OCEAN DRILLING PROGRAM

LEG 128 PRELIMINARY REPORT

JAPAN SEA

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SCIENTIFIC REPORT

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ABSTRACT

Leg 128 represents the second of two legs devoted to probing the history and structure of the Japan Sea, with Leg 127 the earlier companion effort. The unifying goals of these two expeditions were to assess the style and dynamics of marginal sea formation in a continental arc setting and to decipher the parallel paleoceanographic evolution of the sea. Leg 128 drilled two structural highs (Sites 798 and 799) and one basinal site (Site 794, first occupied during Leg 127).

Site 798 in the Oki Ridge yielded an excellent Pliocene and Pleistocene paleoceanographic reference section. These sediments contain a remarkable series of light-dark cyclic deposits that imply rapid and extreme variations in the dissolved oxygen content of the bottom water, perhaps related to periodic isolation of the Japan Sea from the Pacific.

The lower Miocene through Holocene sequence cored in the Kita-Yamato Trough (Site 799) provides information on the depositional and tectonic history in a geologic setting considered ideal for the formation of massive sulfide deposits of the Kuroko or hosted-shale type.

At Site 794 in the Northern Yamato Basin we cored 190.5 m into a series of stacked volcanic sills and flows. Shipboard analysis of these rocks indicate that they represent the product of two magmatic series: an upper set of dolerites typical of island arc volcanism and an older and lower series thought to represent ocean floor basalts of typical back-arc composition.

Leg 128 activities at Site 794 included two unique multi-ship geophysical experiments. A seismic experiment involved the installation of a digital broad-band seismometer at 715 mbsf in igneous basement rock. The seismometer is now engaged in accumulating long-term data on natural earthquakes, which ultimately will be used to create a three-dimensional image of crust/mantle configuration in this region. The second geophysical experiment involved active-source electrical measurements designed to obtain high vertical resolution of the electrical resistivity structure in the crust and upper mantle. These data will yield new estimates of electrical resistivity to a depth of 10 km beneath the Japan Sea.

INTRODUCTION

The Japan Sea is one of the most intensively studied marginal seas in the western Pacific region (Tamaki, 1988). The sea includes several deep basins with water depths in excess of 3000 m and which appear to be floored by oceanic-type crust (Fig. 1). In contrast, seismic data and dredged samples suggest that some of the intervening ridges are underpinned by continental rocks and that they represent continental fragments isolated during the early rifting and spreading processes which formed the Japan Sea. This general picture has been developed from an extensive set of marine geological and geophysical data but suffers from a lack of hard data on the nature and age of the rocks making up acoustic basement. An attempt made in 1973 to drill into the basement during DSDP Leg 31 was, unfortunately, cut short owing to safety and medical reasons.

Two ODP drilling expeditions, Legs 127 and 128, were planned to penetrate sites that would reveal the tectonic, depositional, and paleoceanographic history of the Japan Sea. Three sites were selected for drilling on Leg 128 (Sites 794, 798, and 799; Fig. 1). The locations and primary drilling targets at each of these sites are as follows: (1) Site 798 on the Oki Ridge was aimed at recovery of a paleoceanographic reference section in a basin isolated from coarse terrigenous debris and above the local carbonate compensation depth (CCD), (2) Site 799 is located in the Kita-Yamato Trough with drilling designed to investigate a failed-rift environment thought to be ideal for massive sulfide mineralization of the Kuroko or perhaps shale-hosted type, and (3) Site 794, located in the northern Yamato Basin, was selected both as a site for downhole geophysical experiments and for deeper drilling into basement rocks initially cored on Leg 127.

SITE 798

Site 798 (proposed Site JS-2) lies in the southeastern Japan Sea, about 160 km north of the western coast of Honshu (Fig. 2). Specifically, the site is located in a small sediment-filled graben on top of Oki Ridge at a water depth of 903 m.[1] Oki Ridge is one of a series of northeast-southwest trending ridges and troughs characterizing the eastern and southern Japan Sea. Oki Trough, Kita-Oki Bank, and Yamato Basin represent the ridges and troughs adjacent to Oki Ridge and Site 798. Although Kita-Oki Bank and the insular shelf around the Oki Islands have relatively flat surfaces, the top of Oki Ridge exhibits significant relief. The shallowest areas of the ridge are less than 300 m in depth with the floor of the ridge-top basin containing Site 798. The ridge as a whole exhibits a maximum relief of more than 2200 m, with the steep north flank of Oki Ridge meeting the abyssal plain of the Yamato Basin at a water depth of 2500 m (Fig. 2).

Oki Ridge is on geomorphic and structural strike from the Oki Islands and the geology of these islands has special significance for any interpretation of the rocks forming the ridge. Oki Ridge also forms an effective sediment dam with respect to terrigenous debris being shed westward from central Honshu, with Oki Trough forming a rapidly filling basin.

Objectives

Paleoceanographic History

The primary objective at Site 798 was to obtain a Miocene to Holocene paleoceanographic reference section in sediment thought to have been deposited above the local CCD. Previous piston core studies and deep sea drilling in the Japan Sea demonstrate that the sea apparently has had an unusually shallow CCD (~2000-1500 m) during various phases of its late Neogene evolution (Ujiie and Ichikura, 1973; Ingle, 1975; Ichikura and Ujiie, 1976; Arai et al., 1981; Matoba, 1983), resulting in carbonate-poor sediments

[1]In the Scientific Report, water depths are corrected to mean sea level; water depths in the Operations Synopsis are from the top of the dual elevator stool on the rig floor.

containing few or no calcareous microfossils essential for isotopic and faunal analysis of water mass and climatic history. Consequently, a relatively shallow water site located on a structurally isolated high above 1500 m was sought in order to obtain a carbonate-rich sequence undiluted by coarse gravity-flow sediments common to basinal areas. The small sediment-filled basin located on top of Oki Ridge at Site 798 was considered ideal in this respect. The seismic character of the sediment column at this site suggested the presence of a Miocene to Holocene pelagic-hemipelagic sequence which would provide a high resolution paleontologic, isotopic, and sedimentologic record of (1) surface- and intermediate-water history including variations in productivity, dissolved oxygen, and shallow excursions of the CCD; (2) anoxic to oxic episodes in basin history known to have occurred during Miocene, Pliocene, and Pleistocene time (Ingle, 1975; Matoba, 1983); and (3) faunal and sedimentary responses to extremes in water-mass character and circulation thought to have accompanied the episodic tectonic and eustatic isolation of the Japan Sea from the open Pacific (Matoba, 1983; Burckle and Akiba, 1977).

Bacterial Studies

In addition to paleoceanographic objectives, special collection of bacterial samples from the upper part of the sediment column was planned at Site 798, with one of three holes to be dedicated to this task. The goal of this unusual study was to quantify the role of bacteria in diagenetic processes at increasing depths below the sediment/water interface. Site 798 was considered to be an ideal setting for this study because of the high potential for recovery of a sedimentary record of large-amplitude variations in productivity, anoxia, and resulting organic-rich facies.

Results

Lithology

The sedimentary section cored in Holes 798A, 798B, and 798C consists of 517 m of fine-grained pelagic and hemipelagic diatomaceous and terrigenous sediment, including common volcanic ashes, of late early Pliocene through Holocene age (Fig. 3). Carbonate-rich sediments are restricted to the upper 220 m of the section whereas well-preserved opaline sediments occur from the sediment/water interface to a depth of 400 mbsf. Glauconitic and quartz sands and indurated siliceous claystones form the lowermost 60 m of the section. The sedimentary column at Site 798 was divided into three lithostratigraphic units based on composition, sedimentary structures, and mineralogy:

Unit I (0-220 mbsf; uppermost Holocene to uppermost Pliocene) Clay, silty clay, diatomaceous clay, and diatomaceous ooze, with common foraminifers and calcareous nannofossils. This unit displays well-defined decimeter- to meter-scale rhythmic interbeds of dark, laminated sediments alternating with light, homogeneous to intensely bioturbated intervals. The dark laminated facies is enriched in diatoms, foraminifers, and organic matter relative to low abundances of these components in the light-colored bioturbated facies. These distinctive rhythms are present to a depth of 180 mbsf.

Discrete volcanic ash layers ranging from 0.1 to 10 cm in thickness are common in the upper 170 m of Unit I.

Unit II (220-455 mbsf; upper Pliocene) Moderately indurated diatomaceous clay interbedded with diatomaceous ooze and silty clay. The carbonate content of this unit averages less than 4%. The well defined laminated/bioturbated rhythms characterizing Unit I are absent in this unit, with most sediments bioturbated. Volcanic ashes are restricted to the upper part of Unit II.

Unit III (455-517.9 mbsf; upper to upper lower Pliocene) Siliceous claystone and claystone with glauconite and quartz sands in the lower 30 m. A sharp decrease in preservation of biogenic silica downhole in Unit III is accompanied by the first distinct occurrence of opal-CT. The rhythmic alterations of dark, laminated sediments and lighter colored bioturbated sediments common to Unit I reappear in Unit III but with less clarity and with burrows distorted by compaction. Volcanic ashes up to 15 cm in thickness occur in the lower half of this unit.

Age and Sedimentation Rates

Sedimentation rates at Site 798 are well constrained by microfossil and paleomagnetic datums. Diatoms provide reliable biostratigraphic ages to a depth of 440 mbsf, and age-diagnostic silicoflagellates and ebridians are present to 334 mbsf. The siliceous microfossil data indicate a Holocene to late early Pliocene age range for the Site 798 sequence. The oldest diatoms recognized are assigned to the upper portion of the *Neodenticula kamtchatica-N. koizumii* zone, which is correlated with the upper portion of the Gauss magnetic chron. Calcareous microfossils are best preserved and most abundant in Quaternary sediments, with age-diagnostic calcareous nannofossils present to 191 mbsf. Planktonic foraminifers are present to 249 mbsf, with isolated rare occurrences below this depth. Although the cool-water aspect of the planktonic foraminiferal assemblages at this site precludes the common occurrence of key low-latitude markers, analysis of the coiling ratios of *Neogloboquadrina pachyderma* should allow further biostratigraphic resolution of the upper Pliocene-Holocene section. A good paleomagnetic signature was recorded to a depth of 305 mbsf with clear recognition of the Brunhes, Matuyama (including the Jaramillo and Olduvai events), and top of the Gauss chron. Shore-based processing of cores from the lower portion of Hole 798B will likely provide further definition of the paleomagnetic record and assist in dating the base of this sequence. Combined microfossil and paleomagnetic age data yielded an average sedimentation rate of 120 m/m.y. at Site 798.

Inorganic Geochemistry

Thirty-eight interstitial water samples were collected at Site 798. High-density sampling in the upper 100 m of this sequence allowed construction of high-resolution profiles and close scrutiny of mechanisms of early diagenesis. The relatively high sedimentation rate, high organic carbon accumulation, and vigorous bacterial decomposition of organic matter at this site are responsible for the high concentrations of organic metabolites recorded, with alkalinity reaching 76 mM, ammonia 12 mM, and phosphate 290 mM. These same processes are also responsible for marked sulfate depletion at 12 mbsf, with further decomposition of organic matter proceeding by carbonate reduction and methanogenesis. The upper 50 m of the section is characterized by a decrease in calcium concurrent with high levels of alkalinity. Carbonate diagenesis in this highly alkaline setting is clearly responsible for the formation of the authigenic dolomites encountered between 143 and 335 mbsf, both in the form of small disseminated crystals and cemented zones. The distribution of silica in these sediments is governed primarily by the dissolution of biogenic siliceous components (mainly diatoms) above 425 mbsf and silicification reactions at depth. The opal-A/opal-CT transition is signaled by a severe decrease in dissolved silica below 425 mbsf with the first recorded appearance of opal-CT at 445 mbsf. The calcium, magnesium, and strontium distributions at the bottom of Hole 798B indicate the influence of volcanic rocks known to be present at depth on Oki Ridge.

Organic Geochemistry

Variations in carbonate content allow the Site 798 sequence to be divided into two intervals. Interval I (0-215 mbsf) corresponds to lithologic Unit I and is characterized by carbonate values ranging between 1% and 35%. Within this interval, high-amplitude lithologic variations with higher carbonate values are concentrated in the upper 140 m, whereas the lower part of Interval I (140-215 mbsf) displays values between 1% and 15%. Interval II (215-517 mbsf) corresponds to lithologic Units II and III and is characterized by very low carbonate values of less than 5%. The downhole distribution of total organic carbon (TOC) at Site 798 is characterized by predominantly high values ranging from 1% to almost 6% with the highest values recorded in Holocene through upper Pleistocene sediments and upper lower Pliocene sediments. The distinctive dark/light depositional rhythms present in the uppermost Pliocene through Quaternary portion of the section are also reflected by organic carbon values. The dark basal units of each rhythmic couplet contain up to 5% organic carbon whereas the light upper units contain about 2%. Rock-Eval TOC data, hydrogen index values, and C/N ratios suggest that most of the organic matter in Site 798 sediments is a mixture of kerogen types II (marine origin) and III (terrigenous origin) with marine type II dominant. The organic carbon values at this site are distinctly higher than those recorded in "normal" open-ocean environments and point to special conditions favoring high productivity and/or enhanced preservation during deposition. Combined sedimentologic and organic geochemical evidence within the more organic-rich portions of this sequence suggest that periods of high surface productivity alternated with phases of increased rates of preservation of organic matter at the Oki Ridge site during the past 3.5 m.y.

Elevated concentrations of ethane and propane occurred near 450 mbsf in Hole 798B resulting in sharp decreases in the C_1/C_2 and C_1/C_3 ratios. Significant amounts of butane and pentane also occurred at this latter depth and increased downhole to 517 mbsf. The combined hydrocarbon gas shows in Hole 798B caused drilling to be halted at 517.9 mbsf. The immature nature of the *in-situ* organic matter in Site 798 sediments indicates that these hydrocarbons probably have migrated from other source rocks in this area.

Temperature

Two successful runs using the Barnes-Uyeda temperature probe were made down to 132.8 mbsf in Hole 798A and to 110.4 mbsf in Hole 798C. The combined readings for these two sets of measurements indicate an average temperature gradient of approximately 111°C/km for the uppermost 130 m at this site. The Lamont temperature logging tool (TLT) was run in all three holes at Site 798. The highest temperature measured with the TLT at the bottom of Hole 798B (517 mbsf) was 43°C, yielding a thermal gradient of 83°C/km. However, the time-temperature curves indicate that the temperature was not stabilized at the time of measurement and that the actual gradient may have been somewhat higher. Thus, the lower temperature gradient obtained from the TLT is probably due to thermal disequilibrium, whereas the higher temperature gradients obtained with the Barnes/Uyeda tool may reflect a change in thermal conductivity of the drilled sediments. A previous measurement of heat flow in the Oki Ridge area in 1965 yielded a value of 98 mW/m^2.

Logging

Four successful logging runs were completed at Site 798 including (1) sonic/seismic stratigraphy, (2) formation microscanner, (3) litho-porosity/density, and (4) geochemistry. The quality of the logs obtained was generally excellent. In particular, the spectral gamma ray (SGR) and the aluminum logs yielded an exceptionally clear and continuous record of the cyclic depositional history of upper Pliocene and Quaternary sediments. In fact, preliminary dating and spectral "tuning" of the cyclic gamma ray log pattern using paleomagnetic datums suggest that the depositional cycles delineated by this log have a periodicity of about 40,000 yr. These records, together with analysis of the cyclic lithofacies patterns, geochemical variations, and microfaunal trends within this interval, portend reconstruction of a high-resolution paleoceanographic history at Site 798.

Microbiology

Whole-round samples (3-25 cm) for analysis of bacteria were successfully collected from APC and XCB cores between 0 and 510 mbsf in Hole 798B with the upper part of this hole dedicated to this task. Special techniques were used to prevent sample contamination, including use of a sterile core cutter and flushing of cores by using oxygen-free nitrogen. The aim of this sampling and analysis is to quantify the role of bacteria in diagenesis of marine sediments by measuring variations in their activity and biomass with depth below the sediment/water interface. Shore-based laboratory studies will include direct bacterial counts and analysis of bacterial composition, activity, and lipids. Bacterial samples were offloaded from the ship three days after collection via a specially chartered vessel.

Conclusions

Depositional History and Uplift of Oki Ridge

The 517.9 m of sediments of late early Pliocene through Holocene age cored at Site 798 can be conveniently divided into three lithologic units as described above. Significantly, modern Oki Ridge is topographically isolated from the coarse terrigenous sediments rapidly filling the surrounding basins and troughs via gravity flow processes. The terrigenous claystones and redeposited sands of Unit III thus suggest that these sediments accumulated prior to uplift of the present-day Oki Ridge. In addition, the absence of sands and decreasing terrigenous clays in Unit II and the abundance of diatoms and common occurrence of biogenic carbonate in Unit I argue for increasing isolation and uplift of Oki Ridge above the CCD sometime during latest Pliocene to early Pleistocene time. Although no significant hiatus is apparent in the Site 798 section, there is widespread evidence supporting a major late Pliocene-early Pleistocene episode of tectonic deformation in the eastern Japan Sea. This event is clearly manifest by a ubiquitous unconformity separating deformed pre-late Pleistocene strata from younger relatively undeformed sediments and can be readily identified in onshore sections and in offshore reflection profiles. The widespread nature of this unconformity points to significant tectonic reorganization of the eastern and southern Japan Sea about 2 to 1 Ma, marked by uplift of many of the ridges and banks in this region including Oki Ridge.

Cyclic Deposits and Quaternary Paleoceanography

The most distinctive lithology in the stratigraphic column at Site 798 is the series of latest Pliocene through Pleistocene depositional cycles involving high-frequency alternations of two fundamentally different lithofacies. Although these cycles initially appear in sediments of late early Pliocene age, they did not become common until 1.5 Ma and were best developed during the last 0.4 m.y. Each depositional couplet in this series consists of (1) a dark-colored, laminated diatomaceous unit rich in organic matter (~5%), abundant diatoms, and low amounts of terrigenous clay; and (2) a light-colored, intensely bioturbated to homogeneous unit containing abundant terrigenous clay and relatively low amounts of organic matter (Figure 4). Although the thickness of the cycles varies, the vertical lithologic variation within individual couplets is remarkably constant. A sharp but nonerosional boundary is commonly present at the base of laminated units, signaling the abrupt initiation of each depositional cycle.

These cycles clearly reflect systematic paleoceanographic changes in the Japan Sea during late Pliocene-Quaternary time involving major variations in surface-water productivity, bottom-water oxygen levels, and deposition of terrigenous clays. Severe reductions in dissolved oxygen of bottom waters are likely responsible for deposition of the laminated organic-rich units, with the overlying bioturbated-to-massive units suggestive of increasing levels of oxygen, and with fully oxic conditions during the final phase of each cycle. Changes in the relative abundances among diatoms, calcareous nannofossils, and planktonic foraminifers in these sediments likely reflect changes in productivity and/or dilution by terrigenous clays. Rhythmic variations in the abundance of terrigenous clays probably represent changes in the availability of river-borne suspensates and/or eolian transport of these sediments. In fact, preliminary analysis of cyclic patterns in the natural gamma ray log through part of these sediments (2.5-0.9 Ma) suggests that pulses in the flux of terrigenous clays to this site have a periodicity of ~40,000 yr--very close to the 41,000 yr of the earth's orbital tilt thought to be a major factor controlling Pliocene-

Pleistocene climate. Whatever the origins of the depositional cycles are, they reflect repeated and profound changes in the oceanographic, geochemical, and sedimentologic character of the Japan Sea on relatively short time scales. In particular, evidence for repetitive suboxic to near-anoxic bottom conditions stands in stark contrast with the modern hyperventilated and fully oxic character of the modern Japan Sea.

The rhythmic lithofacies so evident in Site 798 cores have also been reported in upper Pleistocene piston cores and ODP Leg 127 cores elsewhere in the Japan Sea, indicating basinwide control of the processes governing these patterns. Some authors have suggested repeated Quaternary eustatic isolation and reconnection of the Japan Sea with the open Pacific as a possible mechanism for producing the cycles. We reserve judgment on their origin until completion of our detailed studies. However, we point to the fact that similar depositional cycles are present in lower Pliocene sediments at Site 798, which represent a time when global climate and paleogeography of the Japan Sea were surely different from those during the late Quaternary.

Tephrochronology and Plio-Pleistocene Volcanic History

The Site 798 sequence contains 113 discrete volcanic ash beds that, together with the well-constrained sedimentation curve at this site, offer a detailed record of explosive volcanic events in this region over the past 3.5-4 m.y. Indeed, the age of each ash layer has been extrapolated by using this curve and associated paleomagnetic datums. Variations in the frequency, thickness, and petrology of the ashes provide details of the volcanic activity and serve as a guide to the origin of the ashes. The first important activity recorded in this section is represented by Pliocene ashes deposited between 4.0 and 3.5 Ma followed by a gap in ash occurrence in upper Pliocene sediments. Moderate activity is indicated by the reappearance of ashes beginning at 2.5 Ma and continuing to 1.3 Ma. The frequency of ashes increases dramatically in lower Pleistocene sediments with numerous ashes having been deposited between 1.3 and 0.9 Ma, followed by a major pulse of explosive activity and ash deposition between 0.9 and 0.3 Ma. The paroxysmal explosive activity occurred between 0.7 and 0.55 Ma. Based upon composition and thickness, the most likely sources for the various ashes present at Site 798 are the large acidic to intermediate and calc-alkaline volcanoes of the southwestern Japan arc (Izu, Kyushu) and the northeastern Japan arc (Tohoku). Alkaline volcanic islands near Site 798, including Oki-Dogo and Ulleung-Do, may also have contributed to this record. The youngest ashes present in the Site 798 sequence are likely correlative with established Holocene tephra markers in the southern Japan Sea, although actual correlations and age assignments must await post-cruise chemical analysis.

SITE 794

Site 794 (proposed site J1b) in the northern Yamato Basin was scheduled to be visited twice during ODP drilling in the Japan Sea. Initial occupation of this site was to have taken place during Leg 127 when three holes (794A-794C) were to have been drilled in order to (1) meet the primary objective of determining the nature and age of basement rock, (2) recover a complete sedimentary sequence from the northern Yamato Basin, (3) perform an *in-situ* crustal stress analysis, and (4) case and prepare one hole for later reentry during Leg 128 to be used for geophysical experiments. Holes 794A, 794B, and 794C were successfully drilled during Leg 127, with recovery of a 543-m-thick Miocene through Quaternary sedimentary sequence and coring of underlying igneous rocks to a depth of 654 mbsf. However, a stuck bottom-hole assembly (BHA) in Hole 794C during Leg 127 precluded the *in-situ* stress analysis and completion of hole preparation for reentry during Leg 128. This event led to a revised schedule for Leg 128 in order to (1) attempt either to fish for the stuck BHA in Hole 794C or to drill and case a new hole into igneous basement for the planned geophysical experiments, and (2) accommodate a preplanned rendezvous at Site 794 with two supporting vessels *(Kaiko Maru V* and *Tansei Maru)* from the University of Tokyo Ocean Research Institute, scheduled to assist with geophysical experiments at this site. As it turned out, the logistics of Leg 128 drilling and geophysical experiments ultimately required two visits to Site 794 and two visits to Site 799 in order to accommodate this schedule, with two holes drilled at Site 794 during this leg (Holes 794D and 794E).

Location and Bathymetry

Site 794 is located in the northeastern Yamato Basin about 130 km west of the Oga Peninsula and northern Honshu (Fig. 5). This northernmost reach of the Yamato Basin is sometimes referred to as the Yamato Trough because of the narrow configuration of the basin between the Yamato Rise and northern Sado Ridge (Inoue and Honza, 1979). The site is positioned on a gentle north-dipping slope at the base of the northernmost extension of the Sado Ridge. The water depth at Site 794 is 2811 m. This area of the Yamato Basin is somewhat shallower than the abyssal plain of the basin to the south, which averages ~3000 m in depth (Inoue and Honza, 1979; Tamaki, 1988). The difference in depth is due primarily to the rapid progradation of coarse terrigenous sediment onto the floor of the northern Yamato Basin via the Toyama Trough and submarine fan complex (Bouma, 1975). The Site 794 area is partially protected from this process by the Meiyo-Daisan Seamount, the northernmost peak of the Yamato seamount chain (Fig. 5). Another conduit of turbidite deposition, the Mogami Channel, is separated from Site 794 by the northern Sado Ridge to the east. The Mogami Channel currently funnels coarse debris directly to the Japan Basin but may have delivered sediments to the Yamato Basin prior to the Quaternary uplift of the Sado Ridge (Sakurai and Sato, 1971).

Objectives

As mentioned, Legs 127 and 128 had shared objectives but separate drilling responsibilities and programs at Site 794. Leg 127 was responsible for initial drilling at Site 794 for the purposes of (1) coring the sedimentary section, (2) penetrating igneous basement, (3) conducting packer/hydrofracturing experiments in basement rock along with borehole televiewer observations of stress, and (4) preparing a cased holed for later reentry during Leg 128. Leg 128 was originally scheduled to (1) emplace a downhole seismometer and conduct a real-time seismic experiment in the precased hole, and (2) drill a fourth dedicated hole to carry out an oblique electrical resistivity experiment. Leg 127 drilling recovered an excellent sedimentary sequence and successfully cored igneous basement at Site 794 (Tamaki, Pisciotto et al., in preparation) but experienced a stuck BHA in Hole 794C on pullout, preventing the hydrofracturing/crustal-stress observations and leaving this hole in a position to be fished or redrilled during Leg 128. However, the basic objectives of Leg 128 drilling at Site 794 remained intact, as summarized below.

(A) Style and Dynamics of Back-Arc Rifting

The primary drilling objective at Site 794 for both Leg 127 and Leg 128 was determination of the character and age of acoustic basement in a basinal location in the Japan Sea. Drilling in both the Yamato and Japan basins during Leg 31 of the Deep Sea Drilling Project in 1973 had attempted this objective but failed, owing to gas shows and a medical emergency (Karig, Ingle, et al., 1975). Although the intervening 16 years saw repeated sampling of basement rocks on topographic highs in the Japan Sea, including the Yamato Rise (Gnibidenko, 1979; Tamaki, 1988), the nature of acoustic basement beneath the major basins of the sea remained controversial and unsampled.

Site 794 is located at a critical juncture between the apparently thickened transitional crust of the Yamato Basin and the oceanic crust of the Japan Basin. Leg 127 drilling demonstrated that the uppermost 100 m of igneous basement in the Site 794 area consists of stacked dolerite sills intruded into sediment of probable late early Miocene age. Leg 128 drilling was aimed at penetrating deeper into this sequence to further characterize these rocks.

(B) Geophysical Experiments

Two unique downhole geophysical experiments were planned for Site 794 in the northern Yamato Basin. Both of these experiments required the use of supporting ships from the University of Tokyo Ocean Research Institute, which were scheduled to meet *JOIDES Resolution* at Site 794. One experiment would involve the installation of a broad-band digital seismometer in the basement rock beneath this site. The second experiment was to have been an oblique electrical resistivity measurement requiring the drilling of a dedicated hole at Site 794.

Seismometers are designed to capture and record seismic waves as a means of scanning the Earth's interior and to obtain data on the dynamics of source events. The broader the frequency band, and the wider the dynamic range of a given instrument, the more information that can be extracted from the record. A new three-component seismometer system, capable of recording longer period waves (10^{-8} m/s^2 to 100 s and 6 X 10^{-8} m/s^2 to DC) with an 18-bit dynamic range, was developed specifically for the experiment at Site 794. The design of this instrument is such that it can record a wide range of seismic events from high-frequency waves produced by local microearthquakes to surface waves emanating from major earthquakes of global proportions.

The oblique electrical resistivity experiment planned for Site 794 was meant to improve the understanding of the structure beneath the Pacific Ocean floor off eastern Japan, across the Japanese Islands, and into the Japan Sea. In particular, variations in electrical resistivity are sensitive indicators of temperature changes in the crust and mantle and can point to the presence of partial melts or fluid at depth. Measurements of natural electromagnetic disturbances allow the determination of resistivity to a depth of about 300 km in continental areas. However, the restriction imposed by a deep water column makes it impossible to obtain a detailed picture of resistivity in ocean areas without resorting to active experiments. Rather resistive structure is thought to exist to a depth of about 100 km beneath the Japan Sea--resistive even in comparison with the old Pacific crust just prior to its subduction in the Japan Trench. Improved resolution at depth in the Japan Sea is needed to better interpret the structure within the zone of generally low resistivity in the young upper mantle beneath this area, which is characterized by indications of low velocity and high attenuation of seismic waves.

Results

Igneous Rocks

Leg 127 drilling in Holes 794A, 794B, and 794C (645.6 mbsf) recovered an excellent Miocene to Holocene sedimentary sequence and cored an underlying igneous complex (Tamaki, Pisciotto, et al., in preparation). Leg 128 drilled Hole 794D without sampling the sedimentary column, with the aim of further penetrating the igneous complex and preparing this hole for later installation of a downhole seismometer in the basement rock. Coring in Hole 794D commenced at 573 mbsf within the igneous complex, purposely overlapping and duplicating a portion of the same sequence cored in Hole 794C.

The lithologic sequence cored in Hole 794D is predominantly igneous rock with recovery of only a single thin (1.6 m) sedimentary interbed. An average recovery rate of only 21.7 % precluded continuous description of the igneous sequence. However, logging data materially aided recognition of lithologic boundaries and also indicated that unsampled portions of this sequence may include marine sediments and/or weathered zones between the igneous flows and sills (Fig. 6). Shipboard analysis and interpretation of diagnostic mineralogy and texture, X-ray fluorescence (XRF) data, preliminary paleomagnetic data, and logging data from this sequence allowed recognition of nine lithologic units. The interval over which a unit is defined corresponds to the actual recovered material in core, as follows:

Unit 1 (573.0-589.4 mbsf) Highly plagioclase-pyroxene phyric leucocratic dolerite. This rock is a dark-greenish-gray dolerite characterized by abundant, uniformly distributed phenocrysts of plagioclase. Alteration is moderate (15%-20%). Top and bottom contacts were not observed.

Unit 2 (595.4-596.1 mbsf) Doleritic basalt. This unit is dark green, massive, dense, vesicular, and highly altered (65%). No contacts were observed, although evidence of fracturing is present.

Unit 3 (604.6-604.9 mbsf) Aphyric dolerite. This unit is dark green, massive, and nonvesicular. Alteration is moderate to high (45%). No contacts were observed, but slickensided fractures are present.

Unit 4 (619.0-642.2 mbsf) Aphyric to olivine microphyric dolerite. This rock is medium gray to greenish with pale green mottling, massive and dense, and has an intergranular to interstitial texture. Vesicles are rare to uncommon. Grain size of the groundmass decreases toward the bottom of the unit indicating close proximity to the bottom contact which was recovered; the top contact was not observed. Alteration of the rock is high (50%-60%). Fine fractures are common.

Unit 5 (642.2-643.9 mbsf) Tuffaceous clayey siltstone with foraminifers. This unit is composed of dark-gray to dark-brown tuffaceous, clayey siltstone. The entire unit is bioturbated, with only crude bedding preserved. Foraminifers are extensively dissolved and hence are not identifiable; scarce nannofossils and centric diatoms are also present. Vitric debris consists of hydroclastic shards deposited in a crude layer and dispersed in silty clay. Baked contacts are conspicuously absent but contact zones record substantial shearing and brittle deformation.

Unit 6 (643.9-655 mbsf) Olivine-pyroxene microphyric basalt. The rock is medium gray, massive, dense, and vesicular. Vesicles range from 0.3 to 8 mm, are partly unfilled, and become rare at depth. Alteration is high (50%-62%) and includes traces of pyrite. The upper or top contact of the unit was not recovered; overlying sediment (Unit 5) shows no evidence of heating; hence Unit 6 is interpreted as a lava flow on the seafloor; the bottom contact was not observed. A few filled fractures are present.

Unit 7 (660.7-680.5 mbsf) Aphyric dolerite. The rock is dark-grayish-green and massive. Frequent variations in grain size were observed and were attributed to flow differentiation. Alteration is moderate to high. Large veins up to 2.5 cm across are fairly abundant; they have a talc-chlorite border and a fibrous calcite core.

Unit 8 (689.3-708.3 mbsf) Aphyric basalt. This unit varies from fine to coarse grained toward the bottom, with ovoid vesicles (0.1-1 mm) in the upper part of the unit. The upper part of the unit is highly altered (60%-70%). No contacts were found, but the uppermost rock shows evidence of severe quenching and other evidence pointing to proximity of the upper contact. Numerous filled fractures and veins are present, some with slickensides.

Unit 9 (717.1-727.1 mbsf) Olivine dolerite. This rock is dark greenish gray with fine to medium grain size. It is massive and without vesicles. No contacts were observed. Rare filled and bordered fractures are present.

In addition to the nine units recognized in Hole 794D, a doleritic basalt section (Unit 0) was cored at the base of the sediment column in Hole 794C (Tamaki, Pisciotto et al., in preparation) and represents the shallowest and youngest dolerite sill in the igneous complex beneath Site 794.

The coarser textures of the basaltic lavas indicate that they erupted at medium to great water depth into the upper part of a soft sediment pile. In contrast, the medium- to fine-grained dolerite sills (Units 1, 3, 4 and 9) were probably intruded under a thicker cover after the basaltic outpouring. Significantly, no sediments were found below Unit 6, although logging suggests that either sediment or altered igneous rock may be present between igneous units in the lower part of the sequence. This evidence, together with the abrupt changes of trace element concentrations (Nb/Zr, Zr/Y, and Ba/Y) at the top of Unit 6 and the development of hydrothermal mineralization in Units 6 through 9, collectively indicates that two different volcanic complexes are represented within this sequence and involve a lower complex consisting of Units 6 to 9 and an upper complex or series consisting of Units 0 to 4. Moreover, various plots of incompatible elements (Ba, Nb, Zr, and Y) in these rocks very clearly separate them into two groups corresponding to two distinct magmatic series in turn corresponding to the two volcanic complexes: (1) an upper and younger set of sills and flows of probable island-arc tholeiite composition (Units 0, 1, 2, 3 and 4) and (2) a lower and older sequence tentatively interpreted as ocean-floor basalts of back-arc tholeiite composition (Units 6, 7, 8 and 9). Unit 6 appears to represent the most primitive magma within the lower series of basalts with stratigraphic and textural evidence indicating that this rock was extruded onto the early Miocene(?) floor of the Yamato Basin. We interpret the upper surface of Unit 6 as the top of true igneous basement at this site.

It is important to note that the superposition of island-arc tholeiites over back-arc tholeiites is inconsistent with the perceived normal magmatic evolution of a back-arc area. One possible explanation for this irregular order is that the lower volcanic complex may represent a remnant of the initial magmatic activity of an immature magmatic arc generated from depleted upper mantle. Further chemical and isotopic analysis will, we hope, resolve these apparent inconsistencies in magma provenance. No matter what their provenance, both volcanic complexes were emplaced successively and rapidly within the same tectonic context.

Shipboard analysis of fracture patterns and veins and the nature of vein-filling materials and alteration halos within the Site 794 igneous basement complex provide additional insights into the geochemical and tectonic history of these rocks. The fractures fall into two groups or sets, a gently dipping set and a steeply dipping set. The geometry of the gently dipping fractures and veins suggests that they originated as conjugate shear joints (or faults) during a north-northeast/south-southwest compressive phase. The steeply dipping fractures cut across the gently dipping veins and appear to be younger features; their orientation suggests that an east-west extensional phase was responsible for their initiation. Analysis of the processed formation microscanner (FMS) logging record is expected to enhance fracture analysis in that part of the sequence in which this logging tool was run successfully.

Age

As noted earlier, sediments immediately above and intruded by the shallowest dolerite sill (Unit 0) in Hole 794C were assigned a late early Miocene age (~15.8 -16.5 Ma) by Tamaki, Pisciotto, et al. (in preparation), fixing a maximum age for the upper part of the igneous complex as late early Miocene. Unfortunately, foraminifers, diatoms, and radiolarians found in the tuffaceous marine sediments that form Unit 5 of the Hole 794D sequence are so badly altered and recrystallized that they cannot be used to establish a precise biostratigraphic age for this material. Two species of diatoms identified in Unit 5 sediments, *Thalassionema nitzchioides* and *Coscinodiscus curvatulus,* have Neogene to Holocene ranges. The microfossils present in Unit 5 sediments all indicate that deposition occurred in an open ocean and deep bathyal environment.

Paleomagnetic analysis of rocks cored in Hole 794D yielded stable inclinations and natural remanent magnetization (NRM) intensities in Units 1, 2, 4, and 6 through 9. Six of these seven units exhibit negative inclinations. The average period of Miocene polarity events is about 300,000 yr which suggests that the volcanic activity responsible for the Site 794 igneous sequence occurred within a few hundred thousand years. Alternatively, if this activity encompassed more than 1 m.y., then a middle to early Miocene age is likely given the extended period of reversed polarity established between ca. 15.3 to 16.2 Ma (Berggren et al., 1985).

Good paleomagnetic and biostratigraphic age control within the Miocene through Holocene sediments overlying the igneous complexes at Site 794 indicates that the rate of sedimentation in this area ranged from 54 to 29 m/m.y., with an average sedimentation rate of about 37 m/m.y. during late early to early middle Miocene time (Tamaki, Pisciotto, et a., in preparation).

Logging

Poor hole conditions in Hole 794D restricted logging to only one run, using the seismic-stratigraphic combination of logging tools between 560 mbsf (base of cased hole) to 733.5 mbsf (total depth of Hole 794D). The FMS obtained high-quality data from 562 to 595 mbsf and provided the means for constraining the number and thicknesses of the sills and flows making up the igneous complex cored at this site.

Eight volcanic units can be defined on the basis of responses to the natural gamma spectroscopy tool (NGT) and, in combination with the resistivity log, Units 5, 7, and 8 can be further subdivided into smaller subunits. In addition, sedimentary layers and/or zones of altered volcanic rock can be identified from the trace of the gamma ray log (GR) owing to the higher U, Th, and K contents of these materials relative to those of the igneous rocks. Although sediment was recovered only from one interval in this sequence (Unit 5), logging data suggest that sediments and/or altered volcanic rock may be present in unsampled gaps elsewhere in this sequence.

Finally, it is important to note that the limited FMS record in Hole 794D (593-561 mbsf) shows a remarkable amount of detail along the borehole wall, including images of cumulate layering and orientation of infilled veins and fractures on a centimeter scale, with further detail anticipated after processing of this record.

Geophysical Experiments

Downhole seismometer experiment

A downhole seismometer was installed in Hole 794D at 714.5 mbsf in the lowermost igneous basement section. The seismometer is equipped with three-component feedback accelerometers with the same basic design as the state-of-the-art seismographs used in global seismic networks. The sensitivity was compromised in order to make the seismometer package more rugged and to make it fit through the drill pipe (diameter <100 mm) at installation. A leveling mechanism was added to the horizontal sensors so that up to 5° of tilt of the instrument package could be accommodated. The output from each component is amplified in two gains as the A/D converter is limited to a 16-bit dynamic range. The high-gain channel has a sensitivity of about 10^{-8} m/s^2 between 100 s and 30 Hz, while the low gain has a sensitivity of about 5 x 10^{-8} m/s^2 between DC and 30 Hz. These six-channel data are digitally sent at a 80-Hz/ch sampling rate uphole via the seven-conductor logging cable normally used for ODP logging operations.

The installation was made without major difficulties. The instrument was clamped in the hole using a single-arm extension pad. Drill pipe was extracted after cutting the cable at the rig floor. A real-time continuous recording was made in *JOIDES Resolution's* underway geophysics laboratory after reconnecting the cable by "torpedo" splicing. The support vessel *Tansei-Maru* of the University of Tokyo Ocean Research Institute installed an array of eight ocean bottom seismographs (OBS) for the controlled- source (air guns) seismic refraction experiment. One OBS was a digital recording type, which was deployed above the downhole seismometer to compare waveforms. *Tansei Maru* subsequently shot two concentric circles of 10- and 20-nmi diameters around Hole 794D and two straight lines in N60°E and N30°W directions in order to study the detailed seismic structure, taking lateral heterogeneity and anisotropy into account. The records obtained also will be used for orientation of the horizontal sensors. Successful continuous recordings were made with time stamps corrected by Japan Standard Time. However, one horizontal sensor failed to yield meaningful output, possibly owing to leveling failure. A real-time recording was made for about 58 hr, whereas the air gun shooting lasted for 47.5 hr.

The downhole seismometer system was designed to be used for long-term observation as well. Another support vessel, *Kaiko Maru V,* chartered by the University of Tokyo Ocean Research Institute, brought the seafloor recording unit, battery power supply, and retrieval unit to the site. After *JOIDES Resolution* passed the end of reheaded logging cable to the *Kaiko Maru V,* these units were deployed. The seafloor recorder has 60 Mb of digital data storage. The recording is event driven, and detection is made by monitoring the STA/LTA ratio. However, time-window recording is also programmed to take place because the broad-band seafloor noise spectrum is unknown. Although the digital data reach the seafloor at a 80-Hz/ch sampling rate, present technology limits recording to 20 Hz/ch and 1 Hz/ch for each event. Another constraint is the available power supply, which limits recording time to only a few months at present. The deployment was successfully completed at 0020 UTC, 30 September 1989.

Oblique electrical resistivity experiment

Dedicated Hole 794E was drilled for the electrical resistivity experiment near the point where *JOIDES Resolution* had made the real-time seismic experiment observations. This experiment was designed to obtain the electrical resistivity structure to a depth of about 10 km. This scale required an "active" experiment using an artificial source with observation of signals from within the drilled hole. After *Kaiko Maru V* deployed the seismic instruments, it prepared to put electrical currents into the water. Each observation involved injecting an electrical current of 20A into the water column via a seafloor cable with 100V difference between the sea surface and the seafloor (Fig. 7). The electrical field change induced by this charge was recorded on board *JOIDES Resolution* via the electrical cable in Hole 794E with five electrodes arranged at five depths in the hole. Since the signal-to-noise ratio was small, the source signal was repeated to allow stacking of observations. This sequence was repeated at distances of 1, 2, 4, and 7 km from Hole 794E in two directions, N60°E and N30°W. The greater the distance between source and point of measurement, the deeper the resistivity structure is probed. Measurements in two directions were made to obtain an anisotropic effect. The two directions used were specifically chosen from the standpoint of the regional tectonic setting. Successful measurements were made for a 24-hr period with completion of the experiment on 1 October. Interpretation of the data produced by this experiment will require post-cruise processing. When integrated with previous measurements using passive natural sources, these data will yield a higher resolution perspective of resistivity at depth over a 300-km range in the Japan Sea-Japan arc-Japan Trench area.

Conclusions

Igneous Basement beneath the Yamato Basin

Perhaps the highest priority identified for ODP drilling in the Japan Sea was recovery of rocks representing acoustic basement in order to provide the heretofore missing element in analysis of the style and dynamics of rifting in this back-arc basin. Further, the major goal of this quest was to recover true igneous basement rock. Leg 128 drilling at Site 794 penetrated 190.5 m into an igneous complex representing part of the late early Miocene(?) volcanic floor and crust of the northern Yamato Basin. All of the shipboard data we have at hand indicate that the rocks we cored in the lower section of Hole 794D likely represent true igneous basement at this site.

Nine dominantly igneous units were recognized within the sequence cored between 573.0 and 733.5 mbsf in Hole 794D, with good correlation established between the upper units in this hole and the same units cored at the base of Hole 794C on Leg 127. Mineralogical, geochemical, and logging data indicate that the rocks forming this sequence represent two distinct magmatic series responsible for the petrologic differences noted in the cores. The Hole 794D lithologic sequence represents a series of stacked sills and flows, including (1) an upper and younger set of dolerite sills and flows of probable island-arc tholeiite composition and minor interbedded sediments, and (2) a lower and older series of sills and flows comprising ocean-floor basalts of back-arc tholeiite composition. Unit 6 in this latter series is an olivine-pyroxene basaltic flow of primitive composition and is interpreted to represent the top of true igneous basement at Site 794.

Geophysical Experiments

Conclusions from the downhole seismometer experiment, and long-term observations using this instrument and from the electrical resistivity experiments carried out at Site 794 must await laboratory processing of data and further data accumulation over time.

The emplacement of the downhole seismometer in Hole 794D went smoothly. We anticipate that processing of the data from the successful multi-ship experiment using this instrument and a seafloor OBS array will yield new insights into local crustal structure. The program of long-term observations using the downhole seismometer is aimed at acquiring data from natural earthquakes over several months to be used to determine a three-dimensional view of the crust/mantle structure beneath the Japan Sea.

The oblique electrical resistivity experiment at Site 794 also proceeded smoothly, and was aimed at determining high-resolution resistivity structure for a 10-km-deep crustal section beneath Site 794. Results of the experiment together with existing data are expected to establish the resistivity structure within the crust/upper mantle beneath the Japan Sea.

SITE 799

Location and Bathymetry

Site 799 is located in the Kita-Yamato Trough, a narrow sediment-filled graben within the much larger Yamato Rise in the south-central Japan Sea (Fig. 8). The Yamato Rise constitutes the largest and most prominent bathymetric high in the Japan Sea excluding the shelves and plateaus contiguous with mainland areas. Viewed as a whole, it is an oval-shaped feature about 180 km in width and 400 km in length with an east-northeast orientation. The rise exhibits a maximum relief of 2764 m from the floor of the adjacent Japan Basin to its shallowest depths on Yamato Bank (Fig. 8).

The Yamato Rise consists of four discrete bathymetric features including the Kita-Yamato Trough, Kita-Yamato Bank, Yamato Bank, and Takuyo Bank. The crests of both Kita-Yamato and Yamato banks exhibit flat areas thought to represent wave-cut surfaces produced during Quaternary low stands of sea level (Tamaki, 1988). The present water depths of the bank tops (<300 m) and the tilted nature of the Yamato Bank terrace suggest that parts of both banks have subsided during Quaternary time.

Kita-Yamato Trough neatly divides the Yamato Rise in half and separates the two major banks forming the rise proper. The floor of the trough has an average water depth of about 2000 m, with the flanks of the trough rising 1500 m to the top of adjacent Yamato Bank. In detail, the sides of the trough present a nested configuration with the bottom of the trough narrow and steep. The Kita-Yamato Trough trends east-northeast, parallel with the long dimension of the Yamato Rise clearly following the structural grain of the rise (Fig. 8). The sides of the trough demark normal faults bounding the nested structure of this feature which involves three sub-grabens. Significantly, the 2000-m isobath outlining the Kita-Yamato Trough is closed indicating that the depressed central area of the trough is not yet brimful of sediment or, more likely, that the ongoing rate of subsidence is greater than the rate of sediment accumulation in the trough.

Objectives

Development of a Failed-Rift Setting for Massive Sulfide Mineralization

The primary objective at Site 799 was to determine the depositional and tectonic history of the Kita-Yamato Trough as an ideal or typical environment for deposition of massive sulfide mineralization in a rifted continental-arc setting. In fact, Site 799 constitutes the first and only DSDP-IPOD-ODP site aimed primarily at testing concepts of deep-sea metallogeny.

The special importance of the Kita-Yamato Trough lies in the idea that it represents a failed rift created during early Miocene back-arc spreading and extension in the proto-Japan Sea. Multiple spreading centers associated with this process are thought to have isolated the continental fragment which now forms the Yamato Rise. Subsequent spreading and rifting of this block initiated graben formation, which split the rise. For reasons not clearly understood, this process stopped short of complete rifting leaving the Kita-Yamato Trough as a failed rift that subsequently accumulated a thick sequence of Miocene through Holocene sediments (Fig. 8). This unusual geologic setting is broadly analogous to submarine volcanogenic environments that hosted many of the ancient massive sulfide deposits now being mined for Cu, Pb, Zn, Ag, and Au within continental-margin, arc, and back-arc settings in Precambrian through Neogene rocks throughout the world.

Of immediate importance to Site 799 drilling, the Miocene Kuroko deposits of northern Honshu, Japan, constitute one of the prime examples of this type of massive sulfide mineralization. A recent study of these deposits (Ohmoto and Skinner, 1983) presents geochemical and geologic evidence pointing to the formation of the Kuroko ores as precipitates from hot hydrothermal fluids issuing from vent fields within a deep-sea (<2000 m) sedimented failed-rift setting in the western proto-Japan Sea during late early Miocene time. The analogy between the geologic context of the Kuroko deposits and the geologic setting of the Kita-Yamato Rise and Site 799 could not be more direct with one exception--we are not aware of any evidence suggesting Miocene caldera formation in the Yamato Rise area, a prominent feature associated with both Kuroko deposition (Ohmoto and Takahashi, 1983) and modern analogues in the Okinawa Trough (Halbach et al., 1989). Even though our chances of actually encountering a massive sulfide or shale-hosted deposit at Site 799 were remote, we expected to detail the depositional, tectonic, and paleoceanographic evolution of a failed-rift environment essentially identical to that known to contain these deposits.

Results

Lithology

Drilling at Site 799 penetrated 1084 m of lower Miocene through Holocene sediments. Dominant lithologies within the upper 465.7 m of upper Miocene to Holocene sediments cored in Hole 799A include biosiliceous sediments and fine-grained detrital sediments intercalated with carbonate-rich intervals. Coring in Hole 799B began at 450 mbsf, purposely producing an 18.7-m stratigraphic overlap with the base of the column in Hole 799A. The Hole 799B sequence consists of 634 m of lower Miocene through upper Miocene diagenetically altered biosiliceous sediments, diagenetic carbonates, sandstones, and a prominent 24-m-thick altered rhyolitic tuff and tuff breccia.

Authigenic carbonates are abundant in the Site 799 sequence, with dolomite the dominant phase. More than 200 intervals of dolomite nodules, layers, and beds were recovered in cores with many more unsampled zones detected by logging. Biogenic calcite is largely restricted to the upper 125 m of the section, with the final smear-slide observation of foraminiferal test debris made at 345.9 mbsf.

Biosiliceous sediments form a major component in many intervals within Holes 799A and 799B, giving an unusually clear record of silica diagenesis with depth. Transformation of biogenic opal-A to opal-CT occurs within the interval from 410-460 mbsf, with X-ray diffraction (XRD) data and visual observations indicating a major change at 457 mbsf; only traces of original biogenic silica occur below this depth. The opal-A/opal-CT boundary constitutes a major lithologic and geochemical boundary at Site 799, with a pronounced increased in density and state of lithification below this horizon.

Drilling in Hole 799A (0-468.7 mbsf) recovered 198 individual ash layers that were deposited from late Miocene through Holocene time. Alternatively, only 25 ash layers were recovered in Hole 799B between 450 to 1084 mbsf although a major unit of rhyolitic tuff and tuff breccia is present in lithologic Unit IV. All of the volcanic products are air-fall pyroclastics, including crystal-rich layers. The Pliocene and Quaternary ash record is enhanced by logging data at Site 799, with a major pulse of volcanic activity indicated for the late Pleistocene (1.3-0.6 mbsf). Analysis of the ashes at Site 799 allowed recognition of 10 different phases in volcanic activity from early Miocene through Holocene time.

The sedimentary column at Site 799 was divided into five lithostratigraphic units based on shipboard analysis of lithologic composition and variability, sedimentary structures, and diagenetic alteration as follows:

Unit I (0-170 mbsf; Quaternary to upper Pliocene) Diatomaceous clay and ooze, diatomaceous clayey mixed sediment, clay, clayey silt, silty clay, silt, and vitric ash layers. Diatoms, sponge spicules, silicoflagellates, and radiolarians form the biosiliceous component in this unit. Foraminifer-rich sediments including oozes are limited to thin beds and laminae in the upper 90 m with calcareous nannofossils and foraminifers showing progressive alteration and overgrowths below 110 mbsf. Dolomite occurs as shallow as 12.7 mbsf; authigenic carbonate is commonly observed below 100 mbsf. Siliciclastic sands are a minor but conspicuous lithology in Unit I. They are compositionally immature and are restricted to the upper 34 m of the section. Maximum abundances of terrigenous components occur between 0 and 50 mbsf and 105 to 150 mbsf. Unit I displays both thickly bedded and laminated intervals. Although distinctive light/dark rhythms occur in the upper 117 m they are not equivalent in origin and cannot be uniformly attributed to paleoceanographic-paleoclimate cycles. Soft sediment deformation is a common feature within Unit I, including harmonic and disharmonic folding and sediment detachment. Evidence of debris flows was noted also. Coarse-grained and normally graded beds mark turbidite units, which include siliciclastic, foraminiferal, and volcanoclastic-rich sands. Bioturbation is also common in Unit I.

Unit II (170-457 mbsf; Pliocene to upper Miocene) Diatomaceous ooze, clayey diatomaceous ooze, clayey diatomaceous mixed sediment, and diatomaceous mixed clay. Nannofossil-rich and carbonate-rich sediments and sediments rich in sponge spicules occur as minor lithologies throughout Unit II. Sediments in Unit II contain more abundant biosilica and less abundant terrigenous detritus and vitric ash layers compared with Unit I. Biosiliceous sediments dominated by diatoms are the most abundant component in Unit II. Dolomite beds and concretions are prominent between

247 and 394.6 mbsf, and these deposits commonly preserve primary sedimentary structures. Carbonate also occurs as chalky layers that likely represent former foraminiferal and/or nannofossil-rich layers. An isolated but important 2-cm-thick glauconite sand occurs at 374.2 mbsf. The top of Unit II (170 mbsf) marks the deepest occurrence of the light/dark rhythmic sedimentation common in Unit I. In contrast, Unit II is homogeneous in appearance, exhibits common evidence of bioturbation, and lacks evidence of substantial soft-sediment deformation.

Unit III (457-800 mbsf; upper to middle Miocene) Siliceous claystone and porcellanite with intercalated beds, laminae, and concretions of authigenic carbonate occurring mainly in the form of dolomite; rare volcaniclastic layers. The top of Unit III is essentially coincident with the most pronounced zone of diagenetic transformation of opal-A to opal-CT. This transition is marked by a sharp increase in wet-bulk density and a general increase in lithification. The transformation from opal-CT to authigenic quartz also occurs within Unit III between 528 and 585 mbsf but is not accompanied by the dramatic physical changes which mark the opal-A/opal-CT boundary at the top of this unit. Sediments in the upper part of Unit III (457-606 mbsf) are finely laminated, whereas sediments in the lower part of the unit (606-800 mbsf) are predominantly bioturbated. Normal faults occur throughout Unit III with fine networks of veins between 560 and 800 mbsf being interpreted as water-escape structures.

Unit IV (800-1020 mbsf; middle to lower Miocene) Finely laminated to thinly bedded siliceous claystone and porcellanite; interlaminated carbonate-rich laminae, lenses, and nodules of dominantly dolomitic composition; and thin normally graded quartz silts, sands, and glauconitic sands. The siliciclastic beds in Unit IV range from 1 mm to 30 cm in thickness and are collectively interpreted as distal turbidite deposits. Pyrite is common between 875 and 980 mbsf and occurs within concretions and disseminated in the silt-sized fraction. An important and prominent altered rhyolitic tuff and tuff breccia is present between 990.8 and 991.3 mbsf. Logging data indicate that the rhyolitic unit includes at least three discrete depositional units.

Unit V (1020-1084 mbsf; lower Miocene) Siliceous claystone and claystone with silt, including abundant intercalated coarse-grained sand and sandstones. Siliciclastic turbidites are the most conspicuous lithology in Unit V. Immature sands dominate these beds, which average 1 cm in thickness but reach a maximum thickness of 5 m. Individual sand units display normal grading, cross lamination, sharp bases with load casts, and other evidence of gravity-driven flow and redeposition including displaced shallow water benthic foraminifers, calcareous shell debris, and common terrestrial plant debris. Granule and pebble-sized rock fragments are present in coarser sand units along with glauconite, angular quartz, feldspar, biotite, pyrite, and dark lithic fragments. Interbedded siliceous claystones within Unit V contain bathyal *in-situ* benthic foraminifers indicative of water depths between 1500 and 2000 m or deeper.

Age and Sedimentation

Microfossils are common in the uppermost part of the sequence at Site 799 but are generally scarce to absent in the majority of the column owing to diagenesis of both biogenic calcite and silica with depth. These conditions in turn severely limit biostratigraphic age assignments within lower upper Miocene through lower Miocene sediments. Similarly, polarity transitions are clearly recognized within the Pleistocene and Pliocene and perhaps the uppermost Miocene portions of the column. However, overprinting and other problems prevent recognition of older paleomagnetic events and, in turn, dating of these sediments.

In general, planktonic foraminifers and calcareous nannofossils are most abundant and best preserved within Quaternary sediments to about 100 mbsf, with only sporadic occurrences in Pliocene and Miocene sediments. Consequently, siliceous microfossils, including diatoms, silicoflagellates, and isolated occurrences of identifiable radiolarians and calcareous nannofossils, provide irregular biostratigraphic control in the bulk of the Site 799 sequence. All microfossil groups are generally rare to absent in sediments and rocks below the opal-A/opal-CT diagenetic boundary at 457 mbsf.

Sediment ages are well constrained by diatom zones and calcareous nannofossils in lithologic Unit I, and diatoms and silicoflagellates provide reliable ages in the upper part of Unit II. Only isolated occurrences of identifiable radiolarians provide age control in the lower part of Unit II and the upper part of Unit IV. Likewise, isolated occurrences of identifiable calcareous nannofossils allow tentative zonal assignments for limited intervals in Unit III and the base of Unit IV. A calcareous nannofossil flora from 981 mbsf provides the oldest date in the Site 799 column and suggests that these sediments are early Miocene in age (Zone CN4), although the species present also permit an early middle Miocene age. A recrystallized radiolarian assemblage from 904 mbsf contains *Didymocyrtis mammifera* and *Lithopera renza* and also indicates an early Miocene age for the lower part of Unit IV.

Three microfossil datums and nine magnetic reversals constrain estimated rates of sedimentation for Quaternary through upper Miocene sediments at Site 799 (0-~440 mbsf). Rates of sedimentation varied within this time period between 15 to over 175 m/m.y., with an average rate of about 70 m/m.y. The highest rates occur in late Pleistocene time, whereas below average rates occurred in the Pliocene. Calculated accumulation rates vary between 14 g/cm/k.y. and 1.8 g/cm/k.y.

Inorganic Chemistry

Based on interstitial water concentration gradients, the Site 799 column can be divided into four intervals. Interval I (0-44 mbsf) is mainly influenced by early diagenetic processes that coincided with intense sulfate reduction; Unit II (44-220 mbsf) is marked by compositions reflecting organic matter decomposition and biogenic carbonate recrystallization reactions; Unit III (220-435 mbsf) is characterized by an interstitial water composition influenced by silica dissolution, dolomitization, and clay mineral crystallization; and Unit IV (435 mbsf and deeper) is marked by interstitial water strongly influenced by a sink for silica, potassium, magnesium, and chlorinity and served as a source for lithium. The geochemical character of the pore fluids in this interval suggests that at least two different fluid sources influenced this interstitial water mass. The pronounced lithologic boundary associated with the top of the opal-A/opal-CT transition zone clearly acts as a major barrier to interchange of interstitial waters above and below this zone. Water in sediments above this boundary exhibit normal diagenetic exchange reaction profiles. Below the boundary, waters reflect influence from other sources and sinks, with evidence pointing to advection as a major process affecting the chemical character of these waters. Drastic changes in pH and Sr occur in this lower water. Altered rhyolites in the lower part of the Site 799 sequence provide evidence that basement alteration is influencing the composition of pore fluids, leading to consumption of magnesium and the addition of calcium to the water. The presence of thick sands in the basal part of Hole 799B might allow for migration of fluids from distant sources, perhaps including relict Neogene fresh or brackish water.

Organic Geochemistry

Sediments at Site 799 contained large amounts of hydrocarbon gases, with methane concentrations ranging from 14 to 155,000 ppm, whereas ethane and propane concentrations range from below detection levels to 2693 and 1476 ppm, respectively. The ratios of methane to higher hydrocarbons decreased gradually with depth to 420 mbsf when C_1/C_2 decreased rapidly from 900 to 300. These ratios then decreased slowly with depth to 1059 mbsf, at which point the abundance of propane, isobutane, and *n*-butane increased rapidly. Special precautions were taken in analysis of gases below 450 mbsf. Headspace samples from Cores 128-799B-65R and 128-799B-66R exhibited a slow cut fluorescence and an amber residual cut. These same samples yielded large amounts of ethane, propane, and butane; prompted by these observations, we halted drilling at 1084 mbsf.

Sediments at Site 799 contain abundant organic matter with total organic carbon (TOC) values ranging from 0.24% to 5.66%. Calcium carbonate contents ranged from 0.25% to 79.8%, with the highest carbonate contents in Units I and II. Unit III contains little carbonate but abundant organic carbon, reflecting the common presence of laminated sediments between 457 to 606 mbsf, indicating an anoxic-suboxic depositional setting. Older bioturbated intervals in Unit II contain less organic carbon, with similarly low values found in Unit IV. Unit V, although characterized by coarse-grained siliciclastic deposits, is richer in organic carbon than Unit IV and exhibits high C/N ratios.

These various patterns indicate that Site 799 sediments are the product of enhanced deposition and/or preservation of organic matter that in turn may represent a response to high primary productivity, low oxygen bottom water, rapid burial, or high contributions of terrigenous organic matter. Shipboard data indicate that the majority of organic matter in Site 799 sediments is of marine origin. However, sediments exhibiting the highest TOC values in Unit V are dominated by terrestrial organic matter that likely represent a response to rapid burial via turbidite deposition and close proximity to a source of this material.

Logging

Four tool strings were successfully run in Hole 799A and Hole 799B including seismic stratigraphy, FMS, and litho-porosity and geochemical tool combinations. In addition, the TLT was added to the base of the tool strings. The Barnes/Uyeda temperature probe was deployed eight times during APC coring in Hole 799A. Finally, a vertical seismic profile (VSP) experiment was conducted at the completion of Hole 799B. VSP results indicate that acoustic "basement" rocks are located only 120 m below the base of Hole 799B (TD = 1084 mbsf). The log quality at Site 799 is generally excellent; however, a minor degree of post-cruise processing will probably be undertaken.

Results of wireline logging permit the lithologic sequence at Site 799 to be divided into six units. The most pronounced logging events or responses at this site are associated with resistant dolomite zones in lithologic Unit IV. Logging detailed these various zones in a continuous manner, supplementing variable core recovery through the dolomitic sediments. The geochemical tool was able to identify these zones as calcium-rich, confirming resistivity signatures. In addition, the FMS tool also imaged individual dolomite zones with great clarity. The prominent rhyolitic tuff and tuff breccia in Unit IV were fully detailed by the natural gamma ray spectroscopy tool, owing to the high Th contents of these sediments and rocks. Finally, the FMS caliper measurements and imaging of dolomite layers yielded data bearing on the stress field in the Yamato Rise area and the dip of beds in the lower part of the sequence.

Conclusions

Depositional History of the Kita-Yamato Trough

The narrow Kita-Yamato Trough is interpreted to be a failed rift within the larger Yamato Rise. The Yamato Rise is a tectonically isolated continental feature with demonstrated granitic basement and an overlying blanket of Miocene volcanic and volcaniclastic rocks. Seismic reflection profiles clearly illustrate that the Kita-Yamato Trough is a graben with multiple normal faults bounding its central axis. Pre-cruise seismic estimates of total sediment thickness in the trough indicated that between 1200 and 1300 m of Miocene to Holocene sediment is present in the axis of this feature. This thickness is almost twice the average thickness of the sediment columns in the Japan and Yamato basins, the two largest basins in the Japan Sea. The unusual thickness of sediments clearly implies that the Kita-Yamato Trough has experienced pronounced subsidence, likely accommodated by continental crust beneath the Yamato Rise, as opposed to the surrounding oceanic and transitional crust presumably underlying adjacent basins. Drilling and VSP results at Site 799 generally confirmed the pre-cruise estimated thickness of 1200 m.

Drilling penetrated 1084 m of marine sediment at Site 799. Reliable biostratigraphic and paleomagnetic ages are restricted to uppermost Miocene through Quaternary sediments at this site, with extensive and pervasive diagenetic alteration of both biosiliceous and biocalcareous sediments common below 400 mbsf. Fortunately, rare and sporadic occurrences of both siliceous and calcareous microfossils provide tentative age control to the base of the Site 799 column. Calcareous nannofossils and radiolarians provide the oldest dates obtained in this sequence, with analyses of both groups indicating that lithologic Unit V at the base of Hole 799B is early Miocene in age.

Identifiable benthic foraminifers occur sporadically in lower and middle Miocene sediments and commonly in upper Miocene through Quaternary sediments. *In-situ* assemblages in all units indicate that deposition of the entire Site 799 sequence occurred at middle and lower water depths averaging close to the modern water depth of 2084 m at Site 799. However, some faunal evidence indicates that lower bathyal depths in excess of 2000 m may have occurred during the Pliocene.

The sedimentary history chronicled at Site 799 begins in the early Miocene when coarse siliciclastic turbidite sands were deposited in a paleogeographic setting much different than that of the modern Japan Sea. Terrestrial plant debris, shallow-water benthic foraminifers, and other evidence indicate that the sands were redeposited from littoral and neritic environments and in close proximity to an insular or continental shoreline. The composition of the sands reflects a mixed provenance from granitic and volcanic rocks. Intercalated claystones in these deposits contain lower bathyal foraminifers. A major and proximal volcanic event occurred in the Kita-Yamato Trough area in late early Miocene time, as marked by a 24-m-thick unit of altered rhyolitic tuff and tuff breccia. This rock is similar to rhyolitic rocks associated with the Kuroko massive sulfide deposits in northern Japan, and its occurrence at Site 799 was predicted prior to drilling based on the analogy with the geologic setting of these latter deposits.

Upper lower Miocene through upper Miocene sediments are dominated by siliceous claystones and porcellanites, with abundant authigenic carbonate dominantly in the form of dolomite beds and nodules. These sediments are lithologically similar to parts of the Monterey Formation of California and can be correlated with the Onnagawa and lower Funakawa Formations of northwestern Honshu. Both bioturbated and laminated intervals are present within these siliceous deposits and indicate that sustained periods of oxygen-deficient bottom water occurred in the Kita-Yamato Trough area from early through late Miocene time. These suboxic to near-anoxic conditions are also indicated by high TOC values in laminated units. Evidence from other ODP sites in the Japan Sea and well-known stratigraphies along the western coast of Honshu clearly illustrate that these distinctive siliceous lithologies are not restricted to the Kita-Yamato Trough sequence but are a widespread Miocene facies within the Japan Sea area as a whole. Although thin distal turbidites occur in the lower parts of this facies at Site 799, these siliceous rocks are dominantly of hemipelagic and pelagic origin. The sediments exhibit distinct and systematic diagenetic changes with depth at Site 799 with the opal-A/opal-CT and opal-CT/authigenic-quartz transitions observed in cores.

Upper Miocene through upper Pliocene sediments are also rich in biosiliceous sediments, indicating that high productivity of siliceous plankton continued in the Yamato Rise area during this period. Again, these sediments constitute a local manifestation of a facies common to upper Miocene through upper Pliocene sediments elsewhere in the Japan Sea. The sediments in this interval are commonly bioturbated, indicating normal oxic bottom water at Site 799 during most of latest Miocene and early Pliocene time.

Uppermost Pliocene through Quaternary sediments are also dominated by biosiliceous sediments but contain increasing amounts of terrigenous sediments as well. In addition, foraminiferal sands redeposited from adjacent bank tops appear in this part of the column along with coincident evidence of soft-sediment deformation and slumping. In fact, 3.5-kHz seismic reflection records clearly show large slump features on the flanks of the Kita-Yamato Trough, which can be directly correlated with sedimentary evidence of these events in Quaternary cores at Site 799. Volcanic ashes increased in abundance to a peak in late Pleistocene time.

A preliminary and rough estimate of subsidence in the Kita-Yamato Trough over the past 20 m.y. suggests that differential subsidence can account for the approximately 1200 m of lower Miocene through Quaternary sediments present in this feature. This same analysis indicates that the trough experienced accelerated periods of subsidence from early to late Miocene time and a period of little or no subsidence during Pliocene time. Faults and dewatering structures in upper Miocene sediments at Site 799 suggest that an episode of extensional tectonism may have occurred during this time. Significantly, the modern surface of the Kita-Yamato Trough is defined by a closed 2000-m contour, indicating that the trough is not brimful and that subsidence is continuing.

Paleoceanography

A scarcity of well preserved siliceous and calcareous microfossils in the majority of Miocene sediments at Site 799 precludes determination of a detailed paleoceanographic history for this period. However, the biosiliceous origin of the diagenetically altered siliceous claystones and porcellanites at this site and elsewhere in the Japan Sea area indicates that relatively high primary productivity (e.g., diatoms) must have prevailed during Miocene time, as represented by these altered siliceous sediments, in turn indicating vigorous vertical circulation. Most of the dolomitic laminae, beds, and nodules in these same sediments were likely derived from layers rich in calcareous nannofossils and planktonic foraminifers, suggesting alternating periods of dominance among these two groups of plankton and implied variations in surface temperatures and rates of vertical circulation. Analysis of rare identifiable radiolarian faunas and planktonic foraminifers in the middle Miocene part of this section suggests warm surface temperatures and full circulation with the open Pacific Ocean. Alternatively, well-preserved calcareous and siliceous plankton in Quaternary sediments signal subarctic temperatures, with the exception of an apparent increase in surface temperatures near the Pliocene/Pleistocene boundary.

As noted earlier, intervals of laminated sediments and associated high TOC values mark pronounced periods of low-oxygen bottom water in the early mid-Miocene and late Miocene, with some evidence of short periods of anoxic conditions at Site 799 during the late Pliocene and Pleistocene. In contrast, the modern Japan Sea is hyperventilated and fully oxic at all depths.

CONCLUSIONS

One of the primary goals of ODP drilling in the Japan Sea was reconstruction of the paleoceanographic history of the sea as it evolved from a proto-back-arc basin to its modern configuration marked by oceanic water depths (>3500 m) and shallow sills (<150 m). Previous studies of onshore sequences and cores from the Japan Sea proper demonstrate that the sea has experienced a complex history with local tectonic events and global evolution of Neogene climates having forced major changes in water-mass structure, circulation, and productivity. Site 798 on Oki Ridge was specifically aimed at obtaining a Miocene-to-Holocene paleoceanographic reference section for the eastern Japan Sea--the only site so targeted during Legs 127 and 128 drilling. We accomplished a major share of our paleoceanographic objective at Site 798 in recovering an excellent upper lower Pliocene through Holocene sequence of hemipelagic-pelagic sediments rich in siliceous and calcareous plankton. However, a rapid increase in hydrocarbon gases in Hole 798B caused drilling at Site 798 to be halted at a depth of 517.9 mbsf prior to penetration of Miocene strata. We estimate that the average rate of sedimentation for the Site 798 sequence is 120 m/m.y., emphasizing the expanded Pliocene-Pleistocene record contained in these sediments.

We accomplished all of our main objectives at Site 794: (1) to drill deeper into the acoustic basement complex initially encountered during Leg 127 drilling at this site with the goal of reaching igneous basement in the Yamato Basin; (2) to install a newly developed downhole seismometer in basement rock, to conduct a real-time multi-ship seismic experiment, and to initiate a long-term program of seismic observations for the purpose of analyzing deep structure beneath the Japan Sea; and (3) to conduct large-scale resistivity and oblique resistivity experiments using a dedicated hole for determining the deep resistivity structure beneath this site.

We essentially completed all of our objectives at Site 799: (1) to determine the depositional and tectonic history of the Kita-Yamato Trough, thought to be an ideal or typical environment for deposition of massive sulfide mineralization in a rifted continental arc setting; and (2) to obtain information on the paleoceanographic history of the Yamato Rise area and in the Japan Sea in general. We were thwarted in fully completing objective (1) by sharp increases in hydrocarbon gases and a fluorescent liquid hydrocarbon that caused drilling to be halted at 1084 mbsf. VSP results indicate that acoustic basement rocks lie ~120 m below the base of Hole 799B.

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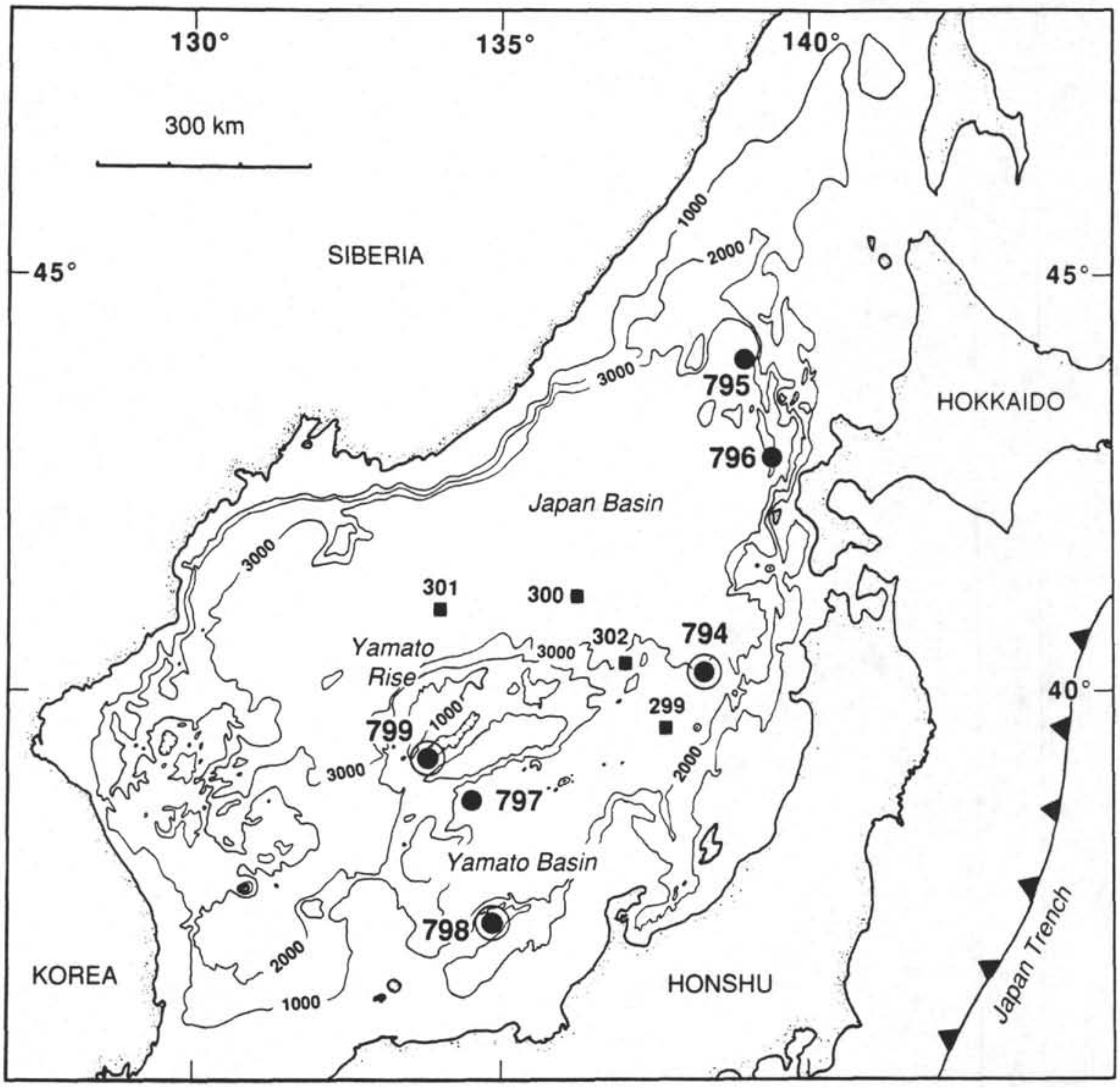
FIGURE CAPTIONS

Figure 1. Map of the Japan Sea showing locations of ODP Leg 127 sites (dots), Leg 128 sites (circled dots), and DSDP Leg 31 sites (squares). ODP Site 794 was occupied on both Leg 127 and Leg 128. Bathymetry in meters.

Figure 2. Location map of the area surrounding Site 798, showing site location and bathymetry. Contour interval is 500 m. Note location of the Oki Islands relative to Oki Ridge.

Figure 3. Summary stratigraphic columns for ODP Sites 794, 798, and 799 in the Japan

Sea. Note that the Site 794 column represents a composite of Leg 127 and Leg 128 columns at this location.
Figure 4. Schematic overview of a typical dark/light bedding sequence.
Figure 5. Location map of Site 794 and bathymetry of the northern Yamato Basin and adjacent Japan Basin. Contour interval 500 m. Figure modified from Tamaki, Pisciotto, et al. (in preparation)
Figure 6. Schematic diagram of the igneous basement sequence drilled at ODP Site 794, representing early Miocene seafloor and crust beneath the Yamato Basin, Japan Sea. Seafloor stages 0, 2, and 6 represent the relative position of the seafloor at the time that Units 0, 2 and 6 were emplaced, i.e., these units were emplaced at or near the seafloor. Other units were emplaced beneath the seafloor. Units are shown in contact only when the actual contact was observed in the cores. The unit numbers in the lower part of the diagram are shown to stress that the stratigraphic position of the units does not represent the order in which they were emplaced.
Figure 7. Schematic illustration of the electrical resistivity experiment at Site 794 and configuration of the sensor cable during the experiment in Hole 794E.
Figure 8. Bathymetric and location map of the Yamato Rise area and Site 799, south central Japan Sea. Note that the Yamato Rise consists of four discrete features: Yamato Bank, Kita-Yamato Bank, Takuyo Bank, and Kita-Yamato Trough (emphasized by stippling). The shallowest areas on the rise are noted by triangles and associated water depths. Contour interval in meters.



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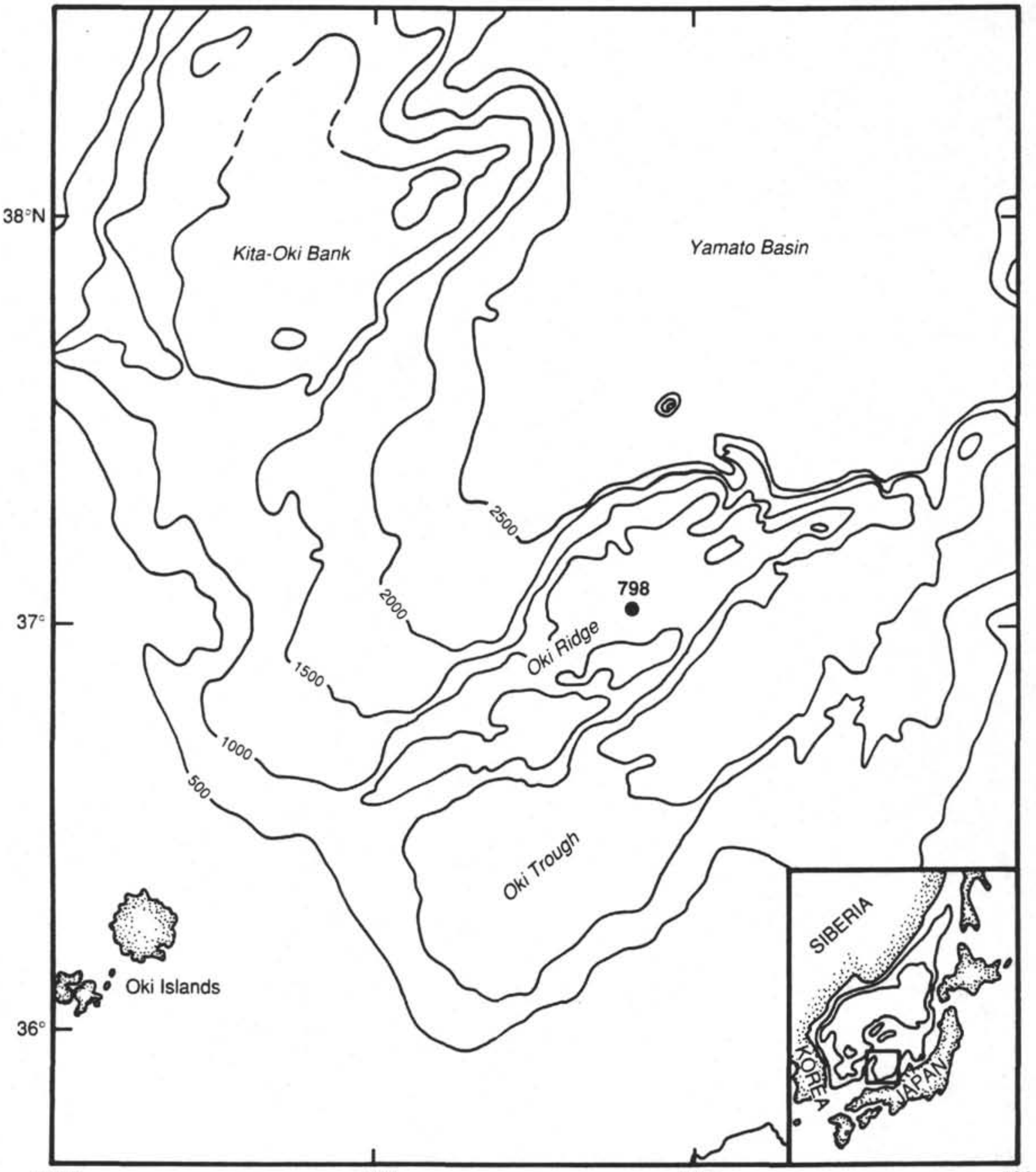

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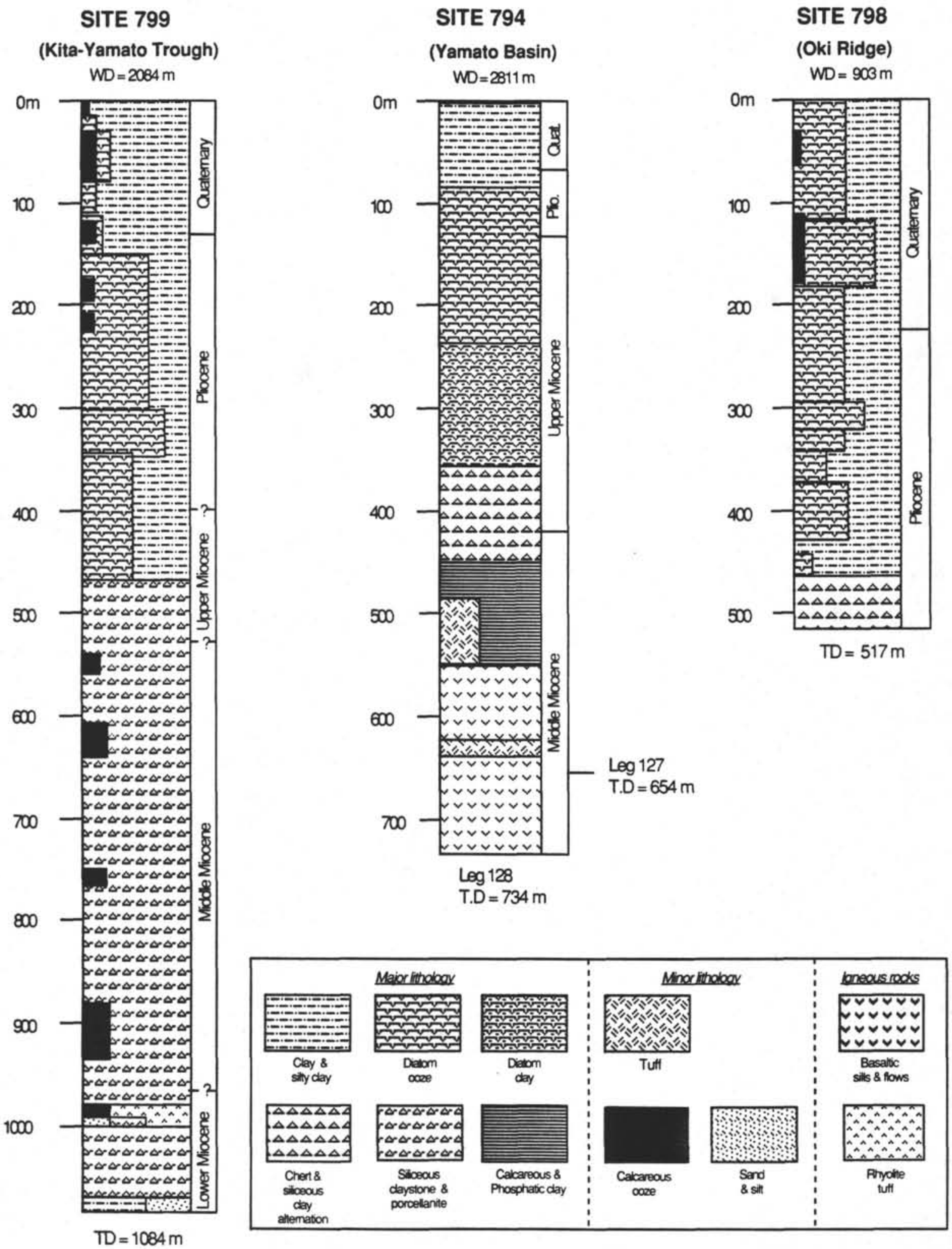

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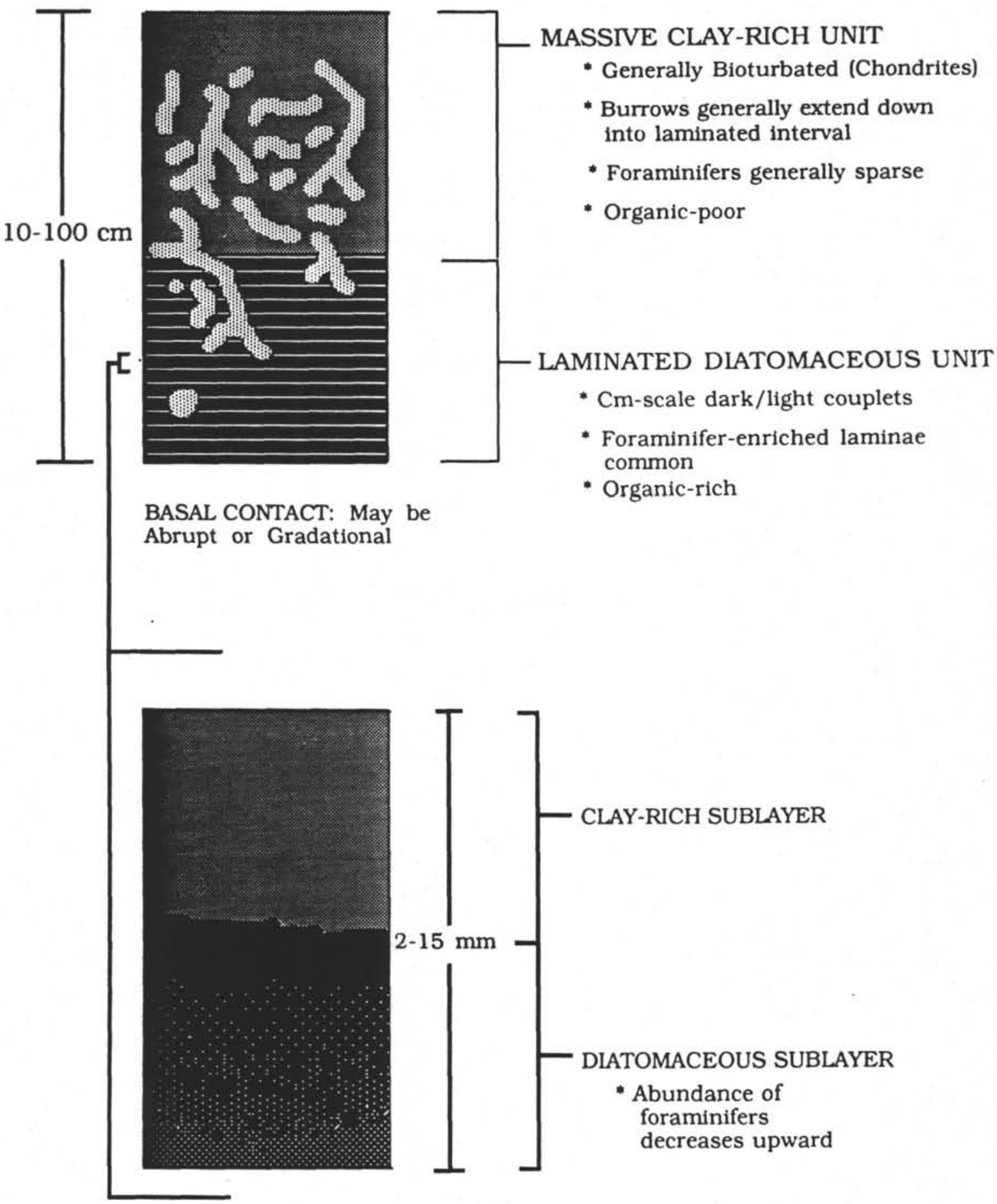
Preliminary Summary of Dark/Light Bedding Rhythms, APC - cored strata, Site 798



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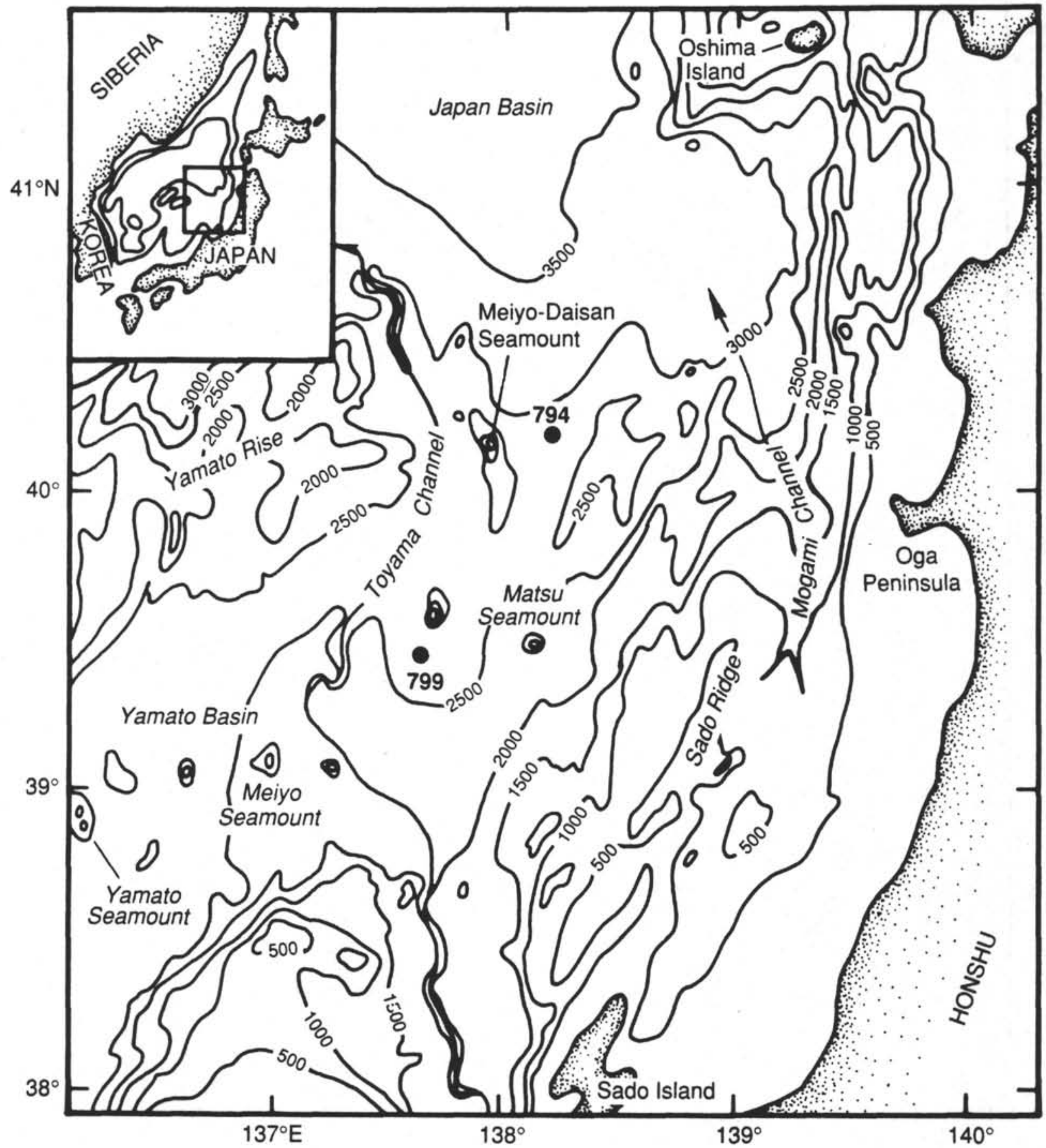

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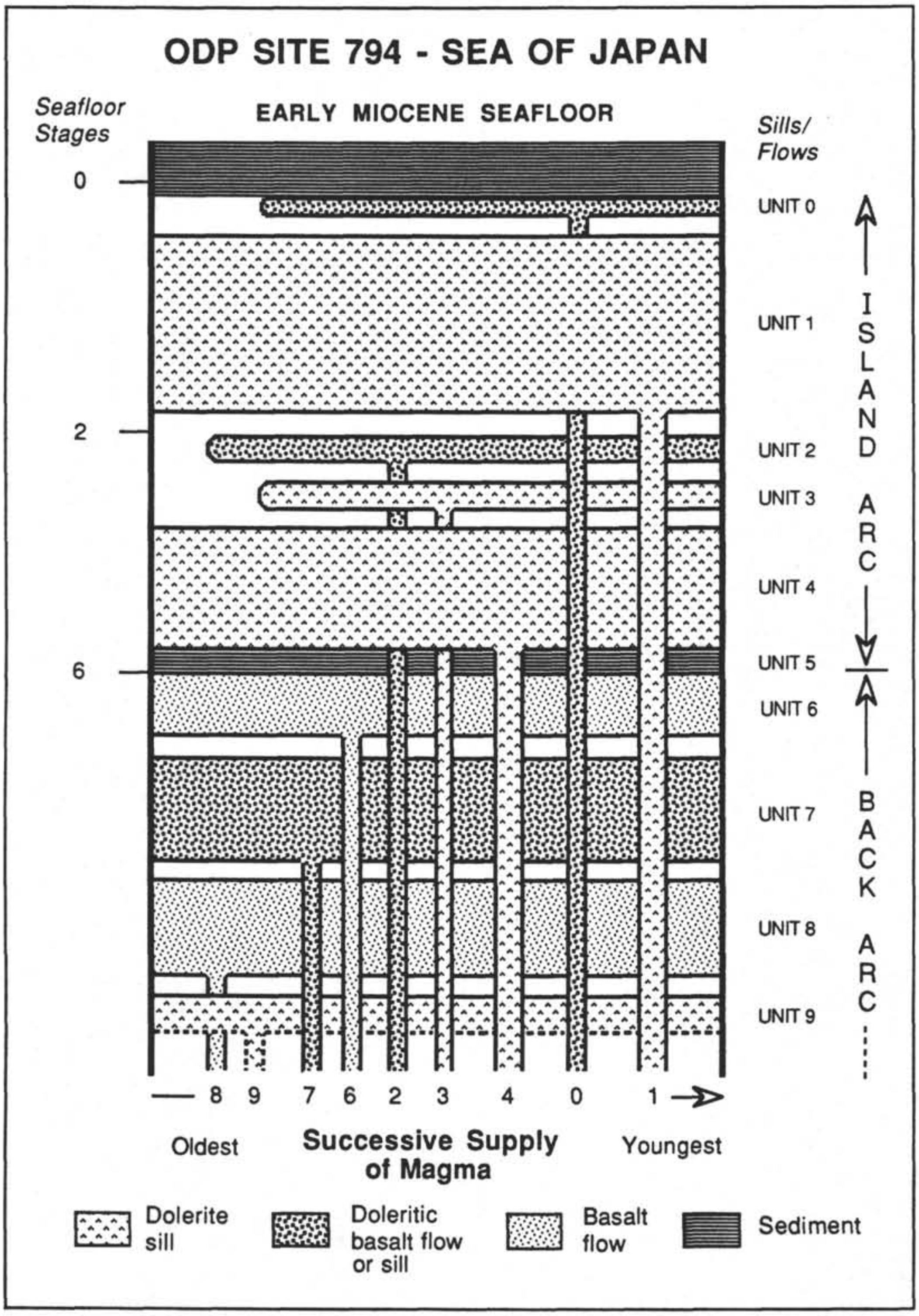

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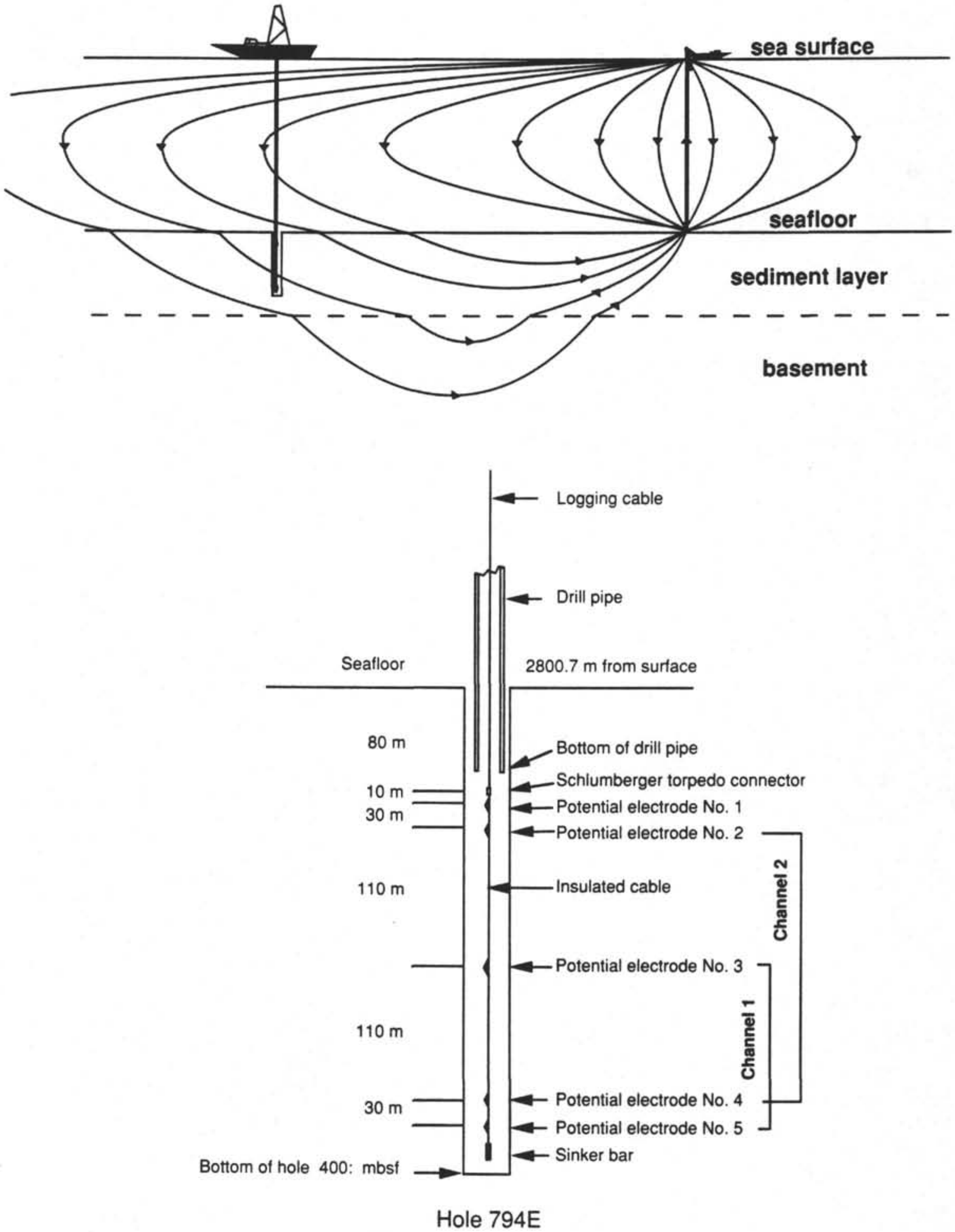

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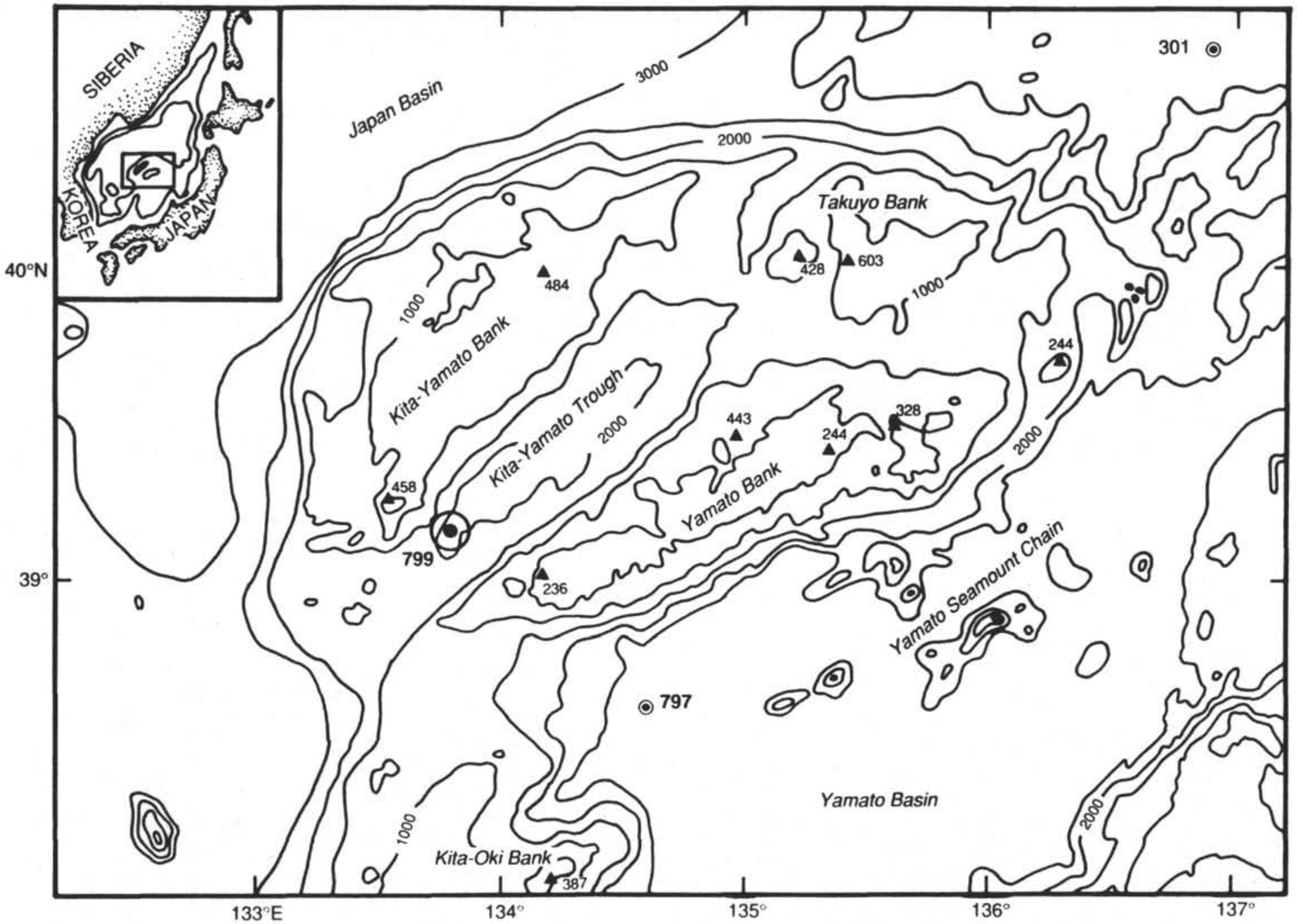

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The shallowest areas on the rise are noted by triangles and associated water depths. Contour interval in meters.

OPERATIONS SYNOPSIS

The ODP Operations and Engineering personnel aboard *JOIDES Resolution* for Leg 128 were:

Operations Superintendent:	Eugene Pollard
Special Tools Engineer:	Hiroshi Matsuoka
Schlumberger Engineer:	Lee Geiser

OVERVIEW

Leg 128 of the Ocean Drilling Program investigated three sites and ran two experiments in the southern half of the Japan Sea. During the course of the leg, seven holes were spudded and 2043.50 m of sediment and basement was penetrated. All sites were in Japanese territorial waters.

Site 798 (proposed site JS-2) was located on the mid-part of Oki Ridge, and the primary objective was to recover a paleoceanographic reference section. A total of 781.3 m were APC/XCB cored in three holes with 101.5% recovery. Temperature measurements, oriented cores, and logs were taken as appropriate. Special sterile sampling techniques were used for a microbiological investigation. Coring was terminated at 517.90 meters below seafloor (mbsf) in Hole 798B, following JOIDES Pollution Prevention and Safety Panel (PPSP) guidelines.

Hole 794C (proposed site J1b-1) had been cored and cased through the sediment section during Leg 127 and was supposed to be ready for the installation of a borehole seismic instrument in basement rock. Unfortunately, during Leg 127 a "fish" (the bottom-hole assembly or BHA) became stuck and was left in the hole. The schedule for Leg 128 was modified to permit two days of fishing operations (to attempt to remove the BHA); however, fishing operations were not successful in cleaning out Hole 794C. Another hole (794D) was drilled to 573 mbsf, a reentry cone was set, and the hole was cored to 733.5 mbsf. A seismometer was installed at 715 mbsf in igneous basement rock for the seismic experiment. Also, a new RCB hole (794E) was drilled to 400 mbsf and electrical resistivity measurements were taken in the uncased hole.

Site 799 (proposed site J2a-1) was located in the southern Kita-Yamato Trough, which was thought to be a failed rift. A total of 468.7 m of APC/XCB cores were taken in Hole 799A with 94% recovery. Oriented cores and heat flow measurements were also taken. A reentry cone was set in Hole 799B, with 11-3/4-in. casing cemented at 440.55 mbsf. RCB coring continued through 633.0 m of sediments, and was terminated per PPSP guidelines.

Operations were interrupted at Holes 794D and 799B in order to meet prior scheduling commitments with the Ocean Research Institute in Tokyo for using the research vessels *Tansei Maru* and *Kaiko Maru V* for seismic and resistivity experiments. Two additional days were required for intersite transits as a result.

Leg 128 began officially at 2100 UTC, 20 August 1989, when *JOIDES Resolution (SEDCO/BP 471)* dropped the first anchor in Pusan Harbor anchorage, Korea, and ended at 2100 UTC, 15 October 1989, when the first anchor was dropped in Pusan Harbor anchorage, Korea. (All times given are UTC unless otherwise noted.)

PUSAN PORT CALL

The ship moved from anchorage to Pier 3 Berth 31, with the first line ashore at 2230 hr, 20 August. The port call agenda consisted of routine crew change and resupply activities. Some delays were experienced in getting equipment to the dock and because of heavy rain, but most freight items were eventually cleared and loaded, including 60 metric tones (MT) of barite, 60 MT of gel, 10 positioning beacons, drill collars, and fishing tools. A shipment of 100 MT of cement arrived too late to accept, and the cement was returned to Singapore. Datasonics repaired four beacons and acceptance tested 10 others. An American Bureau of Shipping (ABS) Surveyor completed an inspection of the ship, and an ABS Certificate of Fitness for the Carriage of Dangerous Goods was received for SOLAS Class 1 Explosives and Class 7 Radioactive substances. As a precaution against further drill pipe (DP) failures, the 5-in. DP used on Leg 127 was set aside, and 2500 m of new 5-in. DP was picked up in triples and set in the racker for use on Leg 128.

The Port Authority requested that we vacate our berth by 0900 UTC, 24 August. The last line was off the dock at 0845 UTC, 24 August, and the ship was moved as originally planned 3 nmi east-southeast to an anchorage in Busan harbor for sonar dome removal by divers. Anchors were dropped at 0930 UTC; the ship was too close to a pipeline and buoy, however, and anchors were picked up at 1000 UTC, the ship moved a short distance, and anchors were dropped again at 1030 UTC, 24 August. The divers removed the sonar dome in 9-3/4 hr and attached a blanking plate. The sonar dome was loaded on a barge for crating and shipment to Singapore. Additional UDI air freight was offloaded from a barge, and final clearance documents were received to depart.

JOIDES Resolution departed Pusan, with the first anchor up at 1920 UTC 25 August, carrying a complement of 108 (47 UDI/SEDCO crew, 14 catering crew, and 47 ODP scientists and technicians). On 3 September, *Nippon Maru* brought seismic and resisitivity experiment tools and an additional scientist to Site 794 and departed with two scientists and their sterile microbiological samples. *Tansei Maru* arrived at Site 794 on 25 September, and *Kaiko Maru V* arrived on 28 September for the seismic and resistivity experiments. Another scientist left the ship aboard*Tansei Maru* on 2 October.

SITE 798 (JS2) OKI RIDGE, SEA OF JAPAN

Site 798 (proposed site JS2) was located in a small fault-bounded and sediment-filled depression on the mid-part of Oki Ridge. Site 798 is located 296 nmi east-northeast of Pusan and required 30-1/2 hr transit at 9.7 kt average. The pre-site survey covered 35 nmi in 5.7 hr at 6.1 kt average. A positioning beacon was dropped at 2045 UTC 26 August, initiating Site 798.

Hole 798A

A 9-7/8-in. PDC (polycrystalline diamond compact) Smith bit (rerun) with an APC/XCB BHA and new 5-in. S-140 DP was run in to near the seafloor. Hole 798A was spudded at 0523 UTC, 27 August, in an estimated water depth of 917.5 m by precision depth recorder (PDR). Spud core 128-798A-1H was shot at 914.2 m and had 1 m of empty core tube; therefore, it was accepted as a mud-line core. Based on subsequent mud-line measurements of 911.1 m drill pipe measurement (DPM)[1] at offset sites, 128-798A-1H

[1]In the Operations Report, depths are measured by drill-pipe length from the top of the dual elevator stool on the rig floor.

may have been taken as much as 1.5 m below the mudline. Continuous APC Cores 128-798A-1H through -15H were taken from the interval 914.2-1056.7 m (0-145.5 mbsf). The next APC could not penetrate the hard rock and picked up the drill string; the refusal was not recorded because there was no recovery.

Heat flow (HF) measurements were taken every other core after Core 128-798A-4H, and oriented cores were taken starting with Core 128-798A-5H. The technique of setting the BHA on bottom for the first three heat flow measurements evidently resulted in some movement (which affected the reading on HF #3); therefore, on future HF readings the bit was left 2 m off bottom, which yielded better data.

XCB Cores 128-798A-16X and -17X were taken from the interval 1056.7-1057.5 m (145.5-146.3 mbsf), but poor recovery (0.8 m cored, 0.37 m recovered) and poor rate of penetration, or ROP (0.8 m in 60 min) with the PDC bit in hard dolomitized ash resulted in a decision to terminate the hole in order to change to an insert bit. A total of 142.5 m were cored in Hole 798A, with 147.65 m recovered (the 103% recovery factor is due to surface expansion of gassy samples). The bit cleared the rotary table at 0124 UTC, 28 August.

Special sterile sampling techniques were used for a microbiological investigation to quantify the role of bacteria in diagenesis by measuring their activity and biomass distribution with depth in sediments.

Severe tropical depression Roger came within 90 nmi of the site on 27 August, with heavy rain, up to 42 kt winds and 14 ft swells, but operations continued without incident.

Hole 798B

The ship was moved 20 m north, and an 11-7/16-in. Security S86 insert bit was run with an APC/XCB BHA. Hole 798B was spudded at 0542 UTC 28 August. Core 128-798B-1H was shot at 911 m and recovered a full mud-line sample. Continuous APC Cores 128-798B-1H through -15H were taken from the interval 911.1-1053.7 m (0-142.6 mbsf). Recovery was 159.74 m. XCB Cores 128-798B-16X through -54X were taken from the interval 1053.7-1429.0 m (142.6-517.9 mbsf), coring 375.3 m and recovering 353.88 m. Many cores were gassy, causing sample expansion with extrusion of some sample from both ends of the core barrel, and some core bits were blown off during removal of the core from the barrel.

Capillary suction tests on clay samples from 30 and 270 mbsf showed negligible swelling tendency in fresh water, indicating that the clays were nonreactive.

Coring was terminated at 1429.0 m, per PPSP guidelines, owing to a rapid decrease in C_1/C_2 ratio, an increase in C_3-C_5, and an anomalous C_1/C_2 ratio (per Claypool), indicating possible thermogenic gas migration. After a short trip to condition the hole, the hole was displaced with 2% KCl mud and the drill pipe was pulled to 86 mbsf. Logs were run as follows: sonic/seismic stratigraphy (DITE/NGTC/MCDG/SDT/TCCB), formation microscanner (FMS/NGTC/TCCB), lithoporosity/density (LDTC/CNTG/NGTC/TCCA), and geochemistry (GSTA/ACTC/CNTG/NGTC/TCCB). Two passes were made with the FMS and GST combinations. All logs were run to total depth with good hole condition. The LDT/CNL tool stuck in the drill collars and had to be pumped down. It is suspected that a centralizer spring got caught in a landing shoulder slot. The top of the hole was filled with 12.0 ppg mud and the bit was pulled out of the hole, clearing the seafloor at 2300 UTC 30 August and ending Hole 798B.

Hole 798C

The ship was offset 20 m north and Hole 798C was spudded at 0030 UTC 31 August in 911.2 m water depth (by DPM). Continuous APC Cores 128-798C-1H through -13H were taken from the interval 911.2-1031.3 m (0-120.1 mbsf), recovering 132.08 m. Heat flow measurements were taken every other core after 128-798C-4H. Coring was terminated at 120.1 mbsf, and the bit was pulled to the seafloor at 1150 UTC 31 August. The bit came through the rotary table at 1440 UTC 31 August, ending Hole 798C. The ship was underway for Hole 794C at 1500 UTC 31 August.

RETURN TO SITE 794

Hole 794C

The transit from Site 798 to Site 794 covered 248 nmi and required 24-1/2 hr, at an average speed of 10.1 kt. The ship arrived at Site 794 at 1524 UTC 1 September. The beacons left during Leg 127 were no longer working, so a Datasonics beacon was launched at 1630 UTC 1 September in 2823 m of water (PDR depth). The purpose in returning to Site 794 was to attempt to "fish" (recover) a BHA lost in Hole 794C during Leg 127, deepen the hole 80 m, and install a bottom seismic experiment package in the borehole. To attempt the recovery, a fishing BHA was run, consisting of a screw-in sub, safety joint, 9-5/8-in. washpipe skirt/cut lip guide, fishing bumper sub, super jars, and intensifier.

The fishing BHA and DP with a VIT frame/TV was run to 2802 m to search for the Hole 794C reentry funnel. The Mesotech sonar was not run because the telemetry pod was not working. An unsuccessful grid search was conducted for 6 hr, based on a preliminary global positioning system (GPS) fix. A subsequent GPS window showed the preliminary GPS positioning to be 700 m off, so the ship was moved and another grid search was conducted. The Hole 794C reentry cone was found in 1 hr and reentered at 0920 UTC 2 September, despite 40 kt winds, 6 ft heave, and strong fluctuating currents. The fishing BHA was run to 2855 m (35 mbsf) where it hung up in the 11-3/4-in. casing. The heave apparently set weight on the unsupported DP, causing the DP to bend at the top of the cone at 2808 m and break at an existing flaw. The DP failure was not observed, owing in part to the effects of rough weather, so the crew continued to run DP (along the seafloor) to the anticipated top of the fish at 3275.2 m. When the top of the fish was not found, DP was run to an equivalent total depth of 3487.65 m to verify that the original fish had not unscrewed and fallen on the seafloor rather than having been left in the hole.

An attempt was made to determine if the fishing BHA had stayed in the reentry cone (i.e., was not lying on the seafloor), but visibility was too poor and clay debris on the DP posed a hazard to the VIT frame. The VIT/TV was pulled and the BHA was pulled out of the hole for inspection. The 5-1/2-in. S140 DP was found to have parted at an existing flaw in the bottom transition joint, leaving a 1.1-m stub sticking up out of the top of the reentry cone. A 9-1/2-in. overshot was run in the hole on the assumption that the DP stub would be engaged inside casing. The rig could not be held in position over the fish after 7-1/4 hr, owing to changing currents, no sonar, inaccurate compass, and a beacon 200 m southeast of the hole location. The cause of the obstruction in the 11-3/4-in. casing was unknown at the time (a casing slip joint was later calculated to be at that depth); a decision was made to drill a new replacement hole (794D) because the 2-day fishing deadline was approaching. The DP was through the rotary table at 1500 UTC 4 September, ending Hole 794C.

Hole 794D

The ship was moved 167 m southeast, which is 30 m from the first beacon. Hole 794D (at proposed site J1b-1) was spudded at 1823 UTC 5 September. The 16-in. casing was jetted in to 2876 m, with the top of the reentry cone at 2815 m (3 m above the mud line). Five joints of 16-in. casing, a 16-in. hanger and a new style reentry cone with an attached beacon were run.

This was the first time the new style reentry cone had been run, and construction and deployment went smoothly with only minor modifications required to set the reentry cone on the guide frame split flange in the moonpool. The new reentry cone features an expanded 7.5-ft X 16-ft mud pan and does not have a flow line tube.

After jetting in the 16-in. casing, the 14-3/4-in. BHA was unjayed and drilled to 3391 m (573 mbsf). The short trip showed that the hole was in excellent shape, and the hole was filled with 10.0 ppg 2.5% KCl mud. The 11-3/4-in. casing (43 joints--559.08 m) was run on 5-1/2-in. DP to just above the reentry cone.

The TV camera failed at 100 m while it was being run in on the VIT frame, and the sonar was not working. Troubleshooting and repair attempts on the TV included reheading the coaxial cable, reterminating the coaxial cable on the winch drum, and numerous adjustments. The VIT frame and TV camera were run and provided a marginal TV picture good enough to assist in reentering Hole 794D after 15 min. The 11-3/4-in. casing was run to 3354 m, where it started taking 20,000-40,000 lb weight. The casing was washed 24 m to bottom, with the shoe at 3377.58 m and the hanger top at 2819 m. The 11-3/4-in. casing was cemented with 760 sacks of Class G cement. Cement was noted in the running tool verifying cement to surface.

A 9-7/8-in. RCB BHA was run with a center bit and tagged cement 1.5 m above the shoe. The 9-7/8-in. RCB bit was a new Security M84F 4-cone insert core bit. The cement, float shoe, and 13.42 m of 14-3/4-in. rathole were drilled in 4-1/2 hr. The center bit was pulled, and RCB Cores 128-794D-1R through -12R were taken from the interval 3391-3484 m (573-666 mbsf), with 93 m of core cut and 26.51 m of core recovered. Poor recovery in fractured basalt in Cores 128-798C-4R through -6R occurred as a result of frequent core breaks, regrinding, and jamming of cobbles in the core bit throat. Pump pressure increases of 300 psi were noted when dropping the core barrel for Core 128-794D-6R, and two attempts to clear the bit with a chisel deplugger and center bit at 1000 psi proved ineffective. A center bit was pumped down at 2000 psi and successfully cleared the bit, returning with sticky clay and ash on it.

The mainly basaltic dolerite formation cored at a steady 2 m/hr despite attempts to improve ROP by varying WOB from 24,000 to 30,000 lb and RPM from 60 to 80. A drilling break from 2 to 10 m/hr occurred in a sediment section at 3459.0-3463.4 m. Hole conditions remained excellent with 30-bbl precautionary high viscosity mud sweeps pumped on every core barrel connection. A survey at 3456.40 m showed a 1/4° hole angle. RCB coring was terminated at 2100 UTC 11 September because of time restrictions. The bit cleared the rotary table at 0500 UTC 13 September, and operations were suspended at Site 794 until installation of the bottom seismic experiment could begin on 25 September.

SITE 799

Hole 799A

The transit from Site 794 to Site 799 covered 201 nmi in 19-1/2 hr at an average speed of 10.3 kt. The pre-site survey covered 47 nmi in 7 hr at an average speed of 6.3 kt. A Datasonics beacon was dropped at 0701 UTC 14 September, and a jet-in test was conducted to 101.6 mbsf.

Hole 799A was spudded at 1635 hr 14 September. Continuous APC Cores 128-799A-1H through -20H were taken from the interval 2084.8-2259.3 m (0-174.5 mbsf), coring 184.1m and recovering 190.72 m, with excellent recovery and some core elongation after recovery owing to minor gas expansion. All cores were oriented, starting with Core 128-799A-5H, and heat flow measurements were taken every two cores starting with Core 128-799A-6H. XCB Cores 128-799A-21X through -52X were taken from the interval 2259.3-2553.5 m (174.5-468.7 mbsf), coring 284.6 m and recovering 244.76 m, with good recovery and some sample elongation owing to gas expansion through Core 128-799A-47X, and poor recovery owing to hard dolomitic sections jamming in the hard formation core catcher. Hard formation XCB bits were burned up on Cores 128-799A-51X and -52X as evidenced by blackened crystallized cores and severe bit wear. Increasing pump pressure and rate from 125 psi at 22 spm to 1625 psi at 82 spm did not prove effective in preventing bit destruction at low ROP in hard dolomite.

The sonic core monitor (SCM) was run on Leg 128 for the second time in ODP history. The SCM run on Core 128-799A-31X produced core height data that correlated extremely well with drilling time data; however, the run on Core 128-799A-51X was unsuccessful because the power cable between the battery and electronics apparently was severed when the instrument sections were installed in the carrier tube. The SCM sections and cables can be modified easily to avoid this problem in the future.

Hole condition was excellent while drilling, short tripping, and logging. Capillary suction tests on clay samples from 160, 190, 326, and 365 mbsf showed negligible swelling tendency in fresh water, indicating nonreactive clays.

The drill string was pulled up to 2189.39 m (104.59 mbsf) for logging, which was deeper than normal to avoid soft sediments near the urface. Logs were run as follows: sonic/seismic stratigraphy (SDT/DIT/NGT/TLT--temperature logging tool), two passes of the formation microscanner (FMS/NGT/TLT), litho-porosity combination (LDT/CNT/NGT/ TLT), and geochemical combination (GST/ACT/NGT/TLT). Hole conditions and log quality were excellent.

While logs were being run through DP, the VIT frame was run to test an EDO-Western 3.5-kHz near bottom profiler. Although the profiler penetrated over 30 m into the seafloor, the record had less definition than our current site approach equipment.

The BHA was pulled out after logging, with the bit through the rotary table at 1025 UTC 18 September, ending Hole 799A.

Hole 799B

The ship was moved 20 m north to spud Hole 799B. Seven joints (69.89 m) of 16-in. casing was run and landed in a new style reentry cone with a Datasonics beacon attached. A jetting assembly with a 14-3/4-in. Smith 4JS bit was latched into the casing with a double-J tool, and it was run in to the mud line at 2083.5 m. Hole 799B was spudded at 0430 UTC 19 September, and the 16-in. casing was jetted in to 2153.8 m. The 16-in. shoe was at 2153.82 m and the top of the reentry cone was at 2081.08 m. The 14-3/4-in. BHA was unjayed and the hole was drilled to 2533.5 m, where it was terminated at the request of shipboard scientists to permit recoring a section. A short trip showed no drag or fill, and the hole was filled with 10.0 ppg 2.5% KCl mud. Thirty-four joints (439.55 ft) of 11-3/4-in. casing was run on DP with a cement stinger, and landed in the 16-in. housing at 1815 UTC 20 September. The left-hand running tool proved difficult to release owing to high torque, but no thread damage was noticed. The 11-3/4-in. casing was cemented with 354 sacks of Class G neat cement at 12.0-15.0 ppg. The BHA was pulled out of the hole and operations were suspended at 0415 UTC 21 September, when the cement stinger cleared the rotary table.

RETURN TO SITE 794

The transit to Site 794 covered 194 nmi in 21 hr at 9.2 kt average and ended at 0448 UTC 22 September. The beacon was still working. A 9-7/8-in. RCB bit and BHA were run in to the mud line, and reentry was accomplished after 14 min at 1133 UTC 22 September. Hole fill was tagged at 3467.5 m (16.5 m off bottom) and cleaned out to the total depth reached earlier in the cruise. RCB Cores 128-794D-13R through -20R were taken from the interval 3484.0-3551.5 m (666-733.5 mbsf). Recovery was poor owing to highly fractured and altered basalt cobbles and wedges jamming in the core catcher. This was the first use of the improved 9-7/8-in. RBI C-7 tungsten carbide button bit, which showed no damage after 21-1/2 hr of rough drilling.Coring was terminated at 2300 UTC 23 September to start logging, owing to time constraints with the schedules of the incoming*Tansei Maru* and *Kaiko Maru V*.

A logging BHA with an 8-3/4-in. X 4-1/8-in. logging bit was run to 2893.5 m (75.5 mbsf). The seismic stratigraphy combination (DITE/NGTC/MCDG/SDT/TCCA), could not get through a bridge at 3425 m (607 mbsf) and the tool was pulled out, logging up. A small sample from the logging tool shoe (and subsequent logs) indicated that flowing silt/clay at 594 and 642 mbsf was bridging the hole. The hole was cleaned out and displaced with 10.0 ppg 2% KCl gel/barite/polymer logging mud. The seismic stratigraphy combination was rerun successfully to total depth of the hole (TD). The three arm caliper was run to help centralize the sonic, but the caliper tool failed at the shoe.

Next the formation microscanner (FMS/NGTC/TCCB) was run. It hit a bridge at 3413.6 m (595.6 mbsf), and was logged up to 3250 m. DP was run, washing out bridges at 3412 and 3458 m. The second attempt to run the FMS stopped on an obstruction in the DP at 3460 m. Attempts to circulate the hole clean and work the tool down were unsuccessful, and logging was terminated owing to time constraints with the Japanese boats' schedule. The FMS tool had a small amount of clay on the shoe, indicating that some bridging material had back-flowed or been swabbed by the logging tool into the DP, restricting the bore. The bridge at 3456 m would not wash out and had to be reamed with the top drive to TD. The DP still had a restriction, so it was positioned 2 m off bottom and a makeshift deplugger (a core barrel with a 4-in. fluted-sub gauge ring) was pumped down, landing with 1450 psi. The deplugger was retrieved on the core line with no recovery, successfully deplugging the DP without requiring a round trip.

The borehole seismometer was reheaded, function tested, and run in at 0215 UTC 26 September to a setting depth of 3532.5 m (714.5 mbsf). The Schlumberger logging cable was cut at 3545 m, and a Bowen rope socket was installed. The DP was stripped out of the hole over the logging cable and two joints with a bottom funnel guide were run to guide the cable safely through the moonpool and away from the ship's bottom. All three sensors worked initially on the seismometer, but one of the two horizontal sensor channels became saturated (possibly because the tool was no longer perfectly vertical).

After checking the seismometer, a torpedo connector was used to rejoin the Schlumberger logging cable. The ship was offset 5040 ft south of Hole 794D at 100 ft/min while the logging unit payed out an additional 4440 ft of cable. Maximum cable tension (overpull) was 200 lb, and the cable-laying operation proved easy to control because the beacon on Hole 794D could be used as far as 4440 ft away. A Datasonics beacon was dropped 4440 ft south of Hole 794D to assist in stationkeeping during the seismic survey and in drilling Hole 794E.

The Japanese research vessel*Tansei Maru* arrived on site at 1430 UTC 24 September, deployed one digital and seven analog ocean bottom seismographs, and took dredge samples. The borehole seismometer experiment real-time downhole measurements were made in Hole 794D for 56-3/4 hr (2130 UTC 26 September to 0615 hr 29 September) while *Tansei Maru* shot an airgun survey pattern around Hole 794D and *JOIDES Resolution*. The seismometer experiment was successful.

An additional length of cable was payed out, and the cable was cut and reheaded. The cutoff end of the cable was keelhauled under the ship from the moonpool to the starboard side using a transfer line that had been installed previously by means of an inflatable bag on an air line. The transfer line broke on the first attempt, but hung up on the side of the ship. It was retrieved and used as a messenger line for the crane whipline. The crane was able to boom out and give enough lateral displacement to pull the logging cable clear of the ship's bottom.

Kaiko Maru V lost one engine enroute to the site and had to heave to until the weather improved enough to permit further headway. The weather was rough with 36-45 kt winds and 20-26 ft seas. *Kaiko Maru V* arrived at 1000 hr 29 September and, after several tries in rough seas, the logging cable was passed from *JOIDES Resolution* at 1400 UTC. Four personnel were transferred to *Kaiko Maru V* to install the seismometer seafloor instrument package and two personnel were transferred to *JOIDES Resolution* to check the resistivity experiment computer. The seafloor instrument package was deployed by *Kaiko Maru V* on 30 September. *Tansei Maru* finished picking up the ocean bottom seismographs and left for Sakata port, Japan, with an ETA of 0100 UTC 1 October.

Hole 794E

JOIDES Resolution moved another 50 m south to Hole 794E (1586 m south of Hole 794D). An 11-7/16-in. APC/XCB bit and BHA were run in to the seafloor. Hole 794E was spudded at 1915 UTC 29 September, with the mud line estimated at 2812.5 m. An 11-7/16-in. hole was drilled through the interval 2812.5-3212 m (0-400 mbsf).The bit was pulled out to 2887.2 m (74.7 mbsf) and logging equipment was rigged up. The electrical resistivity long-spaced tool was made up with five potential electrodes installed on 310 m of cable. The electrodes were run in to 3204 m wireline total depth (WLTD), with the top torpedo splice at 2892.5 m (80 mbsf). *Kaiko Maru V* imposed a 100-volt 20-amp current with a seafloor electrode in a pattern around *JOIDES Resolution* and Hole 794E. The resistivity experiment observations were run from 0815 hr 30 September to 0800 hr 1 October (23-3/4 hr). The resistivity tool detected high background potential (possibly electrical noise created by DP movement or proximity), so the bit was pulled to 65.7 mbsf at 1400 UTC 30 September and to 57 mbsf 2 hr later. This appeared to reduce noise levels, and the experiment was successful. The resistivity cable was pulled out (500 lb initial overpull) and rigged down. The DP was pulled out of the hole, clearing the rotary table at 1520 UTC 1 October, ending Hole 794E.

RETURN TO SITE 799

Hole 799B

The transit to Site 799 covered 211 nmi in 21.6 hr at 9.8 kt average. The sea voyage ended at 1336 UTC 2 October. Navigation was via transit satellite and Decca because the GPS satellite had been out for 4 days. Upon lowering thrusters and hydrophones, the Hole 799A and Hole 799B beacons were both acquired at 1500 m offset. A 9-7/8-in. RCB BHA was run in to the seafloor and the search for Hole 799B began, using both the TV camera and an intermittent Mesotech sonar. No cones were noted above the seafloor, but the sonar identified several mounds. An unidentified hole in the seafloor was reentered at 2150 UTC 2 October, but it proved to have a TD of 2553 m, the TD for Hole 799A. The bit cleared the seafloor and the search continued. The drop beacon for Hole 799A was located, and an unidentified hole was reentered at 0945 UTC 3 October. The bit was run in to firm fill at 60 mbsf; it was assumed to be the 100-m jet-in test hole. The search resumed, and an unidentified hole was reentered at 1258 UTC. The bit was run in to 2525.6 m (442.6 mbsf), where an obstruction was found that was identified as the 11-3/4-in. shoe in Hole 799B. The shoe appeared to be 2.3 m lower than the original setting depth, suggesting that the reentry cone had settled further while setting the 11-3/4-in. casing.

The 11-3/4-in. shoe was drilled in 4-1/4 hr. Core 128-799B-1R was cut from 2533.5 to 2543.0 m (450.0-459.5 mbsf) with no recovery. Because of high pump pressures, a deplugger was dropped and retrieved. Core 128-799B-2R was cut from 2543.0 to 2552.7 m (459.5-469.2 mbsf) and recovered 0.22 m, with part of the DP wiper plug jammed in the shoe. Core 128-799B-3R was cut from 2552.7 to 2562.4 m (469.2-478.9 mbsf). A center bit was dropped, and 1 m of core was drilled from 2562.4 to 2563.4 m (478.9-479.9 mbsf) to break up junk. Core 128-799B-4R was cut from 2563.4 to 2573.1 m (479.9-489.6 mbsf), but had no recovery. Owing to high circulation pressures, a center bit was dropped as a deplugger. The center bit was retrieved and Core 128-799B-5R was cut from 2573.1 to 2578.1 m 489.6-494.6 mbsf), recovering 4.54 m of core plus a large piece of DP wiper plug. RCB Cores 128-799B-6R through -67R were taken from the interval 2578.1-3167.5 m (494.6-1084.0 mbsf) with fair recovery. In Hole 799B, 451.0 m was drilled, 633.0 m was cored, and 280.48 m (44%) was recovered.

Coring was terminated at 3167.5 m (1084.0 mbsf) per PPSP guidelines, when all indicators agreed that we were potentially in the top of a zone in the early stages of petroleum generation. A delayed light-yellow residual (fluorescing) cut and light odor were noted in samples from Cores 128-799B-65R and -66R, and the C_2-C_4 concentration increased. The C_1/C_2 ratio continued to follow a slowly declining trend, averaging 130:1 (indicating mature organic matter), and the Claypool migration chart indicated subnormal unmigrated C_1/C_2. Neopentane had increased to >300 ppm, which the Shipboard Organic Geochemistry reference states "suggests that petroleum genesis is in a very early stage."

A short trip to 2521 m had 10,000 lb of drag and found the top of the fill at 3153.5 m (14 m fill). The hole was cleaned out to 3157.5 m TD and displaced with 10.0 ppg 2.0% KCl logging mud. The drill string was pulled up to 2083 m and the top of the reentry cone was jetted to improve visibility. The XCB bit and BHA waere pulled out and the bit was changed to a reentry bit and paddle running tool. The drill string was run in and reentered Hole 799B at 1243 UTC 9 October with the aid of the Mesotech sonar device. The paddle running tool was landed with 25,000 lb, and the reentry cone appeared to be 4.5 m low.

Logs were run as follows: sonic/seismic stratigraphy (SDT/DITE/NGT/TLT), formation microscanner (FMS/NGT), litho-porosity combination (LDT/CNT/NGT), and geochemical combination (GST/ACT/NGT). Hole conditions and log quality were excellent. A vertical seismic profile (VSP) was run on 50-ft stations from 10,125 to 7,700 ft with a maximum of 15 good-quality shots stacked per station. A 400-in.^{3} 2000-psi water gun was hung over the side of the ship as a source.

While logs were being run through DP, the VIT frame was run to retest the 3.5-kHz near bottom profiler at various impedance settings. The profiler worked but, as before, the record had less definition than our current hull-bottom transducer.

The paddle running tool was shifted by wireline, and the DP was run in hole and tagged a bridge at 2929 m. The hole was displaced with 180 bbl of 12.0-ppg mud, and the DP pulled up to 2540 m (15 m below the 11-3/4-in. shoe). A 204-sack 15.2-ppg Class G cement plug was set from 2540 to 2490 m (45 m above the shoe). The DP was pulled up 60 m, and the casing displaced with 12.0 ppg mud. The reentry BHA was pulled out, clearing the rotary table at 1840 UTC 11 October, ending Hole 799B.

Hole 799C

Post-site survey plans were adjusted to permit another test of the sonic core monitor (SCM). *JOIDES Resolution* was moved 30 m west, and an 11-7/16-in. APC/XCB BHA was picked up and run. Hole 799C was spudded at 0015 UTC 12 October. The 11-7/16-in. XCB BHA with center bit was used to drill from 2083.5 to 2313.5 m (0-230.0 mbsf). The center bit was retrieved and the SCM was run on the XCB barrel. XCB Cores 128-799C-1X through -3X were taken from the interval 2313.5-2336.0 m (230.0-252.5 mbsf). The cored interval was 22.5 m and recovery was 23.93 m. The SCM collected data points on all three runs, but the test was terminated after three SCM runs because the tool functioned erratically. The hole was displaced with 12.0 ppg surplus mud, and the bit was pulled through the rotary table at 1730 hr 12 October, ending Site 799C.

POST SITE 799 SURVEY

Thrusters and hydrophones were pulled and *JOIDES Resolution* started a post-site survey of the Kita-Yamato Rise at 1918 UTC 12 October. A 199.8-nmi underway geophysics survey was conducted at 6 kt, requiring 33.5 hr.

RETURN TO PUSAN

The return transit to Pusan, Korea, covered 330 nmi in 29.25 hr at 11.3 kt. *JOIDES Resolution* dropped anchor in Pusan Harbor at 0820 UTC 15 October. Seventy-four stands of 5-in. and 5-1/2-in. drill pipe due for inspection in Singapore were broken into singles and stored in the riser hold. The pilot arrived on board at 2158 UTC 15 October and the ship proceeded to the Central Pier, Berth C-1. The first line ashore was at 2300 UTC 15 October, ending Leg 128.

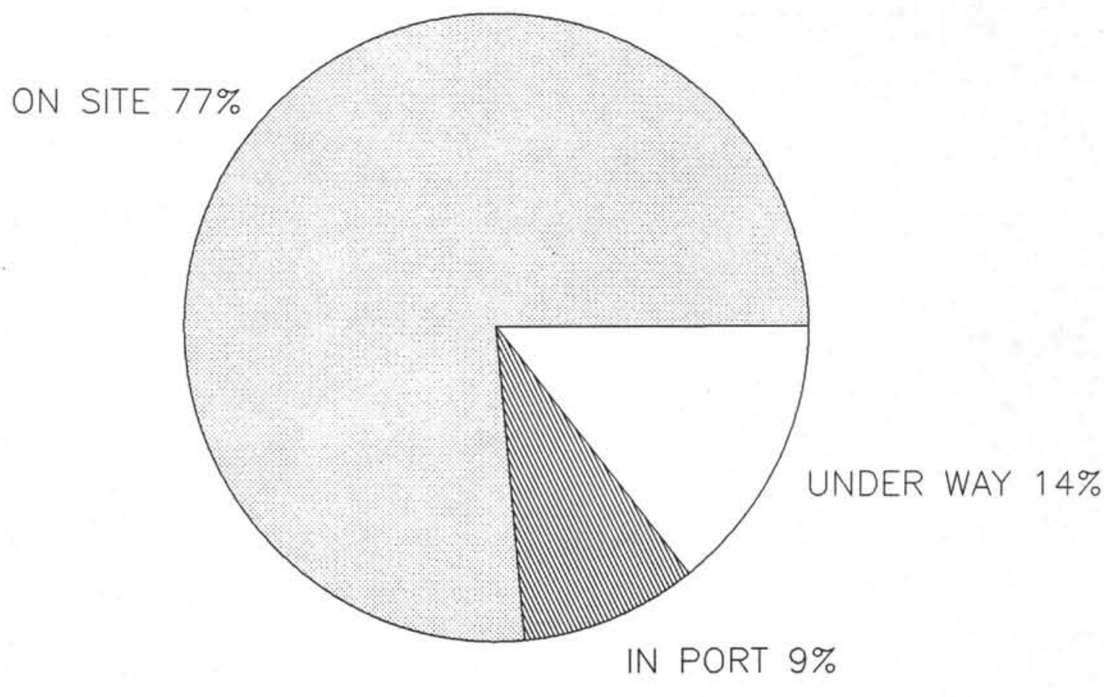
OCEAN DRILLING PROGRAM
SITE SUMMARY REPORT
LEG 128

HOLE	LATITUDE	LONGITUDE	WATER DEPTH (M)	NUMBER OF CORES	INTERVAL CORED (M)	RECOVERED CORE (M)	PERCENT RECOVERED	INTERVAL DRILLED (M)	TOTAL PENETRATION (M)	TIME (HRS)
794C	40-11.41N	138-13.86E	3473.7	0	.0	.0	.0	.0	.0	71.60
794D	40-11.38N	138-13.93E	3551.5	20	160.5	34.9	21.7	573.0	733.5	479.20
794E	40-10.50N	138-13.92E	3212.5	0	.0	.0	.0	400.0	400.0	49.33
	SITE TOTALS:			20	160.5	34.9	21.7	973.0	1133.5	600.13
798A	37-02.30N	134-47.98E	1057.5	17	143.3	147.7	103.1	.0	143.3	28.55
798B	37-92.31N	134-47.98E	1429.0	54	517.9	513.2	99.1	.0	517.9	69.60
798C	37-02.31N	134-47.98E	1031.3	13	120.1	132.0	109.9	.0	120.1	15.67
	SITE TOTALS:			84	781.3	792.9	101.5	.0	781.3	113.82
799A	39-13.22N	133-52.01E	2553.5	52	468.7	439.9	93.9	.0	468.7	99.40
799B	39-13.19N	133-52.02E	3167.5	67	633.0	280.2	44.3	450.0	1083.0	286.00
799C	39-13.20N	133-52.00E	2336.0	3	22.5	23.9	106.2	230.0	252.5	22.83
	SITE TOTALS:			122	1124.2	744.0	66.2	680.0	1804.2	408.23
	LEG TOTALS:			226	2066.0	1571.8	76.1	1653.0	3719.0	1122.18

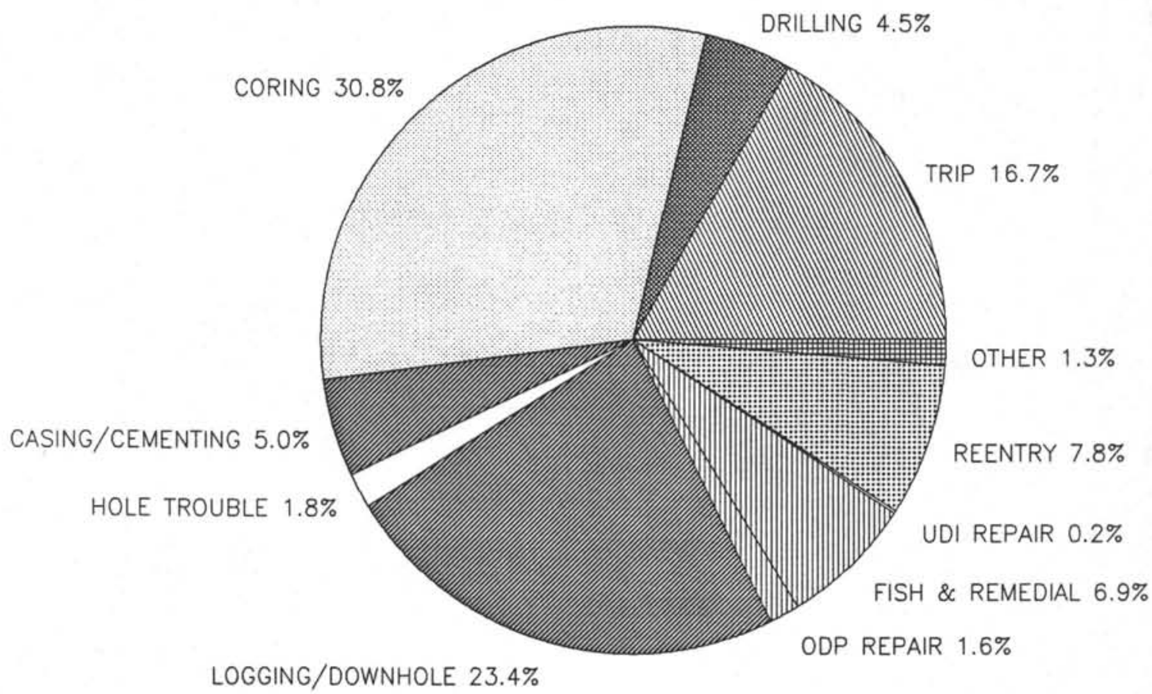
OCEAN DRILLING PROGRAM
OPERATIONS RESUME
LEG 128

Total Days (21 August - 16 October 1989)		56.08
Total Days in Port		5.12
Total Days Under Way		8.05
Total Days on Site		42.91
Trip Time	7.18	
Drilling Time	1.93	
Coring Time	13.23	
Logging/Downhole Science Time	10.05	
Reentry Time	3.35	
Casing and Cementing Time	2.16	
Stuck Pipe/Downhole Trouble	0.76	
Fish and Remedial	2.94	
Repair Time (Contractor)	0.07	
Repair Time (ODP)	0.67	
Other	0.57	
Total Distance Traveled (nautical miles)		1480.00
Average Speed (knots)		10.00
Number of Sites		3
Number of Holes		9
Total Interval Cored (m)		2043.50
Total Core Recovery (m)		1547.84
Percent Core Recovered		75.74
Total Interval Drilled (m)		1423.00
Total Penetration (m)		3467.50
Maximum Penetration (m)		1084.00
Maximum Water Depth (m from drilling datum)		2820.00
Minimum Water Depth (m from drilling datum)		906.40

LEG 128
TOTAL TIME DISTRIBUTION



LEG 128
ON SITE TIME DISTRIBUTION



LOGGING OPERATIONS SUMMARY

The following four pages contain tables showing logging operations for the four holes logged during Leg 128. These logging summaries were prepared by the shipboard logging scientists and engineers for the Leg 128 Hole Summaries and are presented here as part of the Operations Synopsis.

HOLE 794D

TIME	PROCEDURE
1645 Z - 1915 Z (9/24/89)	RIH with Seismic Stratigraphy combination (SDT-DITE-NGT+TLT). Log down from end of casing to 607mbsf where bridge encountered. Unable to pass bridge, log up to end of casing, POOH.
1915 Z - 0500 Z (9/25/89)	Ream through bridges to base of hole, sweep hole and displace with a weighted mud (10ppg) containing 2% KCl. POOH with pipe to 432mbsf.
0500 Z - 0815 Z	RIH with seismic stratigraphy. Logged down to TD setting down once on reforming bridge at 607mbsf. Logged up in to end of casing, POOH.
0815 Z - 1115 Z	RIH with FMS combination (FMS+NGT). Sat down on bridge at 596mbsf, unable to pass . Log up section between bridge and end of casing (twice), POOH to recondition hole.
1115 Z - 15:15 Z	Wash down to TD, bridges encountered at 595, 640 and 672mbsf. Pull pipe back to 648mbsf (just below worst bridge)
1515 Z - 1830 Z	RIH for second attempt with FMS. Tool sat down on obstruction within pipe at 642mbsf. Attempt to work tool out of pipe , apply 400psi water pressure, no success in getting out of pipe. POOH, -out of time, logging aborted.

RIH - RUN INTO HOLE

DITE - PHASER INDUCTION TOOL

SDT - DIGITAL SONIC TOOL

NGT - NATURAL GAMMA SPECTROSCOPY TOOL

END OF CASING - 560 MBSF

TLT - TEMPERATURE LOGGING TOOL (LAMONT DOHERTY)

FMS - FORMATION MICROSCANNER

POOH - PULL OUT OF HOLE

TIMES IN GMT

HOLE 798B

TOOL STRING	TIME	PROCEDURE
Seismic Stratigraphy (DIT-SDT-NGT)	RIH 07:45 (8/30/89) POOH 10:00	Log down to TD. Log up to mud line
Formation Microscanner	RIH 11:20 POOH 14:14	Run down to TD, log up to end of pipe. Run down to 380mbsf for repeat section 370-110mbsf.
Lithoporosity Combination (LDT-CNT-NGT)	RIH 15:45 POOH 18:53	Run down to TD. Log up to end of pipe.
Geochemical Combination (ACT-GST-NGT)	RIH 20:24 POOH 05:55 (8/31/89)	Run down to TD, log up to mud line. Run down to TD for repeat run up to mud line. Pipe raised 30m for second run.

DITE - Phaser Induction Tool
SDT - Digital Sonic Tool
NGT - Natural Spectrometry Tool
LDT - Lithodensity Tool
CNT - Compensated Neutron Tool
ACT - Aluminium Clay Tool
GST - Induced Gamma Ray Spectrometry Tool
TD - Total Depth (518mbsf)
RIH - Run in to Hole
POOH - Pull out of Hole
End of pipe - 85mbsf

<u>TOTAL LOGGING TIME = 22.17 hours</u>

HOLE 799A

TOOL STRING	TIME	PROCEDURE
Seismic Stratigraphy (DITE-SDT-NGT)	RIH 0430 Z (9/17/89) POOH 0642 Z	Log down to TD, log up to 277mbsf. Run down to TD, log up to mud line
Formation Microscanner (FMS-NGT)	RIH 0835 Z POOH 1420 Z	Run down to TD, log up to end of pipe. Run down to TD for repeat from TD to end of pipe.
Lithoporosity Combination (LDT-CNT-NGT)	RIH 1659 Z POOH 1931 Z	Run down to TD, log up to 384mbsf. Run down to TD for main log up to end of pipe
Geochemical Combination (GST-ACT-NGT)	RIH 2110 Z POOH 0339 Z (9/18/89)	Run down to TD. Problem with GST POOH to check wiring. Re-enter hole 08:35. Log up from TD pipe raised 30m . GST fails at 75mbsf, POOH.

DITE - Phaser Induction Tool
SDT - Digital Sonic Tool
NGT - Natural Spectrometry Tool
LDT - Lithodensity Tool
CNT - Compensated Neutron Tool
ACT - Aluminium Clay Tool
* - includes initial rig up and final rig down of tool strings

GST - Induced Gamma Ray Spectrometry Tool
TD - Total Depth (468.7mbsf)
RIH - Run in to Hole
POOH - Pull out of Hole
End of pipe - 104.5mbsf
Times in GMT

*TOTAL LOGGING TIME = 25.25 hours

HOLE 799B

TOOL STRING	TIME	PROCEDURE
Seismic Stratigraphy (DITE-SDT-NGT)	RIH 1415 Z (10/9/89) POOH 1810 Z	Log down to TD (1049mbsf) log up to 946mbsf. Run down to TD, log up to 400mbsf.
Formation Microscanner (FMS-NGT)	RIH 1907 Z POOH 2325 Z	Run down to TD (1045mbsf) log up to 938mbsf. Run down to TD for main run from TD to end of casing.
Lithoporosity Combination (LDT-CNT-NGT)	RIH 2351 Z POOH 0235 Z (10/10/89)	Run down to TD (1033mbsf) log up to 930mbsf. Run down to TD, log up to 687mbsf. Run down to 798mbsf, log up to end of casing
Geochemical Combination (GST-ACT-NGT)	RIH 0425 Z POOH 1315 Z	Run down to TD (1027mbsf), log up to 781mbsf. Run down to 890 mbsf, log up to 233mbsf. (Logging through casing from 433mbsf to 233mbsf)
Well seismic Tool	RIH 1700 Z POOH 0400 Z (10/11/89)	Data recorded at 15.25m stations from 1003mbsf to 385mbsf

DITE - Phaser Induction Tool
SDT - Digital Sonic Tool
NGT - Natural Spectrometry Tool
LDT - Lithodensity Tool
CNT - Compensated Neutron Tool
ACT - Aluminium Clay Tool
* - includes initial rig up and final rig down of tool strings

GST - Induced Gamma Ray Spectrometry Tool
RIH - Run in to Hole
POOH - Pull out of Hole
End of casing 443mbsf
Drilled total depth (TD) 1084mbsf (decreases with logging due to hole fill)
Times in GMT

TOTAL LOGGING TIME = 40 hours

TECHNICAL REPORT

The ODP Technical and Logistics personnel aboard *JOIDES Resolution* Leg 128 of the Ocean Drilling Program were:

Laboratory Officer:	Bill Mills
Assistant Laboratory Officer:	Wendy Autio
Yeoperson:	Jo Claesgens
Curatorial Representative:	Scott Chaffey
Computer System Manager:	John Eastlund
Electronics Technicians:	Jim Briggs Dave Erickson
Photographer:	Chris Galida
Chemistry Technicians:	Valerie Clark Joe Powers
X-ray Technician:	Joan Perry
Marine Technicians:	Bart Collinsworth Joe De Morett Gus Gustafson Kuro Kuroki Michael Moore Dawn Wright

INTRODUCTION

Leg 128 is the second of two consecutive legs to study the tectonics and the sedimentary and paleoceanographic history of the Japan Sea. In addition to routine core analysis, Leg 128 operations also included a variety of special experiments.

JOIDES Resolution set sail from Pusan, Korea, at noon on 25 August 1989 with a crew of 108 (47 scientists and technical staff). After drilling 8 holes at 3 sites, the scientific portion of Leg 128 ended at 0600 hr 16 October 1989, after 52 days at sea. After a 1-day crew change in Pusan, Leg 128 was scheduled to transit to Singapore for drydock activities.

PORT CALL: PUSAN, KOREA

The Leg 128 technicians moved on board at noon on 21 August. Crossover with the off-going crew was completed that afternoon. Moving freight off/on ship commenced that day and occupied most of the 3 days in port. A DEC service call was successful in repairing the VAX's faulty disk drives.

Local labor was hired to clean the fuel tanks directly below the Koomey Room in anticipation of the hot-work necessary for relocating the Cyberex system in drydock. The tanks were inspected and certified as "gas free."

An American Bureau of Shipping (ABS) inspector came on board to inspect our storage methods for radioactive and explosive cargoes. The ship was issued a "Certificate of Fitness for the Carriage of Dangerous Goods."

On 24 August the ship moved from dockside berthing to anchorage just outside the harbor. The following day local divers removed the sonar dome from the ship's keel. The sonar dome was then shipped ahead to Singapore for modifications and will be remounted during the upcoming dry dock.

U/W GEOPHYSICS OPERATIONS

During all of Leg 128's transits, routine bathymetric, magnetics, and navigation data were collected. Seismic equipment was deployed for surveys of Sites 798 and 799 and for special testing of a "high speed" seismic streamer on loan from Lamont-Doherty Geological Observatory. This high speed streamer is being tested to see if usable seismic records can be obtained at top transit speeds. Unfortunately, throughout Leg 128 one propulsion motor was under repair and our top "in-water" speed barely exceeded 10 kt. Also, our transits were mostly in water depths of less than 2500 m. These factors, combined with good transit weather, resulted in excellent records on both the high speed and ODP's seismic streamer. It is recommended that the high speed streamer be kept on board until the propulsion motor problems are solved during drydock and tests can be performed at top speeds in deep water on the transit from Singapore to Guam.

LAB OPERATIONS

Bridge Deck: Core, Physical Properties and Magnetics Labs

A short transit from Pusan to our first site allowed little time for scientists and new marine technicians to become familiar with lab equipment and procedures. In general, lab operations were routine except for special microbiological experiments (discussed in the Special Experiments section), high coring/recovery rates, and gassy cores.

At the first site, shallow water depths, high recovery rates, and exceptionally methodical sedimentologists resulted in cores being stacked on the catwalk (at times as many as 39 cores). Fortunately, our next site did not involve much coring, and after a week the last core from the first site was finally described.

The majority of cores recovered during this leg (from Sites 798 and 799) were extremely gassy and required intense hydrocarbon monitoring. Routine headspace (in duplicate) and vacutainer samples were taken on every core. At Site 799 the fluorometer was used successfully to detect oil shows. Drilling at both sites was terminated prior to the planned drilling depths because of potential hydrocarbon hazards.

Gassy cores were responsible for curatorial problems. Large expansion voids caused core material to be extruded from the liners. Expansion greatly increased core disturbance.

New software was written to correct raw magnetic susceptibility data for baseline drift. This software was incorporated into the program WCSFIX, now called WCSBGFIX.

Fo'c'sle Deck: Chemistry, XRD-XRF, Thin-Section and Paleo labs

In addition to routine analysis, the chemistry lab was kept busy with hydrocarbon monitoring and an expanded interstitial water sampling program. The chemistry lab equipment performed well. The only exception was the Rock Eval unit, which went down early in the leg and was not repaired owing to a lack of spare parts. The parts inventory has been increased.

Both the XRF and XRD analyzers developed electrical and mechanical problems at the beginning of the leg. The problems that were seen are not unexpected for equipment that has been running nonstop for 5 yr. Eventually all problems were solved and the lab produced high-quality XRD and XRF data.

The thin-section and paleo labs saw routine use this leg.

Computers and Software

The central processing units on the VAX 3500's were upgraded to version C. A second internal hard disk was installed on each Mac II. Both the Mac IIs and Mac SEs received expanded keyboards and memory upgrades.

Downhole measurements

In-situ temperature measurements were made at Sites 798 and 799 using the WSTP tool. The WSTP was run every other core in soft sediments with great success using the Uyeda recording package. No water was collected.

Reentry Support

Two reentry cones, a fishing attempt, and logging operations required numerous deployments of the TV/sonar reentry system. After the third reentry, there were serious problems with the Colmek TV system. Troubleshooting was difficult and time consuming.

SPECIAL EXPERIMENTS

Microbiological Sampling

Based on successful results from microbiological sampling during Leg 112, a more comprehensive sampling program was planned for Leg 128. At Site 798, a hole was dedicated to microbiological study. From this hole, 25-cm-long whole-round core samples were taken from the upper sediment down to 510 mbsf. Great care was taken to prevent biological contamination. All sampling and storage materials were autoclaved and sampling equipment was flamed between each sample. Original plans called for culturing the samples on the ship and using radioactive tracers to measure biological activities. To avoid the difficulties of shipping radioactive materials, samples were instead taken to Japan by a specially chartered ship and then flown to a shore-based laboratory for analysis.

Sonic Core Monitor

The sonic core monitor (SCM) was tested several times during this leg. The first test was very successful. The coring rate as measured on the drill floor was mimicked by recovery as measured by the SCM. The second test failed when wires were severed during assembly of the SCM.

After logging Hole 799B, Hole 799C was drilled to a firm formation and the SCM was tested on three cores. All tests produced meaningless results. It is believed that there is a problem with the electronics and the tool will be shipped backed for repairs. The next scheduled test for the SCM will be during Leg 130.

Oblique Resistivity

Hole 794E was drilled exclusively to conduct an oblique resistivity (OR) test. The OR experiment is similar to large-scale resistivity experiments done in the past. In the OR experiment a second ship (in this case *Kaiko Maru V)* was used as the current source instead of using the resistivity cable. The resistivity cable is 300 m long with five silver to silver chloride electrodes spaced out along its length. The cable was built by the technical staff, attached to the Schlumberger logging line, and lowered into the hole. Measurements were collected in the underway geophysics lab using a two-channel analyzing recorder with A/D converter. None of the standard equipment in the downhole measurements lab was used.

Kaiko Maru V provided a 20-amp 100-volt dc signal. At each shooting station one source electrode was lowered to the ocean bottom and a second electrode was lowered to a shallow depth. The shooting pattern was selected so that any electrical resistivity anisotropy would be detected. Although the signal source was not as strong as had been hoped for, the scientists were pleased with the results of the experiment.

Downhole Seismometer

The proposed plan called for the installation of a broad-band, three-component digital seismometer in Hole 794C. Failure to retrieve the BHA left by Leg 127 required that Hole 794D be drilled to install this tool. Prior to deployment the tool was tested on deck through the logging cable, and problems with the DC to DC converter, hampering communications with the tool, were discovered. A new power supply scheme was devised by the ODP electronics technician and the problem was solved.

The tool was deployed and locked into the hole. After confirming that the tool was operational, the cable was cut and the drill pipe was stripped out. The cable was respliced and *JOIDES Resolution* then offset 1536 m while slacking off on the cable. After the cable was respliced, one of the two horizontal component sensors would not work. Using the other horizontal and vertical component sensors, excellent results were obtained during the real time recording portion of the experiment. During the real time experiment, *Tansei Maru* deployed ocean-bottom seismometers (OBS) and began shooting a controlled pattern around the site. After 2 days of recording, the cable was cut again, keelhauled, and passed to *Kaiko Maru V*. On board *Kaiko Maru V* the seafloor recording package and batteries were attached to the end of the cable. This package was then lowered to the seafloor to begin long term observations.

Near Bottom Profiler (NBP)

The NBP system consists of an EDO-Western 3.5-kHz transducer element (with reflection cone), which is mounted on the VIT frame. A DG Obrian connector was spliced on to the original EDO cable, allowing connection to the Colmek cable head. The 3.5-kHz deck unit and flat bed printer in the underway geophysics lab were used to power the system and record data. It was hoped that this NBP profiler system would provide high-resolution seismic profiles of near-surface sediments. However, test results were disappointing. The ship's 3.5-kHz bathymetric surveys had better resolution than the NBP. We suspect the water pressure at depth reduced the efficiency of the transducer element. In the future this system will be tested with a more powerful deck unit. ODP will investigate acquisition of transducer elements more suitable for operating at great water depths.

LAB MODIFICATIONS

During deployment of the downhole seismometer and resistivity experiment, marine technicians began installing some of the furniture planned for installation during drydock. In the second-look lab new cabinets were installed, including two new acid storage cabinets. In the XRF preparation lab the HLF hood was replaced with a smaller, portable model that is stored in the XRD-XRF lab. Also, both desks were replaced and wall cabinets were installed. The desk on the starboard wall was shortened to accommodate the shatterbox and possibly another freeze dryer. In the core lab, new cabinets were installed by the description table to hold the *Initial Reports* volumes.

SAFETY

The technical staff gave special attention to cleaning and ensuring proper labeling of bottles of hazardous chemicals in the labs. Special attention also was paid to proper storage methods and to what types of chemicals can be stored together safely.

The METS team participated in weekly fire drills. The ship's second mate lead the METS on a tour of the ship, pointing out all of the safety equipment on board and describing how it is used.

LABORATORY STATISTICS: LEG 128

General stats	
Sites	3
Holes	8
Meters of core recovered	1498.73
Number of samples	11587
Samples analyzed	
Inorganic carbon	545
Total carbon-CNS	545
Water chemistry	89
Rock-Eval	48
Thin sections	46
XRF (major & minor elements)	88
XRD	570
Underway geophysics	
Total nautical miles transit	1577
bathymetry	121
magnetics	946
seismic	466
Downhole measurements	
Heat flow only	19
Heat flow & *in-situ* water	0