27. SEABEAM BATHYMETRIC AND WATER-GUN SEISMIC REFLECTION SURVEYS IN THE EQUATORIAL PACIFIC[1]

T. H. Shipley, Institute for Geophysics, The University of Texas at Austin
E. L. Winterer, Scripps Institution of Oceanography
M. Goud, Woods Hole Oceanographic Institution
and
S. J. Hills, C. V. Metzler, C. K. Paull, and J. T. Shay, Scripps Institution of Oceanography[2]

ABSTRACT

Five potential drilling sites in the equatorial Pacific were surveyed on the *Thomas Washington* in January and February, 1982, and three of them, Sites 573, 574, and 575, were then drilled on Leg 85 of the Deep Sea Drilling Project. At each of the survey sites we collected Seabeam bathymetry and high-resolution seismic reflection data, which were used to construct charts of bathymetry, navigation adjusted by best fit of the bathymetry, sediment thickness, and basement depth. For completeness, we also constructed similar charts for Site 572 from a 1970 survey. These surveys illustrate the bathymetry, sediment thickness, and basement structure and their interrelationship. They also reveal significant areas of erosion and redeposition (departures from the simple pelagic sequences) to be avoided in detailed siting of the drill holes. These data were used to locate the optimum pelagic sections for the paleoceanographic sampling objectives of Leg 85.

INTRODUCTION

This chapter summarizes the data collected at five equatorial Pacific (EQ) survey sites on the ARIADNE Expedition of the *Thomas Washington* in January and early February of 1982. For each site, four charts have been constructed: Seabeam bathymetry, sediment thickness, basement depth, and navigation. Data from a 1970 SCAN Expedition of the *Thomas Washington* were used to construct charts in the vicinity of Site 572. The purpose of these surveys was to investigate the local history around each proposed site and locate areas with maximum normal section and minimal erosional or depositional unconformities. Besides the maximum-section criterion, the paleoceanographic results would be enhanced if the drill sites were located as far as possible from areas of redeposition, such as those associated with infilling of local bathymetric lows. We designed a survey program to achieve these objectives using Seabeam swath-mapping and high-resolution seismic profiling (Fig. 1). Together, these tools provide a powerful three-dimensional image of the seafloor and subsurface.

The regional objectives included two N–S transects of the equatorial high-productivity zone between the Clipperton and Galapagos fracture zones. One track was between existing DSDP Sites 71, 72, and 73, the other between the EQ sites proposed for Leg 85. We will not report on the results of these more regional surveys. The purpose of the drilling program was to investigate the cyclicity of biogenic sedimentation, the low-latitude signals of climatic variations, and general high-resolution Cenozoic biostratigraphy.

METHODS

Seabeam is a 16-narrow-beam echo sounder that provides bathymetric information for a swath parallel to the ship track, with a width equal to about 80% of the water depth and relief resolution of better than 20 m. Using this system we were able to obtain nearly complete bathymetric coverage within the areas surveyed. Our most significant problem constructing internally consistent bathymetric charts involved the navigational inaccuracies resulting largely from dead-reckoning uncertainties between satellite fixes. We found that better navigation was produced by shifting tracks slightly—but within the error ellipses of the satellite fixes—until unique bathymetric features from overlapping swaths matched. This corrected navigation was used in subsequent analyses. See Renard and Allenou (1979) and references therein for a complete description of the Seabeam system.

The subsurface was explored with a single-channel seismic reflection system using an 80-in.^{3}, 2000-psi water-gun as the sound source (French and Henson, 1978). This source has a much broader bandwidth (Fig. 2A) than conventional air-guns, and does not produce bubble reverberations, since it is an implosive source (Fig. 2B). This source is still not ideal, because it is band-limited, though less so than the air-gun, and it generates a low-amplitude precursor about 20 ms in front of the main pulse. The data were digitally recorded with amplitude preservation for later processing and display. All seismic sections displayed in this chapter were bandpass-filtered 30 to 250 Hz and displayed at the same constant plotting gain. Time-varying and trace-varying amplitude adjustments were not applied to these data, so that amplitudes could be used in the interpretations. Subsurface data were digitized at 5-min. intervals (nominally 500 to 700 m along track) for presentation as charts shown elsewhere in this chapter.

SITE 573 (EQ-3)

This is the southernmost site along the N–S transect across the Pacific equatorial high-productivity zone. The survey comprised several E–W tracks of about 30 km each and two roughly N–S tracks of about 15 km each (Fig. 3). Adjacent track lines were separated by 1 to 3 km. Navigation during the survey was based on seven satellite fixes and dead reckoning. Owing to the strong drift

[1] Mayer, L., Theyer, F., et al., *Init. Repts. DSDP*, 85: Washington (U.S. Govt. Printing Office).

[2] Addresses: (Shipley) Institute for Geophysics, The University of Texas at Austin, Austin, TX 78712; (Winterer, Hills, Metzler, Paull, and Shay) Scripps Institution of Oceanography, University of California, San Diego, La Jolla, CA 92093; (Goud) Woods Hole Oceanographic Institution, Woods Hole, MA 02543.

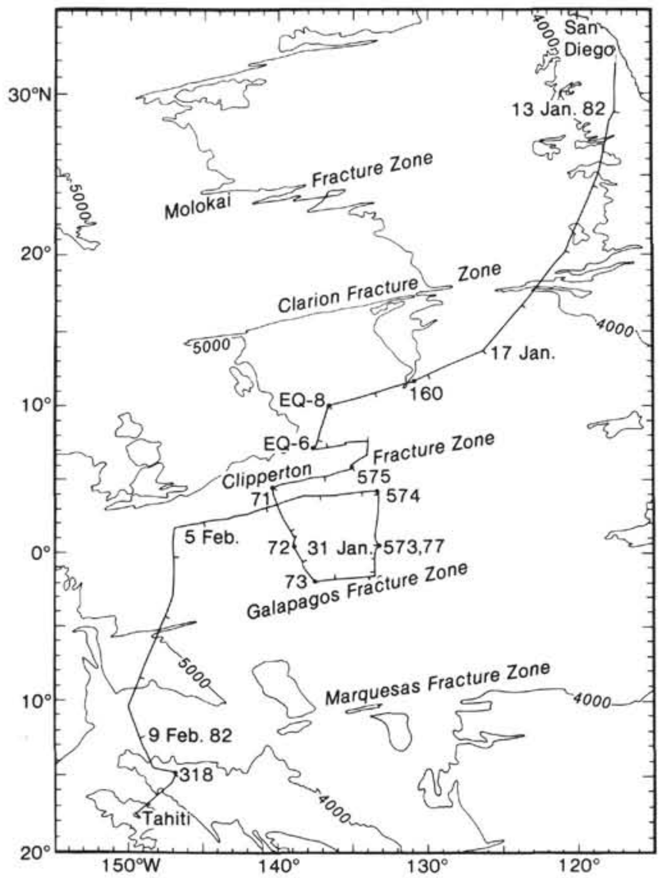

Figure 1. Cruise track of the *Thomas Washington* ARIADNE Expedition Leg 1.

in the survey area and to relatively few satellite fixes, compounded by the temporary failure of the ship's gyro system, the navigation is considered only fair.

The survey area is one of generally low relief, between 4200 and 4330 m, with a single major hill rising to 4020 m. The overall structural trend in the area is northwesterly. The sediment thickness ranges up to 0.55 s; depth to basement ranges from 5.5 to 6.35 s. The survey area can be divided into three regions: a western region, which is a thickly sedimented basin; a broad central, gently sloping region with thick sediments; and an eastern, hilly region with thinner sediments. Each of these regions is discussed here in terms of structure, sediment thickness, and bathymetry.

The western region is a broad basin, trending NW-SE, which deepens to the northwest, where it extends out of the survey area. Depths range between 4200 and 4330 m and generally mimic the basement relief; basement depths range from 6.20 to 6.35 s. Sediment thickness ranges from 0.40 to 0.55 s. The seismic reflection profiles show a section of basin-filling sediment, just above acoustic basement, which is not present elsewhere in the EQ-3 survey area (Figs. 4 to 6). Overlying the basin-filling deposits are thick sheet-drape deposits, which contain more highly reflective layers toward the top of the section. Site 573 was located in this western area to provide the maximum sediment thickness, and was the only location where the oldest sedimentary unit is present.

The central region is broad and slopes gently to the west, with depths of 4200 to 4300 m. Basement has subdued relief and ranges from 6.10 to 6.30 s. The sedimentary section in this region probably consists primarily of sheet-drape deposits. Although not possessing the lowest unit of the western region, the sediments are nonetheless quite thick (0.35 to 0.5 s) and apparently undisturbed. DSDP Site 77, drilled in this region, is easily correlated with Site 573.

The eastern region contains bathymetric and basement highs. Depths generally range from 4200 to 4230 m; there is a single prominent hill 300 m high. Basement depths range from 6.15 to about 5.5 s. The sedimentary section ranges in thickness from nil to 0.5 s, thinning over the highs and apparently absent from the prominent hill. The sediment distribution pattern shows substantial redeposition associated with the hill; a minor erosional moat is present at the base of the west-southwest side.

SITE 574 (EQ-4)

At this site a total of 260 km of tracklines was run, consisting of nine E-W lines, each separated by 2 to 3 km, and two N-S tie lines (Fig. 7). Eleven satellite fixes were obtained during the survey, with the resulting absolute (external) navigational uncertainties probably less than 2 to 3 km. One wide-angle reflection seismic profile was collected from a sonobuoy dropped overboard at the southern end of a N-S line along 133°19′W (Fig. 7D).

The area has low relief; the bathymetry consists of three broad ridges trending N-S and separated by troughs of similar size. The total relief in the area is about 160 m. The acoustic basement is rough (Figs. 8, 9); the sampling and contour intervals of the charts (Figs. 7B, 7C) are too coarse to resolve the local features accurately (Figs. 8, 9). Despite this lack of resolution, gross trends in the basement of the area follow the seafloor bathymetry; elongate lows underlie the seafloor lows and elongate basement highs underlie the broad ridges. Aside from a circular basement low, which extends below 6.7 s, in the NW part of the area, the deepest part of the survey is the trough in the center.

In general, sediment is thickest over basement lows. Notably less sediment is present under the seafloor channel in the western portion of the area, where the youngest part of the section is missing. The most complete section appears to be under the central valley, where the section thickness is about 0.55 s and there is somewhat less high-frequency basement topography. This was the position ultimately chosen for Site 574 (Fig. 10).

SITE 575 (EQ-5)

The northernmost survey area may be divided, for descriptive purposes, into a northern half and a southern half. The northern half was traversed by four E-W tracklines totaling about 130 km. The southern half was traversed by an equal number of E-W tracklines totaling about 110 km. Adjacent E-W lines were separated by 2 to 3 km, and the whole area was tied by two N-S ties (Fig. 11). One wide-angle reflection seismic profile was recorded from a sonobuoy dropped overboard at the southern end of a N-S line along 135°01′W. Fifteen sat-

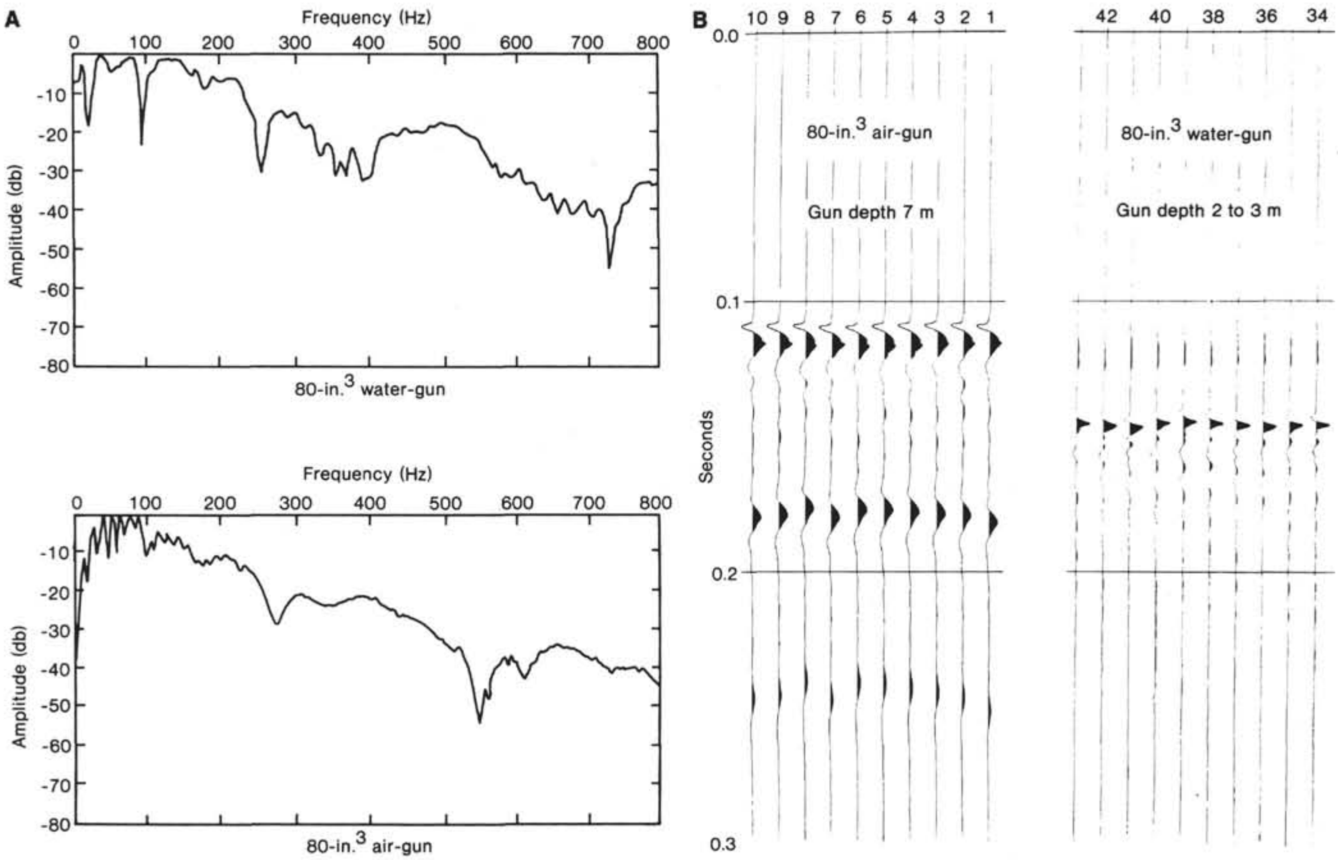

Figure 2. A. Frequency spectra of source-phone data for air-gun and water-gun at a depth of 10 ft. (3 m). The 6-db point is at 90 Hz for the air-gun and 220 Hz for the water-gun. B. Source signatures recorded at 1/4-ms sample period, source phone at 1000 ft. (300 m). Relative amplitudes between air-gun and water-gun have been adjusted for the display.

ellite fixes were recorded, and absolute navigational uncertainties are not more than 1 to 2 km.

The bathymetry of the northern half of the survey area shows low relief in the west, but is dominated in the east by an elongate seamount with relief of over 1000 m. The seamount trends NW–SE and rises from about 4500 m water depth to two separate peaks. The summit of the peak to the northwest reaches less than 3700 m depth; the summit of the southeast peak rises to about 3500 m depth. The detailed morphology of the seamount is unknown, owing to poor Seabeam performance over terrain where the slope parallel to the ship's track is steep. The seafloor to the west of the seamount ranges from 4500 to 4790 m depth. Seismic profiles show truncation of reflectors at the seafloor in this area as the bathymetry deepens toward a centrally located low trending N–S (Fig. 12). This appears to be a channel where more than 0.1 s of sediment has been eroded. The seafloor rises to the western edge of the survey area.

The survey was expanded farther south in an attempt to find an area with a more complete section. Both the bathymetry and basement show much less relief in the southern half of the survey area than in the northern half. The center of the area is an elongated shelf about 8 km wide, extending roughly 12 km southwest of the seamount and ranging in depth from 4540 to 4560 m. Along the western edge of this southern half of the area, the gradient steepens as the seafloor drops into the southerly extension of the channel observed in the northern half. Basement deepens under the channel to the southwest, and seismic reflectors are truncated along its eastern margin (Figs. 13, 14).

The basement below the elongate shelf is similarly low in relief, with only broad, undulatory topography. The sediments are generally about 0.5 s thick, but one notable exception occurs over a basement low along the north central edge of the shelf. Here the sediments are over 0.55 s thick, and the upper units observed in the seismic records are thicker than elsewhere in the survey area. Site 575 was eventually located about 10 km from the base of the seamount.

EQ-6 SITE

Site EQ-6, the next northerly site along the transect, was not drilled. Here the survey consisted of six E–W lines spaced about 2 km apart and two tie-lines oriented NNE and NNW (Fig. 15). Sea conditions were moderate for the duration of the survey, making the 3.5-kHz records unusably noisy. Ten satellite fixes during the survey provided good navigational control.

The EQ-6 bathymetry shows a series of three NNW- to northerly-trending ridges and valleys with a 10-km wavelength. Total depth varies from 4660 to 4850 m. The crests of ridges and floors of valleys tend to be wide and gently sloping, but are separated by more steeply dipping ridge flanks. A subtle ENE trend is superimposed

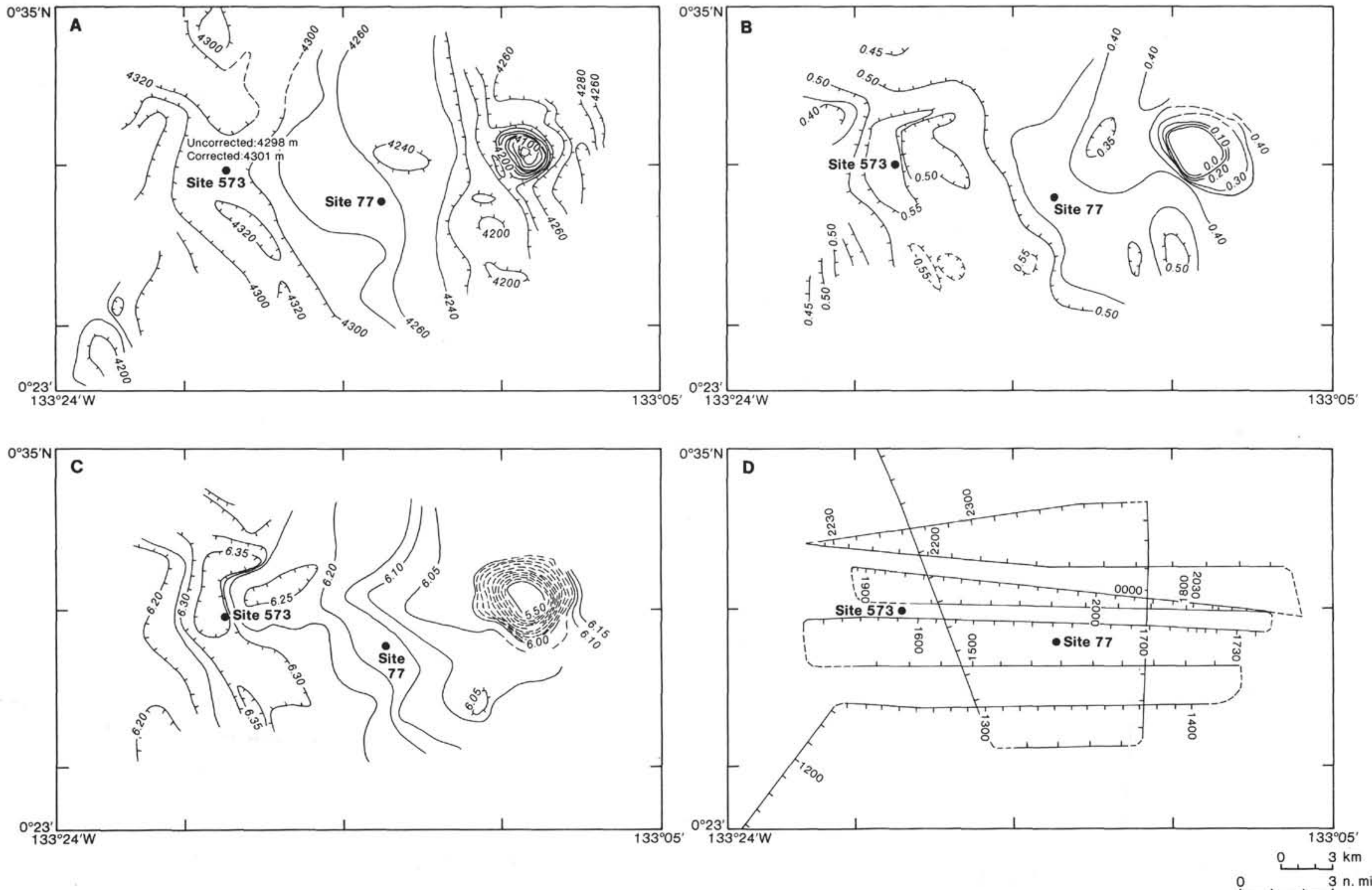

Figure 3. A. Site 573 Seabeam bathymetry. A moat exists on the southwest side of the hill. Contour interval = 20 m. Uncorrected depth: velocity = 1.5 km/s. B. Sediment thickness in seconds of two-way traveltime. Drilling at Site 573 sampled thicker section than at Site 77. Contour interval = 0.05 s. C. Total depth to basement in seconds of two-way traveltime. Contour interval = 0.05 s. D. Track chart after adjustment to make Seabeam data internally consistent. Tick marks at 5-min. intervals.

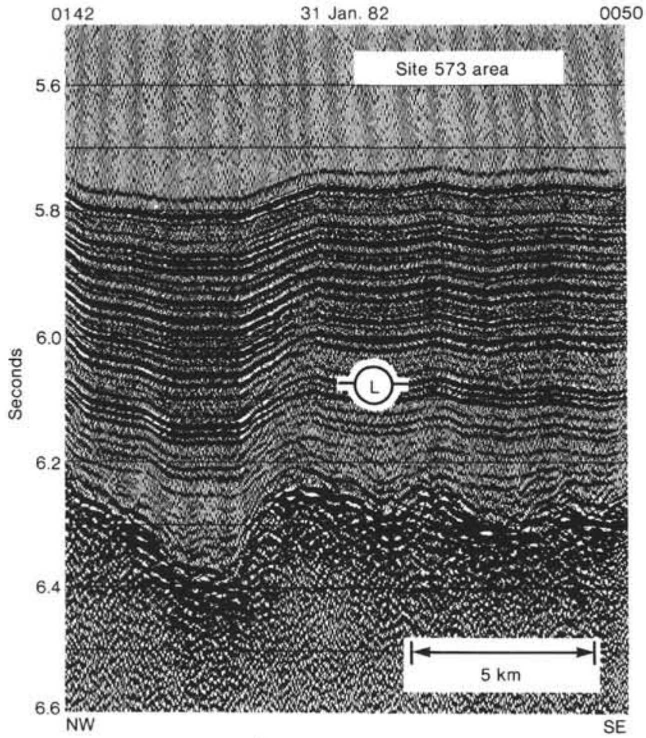

Figure 4. Water-gun seismic data in the vicinity of Site 573. "L" is a reference reflection traced throughout the equatorial Pacific.

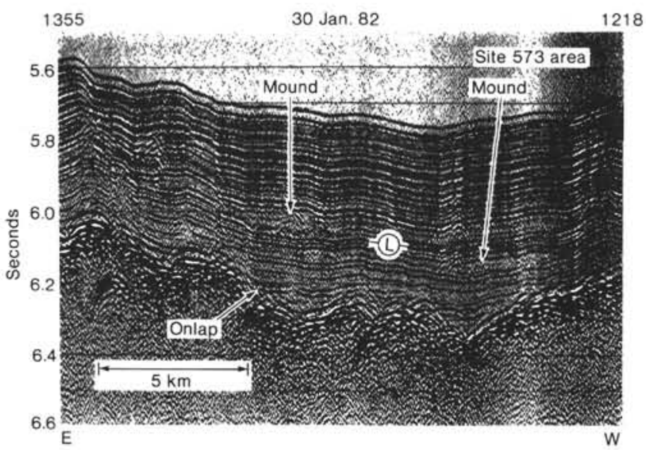

Figure 5. Another seismic profile in the Site 573 area showing the characteristic mounds and basement onlap of the earliest sedimentary deposits.

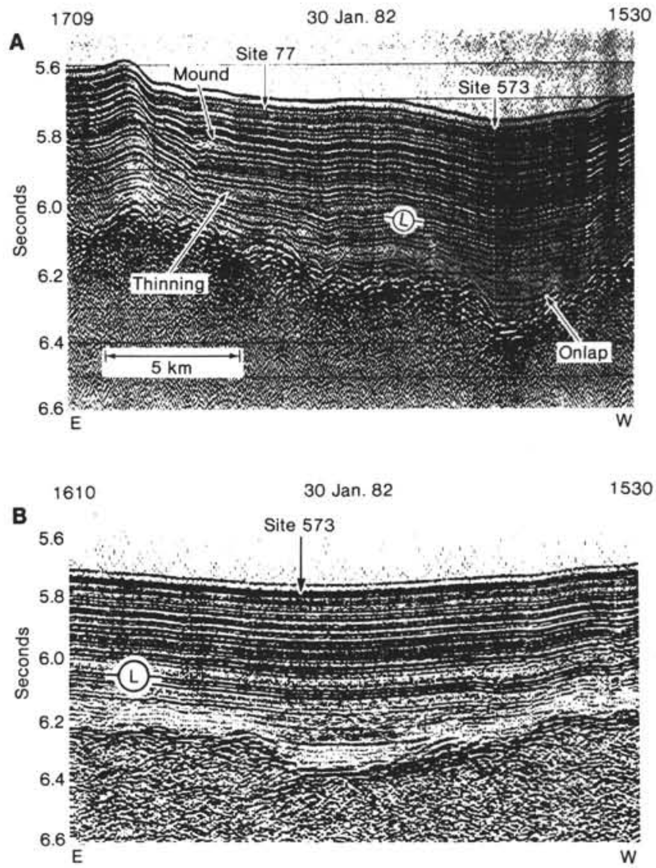

Figure 6. A. Profile through Site 77 and Site 573, showing that coring at Site 77 did not sample the earliest sediments deposited in this area. Note thinning onto the high. B. Migrated portion of Figure 6A, illustrating that even with removal of most hyperbolae associated with the acoustic basement there is still no evidence for a deeper basement at Site 573.

on the dominant NNW trend. Basement shows a series of NNW-trending ridges, with intervening valleys, and a subtler ENE trend, both similar to the bathymetric trends. The isopach map shows that the total sediment thickness varies between 0.25 and 0.40 s, with most areas having slightly more than 0.3 s of sediment which uniformly drapes the basement. Much of the variation in sediment thickness occurs on the flanks of the ridges.

The acoustic stratigraphy of the EQ-6 site is characterized by a fairly uniform section, which drapes over basement and lacks significant unconformities. It may be divided into four subunits: (1) an upper transparent layer, up to 0.03 s thick, present on the gentler flanks of ridges and in valleys but not identified on ridge crests; (2) an upper strong reflective unit, 0.05 to 0.12 s thick, consisting of 3 to 6 wavelets; (3) a transparent unit, 0.10 to 0.25 s thick, without significant reflectors; and (4) an interval with two or three moderately strong reflectors, spaced about 0.05 s apart, which overlie basement. The boundaries between the lower three units are poorly defined.

EQ-8 SITE

EQ-8 is the northernmost of the survey sites. Our survey consisted of seven E–W lines spaced about 2 km apart and two tielines oriented NNW (Fig. 16). Sea conditions caused the 3.5-kHz records to be noisy and effectively useless. Ten satellite fixes during the survey provided good control on absolute position.

The bathymetric trend is NNW and total relief is only 160 m. The eastern section of the survey area is dominated by a broad high, which reaches 4690 m in the southeast corner, the shallowest portion of the area. The seafloor descends to the west to about 4830 m; in the central region the seafloor varies from about 4800 to about 4580 m, in an irregular pattern. The western edge of this central low is marked by a NNW-trending low at least 4840 m deep. The low rises toward the west to a NNW-trending high, which reaches 4710 m.

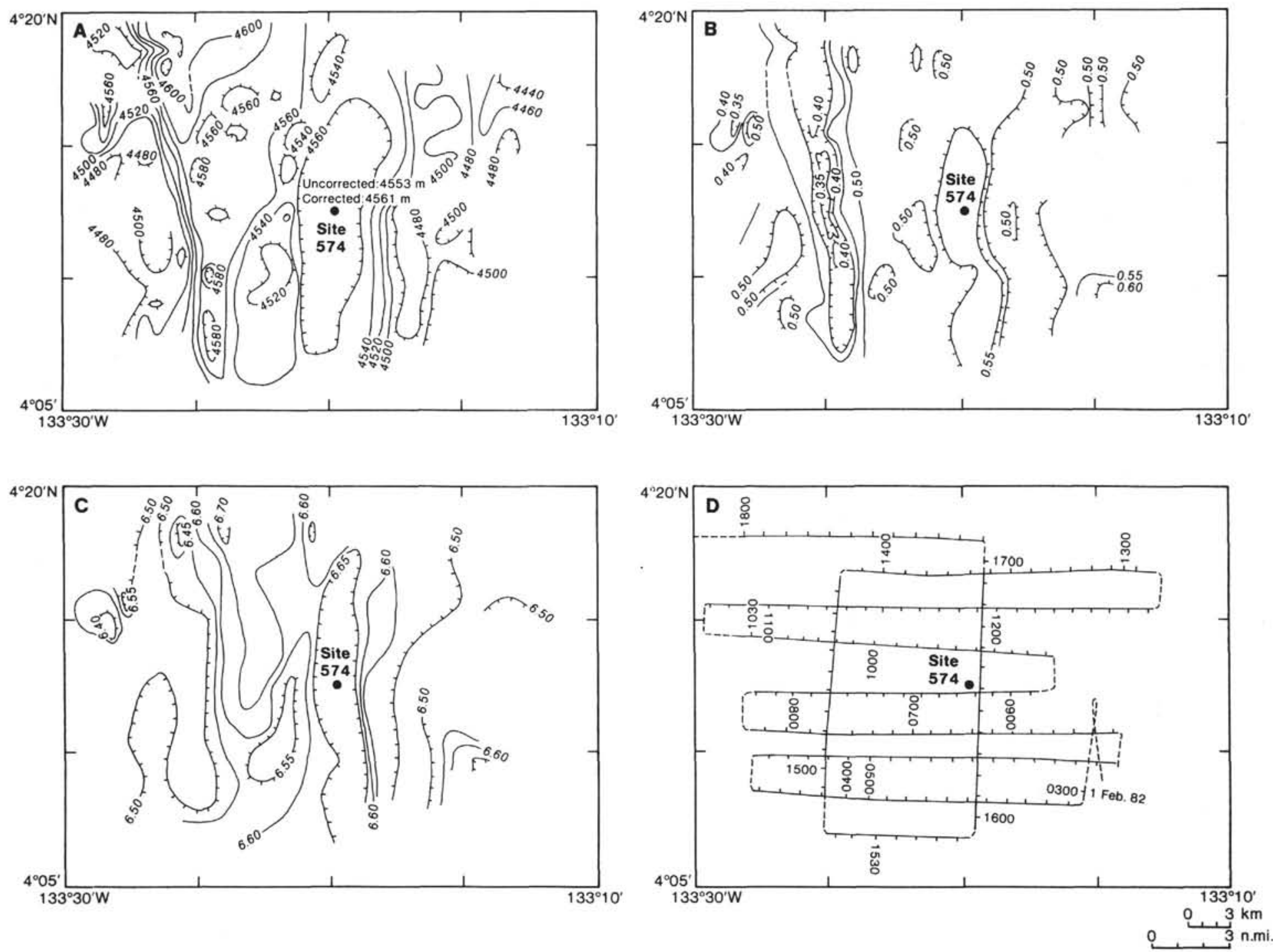

Figure 7. A. Seabeam bathymetry in the vicinity of Site 574. Contour interval = 20 m. Uncorrected depth: velocity = 1.5 km/s. B. Sediment thickness in two-way traveltime based on the seismic data collected along tracks shown in Figure 7D. Contour interval = 0.05 s. C. Total depth to basement in seconds of two-way traveltime. Contour interval = 0.05 s. D. Track chart after the corrections to make the Seabeam bathymetry internally consistent. Tick marks at 5-min. intervals.

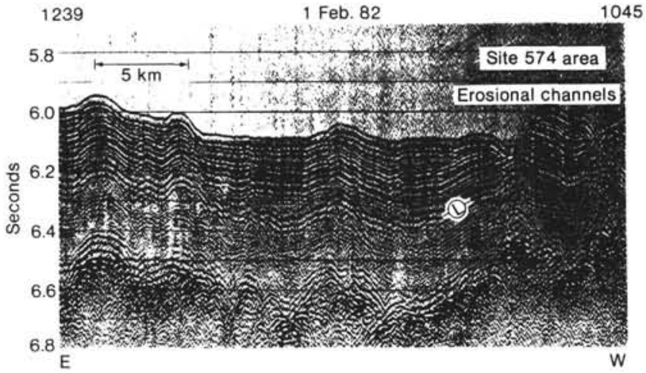

Figure 8. Water-gun seismic section in the vicinity of Site 574. "L" is a reference reflection annotated on most seismic sections from this region.

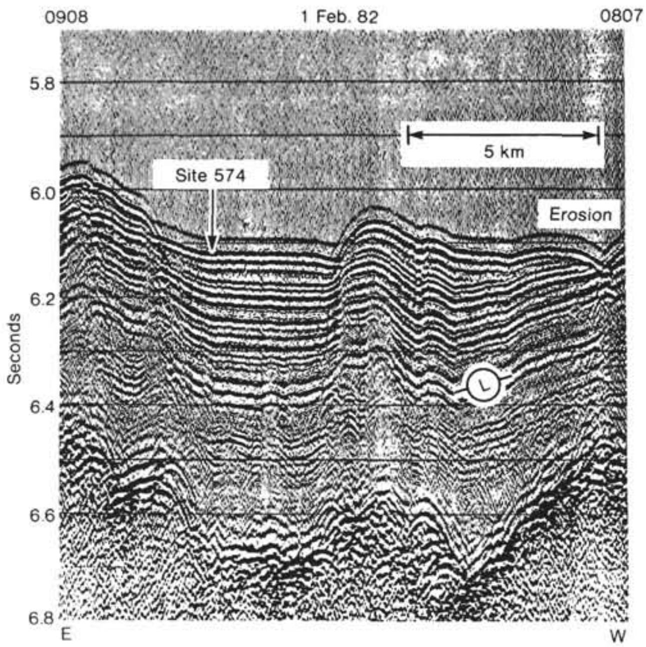

Figure 9. Example of the erosional channels that have removed significant portions of the younger sediments in the vicinity of Site 574.

The broad, NNW-trending pattern of bathymetric highs and lows generally mimics the basement relief, but with some preferential infilling of lows. The most prominent basement feature is a NNW-trending scarp, which truncates the eastern high, dropping into a narrow trough containing the thickest sediments in the area. The seismic facies is generally sheet-drape with no prominent reflectors. The thickness of the section varies from about 0.10 to 0.30; the lower values occur over the basement highs and the higher values occur in some of the low areas. Basement relief in the area is 0.3 s (about 250 m); the seafloor relief is only 160 m. The sediment distribution effectively attenuates the basement relief.

SITE 572 (EQ-1A)

EQ-1A was surveyed of the *Thomas Washington* SCAN Expedition by H. Craig in early 1970. This survey was a post-drilling investigation of Site 81. Standard navigation, magnetics, 12-kHz echo-sounding, and analog seismic profiles were obtained. These data were used to prepare charts of the bathymetry, sediment thickness, and basement relief (Fig. 17).

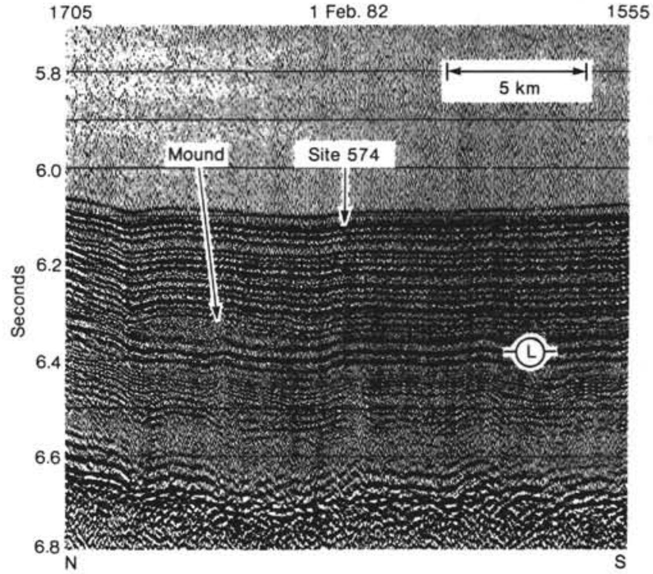

Figure 10. Seismic section at Site 574. Note the appearance of smooth basement in the N-S profile.

The bathymetric relief is about 80 m, and has a NNW trend. Sediment thickness averages about 0.45 s, and is 50 m thicker in basement lows. The preferential infilling of the basement lows has attenuated the effects of basement relief on the seafloor bathymetry.

Site 572 was located in one of the basement lows where the sediment cover is thickest. Site 81 was located just to the northeast, where the sediment thickness was about 50 to 75 m thinner.

DISCUSSION

The mean plate-fabric orientation varies by as much as 25° between the different survey areas, which is more than had been expected. Between the Clipperton and Galapagos fracture zones, the mean trends are N20°W at Site 573, N5°E at Site 574, and N10°W(?) at Site 575, and between the Clipperton and Clarion fracture zones they are N10°W at EQ-6 and N15°W at EQ-8. These trends, the fabric imparted to the crust at or soon after its formation, vary more than the N10°W predicted from the geometry of the major transforms. Similar 20 to 30° swings in trend are also evident in the Seabeam data along the track from San Diego to EQ-8 (Fig. 1). The amplitude and wavelength of the fabric also vary from site to site; amplitude ranges from about 130 to 315 m, and the wavelength varies from 4 to 8 km. Apparently the ridge-crest segments are much smaller than the gross geometry defined by the major fracture zones, and impart a variant to the fabric orientation. These variations are of the same magnitude as those observed by Lonsdale (1983) along the active East Pacific Rise crest, where individual rise crest segments do not always trend normal to the major fracture zones. Although the fabric observed here is probably of similar origin, propagating

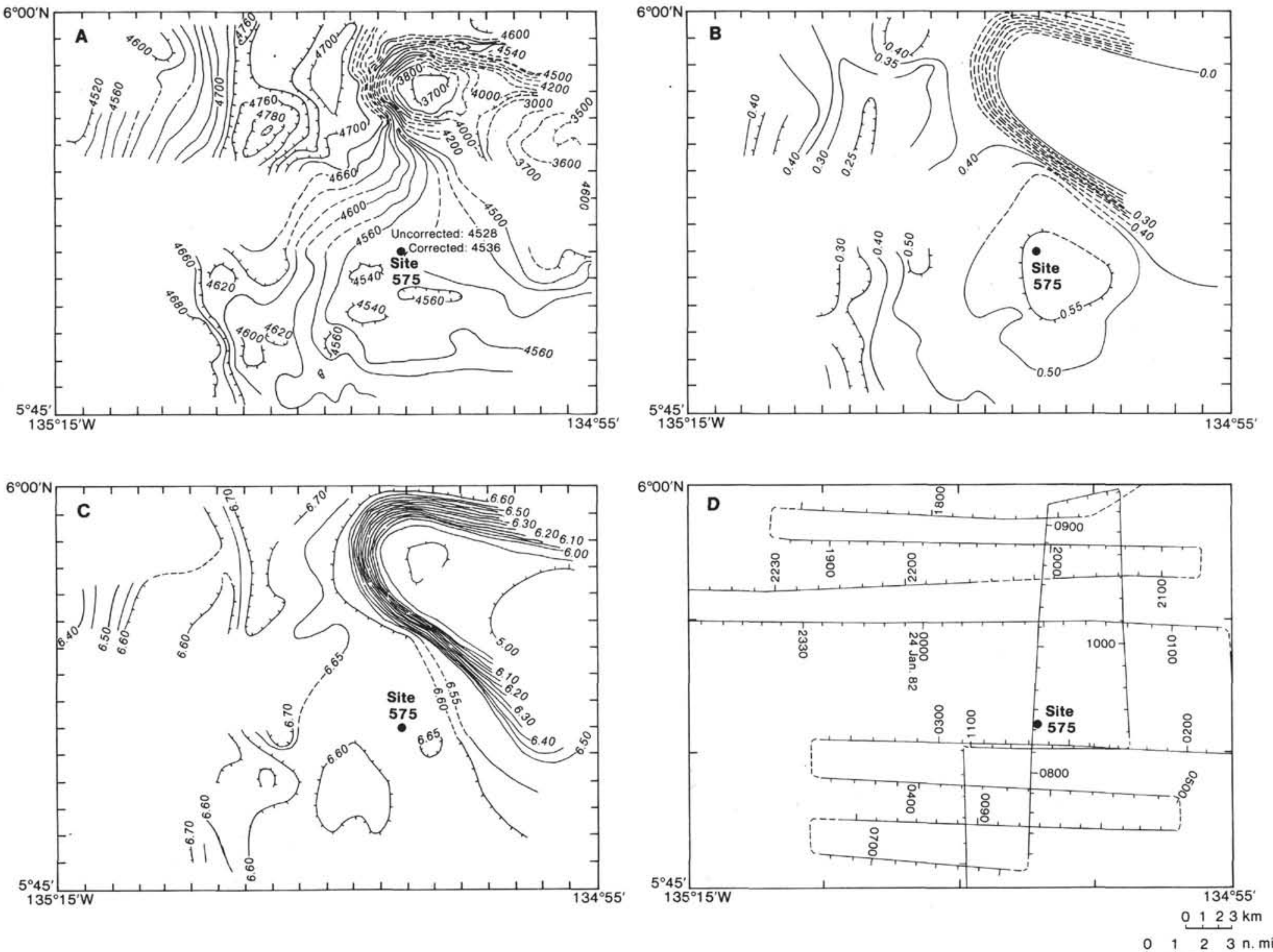

Figure 11. A. Seabeam bathymetry near Site 575. Significant erosion of the seafloor is occurring to the west of the high, and a moat has formed along the northern side of the high. Contours at intervals of 20 m; 100 m when depth <4500 m. Uncorrected depth: velocity = 1.5 km/s. B. Site 575 was situated where the sediment section was thickest. Sediment thickness in seconds of two-way traveltime. Contours at 0.05-s intervals. C. Depth to basement in seconds of two-way traveltime. Contours at intervals of 0.05 s; 0.50 s when <6.00. D. Adjusted navigation resulting from matching overlapping Seabeam bathymetric swaths. Tick marks at 5-min. intervals.

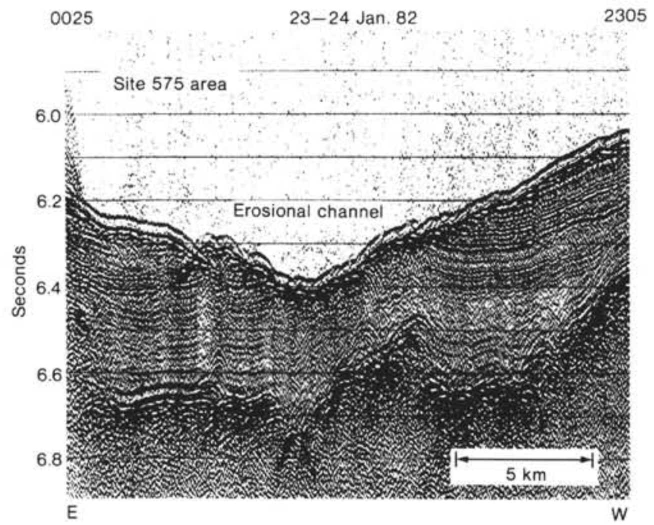

Figure 12. Seismic section to the west of the high, illustrating the seafloor erosion associated with the channel in the Site 575 area.

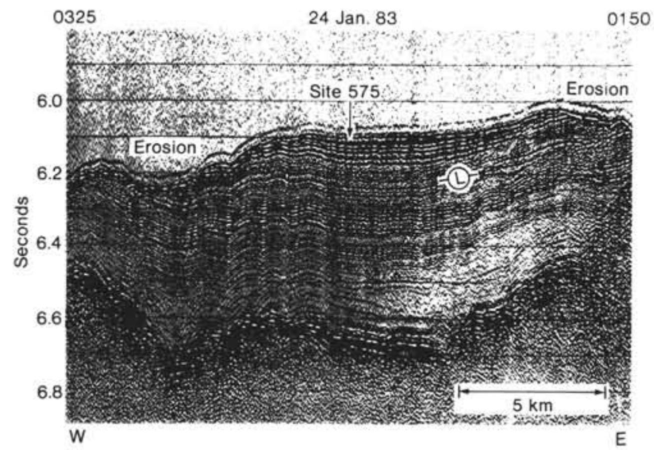

Figure 13. Seismic section illustrating the relationship between the erosional areas and the drill site location.

rifts (Hey et al., 1980) could also be expected to produce similar anomalies in the fabric.

The site surveys provide abundant evidence of recent seafloor erosion. Some, such as erosional moats that have formed at the base of isolated highs (Figs. 3, 11, 12), result from current intensification caused by bottom-water flow around bathymetric obstructions. Others are well-defined channels, located either on basement highs or within lows (Figs. 7 to 9, 11, 13, 14). In a Deep-Tow survey of one of these erosional channels, Mayer (1981) showed that the channels are of very limited extent, unlike some mid-ocean channels; curiously, the one studied by Mayer actually follows the crest of a basement structural high. These erosional features emphasize that there is much redeposition of the sediments within the equatorial Pacific, even if the transport occurs only over a short distance.

The sediment isopach charts show that the sediment thickness varies within a single survey area by 20 to 30%, a significant departure from simple pelagic drape. Most of the variation in sediment thickness results from recent seafloor erosion as well as basin-filling within the low-

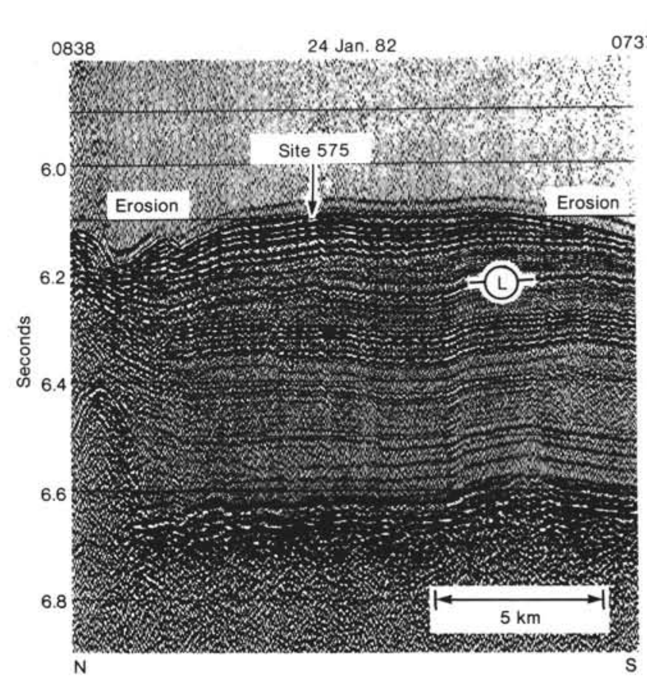

Figure 14. Water-gun seismic section at Site 575. Note that volcanic basement, probably at about 6.67 s, is nearly masked by a shallower reflection at 6.64 s.

ermost (Eocene/Oligocene) sediment intervals. The onlapping character of the basin-filling is illustrated in Figures 5 and 6. Early in their history, depressions act as sediment traps, and only after partial filling and reduction of the seafloor gradients does sediment draping become established.

If erosional episodes and early preferential redeposition in basement depressions are factored out, remaining sediment-thickness anomalies are less than 0.05 s (less than 50 m). Within the sediment section, the seismic reflection data reveal episodes of onlapping and other erosion and mound development. Some episodes appear to be regional in timing and extent, whereas others are apparently localized departures from the pelagic depositional pattern. An example of the thinning by onlap is shown in Figure 6A. This is not an uncommon event, but appears to occur mainly at one stratigraphic level. The simplest explanation for this geometry is an episode of redeposition of sediment from surrounding highs that occurred in association with bottom-current intensification, though other episodes of erosional truncation are found throughout the regional survey data. They are often related to seafloor relief, and few seem to be regionally continuous or synchronous. We are still investigating the possible significance of several regional reflections which at some localities appear as unconformities.

Another depositional feature that accounts for local anomalies in sediment thickness is a mound, lobate in cross section, and usually with no detectable internal structure. Mounds of this type have well-defined tops, often with high-amplitude diffractions. They are fairly common; examples are shown in Figures 5, 6A, and 10. Seldom are such mounds more than 4 km wide in apparent profile; nor are they often more than 20 to 30 m thick. In contrast with the onlapping fill, the relationship between

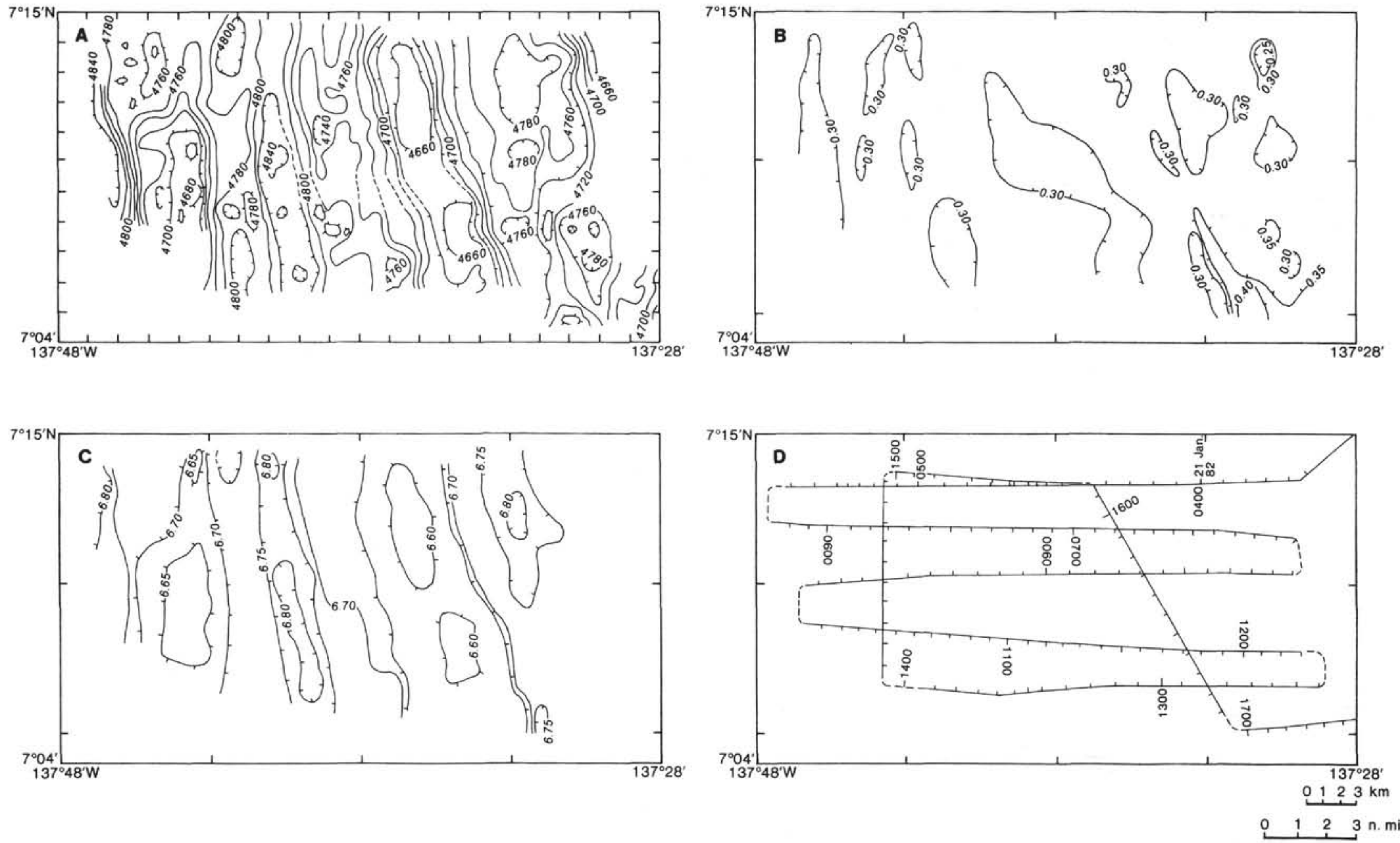

Figure 15. A. Seabeam bathymetry at EQ-6 survey area. Contours at intervals of 20 m. Uncorrected depth: velocity = 1.5 km/s. This site was not drilled on Leg 85. B. Sediment thickness in seconds of two-way traveltime. Contours at 0.05-s intervals. C. Depth to basement in seconds of two-way traveltime. The sediment thickness mimics the basement relief. Contours at 0.05-s intervals. D. Navigation adjusted for best fit of the Seabeam swaths. Tick marks at 5-min. intervals.

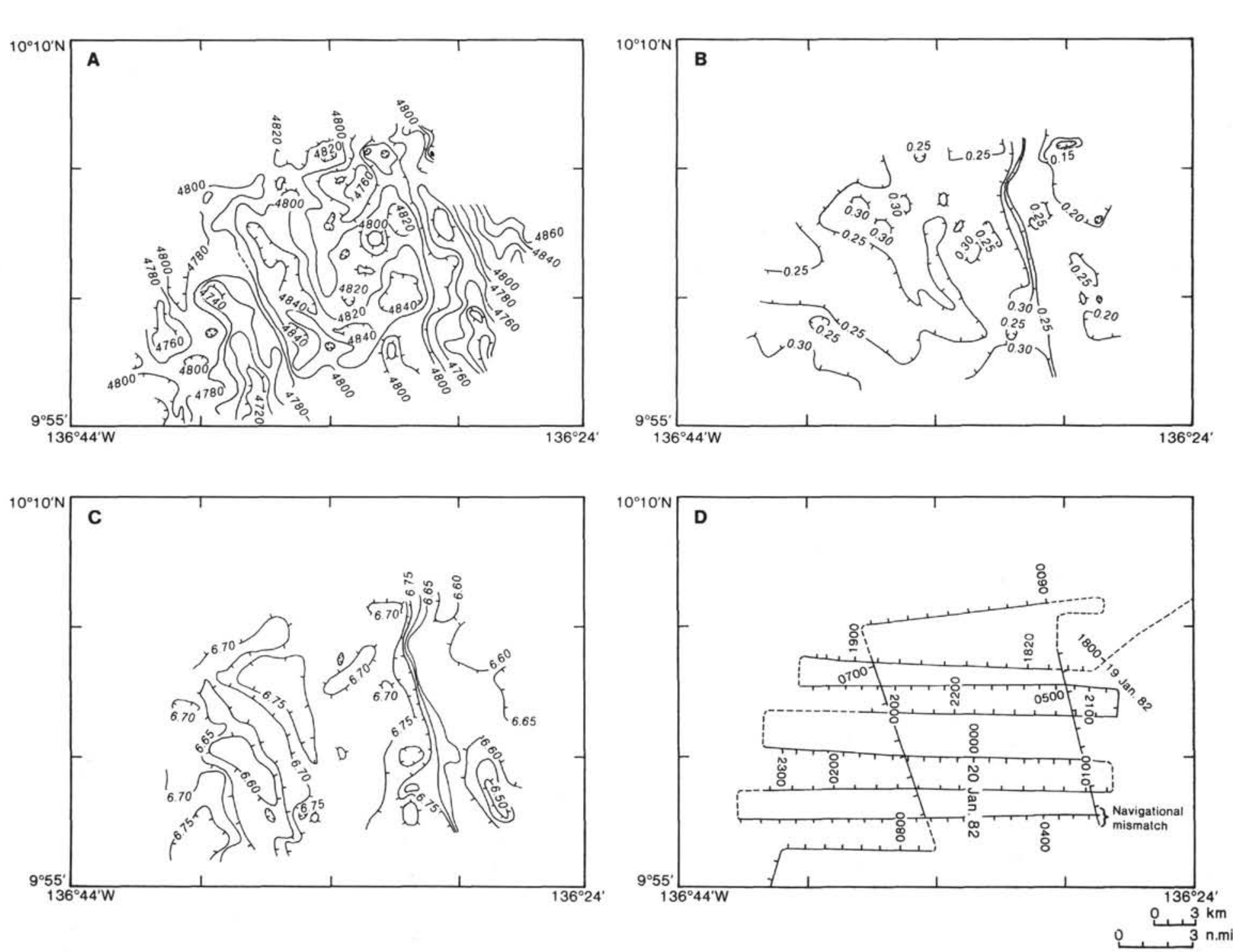

Figure 16. A. Seabeam bathymetry in the EQ-8 survey area. Contours at intervals of 20 m. Uncorrected depth: velocity = 1.5 km/s. This site was not drilled on Leg 85. B. Total sediment thickness in seconds of two-way traveltime. Contours at 0.05-s intervals. C. Total depth in seconds of two-way traveltime. Contours at 0.05-s intervals. D. Navigation adjusted for best fit of Seabeam swaths. Tick marks at 5-min. intervals.

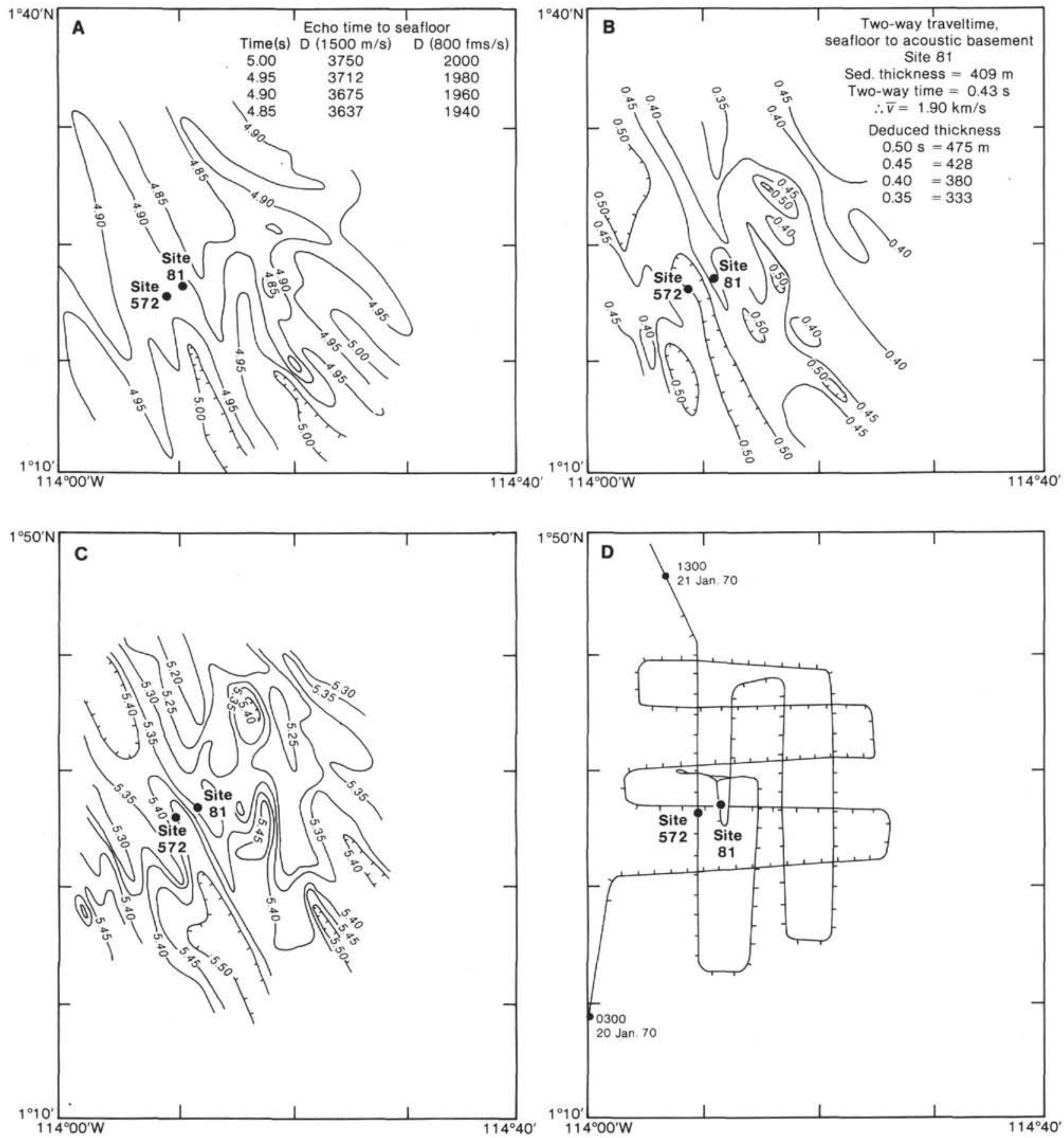

Figure 17. A. Conventional bathymetry in seconds of two-way traveltime at Sites 81 and 572. Based on a 1970 post-drilling survey of Site 81. B. Sediment thickness in seconds of two-way traveltime. C. Basement relief in seconds of two-way traveltime. D. SCAN 10 track chart in vicinity of Site 572 and Site 81, showing data points (ticks) used in preparing bathymetric and isopach maps.

these mounds and thinning within the same stratigraphic interval nearby is imperfect.

Since these depositional and erosional features are so common, the concept of a simple pelagic sediment blanket does not seem appropriate for much of the sedimentary history of this region. Earlier investigations have shown that the sediments on the slopes are thinner than in the lows and on the highs in abyssal hill terrain (e.g., Luyendyk, 1970; Mudie et al., 1972). We find that over a much longer time interval these simple slope-related processes are insignificant compared with other sedimentological processes that are redistributing much of the pelagic sediments.

Isolated volcanic highs were encountered at Sites 573 and 575. The one in the Site 573 area is typical of a class of volcanoes observed in the transits between sites. This particular hill rises 160 m above the seafloor and over 500 m above the surrounding basement, and is nearly conical, 6 km wide at its base with a nearly flat top 1 to 2 km wide (Fig. 3). It is probably a volcano generated near a ridge crest, dormant since the early spreading phase. A second, larger volcano in the Site 575 area caused us to relocate our survey area to the south, away from the sediment-redeposition influence of the high. This hill extends about 1000 m above the seafloor, 1300 m above general basement depth, and at its base is at least 8 km wide and may be elongated toward the southeast (Fig. 11). It represents a class of larger, distinctly more complex, composite volcanic cones. They may be slightly larger than the smaller conical hills because of slightly prolonged volcanism, but still near the ridge crest, or they could result from a more recent off-axis volcanic event. The drilling at Site 575 indicated that the volcano has been influencing sedimentation since at least the early Miocene, represented at the bottom of the drill hole (see Site 575 chapter).

Possibly related to these volcanic episodes are very high-amplitude reflection anomalies encountered in a number of different areas within the regional surveys. Figure 18 shows one example of such an anomaly. The section is true amplitude—all recording gains have been removed—and was bandpass-filtered 30 to 250 Hz and displayed at a constant gain. The anomaly is in fact two wavelets wide, and partially masks reflections from beneath it. They appear to be limited to particular stratigraphic intervals, usually beneath "L" level (Fig. 18). The sharp edges of the features produce strong diffraction hyperbolae, and seismic windows into the deeper section are common (Fig. 18). Because of the very restricted nature of these events, their abrupt terminations, and their ability to mask deeper events, we believe that they may be volcanic sills or flows. (Davis [1982] has reported similar features in the northeastern Pacific.) They could also be diagenetic horizons, perhaps related to turbidites originating from nearby highs, judging from the abrupt termination of the horizons. Our surveying time was insufficient to allow investigation of the spatial form of any of these occurrences and their relationship to adjacent volcanic highs.

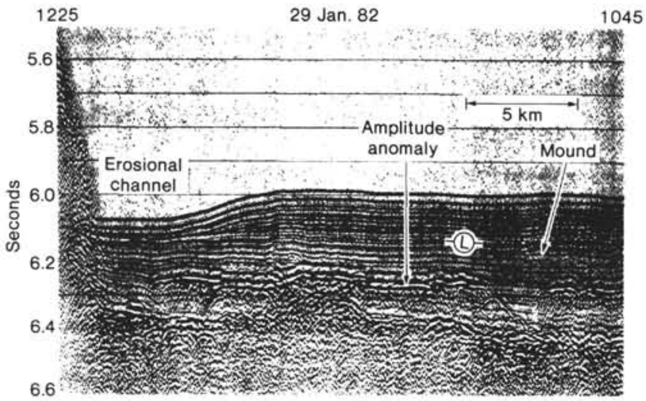

Figure 18. Seismic section illustrating the amplitude anomalies encountered at several locations in transits between the survey sites. Refer to Figure 1 for approximate location.

CONCLUSIONS

The preliminary results of our surveys indicate that the geology, on a scale of a few kilometers, is more complex than the simple model for the pelagic environment would predict. Seafloor erosion, recent and ancient, has sculptured the sedimentary deposits, mostly on a very local scale related to basement highs and channels, but also more regionally in specific stratigraphic intervals. Onlapping fill, general thinning and thickening of sedimentary intervals, and mound development have been widespread in time and space. All of these effects are encountered in the sedimentary section, so they must be recognized and taken into account in reconstructing the paleoceanography of each drill site.

ACKNOWLEDGMENTS

Time for this project was severely limited because drilling was scheduled within weeks after the site survey cruise. It was successful only because of the help of numerous students and staff. The water-gun program succeeded largely because of the efforts of P. Crampton. Shore-based seismic data processing was guided by P. Henkart. Seabeam data processing, much of it accomplished on board ship, was the work of J. Charters and L. Abbott. The work was supported by JOI, Inc. contract no. 42-81. This chapter represents The University of Texas Institute for Geophysics Contribution No. 617.

REFERENCES

Davis, E. E., 1982. Evidence for extensive basalt flows on the seafloor. *Geol. Soc. Am. Bull.*, 93:1023–1029.

French, W. S., and Henson, C. G., 1978. Signature measurements on the water-gun marine seismic source. *Proc. Ann. Offshore Technol. Conf.*, 1:631–638.

Hey, R. N., Duennebier, F. K., and Morgan, W. J., 1980. Propagating rifts on mid-ocean ridges. *J. Geophys. Res.*, 85:3649–3558.

Lonsdale, P., 1983. Overlapping rift zones at the 5.5°S offset of the East Pacific Rise. *J. Geophys. Res.*, 88:9393–9406.

Luyendyk, B. P., 1970. Origin and history of abyssal hills in the northeast Pacific Ocean. *Geol. Soc. Am. Bull.*, 81:2237–2260.

Mayer, L., 1981. Erosional troughs in deep-sea carbonates and their relationship to basement structure. *Mar. Geol.*, 39:59–80.

Mudie, J. D., Grow, J. A., and Bessey, J. S., 1972. A near-bottom survey of lineated abyssal hills in the equatorial Pacific. *Mar. Geophys. Res.*, 1:397–411.

Renard, V., and Allenou, J.-P., 1979. Sea Beam multi-beam echo-sounding in "Jean Charcot" description, evaluation and first results. *Int. Hydrogr. Rev. Monaco*, 56:35–67.

Date of Initial Receipt: 3 November 1983
Date of Acceptance: 2 June 1984