line.

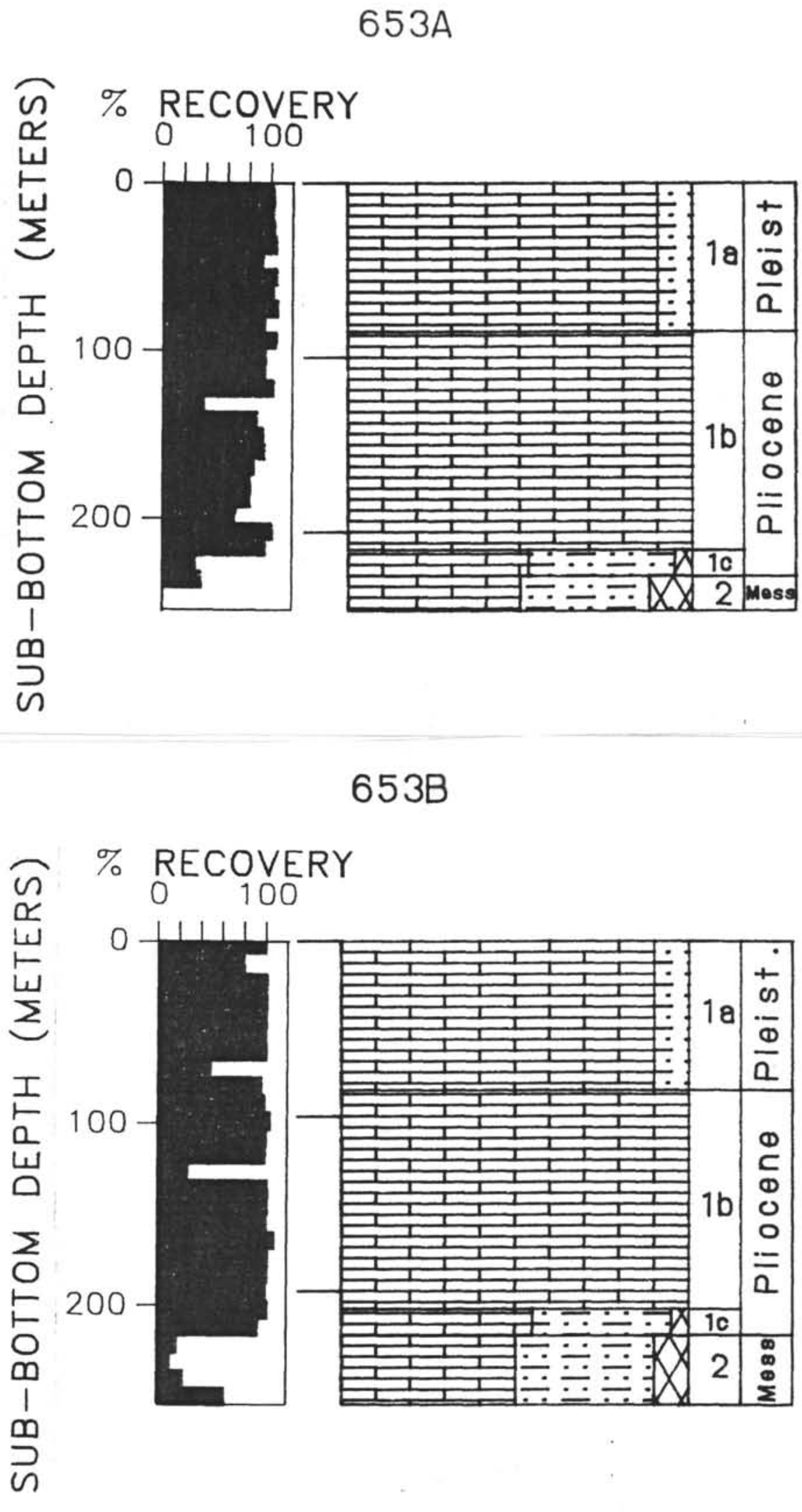



Figure 12: Synthetic lithologic columns and drilling recovery at Site 653.

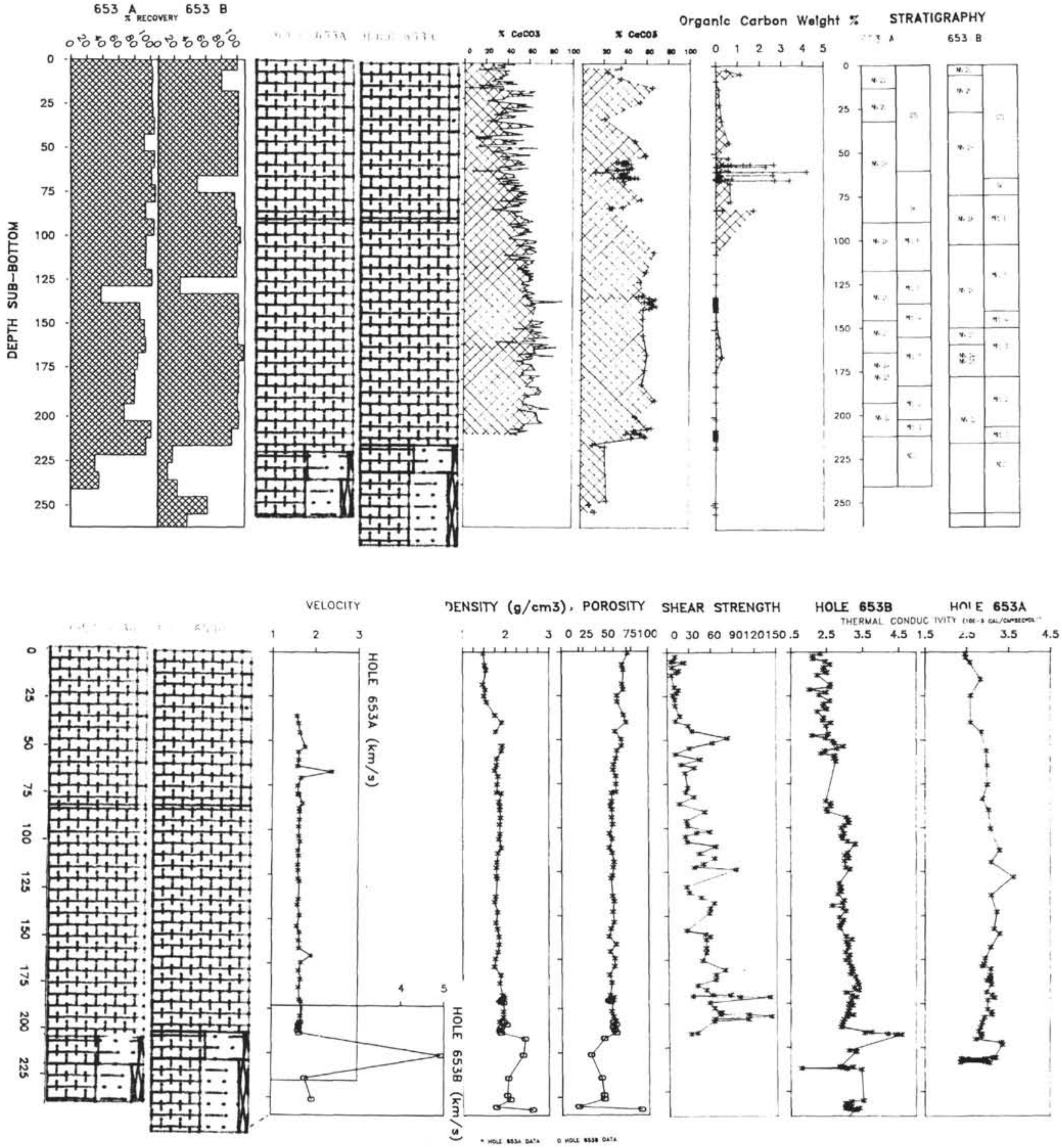



Figure 13: Site 653 summary of measurements.

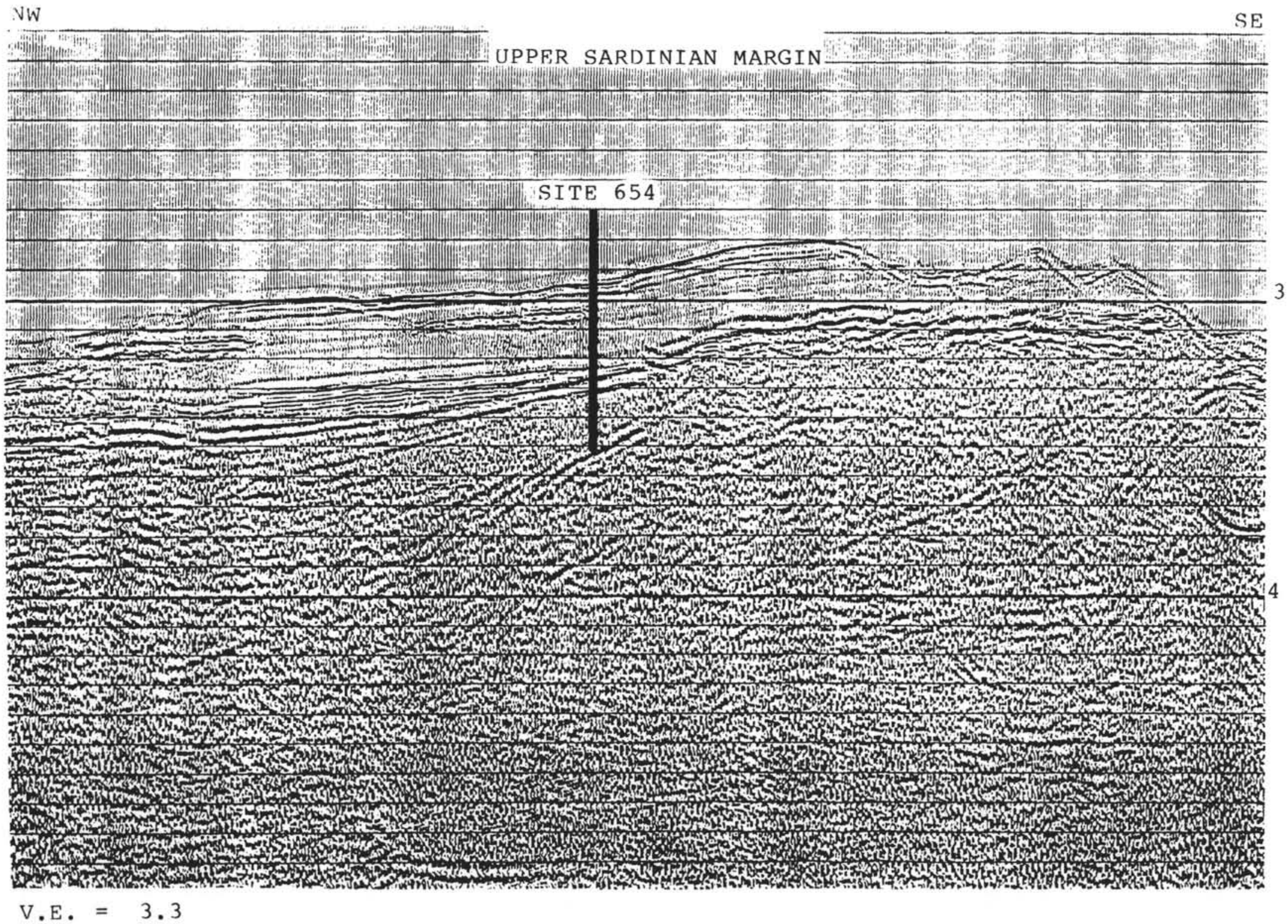



Figure 14: Location of Site 654 on multichannel seismic line ST06 IFREMER-IFP-CNRS.

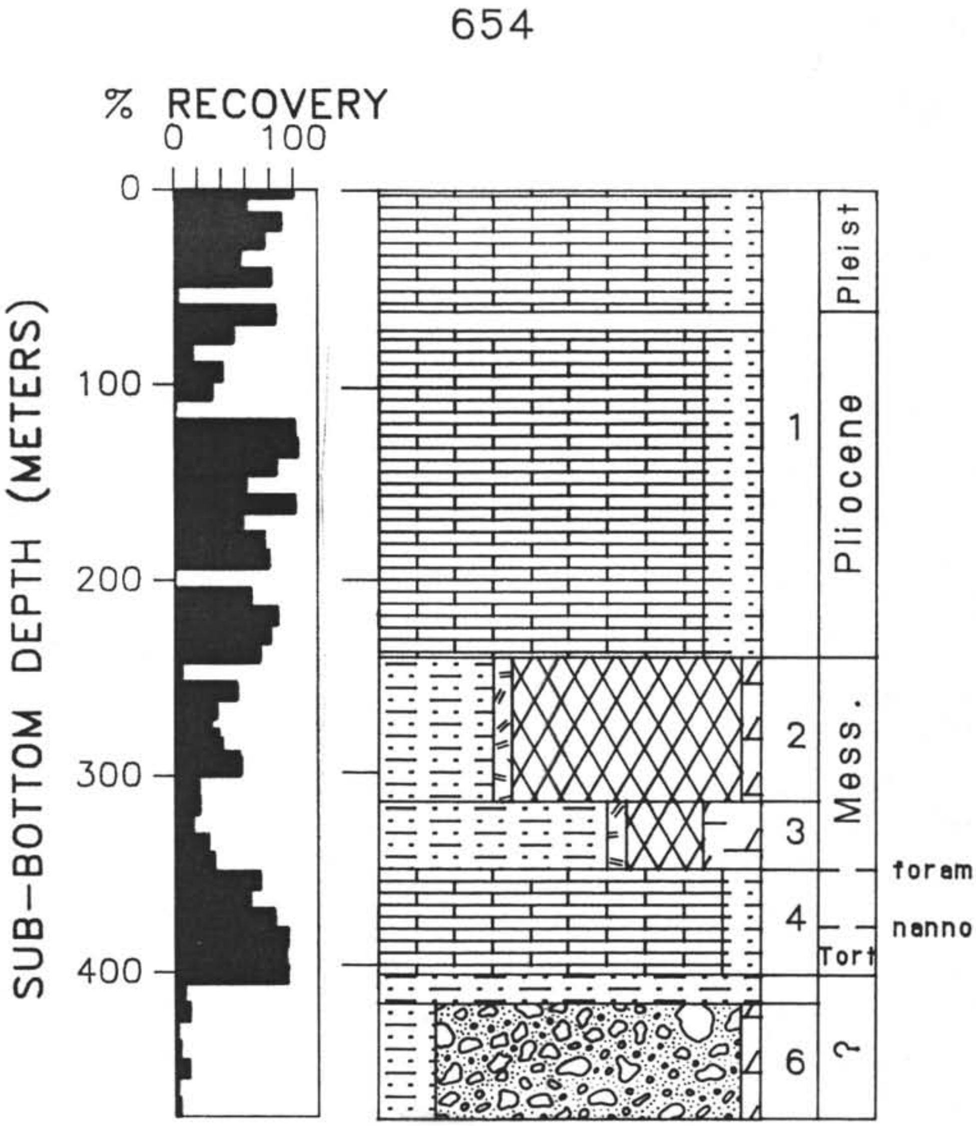



Figure 15: Synthetic lithologic column and drilling recovery at Site 654.

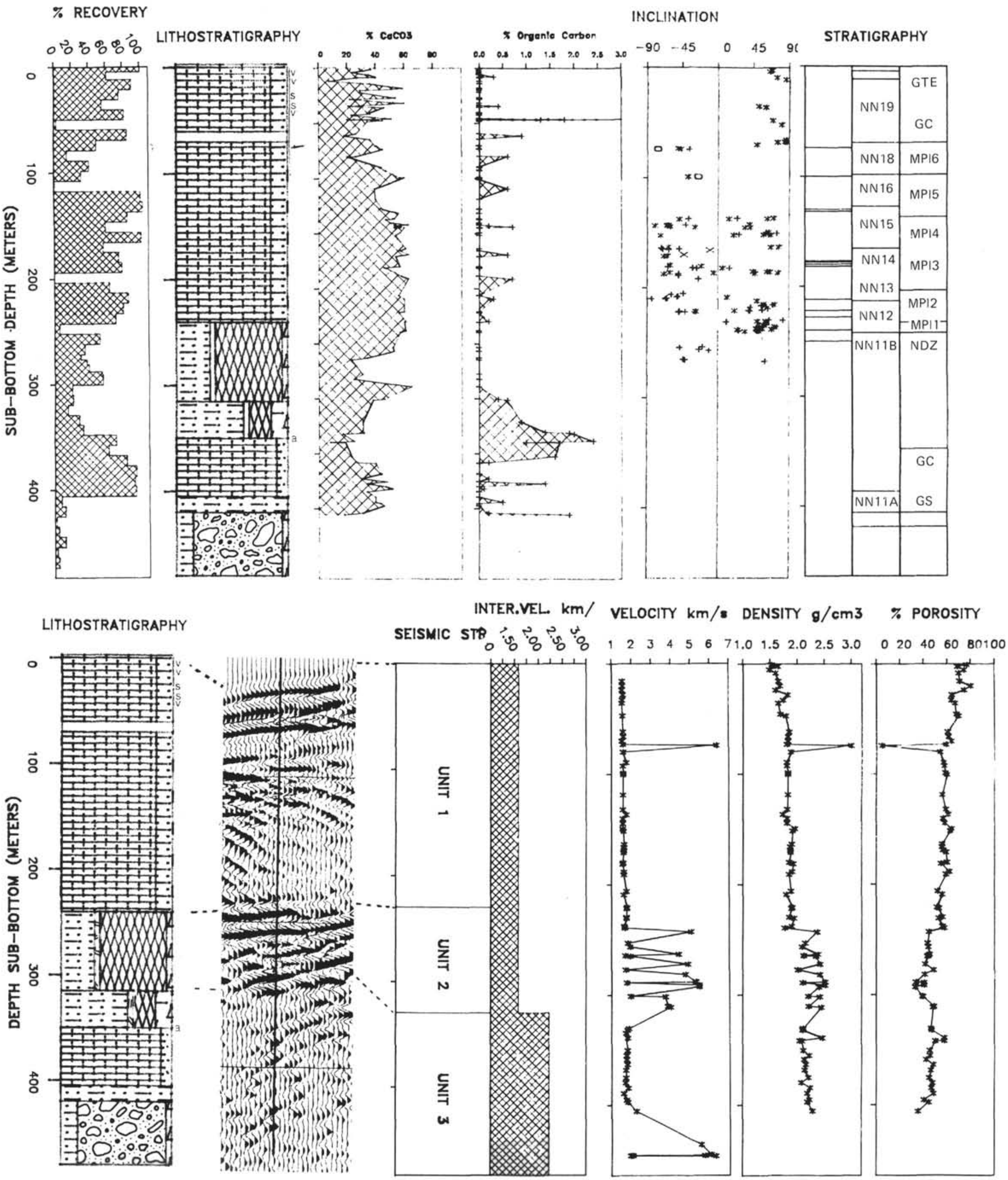



Figure 16: Site 654 summary of measurements.

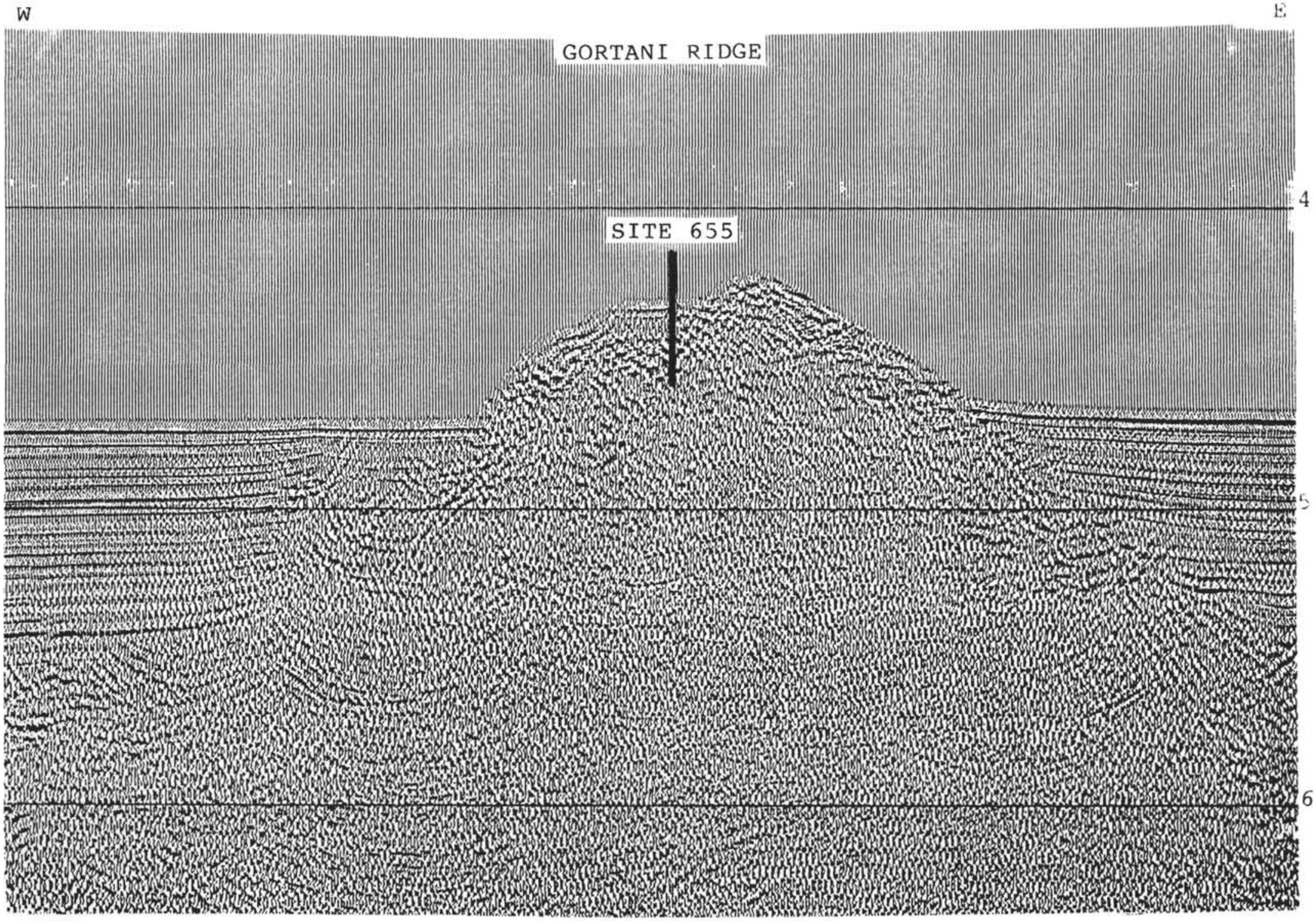



Figure 17: Location of Site 655 on multichannel seismic line ST12 IFREMER-IFP-CNRS.

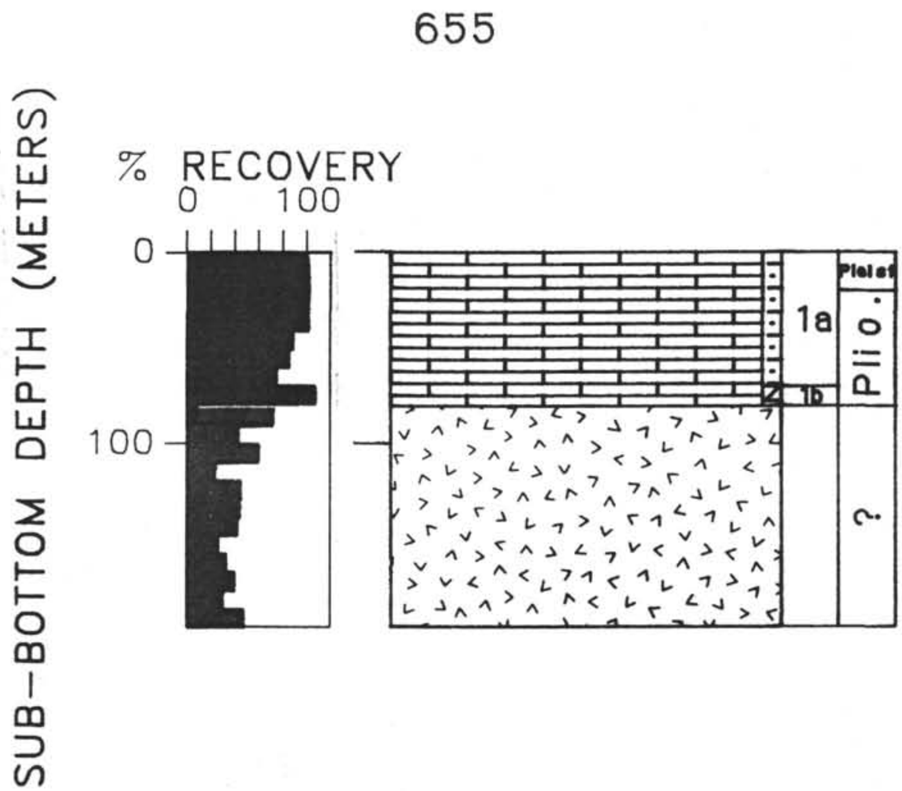



Figure 18: Synthetic lithologic column and drilling recovery at Site 655.

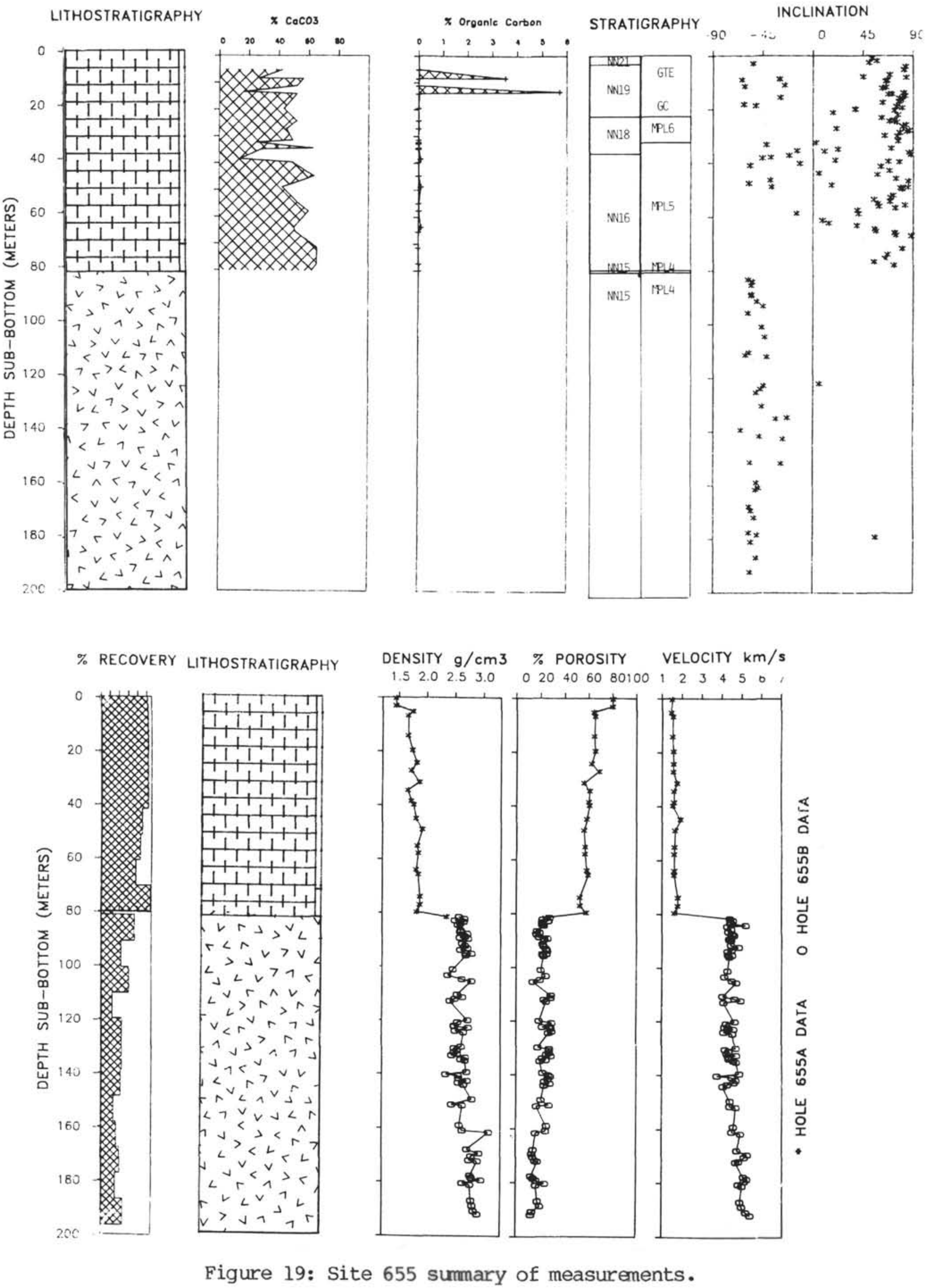



Figure 19: Site 655 summary of measurements.

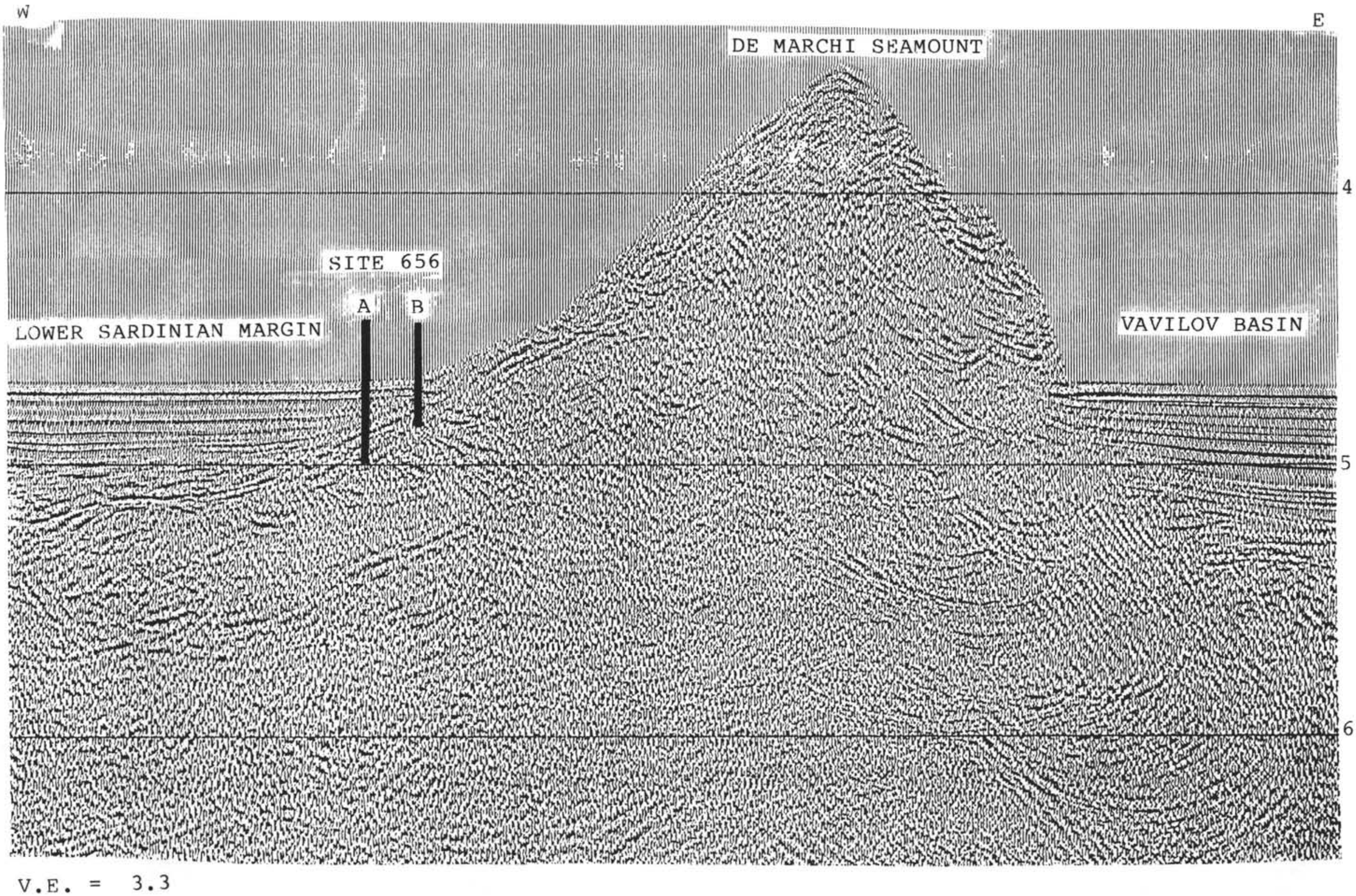



Figure 20: Location of Site 656 on multichannel seismic line ST12
IFREMER-IFP-CNRS.

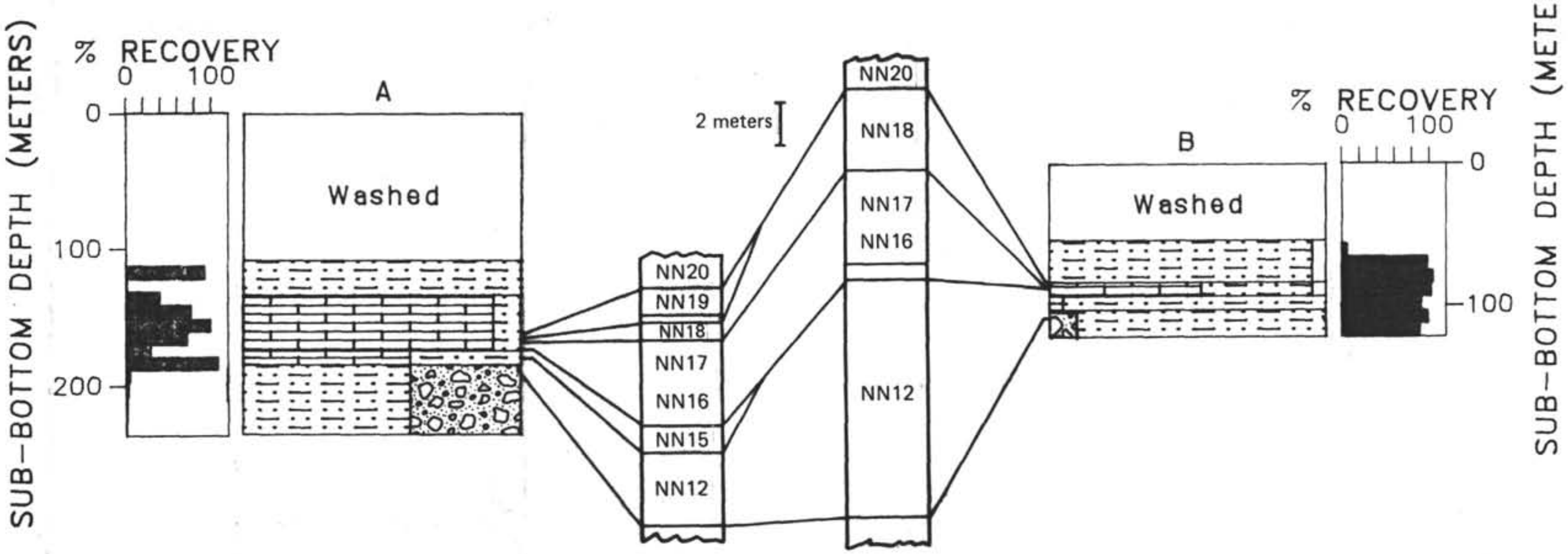



Figure 21: Synthetic lithologic columns and drilling recovery at Site 656.

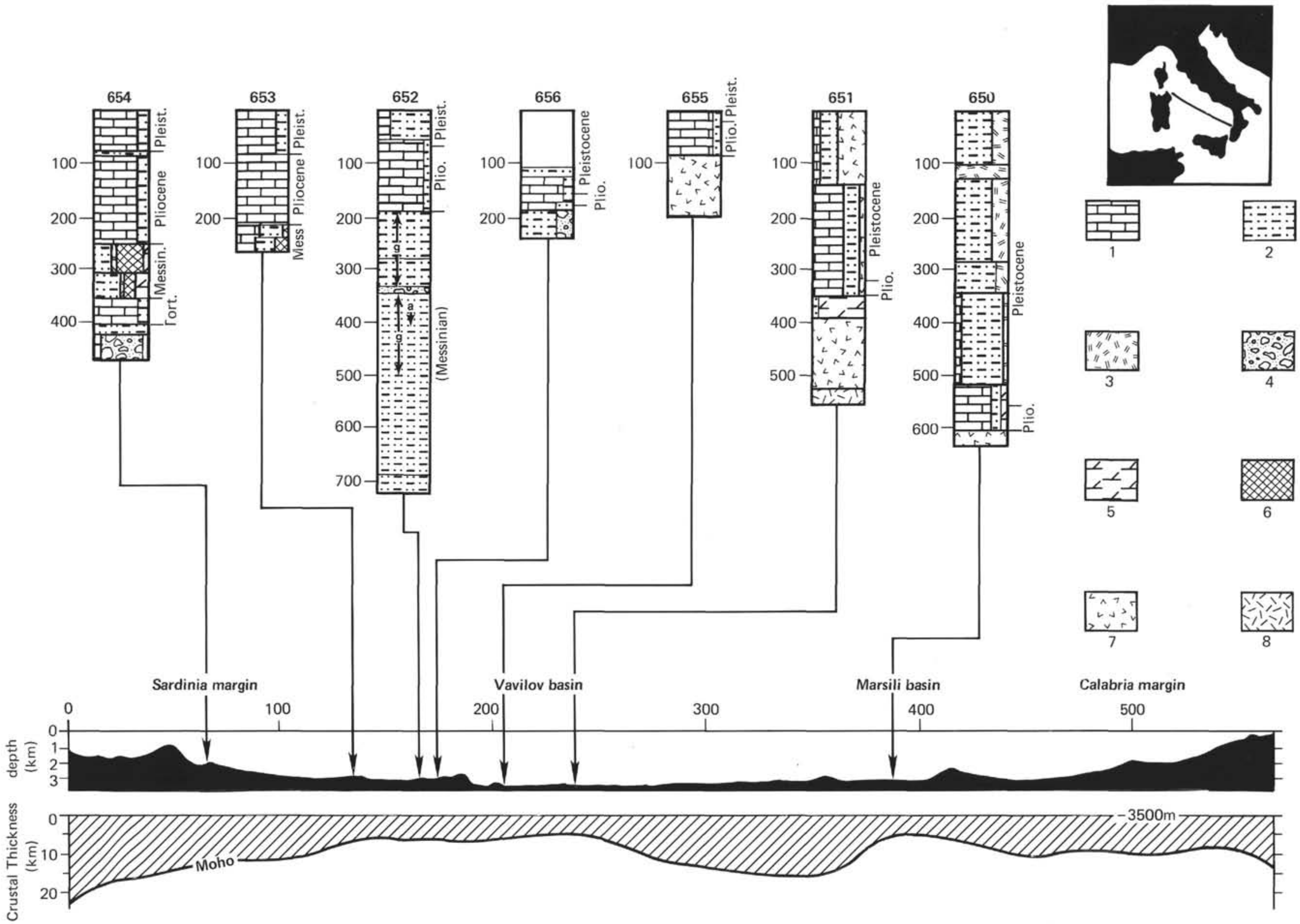



Figure 22: Simplified bathymetric and crustal section across a NW-SE direction the Tyrrhenian Sea (see location in insert). Simplified stratigraphic column of Leg 107 drillsites are projected along the transect. 1) Calcareous Biogenic; 2) Terrigeneous; 3) volcanic; 4) Conglomerate; 5) Dolomite; 6) Evaporites; 7) Basalt; 8) Serpentinite /Peridotite.

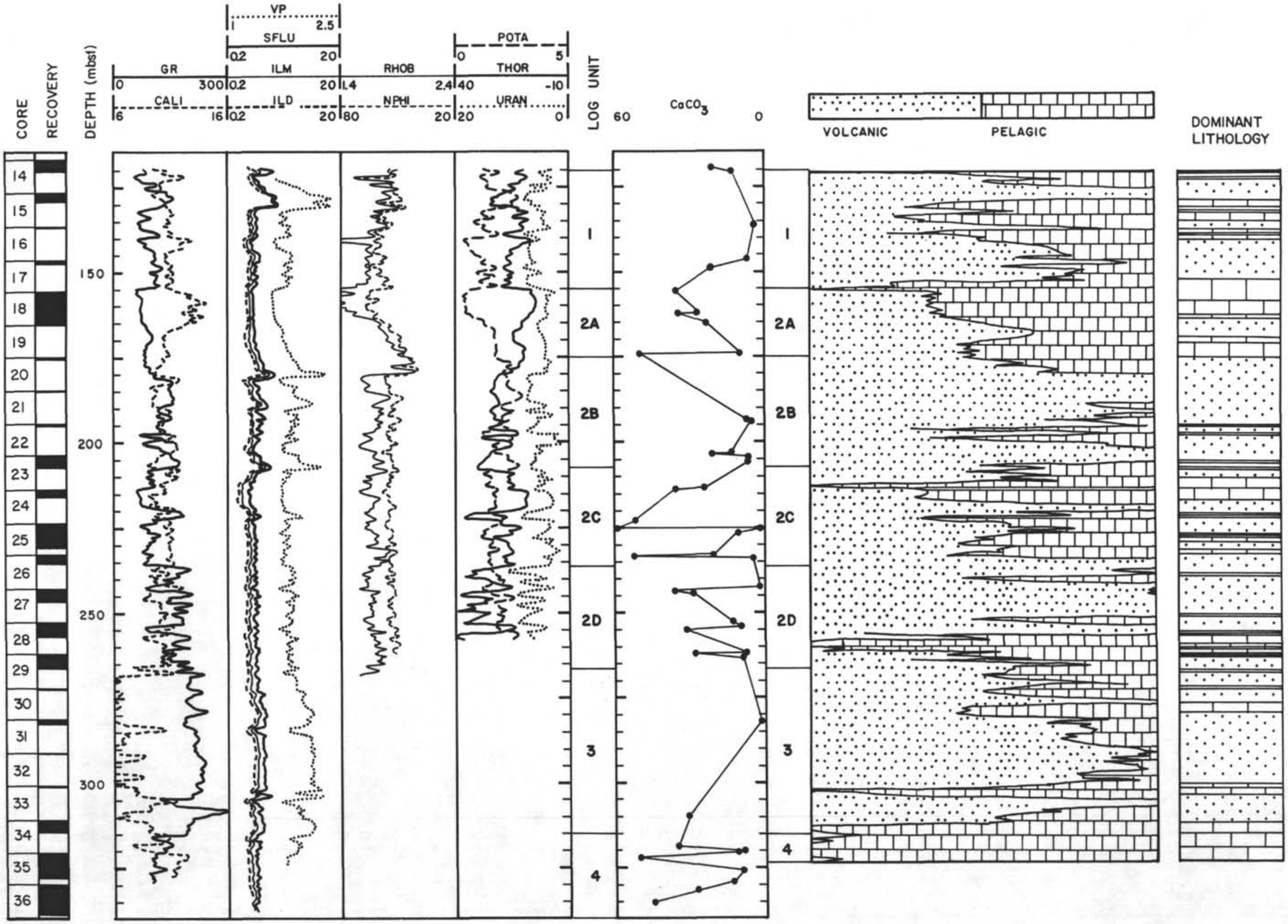



Figure 23: Logging data and log-srtatigraphic interpretation as a fonction of depth at Hole 651A.

REFERENCES


Barberi, F., Innocenti, F., Ferrara, G., Keller, J., Villari, L., 1974. Evolution of the Eolian Arc volcanism (Southern Tyrrhenian Sea). Earth Planet. Sci. Lett., 21: 269-276.

Barberi, F., Bizouard, H., Capaldi, G., Ferrara, G., Gasparini, P., Innocenti, F., Joron, J.L., Lambret, B., Treuil, M., Allegre, C., 1978. Age and nature of basalts from the Tyrrhenian Abyssal Plain. In Hsu, K., Montadert, L., et al., 1978. Intial Report of the Deep Sea Drilling Project, Vol. 42, Part 1: Washington (U.S. Government Printing Office): 509-514.

Boccaletti, M., Horvath, F., Loddo, M., Mongelli, F., Stegena, L., 1976. The Tyrrhenian and Pannonian basins: a comparison of two Mediterranean interarc basins. Tectonophysics, 35: 45-69.

Bolis, G., Capelli, V., Marinelli, M., 1981. Aeromagnitic data of the Italian area: instrumental to a better comprehension of the basement main characteristic in Italy, Carta Magnetica d'Italia, AGIP - 43rd E.A.E.G. meeting in Venezia (Italy).

Della Vedova, B., Pellis, G., Foucher, J.P., Rehault, J.P., 1984. Geothermal structure of the Tyrrhenian Sea, Marine Geology, 55: 271-289.

Dietrich, V., Emmerman, R., Puchett, H., Keller, J., 1978. Oceanic basalt from the Tyrrhenian basin, DSDP Leg 42A, Hole 373A. In Hsu, K.J., Montadert, L., et al., 1978. Initial Reports of the Deep Sea Drilling Project, Vol. 42, Part 1: Washington (U.S. Governmemt Printing Office): 515-530.

Duschenes, J., Sisha, M.C., Louden, K.E., in press. Seismic refraction experiment in the Tyrrhenian Sea. Geophysical Journal of the Royal Astronomical Society.

Fabbri, A., Gallignani, P., Zitellini, N., 1981. Geologic evolution of the Peri-Tyrrhenian sedimentary basins. F. C. Wezel (ed.). Sedimentary basins of Mediterranean margins, p. 101-126. CNR, Italian Project of Oceanography, Tecnoprint, Bologna.

Gasparini, C., Iannacone, I., Scandone, P., Scarpa, R., 1982. Seismotectonics of the Calabrian Arc. Tectonophysics, 84: 131-150.

Hutchison, I., Von Herzen, R., Louden, K., Sclater, J., Jemsek, J., 1985. Heat flow in the balearic and Tyrrhenian basins, Western Mediterranean. Journal of Geophysical Research, 90 (B1): 685-701.

Iaccarino, S. and Salvatorini, G., 1982. A framework of planktonic foramniferal biostratigraphy for Early Miocene to Late Pliocene Mediterrarean area. Paleontl. Stratigr. Evol., 2: 115-125.

Locardi, E., 1967. Uranium and Thorium in the volcanic processes. Bull. Volc., 31: 235-260.

Malinverno, A., Cafiero, M., Ryan, W.B.F. and Cita, M.B., 1981. Distribution of Messinian sediments and erosional surfaces beneath the Tyrrhenian Sea: Geodynamic implication. Oceanol. Acta. 4: 489-496.

Malinverno, A., and Ryan W., in press. The evolution of the Tyrrhenian Sea and of the Apenninic orogenic belt by arc migration. Tectonics.

Moussat, E., 1983. Evolution de la Mer Tyrrhenienne centrale et orientale et de ses marges septentrionales en relation avec la neotectonoque dans l'Arc Calabrais. These 3° Cycle, Universite P. et M. Curie, 122 p., 98 fig.

Moussat, E., Rehault, J-P., Fabbri, A., Mascle, G., 1985. Evolution geologique de la Mer Tyrrhenienne. C.R. Acad. Sc., Paris, 301, 7: 491-496.

Panza, G.F., Calcannile, G., Scandone, P., Mueller, S., 1980. La struttura profonda dell area Mediterrarea. Le Scienze, 141: 60-69.

Recq, M., Rehault, J.P., Steinmertz, L., Fabbri, A., 1984. Amincicement de la croute et accretion au centre du bassin Tyrrhenien d'apres la sismique refraction. Marine Geology, 55: 411-428.

Rehault, J.P., Moussat, E., Fabbri, A., in press. Structural evolution of the Tyrrhenian back-arc basin. Marine Geology.

Selli, R., Lucchini, F., Rossi, P., Savelli, C., and Del Monte, M., 1977. Dati Geologici, petrochimici e radiometrici sui volcani centro-tirrenici. Giorn.Geol., 2, 42, 1: 221-246.

Steinmetz, L., Ferrucci, F., Hirn, A., Morelli, C., and Nicolich, R., 1983. A 550 KM long moho traverse in the Tyrrhenian Sea from O.B.S. recorded Pn waves. Geophysical Research Letters, 10 (6): 428-431.

OPERATIONAL REPORT

The ODP operations personnel aboard JOIDES RESOLUTION for Leg 107 of the Ocean Drilling Program were:

| | |
|---|---|
| Supervisor of Drilling Operations: | Dave Huey |
| Special Tools Technician: | Mark Robinson |

Other operations personnel aboard JOIDES RESOLUTION were:

| | |
|---|---|
| AMOCO Engineer: | Joe Johnson |
| Schlumberger Logger: | Lee Geiser |

## INTRODUCTION

Leg 107 of the Ocean Drilling Program took the drillship JOIDES Resolution to the Tyrrhenian Sea. The voyage began 26 December 1985 when the vessel arrived in Malaga, Spain, and ended 18 February 1986 in Marseilles, France, after five days in port and forty-nine days at sea.

Operationally and scientifically the expedition was a complete success. All five primary plus two alternate drill sites were occupied and cored. Eleven holes were drilled, from which 1908.7 meters of core was recovered. Actual overall core recovery was 58%.

## MALAGA PORT CALL

Following a stop for fuel in Algeciras, Spain, JOIDES Resolution made port in Malaga at 2000 hours on December 26, 1985, marking the official beginning of Leg 107. Items that were accomplished as planned during the port call were crew change, off-loading of return freight, inspection of the bottomhole assembly to be used during the voyage, and completion of the ship's required annual ABS inspection.

Several significant items were missing from the planned equipment inventory at the time of departure, including the incoming ODP air freight, the Sedco air freight, a spare armature for the Top Drive, liquid helium and spare parts for the cryogenic magnetometer, a direct shipment of supplies for the drill pipe severing system and a new, towed 3.5-kHz transducer system. In spite of the missing shipments, the vessel debarked as scheduled, at 2020 hours on 30 December 1985, with the plan of receiving the materials by boat transfer while on site near Naples, Italy. The original operations plan, a west-to-east transect of first-priority sites, was reversed and the easternmost site, TYR 7B, was drilled first. This revised plan kept the vessel closer to Italy during the first several weeks to expedite the boat transfer of the missing shipments.

## MALAGA TO SITE 650

The ship approached the first site on the evening of 2 January 1986, after a brief stop off the southeast corner of Sardinia for compulsory annual test of the radio-direction finding equipment. The beacon was dropped at 2238 hours when the seismic profile observed in the underway geophysics lab corresponded accurately to the seismic lines used to select the site. The global positioning sytstem (GPS) position indicated about a one-mile discrepancy between the selected location and the site survey position established by Loran C. Such discrepancies hampered accurate site location throughout the voyage.

## SITE 650 (TYR 7B)

An APC/XCB bottomhole assembly (BHA) was run to the sea floor. This assembly was used in place of an RCB system to achieve better recovery during the coring of the upper section and to allow for magnetic orientation of the piston-cored sequence. If the XCB system reached "refusal" above the target (a reflector seen on seismic records at about 420 m BSF), a conventional RCB system could be washed down with minimum loss of time to complete coring in an adjacent hole.

## Hole 650A

The hole was spudded with a mudline APC core at 1435 on 3 January. Oriented piston cores with Von Herzen heat flow measurements at five core intervals were taken to Core 13H at 119 m BSF, where APC refusal was defined by consecutive overpulls of 70,000 and 100,000 lbs. XCB coring commenced with Core 14X. Uyeda probe-type heat flow measurements were taken to 200 m BSF, with the tool modified for compatibility with the APC/XCB bottomhole assembly. The hole remained extremely stable.

At 397 m BSF a distinct decrease in penetration rate occurred. Coring continued with relative ease of penetration (30-40 minutes per core) past the calculated depth of the higher velocity reflector. Hard contact with basement or a solid basalt sill occurred at 625.5 m BSF, where the penetration rate dropped suddenly to 1 m/hr. After 1.5 m of laborious penetration had been made, an attempt was made to retrieve the core barrel with the sandline, but the core barrel was firmly stuck. The remaining 7.1 m of the joint was drilled down, but the core barrel remained fixed and the pipe was tripped out. The stuck core barrel was removed from the BHA with difficulty; only 1.06 m of non-definitive rubble was in the core liner.

## Hole 650B

For Hole 650B, the vessel was offset 50 ft and an RCB BHA was made up and run to the sea floor with a center bit in place. The plan was either to wash to the total depth of Hole 650A and core through the basalt sill (or 50 m into basement), or to use the time for spot coring and heat flow measurements at shallower sub-bottom depths, until clearance to depart was received.

Departure approval from the Italian Navy arrived early in the process of washing down. A single heat flow measurement, using the Uyeda tool, was made at 102.4 m BSF and the pipe was tripped back on board. The bit was on deck at 2050 on 10 January.

## SITE 650 TO SITE 651

The vessel steamed 60 miles at better than 12 knots to the turning point for the beginning of the Site 651 survey. An adequate GPS "window" did not exist during the survey, but Loran C proved accurate. The beacon was dropped on the second pass over the site at 0522 on 11 January. The ship applied a 400-m offset to the east of the beacon to enable a possible relocation for a second hole 400 m west of the beacon. PDR depth was determined to be 3589 m.

## Hole 651A (TYR 5B)

A conventional RCB BHA and coring system were made up and the pipe was run to the sea floor. A punch core was taken at 1330 on 11 January, establishing mudline at 3590.9 m below rig floor (BRF). Three additional RCB cores were taken in soft ooze. An Uyeda probe-type heat flow tool was then deployed for an in situ temperature measurement. Cores 5R to 12R contained large amounts of loose coarse sand and pumice that appeared to be free flowing. Planned heat-flow runs at fourth core intervals were cancelled because of the danger of hole collapse during the 15 minutes the tool was imbedded in the sediment and the pipe could not be moved or fluid pumped.

At Core 13R a hard layer was encountered, and the hole drilled through this interval was probably close to gage diameter. Mud sweeps between cores, required earlier, were discontinued, the hole stabilized. RCB coring continued through soft and firm clays with stringers of soft sand. Wherever sand was encountered, core retrieval was followed with a 20-30 barrel mud sweep. RCB coring continued without incident until Core 42R, where basalt chunks were encountered (394 m BSF). Recovery was good in claystone and mudstone but little or nothing was recovered from pumice layers. From Core 43R to total depth (TD) at Core 58R, hard rock interspersed with a complex of alternate materials was encountered. From Core 54R to 58R, some overpull and torquing were experienced. During sandline core retrieval the bit tended to "ratchet" up the hole, indicating ragged hole conditions and probable ledges. Some fill was detected, and mud sweeps between cores were again used. The final cores were apparently in legitimate basement.

After Core 58R was recovered, the pipe was found to be stuck. Working and circulating for almost two hours were required to free it completely. At this point coring was terminated and the hole was swept with mud. The bit was released cleanly and the pipe was then pulled to logging depth of 141 m BSF.

After the logging line and tools were made ready, the pipe was picked up and found to be stuck again. An overpull of 100,000 lbs was required to free the pipe, as no rotation was possible with the top drive set back for logging. The circulating head was made up to the pipe so that the hole could be circulated continuously during logging.

The first logging suite (DIT-GR-SLS-CAL) was run into open hole to a depth of 332 m BSF, where an impassable bridge or ledge was encountered. The hole interval was logged successfully up to the pipe-up depth of 113 m BSF. A second logging run (LDT-CNL-NGT) was made to cover the same hole interval, but the tool would not pass an obstruction at 266 m BSF. The open hole interval was logged and the logging tools retrieved.

The pipe was then run into the hole in an attempt to open up the lower portion of the hole for logging the unreached basement. At a depth of 287 m BSF, the end of the pipe tagged a firm bridge and became stuck. The pipe was pulled and worked continuously with up to 155,000 lbs overpull, but would not come free. Water was pumped down the pipe at over 1000 gpm, but all indications were that the annulus was packed off and the formation was being charged. The top drive was picked up so that torque could be applied along with overpull, and the pipe was finally freed.

The hole was filled with weighted mud and the pipe was pulled clear of the mudline. At 2300 hours on 17 January, the ship got underway for Site 652.

SITE 651 TO SITE 652

The ship made the short transit to Site 652 at full speed for the first 80 minutes and then slowed to deploy the seismic gear. On the first pass over the proposed site, the bathymetry and seismic profiles both matched the survey lines, but on the return pass the vessel was on an apparent parallel course offset from the site. Using the best available combination of GPS positioning, transit satellites and dead reckoning, the vessel returned for a third pass on a good course, and the beacon was dropped at 0820 on 18 January.

Hole 652A (TYR 3A)

The conventional rotary core barrel (RCB) BHA was run with a C-3, long tooth core bit. A mechanical bit release (MBR) was included (the resupply of newer-style HBR components intended as freight to Malaga arrived while on Site 652). The PDR depth at the site was 3457 m, but showed signs of side echoes, suggesting that spud depth would likely be deeper. A water core was taken close to "PDR" depth. Actual bottom was located at 3470.5 m BRF with a mudline punch core at 1845 on 18 January.

Routine RCB cores in nannofossil ooze continued from the mudline down to Core 24R at 228.4 m BSF. Successful heat-flow runs were made after Cores 4R, 8R, 12R, 16R and 20R. While recovering the heat flow probe following Core 24R, the No. 1 sandline parted. Fortunately the lower portion of the line tangled itself into a knot and the heat flow tool was left suspended about 1000 m off bottom for 7-1/2 hours. After the downhole portion of the parted line and the heat flow tool were recovered, the sandline was restrung to the crown and routine coring resumed.

The hole was in excellent condition despite the wait for the sandline repair. Routine RCB coring continued with excellent recovery. At Cores 35R and 36R a bed of rounded pebbles was encountered, and only 0.9 m was recovered. Immediately below, mudstone laced with very thin evaporite layers was cored with excellent recovery and preservation. With Core 52R at 500 m BSF, the rate of penetration dropped from the 16 m/hr average of the previous 100 m of penetration to 9 m/hr and then to less than 5 m/hr in the space of four cores. The cores themselves did not give evidence of a change in lithology to account for this apparent resistance to penetration. Some improvements in ROP for specific cores were made (as high as 15.5 m/hr at Core 65R), but could not be sustained.

A drilling break indicating a soft layer at 683 m BSF was encountered in Core 72R. At Core 74R the ROP slowed suddenly to 2.1 m/hr and improved only slightly in the next core, where the hole was terminated. The core diameter during the last 24 hours of coring had decreased from 2-3/8" to 2-1/8", suggesting severe bit wear.

The hole was cleaned with a 20-barrel high-viscosity mud sweep and left full of sea water, the bit was released after two atempts, and the pipe was then pulled to the logging depth of 100.1 m BSF. The suite of logging tools (DIL-LSS-GR-CAL) stopped at a bridge at 370 m BSF, and the hole was logged up from there. A suite of slim logging tools (GST-CNT-NGT) was made up, but this second run was stopped by an impassable bridge at 275 m BSF and was forced to log up from there.

The pipe was then run to total depth without rotation or circulation, knocking out a weak bridge at 365 m BSF. Sea water was circulated for 30 minutes, and the pipe was pulled to 284 m BSF for a third logging run consisting of the GST-CNT-NGT combination. It was stopped at a bridge at 369 m BSF, so the interval from there to the bottom of the pipe was logged and the tool retrieved. The hole was filled with weighted mud and abandoned. The pipe end arrived on deck at 2120 hours, 28 January, as the ship got underway for Site 653 (TYR 2).

SITE 652 TO SITE 653

The short transit to Site 653 involved relocating and occupying DSDP Site 132. Accurate navigation proved difficult because of contradictions between Loran C and GPS navigation equipment and the pre-site survey seismic data. After the beacon was dropped at the presumed site, at 0158 hours on 29 January, the vessel continued to survey for about 3 km. Upon returning to the beacon, the navigation updates indicated a probable error in drop location, so an offset of 400 m west was made before coring began. Later comparison with DSDP records (that were not themselves entirely consistent) indicated that an error of up to 0.46 nm probably existed between the actual locations of Site 653 and DSDP Site 132.

Hole 653A (TYR 2)

Hole 653A was spudded at 1120 on 29 January, with an APC mudline core. Piston coring continued through core 13H to a depth of 117.3 m BSF when the problem of liner failure became acute enough to warrant abandoning piston coring in favor of the XCB. The XCB was picked up at core 14X and used until TD at 240.7 m BSF. A prototype venturi vent sub was used for the first time with the XCB system (see special tools section of this report), and it appeared to help retrieve undisturbed, high-recovery cores. Recovery was comparable to piston coring and only the advantage of magnetic orientation was lost by switching to XCB coring. Von Herzen type heat flow measurements were made every fourth core, while piston coring and Uyeda probe-type temperature measurements were taken at two more intervals in the XCB sequence.

The sought-after Messinian evaporites were encountered at 224.5 m BSF, according to a marked reduction in ROP. One further core into the presumed evaporites was taken before the hole was terminated, and the pipe was then pulled to 70 m BSF. Preparations were made to deploy the underwater TV system in a special exercise to view the seafloor condition of Hole 653A, attempt a coneless re-entry, and observe the mudline APC core starting Hole 653B (see TV deployment section of this report). The bit cleared the seafloor ending Hole 653A at 1538 hours on 31 January.

Hole 653B

The TV-viewed APC core to start Hole 653B contained 6.1 m, and the next core was advanced 11.5 m to provide for a 4-m overlap between the cores in the two adjacent holes. Piston coring continued through core 8H, where the familiar liner failure problems reappeared. The switch to XCB coring was made immediately, to take advantage of its proven ability to provide better core preservation in this particular formation.

The venturi-sub-modified XCB performed even better in Hole 653B than in Hole 653A; recovery averaged 96.3% through core 23X. In core 24X at 222 m BSF, the gypsum evaporite sequence was again cored with some difficulty. Recovery in the evaporites was mediocre; 40 m of penetration was made.

The hole was filled with weighted mud and the pipe was pulled. The bit was on deck at 0355 on 3 February as the ship got underway for site TYR 1B.

## SITE 653 TO 654

The 6-1/2 hour transit to the next site was accomplished routinely with good navigational fix information from both Loran C and GPS. The beacon was dropped at 1040 on the first pass. The vessel then returned to the site as usual.

## Hole 654A (TYR 1B)

The standard RCB BHA, with a new RBI, C-3 bit and new hydraulic bit release, was made up and run to the seafloor. A mudline punch core was taken at 1611 on 3 February, establishing the water depth at 2218.4 m by DPM. Routine coring continued in soft ooze, using virtually no circulation to avoid washing away the soft material. At core 9R (71 m BSF), within the ooze sequence, an unexpected 2-m layer of solid basalt was cored with 0.24 m recovered. Below that the sediment became gradually stiffer but presented no penetration problems.

At 249.5 m BSF the first of the anticipated Messinian evaporites was identified by a drastic reduction in ROP coupled with moderate vibration and jumping of the entire drillstring. This continued for the final two meters of core 27R. When recovered, the core was found to contain about a half meter of hard, green-veined gypsum. The top 1.5 m of the next core drilled in the same manner, indicating more of the same gypsum. The JOIDES Safety Panel had established specific strictures for the coring operations at this site at the time of site approval: one of these was that drilling would terminate if a Messinian evaporite layer capable of forming a cap structure was encountered. Defining this to mean an impermeable gypsum layer of 3-4 m in thickness, core 28R was continued after a drilling break demonstrated that the first gypsum layer had been only 3-1/2 m thick. The mud recovered from below the gypsum layer was tested for hydrocarbons by both vacutainer and head space analysis. Less than 5 ppm methane was measured and no heavier hydrocarbons were found.

At least five discrete layers of gypsum a meter or more in thickness, interbedded with mud, were penetrated in the next 62.5 m. No methane readings in excess of 6 ppm were recorded in samples from the interbedded mud layers. The evaporites terminated at 312 m BSF and ROP increased as firm laminated mudstones were penetrated.

At about 350 m BSF, a hydrocarbon show appeared as two 1-mm thick laminae visible only in the split core under black light. Several pinhead-sized specks of the same material were found in the next two cores. These were determined by extract analysis to be asphaltines with all volatile hydrocarbons lighter than $C_{13}$ long since departed. $C_1$, $C_2$, and $C_3$ volumes measured by headspace analysis from samples of the normal formation in this interval peaked out at

12, 1, and 2 ppm, respectively and then quickly decreased in the next two cores to the normal background level of 3 ppm methane with no detectable heavier hydrocarbons.

Coring continued (in search of basement) into a conglomerate containing pebbles of all sizes. Recovery in the conglomerate sequence dropped to generally less than one meter per core. After six cores in the unstable mixture, no hard basement had been encountered, and torquing and a momentarily plugged bit were experienced while cutting core 51R. Core 52R had fill from the bottom of the hole and core 53R came up empty. A core barrel with a bit deplugger was dropped downhole in case the throat of the bit was clogged. While recovering the bit deplugger barrel, the pipe became stuck and was freed only after 3-1/2 hours of strenuous working of the pipe, with up to 265k lbs overpull. The bit immediately was pulled two stands up-hole where hole conditions were assumed to be stable. It was obvious that continuation of the hole would not be advisable.

Two unsuccessful attempts were made to release the bit in order to log the hole. The first attempt was while the pipe was stuck. The second was after the pipe was worked free and pulled uphole. In both cases the HBR failed to respond to normal activation pressurs. The pipe was pulled to a depth of 320.6 m BSF, a 50-bbl cement plug was set across the evaporite sequence (approximately 100 m thick), and the hole was abandoned. On deck the HBR mechanism was inspected: The only evidence of the cause of the bit-release failure was the presence of sand in the moving parts, although it was not clear when in the sequence of events the grit had penetrated into the mechanism.

The bit arrived on deck at 1515 on 8 February, and the ship was under way at full speed for Site 655 by 1530 hours.

SITE 654 TO 655

The approach to the next site was made without streaming seismic gear, because the desired location was on top of a distinct north-south ridge which could be readily identified using echo-sounding equipment alone. At 2200 hours the vessel crossed the ridge crest at 3 kts. The beacon was dropped at 2340 on 8 February, as close to the crest as could be determined.

Hole 655A (TYR 5A)

Site 655 (TYR 5A) had originally been thought to be a difficult hole to spud, being on top of a slight rise with little or no sediment cover to stabilize the BHA while starting the hole. Processed seismic data reaching the scientific party shortly before the departure of the cruise, however, indicated that the subsurface velocity of the material overlying the hard basement on top of the rise was low enough to probably be soft sediment. In fact, up to 165 m of soft ooze and marl were expected. The primary objective was to sample the unknown basement formation, but not with any significant penetration. Since this was the case, and the sedimentary sequence was of value, the APC/XCB bottomhole assembly was made up and run to the seafloor in order the maximize the opportunity for good core preservation and recovery.

The hole was spudded with a good mudline core at 1115 on 9 February and oriented piston coring continued for eight cores. Von Herzen heat flow measurements were taken successfully with cores 4H, 6H and 8H. Indications of liner overload forced a switch to XCB coring starting with core 9X. In core 10X at 80 m BSF, altered basalt chunks were cored with poor recovery, suggesting a rubble zone. Penetration was very slow (practically zero at times) and three short cores were brought up in order to experiment with different cutting shoes on the XCB. Nothing improved the recovery (less than one meter per core) or poor penetration rate. The hole was terminated (at 90.4 m BSF) to leave time to trip the pipe for the RCB system, since significant further penetration was desired and the basalt "rubble" was expected to continue for some depth.

Hole 655B

The pipe was pulled to the surface and the bottomhole assembly was changed for the RCB coring system, an HBR, and McCullough "torque" jars to help in the event of stuck pipe. The pipe was run back to bottom with a center bit in place and the hole was drilled to 81.2 m BSF before RCB coring resumed. The "basalt rubble" found in Hole 655A turned out to be highly altered and fractured basalt. The core recovery and penetration rate with the RCB system were good (ROP: 4.6-16.2 m/hr; recovery: 40%) and continued so until core 12R, where the hole was terminated at 196.1 m BSF in somewhat more dense basalt.

The bit was released, the pipe was pulled to 87.8 m BSF and the logging equipment was rigged up. Logging run #1 (DIT-CAL-GR-SONIC) was accomplished with the suite of tools reaching TD after one minor hang-up on an apparent ledge. A second logging run with the Lamont borehole televiewer (BHTV) was aborted when the tool's cablehead flooded as the tool was being lowered inside the pipe. The BHTV was recovered, the logging equipment was rigged down, and the vessel got under way at a speed of one knot at 1355 on 13 February while the pipe was being pulled from the hole.

SITE 655 TO 656

When the bit was on deck, the thrusters were pulled and the vessel made full turns for about forty minutes before slowing to 6 kts to stream seismic gear for the pre-Site 656 survey. The beacon was dropped on the first pass at 1600 hours and the seismic gear was recovered as the vessel made its way back over the site, offset 400 m west of the beacon.

Hole 656A (TYR 4)

The RCB BHA was made up with the McCullough torque jars and center bit, and run to the seafloor. The hole was spudded at 0100 on 14 February; the mudline was tagged at 3606 m BRF and the hole was washed without coring to about 100 m BSF. Coring began at 102.8 m BSF and continued through firm ooze and breccia until core 10R (at 197.8 m BSF) came up with 0.4 m of sediment. The next four cores were apparently all from a loose sand interval and the total recovery for all five was 0.96 m. While preparing to drop the core barrel for core 14R the pipe was found to be plugged and stuck. The torque jars were activated and the pipe was eventually freed. The plug inside the pipe could not be dislodged and circulation could not be reinstated.

The pipe was pulled clear of the seafloor at 0625 on 15 February and the vessel was offset in DP mode to the location chosen Hole 656B, some 580 m east. During the move the pipe was left suspended about two stands above the seabed while attempts were made to clear out the plug and regain circulation. When the ship steadied up on the new location, circulation still had not been achieved. The pipe was pulled to the deck and the entire Outer Core Barrel was found packed off with sand and mud. This material was washed away with a high pressure hose, and the center bit was landed in place before starting the pipe trip to the seafloor one last time.

Hole 656B

Hole 656B was spudded at 2100 on 15 February, in 3606 m of water. This hole is up-dip from the original site in a location where seismic data indicated that the syn-rift sequence that had contained so much unstable sand would be either thin or entirely absent. As the superficial sediment cover would also be thinner, the hole could be safely washed to only about 50 m BSF without the risk of missing the syn-rift/pre-rift contact. The hole was drilled with a center bit to 55.5 m BSF, where the center bit was pulled and RCB coring commenced. Seven cores were taken to a sub-bottom depth of 121.8 m BSF. At that point, time for coring operations had expired and the final pipe trip out of the hole was begun.

SITE 656 TO MARSEILLE

The pipe was pulled to the deck and the vessel was under way at 1845 on 16 February. The transit from the Tyrrhenian Sea to Marseille, France, took the ship through the Strait of Bonafacio between the French island of Corsica and the Italian island of Sardinia. After just over one day of steaming, the first line was on the pier in Marseille at 0642 hours on 18 February, marking the official end of Leg 107.

UNDERWATER TV DEPLOYMENT EXERCISE - SITE 653

The underwater TV system was deployed between Holes 653A and 635B with the following objectives:

1) to provide a dress rehearsal for Leg 109 TV deployments,
2) to observe the hole made in soft sediment after routine, single-bit coring operations,
3) to observe pulling out of the hole and attempt re-entry, and
4) to observe a mudline piston core shot.

The crew had no problems deploying or retrieving the VIT frame. The upper guidehorn was pulled and reinstalled when the VIT was deployed and again when it was recovered. The camera performed up to expectations. About three hours of videotapes were recorded, but visibility was not as impressive as the scenes on the Leg 106 videotapes, probably due to a high plankton level in the warm (57$^{O}$F) bottom waters.

The pipe was left 70 m BSF in the Hole 653A until the camera arrived at the bottom. The hole itself appeared as a faint 6-8 ft diameter crater with some dark cuttings visible downslope and down-current from the crater lip. The crater's depth was indistinguishable. The hole was clearly bridged across to the sides of the drill collar with no annulus visible. Sediment clouds were made as the pipe heaved but a steady bottom current swept them slowly away.

The bit was pulled out of the hole and the pipe immediately slewed sideways 25-50 ft, dragging the seafloor until the bit was pulled completely clear. The hole disappeared off the screen and did not reappear despite random movements of the vessel and pipe. It is doubtful that the hole could have been visually located again even if a slow, painstaking search had been conducted. The seafloor appeared featureless and the hole itself had been indistinct even with the pipe still in it.

The re-entry attempt was abandoned and the APC was run to the bit. The core barrel was landed very gently to avoid premature failure of the shear pins. While attempting to pressure up for the core shot one of the hydraulic lines to the wireline BOP failed and the BOP partially opened. Before the problem could be identified the shear pins gave out, probably due to heave-induced fatigue. The core barrel slid out the end of the bit slowly and penetrated the seafloor anticlimatically. As the APC was retrieved, it was obvious that the core barrel had been holding the pipe in place on the seafloor against the mild tendency of the pipe to swing away in response to random positioning movements and bottom current.

## DRILLING AND CORING EQUIPMENT

### Bottom Hole Assemblies

Two standard BHAs were used during the cruise with minor variations: one for RCB coring and another for APC/XCB coring. When logging was anticipated, one of three types of bit releases was included directly above the core bit: old style hydraulic bit release (HBR), mechanical bit release (MBR) or the newest version of the hydraulic bit release (HBR-107). The APC/XCB BHA used at Holes 650A, 653A, 653B, and 655A consisted of: 11-7/16" x 3.80" APC/XCB core bit, MBR (Long Bit Sub at 653), Seal Bore drill collar (DC), Landing/saver Sub, Long Top Sub with Double Window Latch Sleeve, Head Sub, Non-magnetic DC, Seven 8-1/4" DC's, crossover (XO), 7-1/4" DC, XO, one stand of 5-1/2" drill pipe. The RCB BHA used at Holes 650B, 651A, 652A, 654A, 655B, and 656A, 656B was: 9-7/8" core bit, bit release, Outer Core Barrel, Long Top Sub, Head Sub, seven 8-1/4" DC's, XO, 7-1/4' DC's, XO, one stand of 5-1/2" drill pipe. At Holes 655B, 656A, and 656B a McCullough double-acting rotary "torque" jar was included in the BHA just under the top two 8-1/4" DC's. The jars were credited with greatly helping free the pipe during a stuck-pipe incident at Hole 656A. The pipe was stuck earlier in the voyage at Holes 651A and 654A and in both cases required a great deal more effort to free than at Hole 656A.

### Bit Releases

The last old-style HBR was used to release the bit for logging at Hole 651A. The HBR held pressure for about 8 minutes and then released suddenly. An MBR was used to release the bit at Hole 652A and functioned flawlessly. The new HBR-107 got its first trial at Hole 654A. At the end of the hole, the pipe became firmly stuck and was worked (with good circulation) for several hours, using some overpulls up to 265,000 lbs. Then the HBR go-devil was pumped down to attempt to release the bit as a means to help free the stuck pipe. The HBR apparently did not activate, but shortly thereafter the pipe was worked free. With the pipe hanging in the hole well above bottom a final unsuccessful attempt was made to release the bit. The go-devil was retrieved and the pipe was pulled. On deck the HBR release sleeve was found to be completely shifted and locked in the "disengage" position by a quantity of sandy grit that had been ingested into almost all cavities of the mechanism. The same grit had apparently prevented the HBR parts from separating and releasing the bit. It could not be determined whether the grit had entered the mechanism during the routine coring operations or as a result of the attempt to shift the bit while the pipe was stuck in the hole. The HBR-107 was again deployed in Hole 655B where it activated properly and released the bit after two pressure-up cycles and tagging bottom with the bit.

## Transition Stand above the BHA

In the previous year several different stands of 5-1/2" drill pipe have been used in the transition from the BHA to 5" drill pipe. Three such stands were on top of the 5-1/2"-pipe racker at the start of Leg 107. Since accurate records of which joints had been in service the longest were not available, the best-appearing three joints were selected for the transition stand on Leg 107 and the remaining six joints were removed to the riser hold for later disposal.

## Core Liners

Several incidents of failed butyrate core liners were experienced, although the frequency of failures was significantly lower than during recent legs. The failures may well have been due to the unusually warm mudline water temperatures in the Mediterranean (57$^{O}$F as compared to about 35$^{O}$F in the major oceans) and mild on-deck temperatures. There seems to be a correlation between service temperature, both in the water and on deck, and frequency of core liner failures. Enough failures occurred to force early changeovers from APC to XCB coring at two sites. A more rugged core liner is needed.

## SPECIAL TOOLS REPORT

Both the Advanced Piston Corer (APC) and the Extended Core Barrel (XCB) systems were used in Holes 650A, 653A, 653B, and 655A. The APC in Hole 650A was totally trouble-free. In Hole 653A, the sticky, expanding sediments in cores 10H thru 13H caused severe liner failures, so the APC system was abandoned despite ease of penetration and low overpull. Hole 653B was cored with APC until core 8H, when the liner came up collapsed. All of the APC cores were oriented with the Eastman Whipstock Multiple Shot Survey Instrument. A successful Von Herzen heat flow program was used on the APC cores.

The XCB system was used on Hole 650A with fair recovery until the barrel got stuck while cutting core 69X. Several unsuccessful attempts were made to recover the core barrel. After pulling out of the hole the major problem was found to be the cutting shoe box, which had swelled to over 4 inches diameter. This caused it to become stuck under the 3.8-inch I.D. of the guide ring. Hole

655A was XCB-cored until basalt and limestone rubble were encountered. The new Venturi Vent Subs were used on Holes 653A and 653B. Both 3/4-inch and 1-inch Venturi nozzles and orifices were used and produced remarkable recovery and lack of disturbance. Good "Uyeda" heat flows were obtained between the XCB cores.

The Rotary Core Barrel (RCB) System was used in Holes 651A, 652A, 654A, 655B, 656A, and 656B, with fair-to-good recovery and no operational problems. Successful "Uyeda" heat flow runs were done on RCB Holes 651A, 652A, and 654A.

## LOGGING SUMMARY

Pre-cruise plans consisted of logging at Sites 650, 651, 652 and 654. Logging operations were conducted at Sites 651, 652 and 655 (TYR 4, second priority). Site 650 could not be logged due to a stuck XCB core barrel. Site 654 could not be logged because of stuck drill pipe and the ensuing failure of the HBR.

### Site 651

Logging operations began at Site 651 at 2200 hours on 16 January. The bit was released and the pipe tripped up to 119 m BSF. Run 1 (DIL-LSS-GR- CAL) was put in the hole at 0100 on 17 January and was back on deck at 0600. The tool experienced difficulty running in, and could not be passed below 332 m BSF. The second run (LDT-CNT-NGT) was run in at 0600 and was back on deck at 1200. This string would not pass below 266 m BSF. Attempts to clear the hole with the drillstring failed when the pipe became stuck at this same depth, and logging operations were terminated at 1600 on 17 January.

### Site 652

Logging operations at Site 652 began at 0330 on 27 January. The bit was released and the pipe was tripped up to 72 m BSF. Run 1 (DIL-LSS-GR-CAL) was put in the hole at 0700 on 28 January and was back on deck at 1300. The tool experienced considerable difficulty running in, and could not be passed below 370 m BSF. The second suite (GST-CNT-NGT) was run in at 1400 and was back on deck at 2300. This string would not pass below 275 m BSF. Drill pipe was run back into the hole to clear the hole to total depth. At 0430 on 28 January the GST-CNT-NGT combination was run back into the hole to recover data over the deeper interval. This time the tool string stopped at 372 m BSF. Logs were recorded up with a sufficient overlap. An extremely washed-out hole adversely affected the log quality, so no further runs were planned. Logging operations were rigged down at 1130 on 28 January.

### Site 655

Logging operations began in Hole 655B at 2315 on 12 February. The bit was released and the pipe tripped up to 70 m BSF. Run 1 (DIL-LSS-GR-CAL) was put in the hole at 0200 on 13 February. The tool was run in through basalt and reached TD (195 m BSF) with only minor difficulties. A satisfactory log was recorded and the tool was back on deck at 0630. At 0720 the borehole televiewer (BHTV) was run in the hole. The tool failed at 30 m below the water surface, probably from a leak in the cablehead. An extremely tight timetable did not permit re-heading the cable, so the tool was pulled out of the hole and logging equipment was rigged down. Logging operations terminated at Site 655 at 0900 on 13 February.

An additional sinker weight was built to fit the bottom of the BHTV. Constructed from a cement-filled core barrel, this device adds 200 lbs to the tool weight and nothing to the rig-up time. No noticeable slackening of the cable was observed while running the televiewer in at Site 655.

## HYDROCARBONS

Hydrocarbon safety was not an issue at any site except Sites 653 (TYR 2) and 654 (TYR 1B). Hydrocarbon background levels at Site 653 were recorded for critical comparison while drilling Site 654, but the precaution proved unnecessary as light hydrocarbon levels remained very low (never higher than 12 ppm methane at any site). Traces of asphaltines were found in one core of Site 654 but were determined to be benign "dead oil". The traces quickly disappeared in the succeeding two cores and no further significant hydrocarbon shows were observed.

## WEATHER

The weather patterns in the Tyrrhenian Sea proved to be volatile. High winds, rain, some hail, and heavy seas were experienced every few days throughout the voyage but had no ill effects on operations beyond discomfort and some loss of efficiency for crew members working outside.

## PERSONNEL AND EQUIPMENT TRANSFERS

A seagoing tug, Jumbo Primo, arrived alongside from Naples at 0115 on 22 January with the freight items that had arrived in Malaga too late for loading during the port call. The boat also brought mail, fresh produce, and a temporary Catermar cook.

On the same day at 1540 hours a helicopter from Rome arrived carrying a film crew from the Dutch National Television Company. The helicopter departed moments after landing, taking a scientist who had requested medical evacuation for seasickness. The film crew stayed on board for three days and filmed aspects of life and labor aboard the vessel, including interviews with scientists and operations on the rig floor.

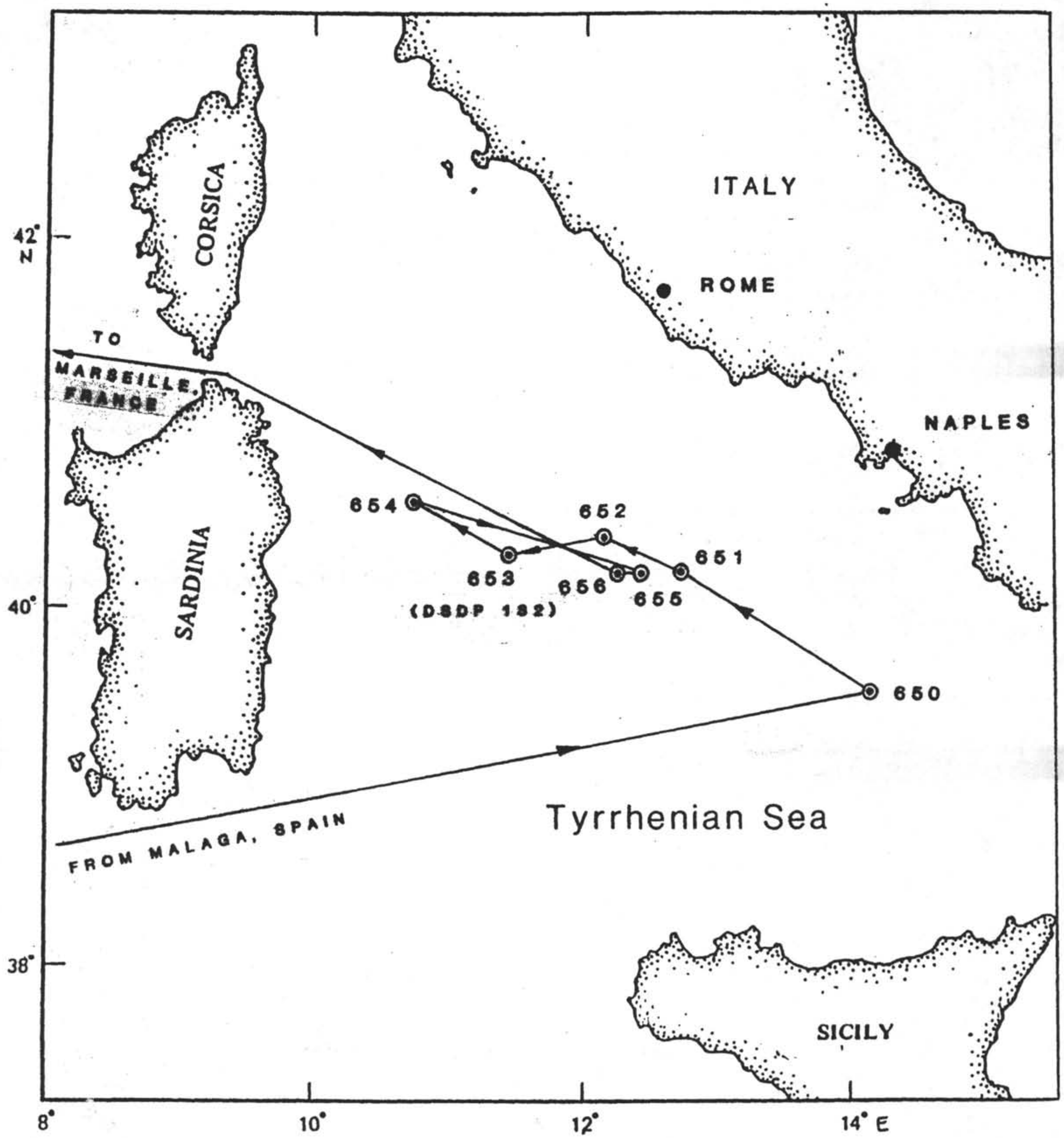
The helicopter returned at 0800 hours on 25 January with an ODP draftsman and left a few minutes later with the satisfied film crew.

## SHIPBOARD PARTY

The entire leg was characterized by high morale, efficient work habits, complete professionalism and exemplary cooperation between all elements of the shipboard complement: Sedco, ODP staff, scientists and Catermar.

# OCEAN DRILLING PROGRAM
## TIME DISTRIBUTION
## LEG 107

| | |
|---|---|
| Total Days (December 26, 1985-February 18, 1986) | 53.49 |
| Total Days in Port | 4.01 |
| Total Days Cruising including Site Survey | 6.28 |
| Total Days on Site | 43.20 |
| Trip Time | 5.70 |
| Drilling Time | 0.54 |
| Coring Time | 29.65 |
| Logging Time | 3.39 |
| Mechanical Repair Time | 0.31 |
| Wait on Weather | 0.00 |
| Other Miscellaneous | 3.61 |
| Total Distance Traveled (Nautical Miles) | 1503 |
| Average Speed Knots | 11.8 |
| Number of Sites | 7 |
| Number of Holes Core | 11 |
| Total Cores Attempted | 353 |
| Total Meters Cored | 3297.4 |
| Total Meters Recovered | 1908.7 |
| Total Meters Drilled | 341.9 |
| Total Meters of Penetration | 3639.3 |
| Percent Recovered | 57.9 |
| Maximum Penetration | 721.1 |
| Maximum Water Depth | 3606.0 |


ITALY
CORSICA
ROME
NAPLES
TO
MARSEILLE,
FRANCE
SARDINIA
654
652
651
653
656
655
(DSDP 132)
650
Tyrrhenian Sea
FROM MALAGA, SPAIN
SICILY
42°
N
40°
38°
8°
10°
12°
14° E

OCEAN DRILLING PROGRAM
BEACON SUMMARY
LEG 107

| SITE NO. | MAKE | FREQ. KHz | SERIAL NUMBER | SITE TIME HOURS | WATER DEPTH | REMARKS |
|---|---|---|---|---|---|---|
| 650 | Datasonics | 15.5 | 228 | 191.2 | 3529.0 | Good operation Model 352 |
| 651 | Datasonics | 14.5 | 230 | 185.6 | 3590.9 | Good operation Model 352 |
| 652 | Datasonics | 16.5 | 235 | 253.0 | 3470.5 | Good operation Model 352 |
| 653 | Datasonics | 15.5 | 234 | 121.9 | 2831.0 | Good operation Model 352 |
| 654 | Datasonics | 14.5 | 227 | 124.6 | 2218.4 | Good operation Model 352 |
| 655 | Datasonics | 16.5 | 229 | 110.1 | 3330.8 | Good operation Model 352 |
| 656 | Datasonics | 15.5 | 231 | 74.7 | 3606.0 | Good operation Model 352 |

OCEAN DRILLING PROGRAM
SITE SUMMARY
LEG 107

| HOLE | LATITUDE | LONGITUDE | DEPTH METERS | NUMBER OF CORES | METERS CORED | METERS RECOVERED | PERCENT RECOVERED | METERS DRILLED | TOTAL PENET. | HOURS ON HOLE | HOURS ON SITE |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 650A | 39 21.41N | 13 54.02E | 3529.0 | 69 | 633.8 | 364.05 | 57.4 | -0- | 633.8 | 160.9 | |
| 650B | 39 21.44N | 13 54.05E | 3529.0 | -0- | -0- | -0- | -0- | 102.4 | 102.4 | 30.3 | |
| | TOTAL 650 | | | 69 | 633.8 | 364.05 | 57.4 | 102.4 | 736.2 | | 191.2 |
| 651A | 40 09.03N | 12 45.39E | 3590.9 | 58 | 550.9 | 187.75 | 34.0 | -0- | 550.9 | 185.6 | 185.6 |
| 652A | 40 21.30N | 12 08.59E | 3470.5 | 74 | 721.1 | 445.32 | 61.7 | -0- | 721.1 | 253.0 | 253.0 |
| 653A | 40 15.86N | 11 26.99E | 2831.8 | 26 | 240.7 | 211.28 | 87.8 | -0- | 240.7 | 61.7 | |
| | | | | UNDERWATER TV DEPLOYMENT EXCERCISE | | | | | | 1.7 | |
| 653B | 40 15.86N | 11 26.99E | 2831.4 | 28 | 262.3 | 219.08 | 83.5 | -0- | 262.3 | 58.5 | |
| | TOTAL 653 | | | 54 | 503.0 | 430.36 | 85.6 | | 503.0 | | 121.9 |
| 654A | 40 34.76N | 10 41.80E | 2218.4 | 53 | 483.4 | 239.83 | 49.6 | -0- | 483.4 | 124.6 | 124.6 |
| 655A | 40 10.33N | 12 27.90E | 3330.8 | 12 | 90.4 | 77.38 | 85.6 | -0- | 90.4 | 49.8 | |
| 655B | 40 10.32N | 12 27.93E | 3330.8 | 12 | 114.9 | 48.93 | 42.6 | 81.2 | 196.1 | 60.3 | |
| | TOTAL 654 | | | 24 | 205.3 | 126.31 | 61.5 | 81.2 | 286.5 | | 110.1 |
| 656A | 40 11.06N | 12 11.03E | 3606.0 | 14 | 133.6 | 58.69 | 43.9 | 102.8 | 236.4 | 46.0 | |
| 656B | 40 11.09N | 12 11.45E | 3606.0 | 7 | 66.3 | 56.39 | 85.0 | 55.5 | 121.8 | 28.7 | |
| | TOTAL 656 | | | 21 | 199.9 | 115.08 | 57.6 | 158.3 | 358.2 | | 74.7 |
| GRAND TOTALS | | | | 353 | 3297.4 | 1908.7 | 57.9% | 341.9 | 3693.3 | | 1061.1 |

OCEAN DRILLING PROGRAM
LOGGING SUMMARY
LEG 107

| HOLE | TOTAL DEPTH METERS | WATER DEPTH METERS | OPEN ENDED PIPE AT METERS | FLUID IN HOLE | BIT SIZE | TOTAL TIME FOR LOGGING (HOURS) | RUN NO. | LOGS RECORDED | FROM METERS | TO METERS | OBSERVATIONS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 650A | 4162.8 | 3529.0 | | | | -0- | | | | | Core barrel stuck/POOH at 634 mbsf |
| 651A | 4141.8 | 3590.9 | 3710 | Seawater | 9-7/8 | 2200-0600 | 1 | DIL/LSS/ GR/CAL | 3931 | 3710 | |
| | | | | | | 0600-1200 | 2 | LDT/CNL/NGT | 3851 | 3710 | |
| | | | | | | 1200-1600 | Wiper | | 3851 | 3710 | Pipe stuck while picking up top drive |
| 652A | 4191.6 | 3470.5 | 3542 | Seawater | 9-7/8 | 0330-1430 | 1 | DIL/LSS | 3842 | 3542 | |
| | | | | | | 1430-2330 | 2A | GST/CNL/NGT | 3745 | 3542 | |
| | | | | | | 2330-0430 | -- | Wiper Trip | 3900 | 3570 | |
| | | | | | | 0430-1130 | 2B | GST/CNL/NGT | 3840 | 3728 | Firm bridge at 3840 |
| 655B | 3526.9 | 3330.8 | 3401 | Seawater | 9-7/8 | 0015-0630 | 1 | DIL/LSS/ GR/CAL | 3526 | 3401 | |
| | | | | | | 0630-0900 | 2 | BHTV | --- | --- | BHTV Failed |

OCEAN DRILLING PROGRAM
BIT SUMMARY
LEG 107

| HOLE | MFG | SIZE | TYPE | SERIAL NUMBER | METERS CORED | METERS DRILLED | TOTAL PENET | CUMULATIVE METERS | HOURS THIS HOLE | TOTAL HOURS | CONDITION | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 650A | RBI | 11-7/16 | APC XCB | AE3465 | 633.9 | -0- | 633.9 | 633.9 | 22 | 22 | BT1-B4-I | Retired |
| 650B | RBI | 9-7/8 | C-3 | AP637 | -0- | 102.4 | 102.4 | 102.4 | 1 | 1 | T1-B1-I | |
| 651A | RBI | 9-7/8 | C-4 | AT132 | 550.9 | -0- | 550.9 | 550.9 | 20.5 | 20.5 | Released | |
| 652A | RBI | 9-7/8 | C-3 | AT122 | 721.1 | -0- | 721.1 | 721.1 | 60.2 | 60.2 | Released | |
| 653A | RBI | 11-7/16 | APC XCB | AS813 | 240.7 | -0- | 240.7 | 253.7 | 6.7 | 8.2 | Continued in B-Hole | RR |
| 653B | RBI | 11-7/16 | APC XCB | AS813 | 262.3 | -0- | 262.3 | 516.0 | 13.3 | 21.5 | T1-B2-IG | RR |
| 654A | RBI | 9-7/8 | C-3 | AT125 | 483.4 | -0- | 483.4 | 483.4 | 35 | 35 | T3-B7-1/8 | Retired |
| 655A | RBI | 11-7/16 | APC XCB | AS813 | 90.4 | -0- | 90.4 | 606.4 | 3.6 | 22.1 | T2-B2-I | RR |
| 655B | RBI | 9-7/8 | C-3 | AP637 | 114.9 | 81.2 | 196.1 | 298.5 | 18 | 19 | Released | RR |
| 656A | RBI | 9-7/8 | C-3 | AS010 | 133.6 | 102.8 | 236.4 | 698.4 | 5.7 | 25.7 | Continued in B-Hole | RR |
| 656B | RBI | 9-7/8 | C-3 | AS010 | 66.3 | 55.5 | 121.8 | 820.2 | 3.3 | 29 | T4-BT-1/8 | Retired |

# TECHNICAL REPORT

The ODP technical and logistics personnel aboard JOIDES Resolution for Leg 107 of the Ocean Drilling Program were:

| | |
|---|---|
| Laboratory Officer: | Ted "Gus" Gustafson |
| Senior Marine Technician: | Brad Julson |
| Curatorial Representative: | Bob Hayman |
| System Manager: | Bill Meyer |
| Chemistry Technician: | Larry Bernstein |
| Chemistry Technician: | Tamara Frank |
| X-Ray Technician: | Bettina Domeyer |
| Electronic Engineer: | Bill Robinson |
| Electronic Technician: | Dwight Mossman |
| Yeoperson: | Gail Peretsman |
| Photographer: | Roy Davis |
| Marine Technician: | Wendy Autio |
| Marine Technician: | Henrike Groschel |
| Marine Technician: | Harry "Skip" Hutton |
| Marine Technician: | Jessy Jones |
| Marine Technician: | Mark "Trapper" Neschleba |
| Marine Technician: | Gregory Simmons |
| Marine Technician: | John Weisbruch |

## INTRODUCTION

Leg 107 began in Malaga, Spain, on 27 December 1985, and ended in Marseille, France, on 18 February 1986, following 48-1/2 operating days at sea. A total of 11 holes were drilled at seven sites, recovering 1980.7 meters of core from which more than 11,500 samples were taken for shipboard and shorebased studies. Downhole logging was attempted at three sites, and underway geophysical data were routinely collected for site surveys.

## MALAGA PORT CALL

Technician crossover activities took place on 28 December, 1985. Service calls for the Xerox, Magnavox GPS and ARL X-ray fluorescence unit were accomplished in Malaga. Ship tours for the press, Spanish authorities and the public were held throughout the port call period. Airfreight difficulties for both Sedco and ODP resulted in lost or misrouted air freight shipments. The missing shipments were eventually located after the ship sailed from Malaga, and were forwarded to Naples, Italy, where a seagoing tugboat was chartered to deliver the freight to the ship while on site. The ship departed Malaga on the evening of 30 December 1985.

## CRUISE ACTIVITIES

Changes in site scheduling forced us to remain flexible with respect to timing as scientific objectives were accomplished at the various drilling locations. The downhole logging program achieved limited successes in poor hole conditions at three site locations. Time considerations precluded a more extensive logging program. Both the Uyeda and Von Herzen heat flow tools were used extensively at six of the seven sites with great success. The multishot tool was used for core orientation in the HPC holes. It was also used for drift measurements in other holes.

The sub-sea camera was used after completion of Hole 653A in an attempt to observe the hole prior to clearing seafloor with the drill bit. The hole was indistinct on a featureless seafloor and after pulling completely clear of the seafloor it was impossible to relocate the hole, precluding a re-entry attempt. The spud-in of Hole 653B with the APC system was observed with the camera. The sub-sea camera system is potentially a versatile tool, but it requires some modifications to suit intended applications.

The seagoing tugboat Jumbo Primo rendezvoused with the ship at Site 653 and delivered the delayed freight and supplies along with fresh fruit and vegetables. Later the same day, we were joined by a Dutch film crew who arrived by helicopter. On the return flight to Italy the helicopter transported a seasick scientist who wished to go home. The helicopter returned several days later, bringing to the ship an ODP draftsman and returning to Italy with the film crew.

Geophysical gear was not routinely deployed on transits except for site selection and related survey requirements. Navigation header data were routinely collected on all transits. Navigation was enhanced by the use of

Global Positioning System (GPS) satellites as well as regular satellite navigation and conventional methods. The GPS will be upgraded in Marseille to allow for accurate positioning with only two operating satellites.

A towed 3.5-kHz sonar system was tested this cruise. It consisted of a four-element transducer array mounted in a towed "fish" connected to the ship via a faired E.M. cable. Initial tests indicated the "fish" and cable to be well-engineered and suitable for both low- and high-speed towing. However, signal quality was disappointingly poor and is being investigated. The tests were conducted using Number 3 crane to deploy and retrieve the fish. The fish was towed at a depth of 30 feet for all tests.

The magnetometer system was inoperative at the start of the cruise because of two broken tow leaders and one possibly bad sensor. A tow leader and the sensor were returned to ODP from Malaga for repairs. The remaining tow leader was repaired during the voyage. A platform was constructed aft of the port streamer winch and the starboard magnetometer winch was relocated forward on the deck. Foundations were constructed for the eventual installation of levelwinds on these winches. The starboard streamer winch will have a platform constructed as soon as possible.

ODP electronics engineer Bill Robinson helped identify, isolate, and resolve A.C. power problems. With the assistance of the Sedco shipboard electrical department the following problem areas were resolved:

1) Transient voltage spikes in the underway geophysics lab have been reduced to an acceptable level by the installation of ODP-supplied Sola saturable reactor transformers,
2) The three-phase regulated power to the lab stack was load- balanced,
3) The chemistry lab CHN analyzer has been permanently wired to a dedicated ship's power circuit via a Sola saturable reactor transformer; the transformer is oversized for the load and should be replaced with a suitably-sized model,
4) The computer facility power distribution unit was discovered to have an improper ground connection wired by the shipboard; it was fixed,
5) A preliminary baseline survey of ship's power and regulated power was conducted, which identified other potential concerns.

## LABORATORY OPERATIONS

The operational readiness of some lab facilities was adversely affected by the missing freight and supplies in Malaga. Most of the affected laboratory services normalized following the supply-boat rendezvous midway through the cruise. Several problems still require attention:

1) Paleomagnetics lab: The flux-counting modifications made by the vendor apparently do not work on extended ranges above 80 Oe.
2) The chemistry laboratory has a continuing saga of problems with the Rock-Eval, which require the assistance of a technical representative.
3) The X-ray lab XRF unit was not operational following the Malaga service call. Software problems remain essentially the same as noted by the Leg 106 crew. Hardware problems also noted by Leg 106 persist despite the delivery of new chips for various controller boards. A service call was

scheduled for Marseille. The XRD tube burned out following a period of 12 hours when the machine was intentionally shut down. A new tube was received and after several attempts to fit the new tube into the machine, the XRD was again operational. Past tube failures might be related to cooling-water-induced condensation on the x-ray tube. Poor laboratory ventilation and high temperatures caused several XRD generator shutdowns. The removal of side panels increased cabinet air flow and several strategically placed fans helped keep the problem in check. Sample changer problems noted on Legs 105 and 106 are still present.

4) Core lab work was routine with few problems. The motorized vane shear, damaged on Leg 105, has been repaired. The DSDP vane shear was used in favor of the new unit, owing to suspected inaccuracies or a misunderstanding of the units of measurement. A sonic velocity transducer was discovered crushed prior to arrival at our first site. No spare transducers exist if the set in use should become damaged. The thermal conductivity apparatus was troublesome again this cruise and all persons involved with it believe the software should be rewritten.
5) The multishot tool was used extensively on 2 HPC holes with no major problems. The failures were attributed to improper film advance and low batteries.
6) Microscope maintenance was for the most part minor, requiring cleaning, adjusting, and stage centering. A specimen holder was severely bent and required straightening; it is now usable.
7) We ran out of D-tubes at the final drilling location. We covered the unboxed cores with Saran Wrap until they can be packaged properly in D-tubes.
8) On the foc'sle deck, adequate ventilation is still a problem. Although exhaust filters have been fitted on most equipment requiring filters, there is a sufficient build-up of irritating fumes and vapors from the various chemicals, resins, oils, and solvents to warrant the installation of an exhaust hood or fan system. There are increasing complaints of eye irritation and respiratory problems.

The computer facility is continuing to improve with time. During this cruise the facility had little down time of consequence. All major systems are operational. The uses of PICSURE graphics steadily grow. SMOOTH, a program designed for plotting track lines aboard ship, was in use this cruise. Although it is helpful for some applications, it cannot be considered a true geophysical smooth-tracking tool in the classical sense.

The problem of dealing with voids in core material while the liner is being cut on the catwalk is still unsolved, and deserves a more realistic policy review. Another area that deserves review is the policy governing the yeoperson's responsibility to have Hole Summaries completed prior to reaching port. This cruise, as on several previous cruises, the distance from the last drill site to port was less than two days, not enough time to completely organize the extensive and diverse shipboard data.

A continuing list of concerns and suggestions for improving the overall storekeeping system was established, along with examples of problems encountered with shipping documentation.

PERSONNEL

We are continuing to shift various personnel into other areas of responsibility, both formally and informally, for cross-training purposes. The Marine Emergency Training Squad is continuing training; safety meetings were held weekly for the marine technicians.