# 1. INTRODUCTION

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## OBJECTIVES

Leg 7 of the Deep Sea Drilling Project was designed principally to explore the western equatorial Pacific (Plate 1)–seaward of the island arcs and trenches–to learn something of the age of the crust in various parts of this region by drilling all the way through the sediment cover, to establish standard biostratigraphic sections by continuous coring in the thick sequences of biogenous sediments, and to examine the nature and age of the many acoustic reflectors observed on seismic reflection profiles taken in this region. Four rather different provinces were to be sampled (Figure 1):

1. The Mariana Basin, immediately east of the Mariana Trench, near the island of Guam. Sediments of Late Cretaceous age had been recovered in this deep basin at Site 59, on Leg 6, but basement had not been reached. Our objective was to drill near Site 59 in a place where the entire sediment column to basement could be explored.

2. The region of small basins and shallow ridges and plateaus lying south of the Caroline Ridge and north of New Guinea and the Solomons. Oligocene and early Miocene volcanic basement was found on Caroline Ridge during Leg 6. Drilling on Eauripik Ridge and in the East Caroline Basin was planned for Leg 7 to explore the extent of this region of relatively young vulcanism, and to elucidate the history of the basins and ridges. The site on Ontong-Java Plateau was designed to sample as continuously as possible the very thick (about 1 kilometer) section of acoustically highly stratified sediments known from reflection profiles (Woollard *et al.*, 1967), and to sample the prominent deepest reflector, whose petrologic indentity was of considerable interest, since the plateau is a region of anomously thick (25 kilometers) crust (Furumoto *et al.*, 1970).

3. The deep Central Basin, between the Marshall and Gilbert Ridges on the west, and the Line Islands Ridge on the east. This region lies on the crest of the supposed Darwin Rise (Menard, 1964), and the sediments there should reflect the history of bathymetric changes implied by the Rise hypothesis. Seismic reflection units recognized and correlated over much of the Northwest Pacific by Ewing *et al.* (1968) are well developed in the central Basin, and we wished to establish their lithologic nature and age ranges.

4. The Hawaiian Arch, north of the island of Oahu, which lies west of Magnetic Anomaly No. 32 (Heirtzler, 1968), believed to be of Late Cretaceous (75 million years) age but close to the (presumably) younger Hawaiian Ridge. Drilling here would provide an age for part of the "quiet zone" beyond Anomaly 32, and should yield information on the history of the Hawaiian Ridge and its archipilagic apron and moat (Menard, 1964).

## OPERATIONAL SUMMARY

*Glomar Challenger* left Guam on August 8 and arrived in Honolulu on October 2, 1969, for a total of 56 days at sea (including a repeated September 15, because of crossing the International Date Line). The track of the vessel is shown in a general way on Figure 1, and in more detail on Plate 1.[1] The distance traversed was about 6000 miles; 27 days were spent steaming between drilling sites, while 29 days were spent at the seven different sites.

While underway, echo soundings and magnetometer readings were recorded, and the original records are on file at the Scripps Institution of Oceanography. The magnetometer data have been digitized and stored on magnetic tape.

The seismic reflection profiling system was virtually inoperative at the beginning of Leg 7, and a detour was made back to Guam after completion of the drilling at the first site in order to put aboard replacement elements in the system. The first usable records were obtained one day out of Guam, on the way to Site 62, and the system was operating along the rest of the track, all the way to the last site, Site 67. All the records are reproduced in the chapter on Reflection Seismology, and the locations of each segment of record are shown on the regional bathymetric and track chart (Plate 1). The originals of the records are on file at the Scripps Institution of Oceanography.

A summary of the drilling statistics for the 15 holes, drilled at 7 sites, is given in Table 1. Water depths ranged from 2062 meters at Site 64 to 6142 meters at Site 65, where in Hole 65.1 the total length of the drilling string, at the total depth, was 6326 meters. The deepest penetration was at Site 64, where Hole 64.1 was terminated at 985 meters below the sea floor.

[1] In pocket at back of book.

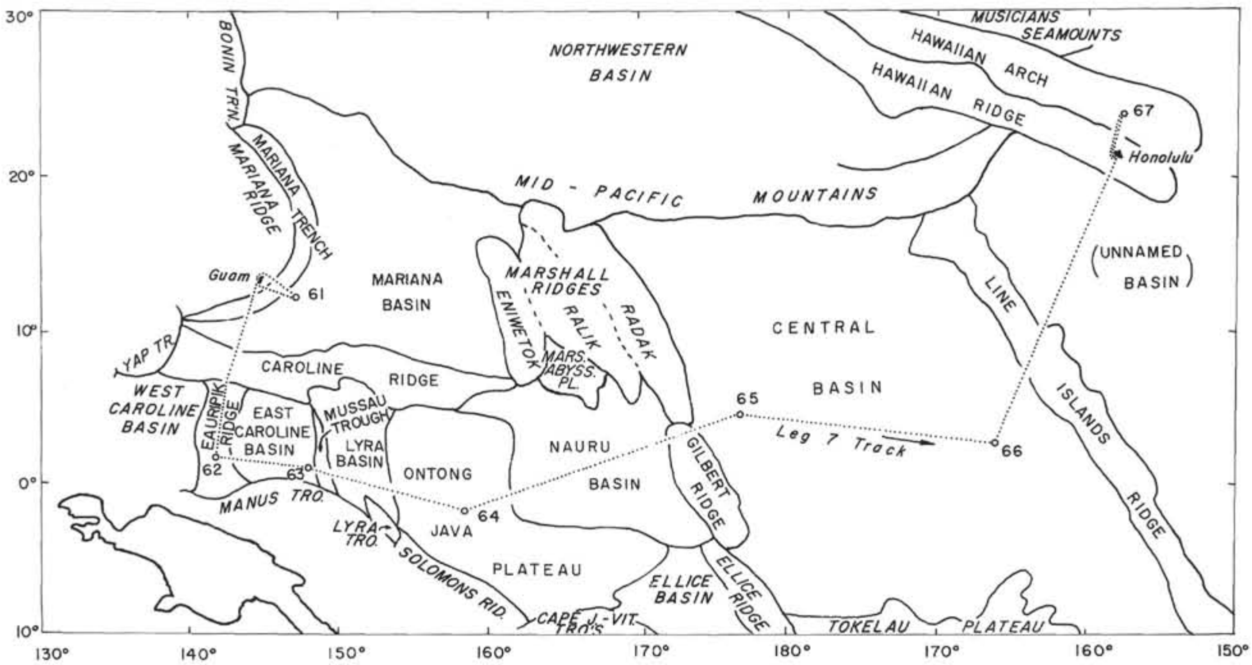


Figure 1. *Geographic subdivisions of the western equatorial Pacific, showing the drilling sites and the track of D/V* Glomar Challenger *on Leg 7.*

At all sites at least two holes were drilled. Generally, the first hole was designed to explore rapidly the total sedimentary section by taking cores at widely spaced intervals, and to sample the basement rocks. The primary intention in drilling the second hole was to sample continuously either all or some chosen parts of the sedimentary column, and to obtain spot samples from between cored intervals in the first hole. For the most part, the second hole was drilled very close to the first: the drill string was simply raised above the sea floor a few tens of meters and lowered again to begin a new hole, without moving the vessel with respect to the acoustic beacon on the sea floor. At Site 64 there was evidence of cratering and slumping around the first hole, so at this and subsequent sites the ship was moved slightly between holes.

During the coring operations, numerous methods were tried in attempts to improve recovery of continuous, undisturbed and uncontaminated cores. The causes and effects of disturbances and contamination are treated at some length in a later section of this report. Several major problems confronted us: (1) collapsing plastic core liners, (2) mechanical crushing or distortion of the sediments, (3) injection of drilling fluid (sea water) into the cores. The liner-collapse problem was solved by several improvements: careful inspection of the liners for flaws, enlargement of the small relief hole in the top of the core barrel, and shortening of the "fingers" of the plastic core retainer, which tended to break off and clog the relief hole. No adequate solution was found to the problem of crushing and distortion—perhaps punch-coring ahead of the drill string would be helpful. We tried to minimize sea-water injection by cutting cores without much use of the water-circulating pumps. This "dry" technique was judged moderately successful.

Details of the drilling operations at each site are given in the individual Site Reports.

## SUMMARY OF RESULTS

The accompanying diagram (Figure 2) summarizes the principal results of this leg, which are somewhat amplified below.

### Mariana Basin

At Site 61 on the extreme western edge of the Pacific Basin, close to the Mariana Trench, we found extrusive basalt below a thin sequence of Upper Cretaceous and Tertiary ashy radiolarian clays and chert. The Cretaceous sediments at this site are similar to those accumulating there today, and the lack of any biogenous carbonate in them indicates that they were deposited in an area that lay below the calcium-carbonate compensation depth, while the presence of siliceous microfossils suggests at least moderately high biological productivity. Nearby seismic-reflection profiles suggest that additional sediments may underlie the basalt that stopped the drill at this site.

**TABLE 1**
**Drilling Statistics for Leg 7, Deep Sea Drilling Project**

| Hole | Date (1969) | Water Depth (ft) | (m) | Latitude | Longitude | Penetration (ft) | (m) | No. Cores | Cored (ft) | (m) | Recovery (ft) | (m) | Per Cent Recovery |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61.0 | Aug. 11 | 18,270 | 5570 | 12° 05.02′N | 147° 03.70′E | 330.0 | 101 | 2 | 43.0 | 13 | 10.00 | 3 | 23 |
| 61.1 | Aug. 12 | 18,270 | 5570 | 12° 05.02′N | 147° 03.70′E | 325.0 | 99 | 2 | 43.0 | 13 | 11.00 | 3 | 14 |
| 62.0 | Aug. 15-18 | 8533 | 2602 | 1° 52.2′N | 141° 56.3′E | 1905.0 | 581 | 8 | 190.0 | 58 | 149.00 | 45 | 78 |
| 62.1 | Aug. 19-21 | 8553 | 2607 | 1° 52.2′N | 141° 56.3′E | 1175.0 | 358 | 39 | 1134.0 | 345 | 1022.00 | 311 | 90 |
| 63.0 | Aug. 23-26 | 14,714 | 4486 | 0° 50.13′N | 147° 53.39′E | 1858.0 | 566 | 11 | 281.0 | 86 | 204.00 | 62 | 73 |
| 63.1 | Aug. 27 | 14,714 | 4486 | 0° 50.13′N | 147° 53.39′E | 634.0 | 193 | 14 | 428.0 | 130 | 294.00 | 90 | 69 |
| 63.2 | Aug. 28 | 14,714 | 4486 | 0° 50.13′N | 147° 53.39′E | 129.0 | 39 | 3 | 93.0 | 28 | 72.00 | 21 | 76 |
| 64.0 | Aug. 31- Sept. 2 | 6758 | 2060 | 1° 44.53′S | 158° 36.58′E | 2800.0 | 853 | 10 | 267.0 | 81 | 247.00 | 75 | 93 |
| 64.1 | Sept. 3-6 | 6758 | 2060 | 1° 44.53′S | 158° 36.58′E | 3231.0 | 985 | 11 | 221.0 | 67 | 224.00 | 68 | 101 |
| 65.0 | Sept. 12-14 | 20,146 | 6142 | 4° 21.21′N | 176° 59.14′E | 477.0 | 145 | 17 | 477.0 | 145 | 434.00 | 132 | 91 |
| 65.1 | Sept. 15 | 20,146 | 6142 | 4° 21.21′N | 176° 59.16′E | 606.0 | 184 | 7 | 152.0 | 46 | 52.33 | 16 | 33 |
| 66.0 | Sept. 19-21 | 17,417 | 5310 | 2° 23.61′N | 166° 7.31′W | 661.0 | 201 | 11 | 265.0 | 80 | 155.08 | 47 | 68 |
| 66.1 | Sept. 22 | 17,468 | 5326 | 2° 22.61′N | 166° 7.31′W | 231.0 | 70 | 8 | 225.0 | 68 | 193.00 | 59 | 96 |
| 67.0 | Sept. 29-30 | 14,714 | 4486 | 24° 22.56′N | 157° 38.88′W | 15.0 | 4 | 1 | 15.0 | 4 | 5.00 | 1 | 33 |
| 67.1 | Oct. 1 | 14,709 | 4484 | 24° 22.56′N | 157° 38.88′W | 197.5 | 60 | 2 | 30.5 | 9 | 5.50 | 2 | 18 |
| Totals | 15 Holes | | | | | 14,574.5 | 4439 | 146 | 3864.5 | 1173 | 3077.91 | 935 | 80 |

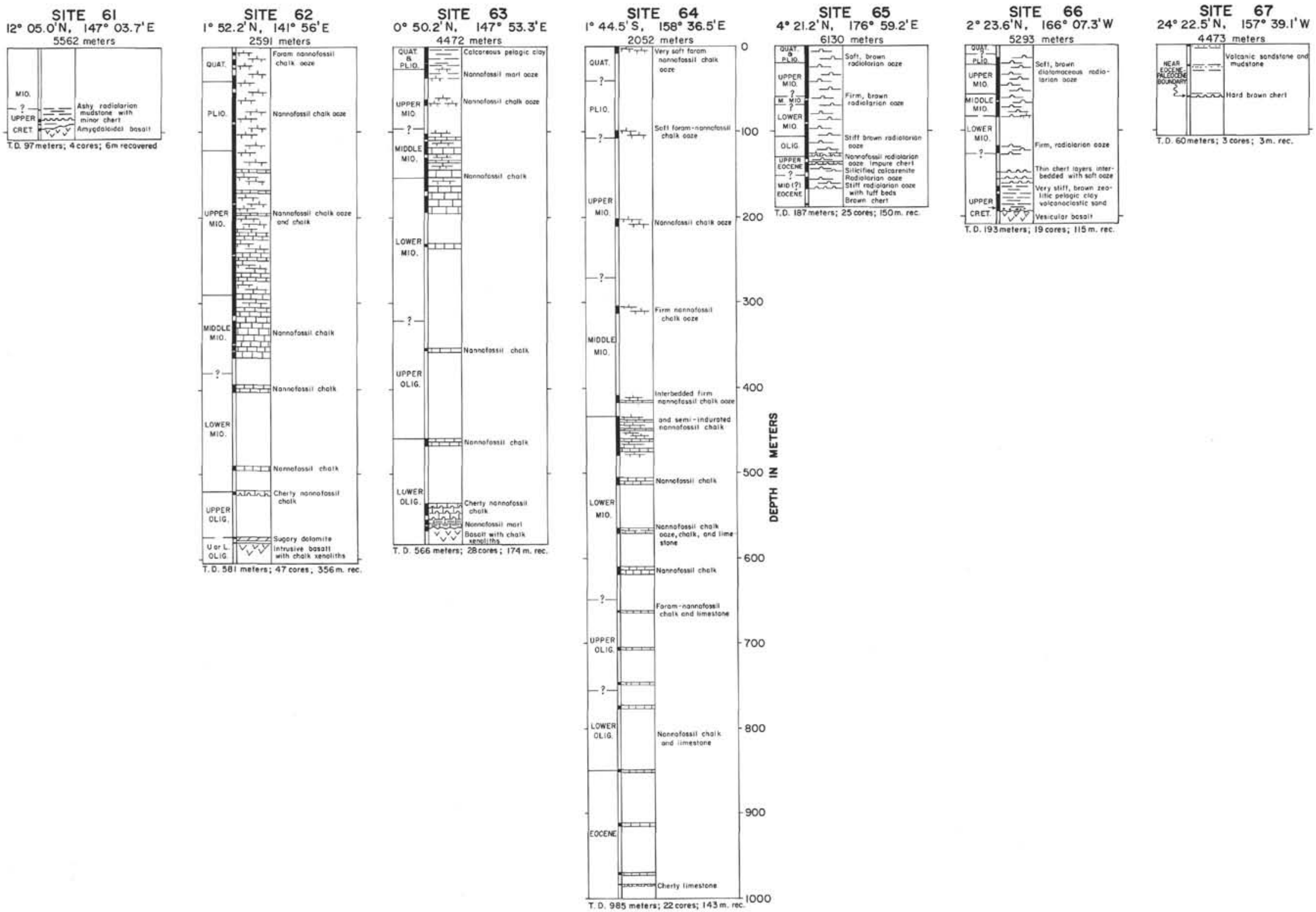


Figure 2. *Graphic summary logs for each drilling site of Leg 7.*

### Caroline – Ontong-Java Region

Uniform calcareous sequences through the entire Neogene and Oligocene (to late Eocene at Site 64), generally containing siliceous microfossils as well, attest that depositional conditions have not changed markedly since at least the Oligocene; the only serious complication in this simple picture is evidence of less biologically productive conditions during the Pliocene at Site 62 (and, to a lesser degree, at Site 63). Sediment accumulation rates in this part of the equatorial Pacific have averaged close to 25 meters per million years over the last 30 million years (as contrasted to about 5 meters per million years for the radiolarian oozes at the Central Basin drilling sites). At Site 62, we cored a nearly continuous fossiliferous section from the Quaternary back through the middle Miocene, and this section was supplemented with more widely spaced cores at Sites 63 and 64. The Ontong-Java Plateau proves to be an ideal site for continuous coring during later drilling, to provide a standard biostratigraphic section for that region since late Eocene.

Calcareous oozes show progressive increases in induration and in the degree of silica mobilization and recrystallization with increasing depths of burial; and some of the persistent reflecting layers seen on seismic-reflection profiles can be correlated with changes in induration or presence of flinty chert in the chalks.

Basaltic basement of Oligocene age is now known to underlie the sedimentary layers in the East Caroline Basin and on the Eauripik Ridge, thereby greatly extending the region underlain by the mid-Tertiary basement discovered on the Caroline Ridge during Leg 6. The boundary between the mid-Tertiary and Mesozoic basement provinces is at the northern edge of the Caroline Ridge, very near Site 61. At Site 62 the basalt is intrusive into the sediments, but at Site 63 the sediments rest in depositional contact on basalt. Basement beneath the Ontong-Java Plateau was not reached, but is older than middle Eocene and is probably not much older than earliest Tertiary, if we extrapolate accumulation rates calculated from the 985 meter column drilled at Site 64.

### Central Basin

In this basin, basaltic basement lies beneath Tertiary radiolarian oozes and cherts, and Upper Cretaceous pelagic clays. Calcareous pelagic sediments are very rare at Sites 65 and 66, indicating that this region, like the Mariana Basin, has remained deeper than the compensation depth for calcium carbonate for most of the last 80 to 100 million years. This result strains the concept of a great regional shallow area, the Darwin Rise, in the central and western Pacific, and suggests that the subsidence of groups of guyots and atolls may not be matched by similar amounts of subsidence in the adjacent deeper basins.

At Site 65 a set of nearly continuous cores of an apparently uninterrupted section of radiolarian ooze ranging in age from middle Eocene to Holocene was obtained, but the bit did not reach the deepest seismic reflector. Below a depth of 127 meters in the Oligocene and Eocene, thin chert and turbidite beds, are sparsely interbedded with ooze. Calcareous nannofossils and detrital foraminifers, including specimens of late Cretaceous, Paleocene and Eocene age, as well as grains of pyroclastic and hyaloclastic rocks and mudstone, occur in the turbidites. The chert is commonly associated with the turbidites. Reworked radiolarians are present, sometimes very abundantly, in all samples younger than middle Eocene. Reworked Cretaceous radiolarians are present in a sample from the Upper Eocene. The upper 127 meters is identified as part of the upper very transparent layer on reflection profiles in this region, and its base is at least as old as Oligocene.

At Site 66 an apparently uninterrupted Quaternary-to-Oligocene sequence of radiolarian ooze about 163 meters thick, containing minor thin beds of chert in the lower 16 meters, overlies a section of stiff, very fine-grained brown clay about 19 meters thick. Poorly preserved Cretaceous radiolarians of Cenomanian or Turonian age occur 2 meters above the base of the clay, which is interbedded in its lower 2 meters with layers of volcanoclastic sand and pebbles. The clay contains terrigenous quartz and mica, along with attapulgite and K-feldspar. Lying unconformably beneath the clay is altered vesicular basalt. The lower part of the clay is strongly enriched in iron, manganese, copper, nickel, zinc, vanadium, arsenic and molybdenum, and suggests that the basalt sediments accumulated on an active sea-floor spreading center except for a brief interval in the Middle Miocene. The sea floor at this site has been below the calcium-carbonate compensation depth since the beginning of the sedimentary record, and the slowly accumulated, sparsely fossiliferous Cretaceous part of the section raises the question of the relation of its site of deposition to the position of the equatorial current system at that time. The lithology suggests deposition beneath a central water mass, with eolian contributions. Paleomagnetic studies of the clays indicate a 30-degree shift in the latitude of the site since mid-Cretaceous times. The oozes are correlated with the seismic Transparent Layer, the interbedded cherts and oozes with the Opaque Layer, the clays with the Lower Transparent Layer, and the top of the basalt with Horizon B of Ewing *et al.* (1968).

### Hawaiian Arch

Well-consolidated and bedded volcanic sandstone and mudstone, and dark brown clay, extend from the sea floor to a depth of 60 meters, where a layer of hard brown chert stopped the bit. Displaced radiolarians in mud from a core at 60 meters indicate that sediments of early Eocene or late Paleocene age are present somewhere above that depth. Only about a third or one half of the total stratigraphic column, as inferred from the seismic-reflection profiles, was penetrated; thus, the chances of finding Mesozoic basement here on a later drilling attempt are very good.

## REFERENCES

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