OCEAN DRILLING PROGRAM

LEG 192 SCIENTIFIC PROSPECTUS

BASEMENT DRILLING OF THE ONTONG JAVA PLATEAU

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May 2000

Scientific Prospectus No. 92

First Printing 2000

Distribution

Electronic copies of this publication may be obtained from the ODP Publications homepage on the World Wide Web at: http://www-odp.tamu.edu/publications

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This publication was prepared by the Ocean Drilling Program, Texas A&M University, as an account of work performed under the international Ocean Drilling Program, which is managed by Joint Oceanographic Institutions, Inc., under contract with the National Science Foundation. Funding for the program is provided by the following agencies:

Australia/Canada/Chinese Taipei/Korea Consortium for Ocean Drilling
Deutsche Forschungsgemeinschaft (Federal Republic of Germany)
Institut National des Sciences de l'Univers-Centre National de la Recherche Scientifique (INSU-CNRS; France)
Ocean Research Institute of the University of Tokyo (Japan)
National Science Foundation (United States)
Natural Environment Research Council (United Kingdom)
European Science Foundation Consortium for the Ocean Drilling Program (Belgium, Denmark, Finland, Iceland, Italy, The Netherlands, Norway, Portugal, Spain, Sweden, and Switzerland)
People's Republic of China

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Technical Editor: Karen K. Graber

ABSTRACT

Ocean Drilling Program Leg 192 will attempt to penetrate a minimum of 100-150 m of igneous basement in each of four sites on the Ontong Java Plateau (OJP), the largest of the world's large igneous provinces. Primary objectives of the leg are to determine the age and duration of emplacement of the plateau, the range and diversity of magmatism, and the environment and style of eruption. Objectives at all sites are aimed at investigating the causes of plateau formation and fundamental processes governing the crustal development of oceanic plateaus. Additional insight will be accrued on the relation of plateau emplacement to Cretaceous oceanographic, climatic, and biological events.

Drilling will provide samples for geochronological, petrological, chemical, and isotopic studies of widely distributed, previously unsampled areas across this 1.6×10^6 km^2 plateau, as well as information on paleodepths. Data from these studies will be combined with results from the three previous drill sites that reached basement, and from obducted slivers of OJP crust exposed in the eastern Solomon Islands, to determine the chronology of the plateau's formation, the nature of its mantle sources, the characteristics of magmatic evolution, and the water depth of basement at the time of volcanism. This information will be used to test models for plateau formation, particularly the currently preeminent plume-head model. Contrary to the predictions of this model, basement lavas from existing sites document the presence of two, rather than one, major eruptive episodes (at 122 ± 3 Ma and 90 ± 4 Ma), have an unexpectedly limited range of chemical and isotopic compositions, and appear to have been emplaced under considerable depths of water. Data from key regions of the OJP to be sampled during Leg 192, including the large eastern lobe and the central dome of the main plateau, will provide a much more complete picture of the range of ages, compositions, and eruptive environments. Together with paleodepth data, information on the content of volatiles and the extent of post-magmatic hydrothermal modification of the upper levels of basement crust will be used to assess the environmental consequences of plateau magmatism.

INTRODUCTION

Volcanic oceanic plateaus are formed by immense volumes of magma emplaced in the oceanic lithosphere. Nearly all of the plateaus in the present oceans were formed during the Cretaceous period and may reflect a major mode of mass and energy transfer from the Earth's interior to its surface that is different from the mid-ocean ridge-dominated model of the Cenozoic (e.g., Stein and Hofmann, 1994; McNutt et al., 1996). Since the mid-1980s, plateaus have been recognized as the counterparts of continental flood basalt provinces and associated thick volcanic sequences at many passive continental margins, collectively termed large igneous provinces, or LIPs (e.g., Coffin and Eldholm, 1994). In the last decade, these features have been ascribed by many workers to the initial plume-head stage of hot-spot development (e.g., Richards et al., 1991; Saunders et al., 1992). Alternative, nonplume models exist (e.g., Smith, 1993; Anderson, 1996) but have thus far not received widespread support. The plume-head model, in particular, predicts that such provinces are formed from ocean-island-like mantle in massive eruptive outpourings lasting only a few million years or less. For many continental flood basalts and at least some volcanic passive margins, eruption appears to have occurred rapidly, but melting in the continental lithosphere has often overprinted the signature of the sublithospheric mantle source. Many plateaus appear to have been formed in intraoceanic locations far from any continental lithosphere; however, comparable data on eruption ages and source geochemistry are lacking because very few crustal basement sites have yet been sampled. Because of the thick sediment blankets that cover plateaus, drilling is generally the only way to sample basement crust effectively.

The climatic, oceanographic, and associated biospheric effects of plateau emplacement are poorly known but appear to have been very significant in some cases (e.g., Jones et al., 1995; Kerr, 1998; Tarduno et al., 1998). After emplacement, plateaus also appear to have important effects on subduction patterns, plate motions, continental growth, and crustal evolution; large plateaus, in particular, tend to resist subduction and thus may form an important early stage in the growth of continents (e.g., Kroenke, 1974; Cloos, 1993; Tejada et al., 1996; Albarède, 1998; Wessel and Kroenke, 1999; Polat et al., 1999). The Ontong Java Plateau (OJP) in the western Pacific (Fig. 1) is the largest plateau, indeed the largest existing LIP, in the world, with a crustal volume of approximately 5×10^7 km^3 (e.g., Mahoney, 1987; Coffin and Eldholm, 1993). If the great bulk of the OJP was formed in a single geologically brief magmatic episode, then the rate at which it was emplaced would have rivaled the entire magma production rate of the global mid-ocean ridge system at the time; if so, the OJP represents the largest igneous event of the last 200 m.y. (Tarduno et al., 1991; Mahoney et al., 1993).

The goal of Leg 192 is to sample the basement of the OJP to minimum depths of 100-150 m at four widely distributed sites. The rocks recovered will be used, together with data for previously studied sites, to determine the age and duration of magmatism, the composition of the mantle source(s), and the characteristics of magmatic evolution. They will also be used to evaluate the environment and style of eruption with special reference to the association of OJP emplacement with changes in paleoceanographic and paleoclimatic conditions.

BACKGROUND

Previous Basement Sampling

Although it has been sampled in only a few locations, the basement of the OJP is the best sampled of any Pacific plateau with drill holes (Fig. 1) at Deep Sea Drilling Project (DSDP) Site 289 (9 m basement penetration) and ODP Sites 803 (26 m) and 807 (149 m). Unlike any other Pacific plateau, slivers of the southern edge of the OJP are exposed above sea level in the eastern Solomon Islands, principally on the islands of Santa Isabel and Malaita, where ~1.2- and 3.5-km-thick basement crustal sections have been sampled recently (Tejada et al., 1996; Parkinson et al., 1996; Petterson et al., 1997).

Physical Features and Gross Structure of the OJP

The OJP covers an area of more than 1.5 x 10^6 km^2 (roughly the size of Alaska) and consists of two parts: the main or high plateau in the west and north and the eastern lobe or salient (Fig. 1). The plateau surface rises to depths of about 1700 m below sea level (mbsl) in the central region of the high plateau but lies generally at depths between 2000 and 3000 mbsl. The plateau is bounded by the Lyra Basin on the northwest, by the East Mariana Basin to the north, by the Nauru Basin to the northeast, and by the Ellice Basin to the southeast. The southern and southwestern boundaries of the OJP have collided with the Solomon Islands arc and now sit at the junction of the Pacific and Australian plates. Much of the plateau's surface is relatively smooth, although it is punctuated by several large seamounts. In many areas, the basement crust is covered with pelagic sediments >1 km thick. Physiography around the margins of the plateau is complicated. In the north and northeast, numerous horst and graben structures appear to predate much of the sediment cover (e.g., Kroenke, 1972; Berger et al., 1992). Faulting and deformation along the OJP's southern and southwestern margins are associated with the plateau's collision with the Solomon arc (e.g., Petterson et al., 1997). An extensive fold belt, the Malaita Anticlinorium, embraces the island of Malaita and the northern half of Santa Isabel.

Crustal thickness on much of the high plateau is considerable, even in comparison to other plateaus. Seismic and combined seismic and gravity evidence indicate crustal thickness is generally in the 30-43 km range (e.g., Furumoto et al., 1976; Hussong et al., 1979; Miura et al., 1996; Richardson and Okal, 1996; Gladczenko et al., 1997). Over much of the high plateau, the depth to the top of Layer 3A is 10-16 km (Neal et al., 1997). Lower crustal seismic wave velocities suggest a granulite-grade gabbroic lower crust, whereas sub-Moho *P*-wave velocities of 8.4-8.6 km/s detected in the northwest and southwest portions of the plateau may indicate the presence of eclogite at depth (Saunders et al., 1996; Neal et al., 1997). The maximum extent of OJP-related volcanism may reach well beyond the plateau proper, as the Early Cretaceous lavas filling the Nauru Basin, and similar lavas in the East Mariana and Pigafetta basins to the north, may be closely related to the OJP (e.g., Castillo et al., 1994; Gladczenko et al., 1997; Neal et al., 1997).

Tectonic Setting and Age of Emplacement

The original plate-tectonic setting of the OJP is open to some question because well-defined magnetic lineations do not appear to be present on the plateau. However, block-faulting structures along the eastern margin of the high plateau, interpreted as roughly north-northeast-trending fracture zones, led to proposals that the OJP formed at a west-northwest-trending ridge (Hussong et al., 1979) and possibly at a triple junction (Winterer, 1976; Hilde et al., 1977). Preliminary isotopic study of OJP basement lavas suggested a hot-spot connection and that the plateau may have formed at a ridge-centered or near-ridge hot spot (Mahoney, 1987). Subsequent major and trace element data were found to be consistent with plateau formation on thin lithosphere by large fractions of partial melting of a hot-spot-type source (Mahoney et al., 1993; Tejada et al., 1996; Neal et al., 1997). From bathymetry and satellite-derived gravity fabric, Winterer and Nakanishi (1995) inferred that a north-northeast-trending spreading axis ran through the OJP, whereas Neal et al. (1997) argued that the north-northeast-trending fabric represents fracture-zone orientation. M-series magnetic lineations adjacent to the plateau in the Nauru and Lyra basins run east-northeast to west-southwest. Coffin and Gahagan (1995) reviewed the available geophysical evidence and concluded that it weakly favors emplacement of most of the OJP in an off-ridge location.

Richards et al. (1991), Tarduno et al. (1991), and Mahoney and Spencer (1991) all favored the starting plume head of the Louisville hot spot (now at ~50°S) as the source of the OJP, but a recent plate reconstruction suggests the plateau was formed well to the north of this hot spot's current location (Neal et al., 1997). As noted above, the plume-head model predicts that plateaus are emplaced in single massive eruptive events of short duration. Surprisingly, however, ^{40}Ar-^{39}Ar ages of OJP lavas in the Solomon Islands and at existing drill sites reveal a sharply bimodal distribution (Fig. 2), with ages of 122 ± 3 Ma and 90 ± 4 Ma (total ranges); thus, it is possible that most of the plateau may have formed in two relatively brief episodes (Mahoney et al., 1993; Tejada et al., 1996; Parkinson et al., 1996). Because sampling over the plateau's huge area has been very limited, the relative importance of these two episodes is unclear. However, Tejada et al. (1996) argued that the 122-Ma event was significantly larger than the 90-Ma event, which they hypothesized to have been largely focused on the eastern salient. Alternatively, further sampling may show that eruptions actually occurred over a span of 30 m.y. or more (e.g., Tejada et al., 1996; Ito and Clift, 1998).

Between 124 and 100 Ma, the OJP appears to have been positioned close to the Pacific-plate Euler pole, so that the plateau would have moved little relative to the inferred hot-spot source (Neal et al., 1997). At ~100 Ma, plate motion changed from a northwestward to a more northward trajectory, and from that time until about 85 Ma the OJP moved northward, such that at ~90 Ma the southeastern corner of the plateau may have been situated rather close to the 120-Ma position of the central high plateau. Following the 90-Ma eruptive episode, postemplacement rifting and seafloor spreading may have occurred for up to several million years within the OJP's eastern salient, in conjunction with spreading in the Ellice Basin to the east (Neal et al., 1997).

After a long period of northward and northwestward motion, the OJP collided with the old Solomon arc during the early Neogene, initially in a diachronous "soft docking" without significant deformation. Following a reversal of subduction direction, the intense deformation of the Malaita Anticlinorium occurred in the late Miocene through Pliocene (Petterson et al., 1997). The bulk of the plateau appears to be more or less unsubductible (Cloos, 1993; Abbott and Mooney, 1995), but the post-Miocene removal of a portion of the lower OJP between Santa Isabel and San Cristobal (Makira) is evident from recent seismic surveys (Mann et al., 1996).

Results from Previous Sampling of Igneous Basement

OJP basement at all previously drilled sites, and in the islands of Malaita and Santa Isabel, consists of pillowed or massive flows of basalt averaging ~9 m in thickness. Dikes are rare in the island exposures; hence, the eruptive vents for most of the lavas may be rather distant. All of the basalts appear to have been emplaced well below sea level and are overlain by bathyal pelagic marine sediments (Neal et al., 1997, and references therein). However, all of the sites except Site 289 are located at the margins of the plateau; it is possible that the shallow central regions of the high plateau and eastern lobe were originally shallow or even subaerial. Basement of the 122-Ma age group comprises lavas from Sites 289 and 807, Malaita, and part of Santa Isabel, whereas the 90-Ma lavas are found at Site 803 and in Santa Isabel (Fig. 2; Mahoney et al., 1993; Tejada et al., 1996; Parkinson et al., 1996). Also, volcanic ash layers of Cenomanian to Coniacian age (i.e., in roughly the ~95- to 87-Ma range) are present at DSDP Site 288 (which did not reach basement) on the western end of the plateau's eastern salient (Andrews, Packham, et al., 1975). At Site 289, several late Aptian ash layers lie above basement (Andrews, Packham, et al., 1975) and may indicate fairly prolonged volcanism in some areas following eruptions at 122 Ma (early Aptian).

The basalts at all sites are unmetamorphosed, moderately evolved (Fig. 3), low-K tholeiites with relatively flat primitive-mantle-normalized incompatible element patterns (intermediate between those of normal mid-ocean ridge basalts and most oceanic island or continental tholeiites; Fig. 4) and a narrow range of ocean-island-like Nd-Sr-Pb isotopic ratios (Fig. 5). Major and trace element modeling indicates the lavas represent high-degree partial melts (Mahoney et al., 1993; Tejada et al., 1996; Neal et al., 1997). Two geochemically and stratigraphically distinct groups of lavas are apparent in the basement section at Site 807 and in the much thicker section on Malaita. The upper 46 m of lavas at Site 807 (Unit A) are isotopically and chemically very similar to the upper 750 m of lavas in central Malaita, termed the Singgalo Formation. The lower basalt units at Site 807 (Units C-G) and the single flow encountered at Site 289 resemble the lower 2.7 km of the volcanic pile on Malaita, termed the Kwaimbaita Formation (Tejada, 1998). The 90-Ma lavas of Site 803 and Santa Isabel are isotopically similar to the stratigraphically lower 122-Ma Kwaimbaita and Units C-G basalts (Mahoney et al., 1993; Tejada et al., 1996). Thus, an isotopically ocean-island-like mantle source containing (at least) two distinct components was important at the northern and southern margins of the plateau, and the source of the 90 Ma lavas was similar to the source of the stratigraphically lower lavas erupted at ~122 Ma.

SCIENTIFIC OBJECTIVES

1. Age and duration of emplacement. Plume-related hypotheses for emplacement of large igneous provinces include rapid-eruption, age-progressive, and episodic growth models. **A.** Rapid-emplacement models are of two main types. The plume-head or "plume-impact" model (e.g., Richards et al., 1991; Saunders et al., 1992) predicts that large oceanic plateaus are formed by widespread basaltic flood eruptions as the inflated head of a new mantle plume approaches the base of the lithosphere. An alternative model devised specifically for continental and continental-margin flood basalt provinces (White and McKenzie, 1989), sometimes called the "plume-incubation" model (e.g. Saunders et al., 1992), considers flood volcanism to result from cataclysmic pressure-release melting when a rift propagates above the enlarged top of a more or less steady-state mantle plume that has accumulated gradually (perhaps over several tens of millions of years) beneath thick, slow-moving continental lithosphere. Both types of model predict that the great bulk of magmatism occurs in only a few (probably $\leq$5) million years. **B.** In contrast, an age-progressive, Icelandic style of construction, in which plateaus are formed over much longer intervals (tens of millions of years), remains a distinct possibility for many plateaus (e.g., Mahoney and Spencer, 1991; Coffin and Gahagan, 1995; Ito and Clift, 1998). **C.** Alternatively, plateau growth may occur in two or more discrete pulses of activity, dependent on mantle plume dynamics or the interplay between episodes of lithospheric extension and mantle melting (Bercovici and Mahoney, 1994; Larson and Kincaid, 1996; Neal et al., 2000).

As the world's largest oceanic plateau, the OJP is an important test case. Its great crustal volume implies partial melting of at least 150-400 x 10^6 km^3 of mantle, which virtually necessitates involvement of the lower mantle if the bulk of the plateau was formed in the 122-Ma event (e.g., Coffin and Eldholm, 1994). Melting on such a scale is unknown today, and this consideration has helped fuel suggestions of fundamental differences in Cretaceous and Cenozoic mantle convection. On the other hand, if the plateau accreted more slowly over several tens of millions of years (like the much smaller Icelandic Plateau) or in two or more discrete pulses, then this partial melting requirement is eased considerably, but simple plume-head models must either be modified significantly or do not apply. The few existing basement sites demonstrate that 122-Ma and 90-Ma lavas are both present in far separated locations, but the importance of the 90-Ma episode is unclear. In many places, 90-Ma lavas may form a relatively thin carapace over a thick 122-Ma pile. Biostratigraphic dates of basal sediments and intraflow sedimentary beds, and ^{40}Ar-^{39}Ar dating of lavas recovered in the four widely distributed sites to be cored during Leg 192 will provide a much more detailed picture of the plateau's constructional history than is currently available. If suitable lava samples are recovered, some ^{40}Ar-^{39}Ar dating also may be carried out on feldspar separates.

2. Range and diversity of magmatism. Laboratory modeling suggests that starting-plume heads should be strongly zoned because of entrainment of large amounts of ambient, nonplume mantle during their rise to the base of the lithosphere (e.g., Campbell, 1998). Thus, even if a plume's source region (usually assumed to be at the base of, or deep within, the mantle) is compositionally homogeneous, significant isotopic and trace element heterogeneity is nevertheless predicted in magmas erupted from different parts of the plume head or at different times. Major element compositions are predicted to vary as well, with lavas erupted above the hottest (axial) parts of the plume head having picritic (e.g., Campbell, 1998) or possibly even komatiitic (Storey et al., 1991) affinities, whereas more ordinary basalts are predicted above cooler, more distal regions. In this regard, the two most remarkable features of the existing OJP basement samples are (1) the limited overall range of chemical and isotopic variation in the 122-Ma lavas, and (2) the isotopic and chemical similarity of the 90-Ma lavas to the 122-Ma ones. The isotopic and incompatible element results could indicate that the world's largest plateau had a much more homogeneous source (both relative to the scale of melting and in time) than predicted by plume-head models, whereas the combined major and trace element data imply a dominant role for large magma chambers.

Data for basement lavas from the four sites to be drilled on Leg 192 will place more accurate bounds on the compositional and thermal characteristics of the plateau's mantle source and on the nature, extent, and mechanisms of magmatic evolution. Isotopic work will include Nd, Sr, Pb, and Hf isotope-ratio and parent-daughter measurements of whole rocks and, where feasible, of clinopyroxene or plagioclase separates. Os and O isotopes also may be measured in suitable samples. Elemental data, complemented by petrographic studies, will include major element measurements on whole rocks and minerals, and a comprehensive suite of whole-rock trace element analyses.

3. Eruptive environment and style. Plume-head models predict as much as 1–3 km of dynamic uplift associated with the arrival of a large starting-plume head at the base of the lithosphere (e.g. Hill, 1991; Neal et al., 1997). The associated constructional volcanism also creates a much thicker crust than normal oceanic crust. The combination of these effects is predicted to elevate parts of a plateau's surface to shallow water depths and/or cause portions to emerge above sea level. Indeed, significant portions of several plateaus are known to have been initially shallow or subaerial (e.g., Richards et al., 1991; Coffin, Frey, Wallace, et al., 2000). However, although most of the OJP stands 2–3 km above the surrounding seafloor today, basement lavas from all locations studied thus far all came to rest at fairly great depths, probably beneath the calcite compensation depth in some cases (Neal et al., 1997; Ito and Clift, 1998). The reasons for this behavior and whether it is typical of the plateau as a whole are unknown, but critical for understanding how plateaus are constructed, and for testing the plume-head model in particular. Moreover, whether or not parts of the OJP were shallow has important ramifications for how its emplacement affected large-scale climatic, oceanographic, and biospheric conditions. If significant amounts of magma were erupted at shallow depths or subaerially, the flux of climate-modifying volatile species (SO_2, Cl, F, CO_2) to the atmosphere would have been much greater than if the bulk of plateau volcanism occurred at greater depths.

All but one of the existing basement sites are located at the margins of the plateau. The part of the OJP most likely to have been originally at shallow levels is the broad domal region of the high plateau that today lies at water depths shallower than 2000 m (Fig. 1; see Site OJ-3 below), which is also where the crust of the plateau is thickest. This domal region is likely to have been the principal locus of eruptive activity during the ~122-Ma phase of plateau construction (Tejada et al., 1996; Neal et al., 1997). The other area most likely to have been at shallow depths is the crest of the eastern salient (Fig. 1; see Site OJ-6 below), which may correspond to the main locus of 90-Ma eruptive activity, as noted above. Sampling these summit regions during Leg 192, as well as the other two planned sites, will establish whether they were originally shallow or subaerial, or were emplaced in a deep-water environment. Paleodepths will be estimated from microfossils and physical-chemical characteristics of near-basement and intraflow sediments (Ito and Clift, 1998) and from measurements of volatile abundances in volcanic glass (Michael, 1999).

The physical volcanology of large-scale submarine lava flows is poorly known, as are the nature and scale of hydrothermal fluid fluxes associated with plateau magmatism. Knowledge of the physical volcanology of lavas is important for understanding eruption mechanisms and how the volcanic pile accumulated, whereas data on hydrothermal activity are critical for understanding the oceanographic and climatic effects of plateau formation. Flows comprising continental flood basalt provinces are typically 10-30 m thick and, in some cases, have been traced for distances of several hundred kilometers (e.g., Hooper, 1997). Areas distant from eruptive sources tend to be composed of simple flows, whereas compound flows are more indicative of relative proximity to eruptive vents. Previous sampling of OJP basement has revealed that flow thickness varies from <1 to 60 m, although most flows are in the 4-12 m range (e.g., Neal et al., 1997). The lavas are predominantly simple, consistent with the locations of most existing basement sites at the margins of the plateau and presumably far from their eruptive vents. Very little interlava ash has been found. With regard to hydrothermal activity, existing OJP basement sites show almost no evidence of anything but low-temperature seawater-mediated alteration in either the lavas or overlying sediments (e.g., Babbs, 1997). This lack of hydrothermal alteration may again indicate that these are distal portions of lava flows erupted far from eruptive vent systems, whereas major hydrothermal systems would be expected to be centered around major eruptive locii. During Leg 192, sites at the crest of the high plateau and eastern salient, in particular, may show a fuller range of physical features and evidence of significant hydrothermal activity.

DRILLING STRATEGY

The OJP is the world's largest LIP. Despite the considerable geodynamic significance of LIPs, relatively little is known about the composition and origin of large oceanic plateaus, and the primary objective of Leg 192 is to address these questions by recovering rock samples from the basaltic basement of the OJP. The four drilling sites (Fig. 1) have been selected to maximize the scientific return by sampling as much of the history of the plateau as possible. The first-priority site (Site OJ-3) is located on the crest of the main part of the plateau. The second priority site (Site OJ-6) is located on the crest of the eastern salient. Next in order of priority are Sites OJ-11, where we aim to sample basalt emplaced on the eastern flank of the main plateau, and OJ-7, where we will sample the southern portion of the eastern salient, which appears to have rifted away from the main part.

The specific objectives at each site are similar. Basalt recovery is the priority objective at all sites because we need samples to address the primary questions of the age of the plateau and the composition and temperature of the mantle source. Good basaltic core recovery will also allow us to assess the character and mode of emplacement of the lava flows and to address the important questions of whether volcanism was submarine or subaerial and how far from the eruption site the flows were emplaced. Basement logging at two sites (Sites OJ-3 and OJ-7) will provide additional information on lava-flow morphology and stratigraphy. The planned basement penetration (150 m at Site OJ-3 and 100 m at the other sites) is the minimum needed to yield sufficient flow units for conclusions to be statistically robust. However, sampling basalt alone will not provide all the answers. The age of the sediments immediately overlying basement, the environment of deposition, and the early subsidence history of the OJP are all important for understanding the origin and environmental impact of oceanic LIPs. We therefore plan to core a significant proportion of the sedimentary cover. If all goes well, we should recover enough igneous and sedimentary material to allow us to address all of our objectives. If, however, drilling problems put us behind schedule, we may have to start coring sediment at greater depths than planned and reduce basement logging to achieve our primary goal of basement penetration. In the event that drilling proceeds faster than planned, we shall use extra time for additional coring and logging of the igneous basement.

Leg 192 is scheduled to start and finish in Guam. Transit to the first site (Site OJ-3) is estimated to take 4.7 days, and we plan to spend 18.3 days drilling, casing, and logging this site. Transit to Site OJ-7 should take 1.9 days, followed by 14.7 days of drilling and logging. Corresponding transit and drilling times for the other two sites are, respectively, 1.1 and 4.5 days (Site OJ-6), and 1.2 and 4.0 days (OJ-11). Sailing the 1620 nautical miles back to Guam from Site OJ-11 is estimated take 5.0 days.

PROPOSED DRILL SITES

The Pollution Prevention and Safety Panel has endorsed four primary sites (Sites OJ-3B, OJ-6B, OJ-7D, and OJ-11C) and three alternates (Site OJ-3C, OJ-6C, and OJ-7E).

Site OJ-3B (OJ-3C, alternate). This site is located near the shallowest part of the high plateau, where the depth to the top of Layer 3A is also the greatest. This region is where the original basement surface of the high plateau was probably shallowest, and also was likely the area of greatest eruptive activity, especially during the 122-Ma period of basement construction. As such, this part of the plateau is where the widest compositional range of basement lava types may be found. For example, at DSDP Site 289, some 200 km northeast of this site, an ash layer containing about 50% K-feldspar was cored just above basement (Andrews, Packham, et al., 1975). A sediment package above basement at Site OJ-3B may include carbonate reefal deposits. Rather than the 100 m of minimum basement penetration planned for the other three sites, a minimum penetration of 150 m is planned at this site.

Site OJ-6B (OJ-6C, alternate). This site is located near the crest of the large eastern lobe of the plateau, which has not been sampled previously. By analogy with Iceland, this lobe could represent a feature like the Reykjanes Ridge. Alternatively, it could be the trace of the plume tail following the emplacement of the high plateau and, specifically, may be the main locus of 90-Ma eruptions. Like the domal region of the high plateau, this area originally may have been at relatively shallow water depths.

Site OJ-7D (OJ-7E alternate). The site sits atop the Stewart Arch between Malaita and DSDP Site 288 (which did not reach basement); this part of the plateau may have been rifted from the eastern salient by spreading in the Stewart Basin following the 90-Ma eruptive event. Basement lavas here may be either 90 or 122 Ma.

Site OJ-11C. Seismic reflection data indicate that a highly reflective carapace of lavas (or possibly sills) may overlie deeper basement in this area. The 26 m of lavas penetrated at ODP Site 803 belong to the 90-Ma eruptive episode, and we postulate that the carapace is also 90 Ma. If so, drilling 100 m into basement here will provide a more complete section of 90-Ma lavas and may penetrate completely through the carapace.

SAMPLING STRATEGY

Shipboard Samples and Data Acquisition

Following core labeling, nondestructive whole-core measurements, and core splitting, samples will be selected from the working halves of cores (1 to 2 samples per 9.5 m of core) by members of the shipboard party for routine measurement of physical and magnetic properties and bulk chemical and mineralogical analyses by, as needed, inductively coupled plasma—atomic emission spectrometry, carbon-nitrogen-sulfur analyzer, and X-ray diffraction spectrometry. Polished thin sections of samples will be prepared for identification of minerals, determination of mineral modes (by point counting), and studies of texture and fabric.

Sampling for Shore-Based Studies

Shipboard scientists may usually expect to obtain a total of ~100 samples. Normally, the size of individual samples will be ≤ 15 cm^3, although sample size will depend on the number of investigators in the group. In special cases, additional or larger samples may be obtained with the approval of the Sample Allocation Committee (SAC), composed of the two co-chiefs, the staff scientist, and the ODP curator (or the shipboard curatorial representative). Soon after the cores return to the ODP Gulf Coast repository, additional samples may be obtained upon written request. Short intervals of unusual scientific interest (e.g., veins, ores, and dikes) may require a higher sampling density, reduced sample size, continuous core sampling by a single investigator, or use of sampling techniques not available on board the ship. These intervals will be identified during the core description process, and a specific sampling protocol will be established by the interested scientists and the shipboard SAC. Glass will be treated as follows: small chips will be taken at sea and characterized by electron microprobe analysis soon after the cruise; guided by the results of the microprobe analysis, further sampling will be done onshore before the first postcruise meeting. A small number of basement samples may be prepared as "leg-specific" geochemical reference samples for evaluating interlaboratory biases.

Redundancy of Studies

To minimize the time, effort, and expense of shore-based studies, we encourage sampling consortia involving researchers with complementary expertise. Minimizing the redundancy of measurements among the shipboard party and shore-based collaborators will be an important factor in evaluating sample requests. Requests from independent shore-based investigators that substantially replicate the intent and/or measurements of shipboard participants will require the approval of both the shipboard investigators and the SAC.

LOGGING PLAN

Downhole logging will be used during Leg 192 to address issues of volcanic stratigraphy, eruptive morphology, and stress orientation and to create synthetic seismograms for depth-time conversions, which calibrate the interpretation of regional seismic data. Logging data will also be used to measure in situ physical properties and to position and orient cores. Whereas core recovery is often biased and incomplete in variable lithology such as alternating pillows and massive flows, logging data are continuous and therefore provide useful information over intervals of low core recovery.

Logging is scheduled for Sites OJ-3B and OJ-7D. At each, the basalt basement and bottom of the sedimentary column will be logged. The logging time estimate (not including hole conditioning) is 27.7 hr at Site OJ-3B to log 150 m of basalt and the lower 375 m of sediments. At Site OJ-7D, it is estimated that logging will take 23.3 hr to log 100 m of basalt and the lower 100 m of sediments. Because of time constraints, no logging is planned at Sites OJ-6B and OJ-11C. This exception to the normal JOIDES logging policy was approved by OPCOM to provide maximum time for achieving the primary objective of coring in basement.

Three tool strings have been selected to address the scientific objectives of the leg: the triple combination (triple combo), Formation Microscanner (FMS)/sonic, and the well seismic tool (WST). The triple combo (also known as Geophysical) tool string provides a basic suite of downhole physical properties measurements: natural gamma, porosity, density, electrical conductivity, and temperature. These logs are used for determining petrophysical and lithologic variations in both sediments and basalts. The triple combo consists of the following units: the hostile environment natural gamma sonde (HNGS), which is a high sensitivity spectral gamma-ray tool; the accelerator porosity sonde (APS), which uses an electrical neutron source to measure porosity; the hostile environment litho-density tool (HLDT), which measures density and photoelectric absorption through the interaction of gamma rays with electrons in the formation; the dual induction tool (DIT), which measures the electrical conductivity of the formation by electromagnetic induction; and the temperature/ acceleration/pressure (TAP) tool developed by the Lamont Borehole Research Group to collect data for the shipboard heave compensation system that decouples the logging tool from the adverse effects of the ship’s motion.

The FMS/Sonic tool string gives oriented electrical resistivity images of borehole walls with millimeter-scale resolution, the downhole magnetic field vector, *P*- and *S*- wave interval velocities, and a low-sensitivity measurement of natural gamma that is used for depth matching between logging runs. The FMS/Sonic tool string is comprised of three tools: the FMS, the dipole shear sonic tool (DSI), and the natural gamma-ray tool (NGT).

The WST is a single-axis checkshot tool used for zero offset vertical seismic profiles (VSPs). The WST records the acoustic waves received downhole from an air-gun source located near the sea surface. The source bandwidth approximates that used in seismic surveys, and the velocity measure obtained is an integrated one that is robust with respect to local heterogeneities. WST logs are therefore used to construct high-quality synthetic seismograms that calibrate time-depth conversions for the interpretation of regional seismic data. This enhanced interpretation of seismic data will permit extrapolation of the drilling results away from the drill site.

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