24. UNDERWAY GEOPHYSICS DURING LEG 95[1]

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INTRODUCTION

An underway geophysical watch was maintained throughout Leg 95. The marine technicians kept records of satellite positions, total field magnetics, bathymetry, shallow-penetration echo-sounding profiles, and single-channel seismic profiles. The seismic profiles were recorded in analog form on shipboard recorders as well as on digital tape; selected profiles were processed ashore. Bathymetric, magnetic, and seismic data as well as the ship tracks are shown in this report. The emphasis is on a clear explanation and presentation of the data; detailed interpretation of their significance can be found elsewhere in this volume.

NAVIGATION

Satellite positions were recorded throughout Leg 95; although the ship's officers incorporated Long-Range Navigation (LORAN-C) fixes in their bridge plots, these were not passed along to the log kept in the underway geophysics lab. Consequently, only satellite positioning and dead-reckoning changes in course and speed were used to reconstruct the ship tracks shown in Figures 1 and 2. The detailed presite and postsite surveys on the New Jersey slope in Figure 3 were prepared with additional information, as will be described.

The *Glomar Challenger* left St. John's, Newfoundland at 0407 hrs. on 21 August 1983; all times cited herein are Greenwich Mean Time (GMT). The first satellite fix came in at 0830, and distances along track (Fig. 4) are measured relative to this position. Poor weather during the first two days hampered progress toward the first drill site, and speed was reduced to 7 knots during spells of rain, fog, and high seas. The weather improved by 23 August as the vessel left the Grand Banks and approached Georges Bank, and speed was sustained from then on at 10 knots or better.

The vessel approached the New Jersey margin from the northeast during the early hours of 26 August. Our intention was to turn northwest at the base of the slope, cross Sites 604 and 605, drilled on Leg 93 (van Hinte, Wise, et al., in press), and proceed upslope to tie into NJ-2, the top-priority site of Leg 95. This site was to be located on the upper slope at the junction of United States Geological Survey (USGS) multichannel seismic lines 25 and 34. Several commercial seismic survey vessels were operating in the area as the *Glomar Challenger* turned upslope and slowed to 7 knots at 0109 on 26 August, and this necessitated numerous small changes in course and speed during the tie-in. Few of these changes could be accurately accounted for in dead reckoning between the spotty satellite fixes. Consequently, the LORAN fixes recorded manually on the bridge plots were used in part to construct the track shown in Figure 3. Furthermore, a very detailed, LORAN-navigated seismic and bathymetric survey conducted previously by the USGS (Robb et al., 1981) provided a very reliable grid. Crossings within this grid have been rigorously compared, and relative accuracies of overlapping USGS tracks have been found to be good to within 300 m. Consequently, *Glomar Challenger* positions, aided by the bridge plots, were adjusted manually to agree at crossings with this USGS grid. None of these adjustments required ignoring a *Glomar Challenger* LORAN fix, and none moved a fix more than about 200 m. It was therefore determined that the ship passed directly over Holes 604 and 604A at 0138 and 0144, respectively, but fell off the intended line and passed about 400 m southwest of Site 605 at 0207 (Fig. 3). The beacon was dropped at 0332, 1.6 km north of the intended site (the junction of lines 25 and 34). After retrieving the streamed gear and reversing course, the ship offset from the beacon and spudded in for Site 612, 1.0 km north of NJ-2.

A postsite survey was conducted on 31 August to tie in to existing wells and seismic lines, and to survey for another site to drill after completing work at Site 603 on the lower continental rise. Gear was streamed while departing Site 612, the vessel headed southwest at about 8 knots, and at 1022 passed 200 m upslope of Atlantic Slope Project (ASP) Site 15 (Poag, 1978, 1985). The course was reversed at 1032 and the vessel headed northeast, passing directly over Site 612 at 1106. Turning nearly due north, the ship passed 400 m due east of Continental Offshore Stratigraphic Test (COST) Well B-3 (Scholle, 1980) at 1146. Shortly thereafter, it turned upslope in an attempt to duplicate and eventually correlate with USGS/BGR (Bundesanstalt für Geowissenschaften und Rohstoffe) line 218 (Poag and Mountain, this volume). The ship continued northwest to the shelfbreak, and then turned southwest, following the shelf edge for approximately 8 km. At 1257 the vessel once again turned southeast, and proceeded downslope in a line that at 1447 passed 200 m southwest of DSDP Site 108 (Hollister, Ewing, et al., 1972). Drilling on the uppermost rise had ended in Miocene sands in DSDP Holes 604 and 604A (van Hinte, Wise, et al., in press), and we hoped another potential site could be located away from these sands. Shot point 1450 on USGS line

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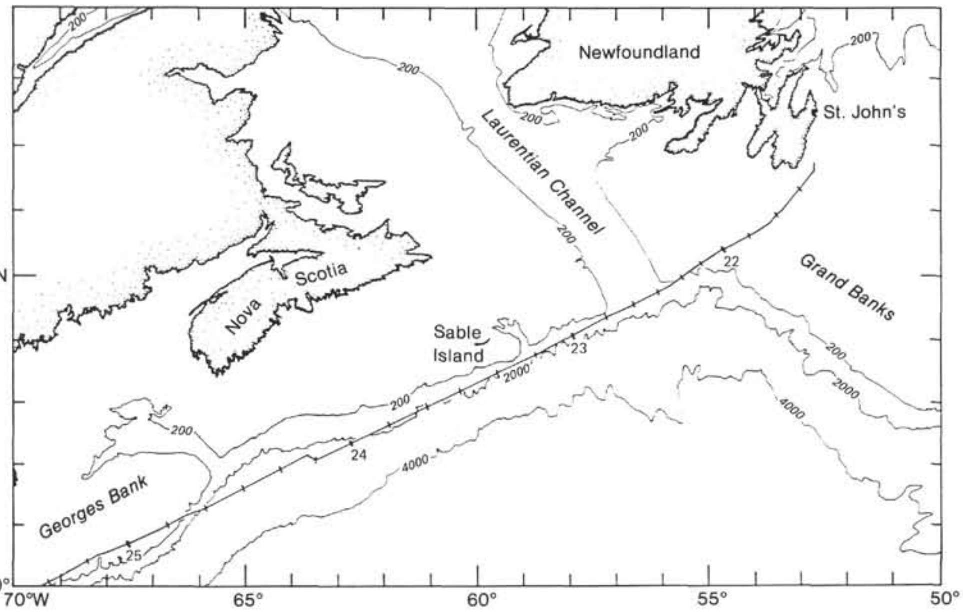

Figure 1. Northern portion of Leg 95 track chart. All navigation calculated by satellite positions and dead reckoning. Day of month and tick marks every 4 hr. (GMT) are shown along the track. Isobaths in meters.

35 looked like a strong candidate, was designated Site NJ-12 aboard ship, and was crossed at 1544 hrs. At 1552 the vessel turned south-southeast, increased speed to a little over 10 knots, and headed directly for Site 603.

We approached Site 603 from the northwest on 1 September. Using satellite positioning alone, the ship ran along L-DGO line 77, on which the original Site ENA-3 had been located. The beacon was dropped at 1507, roughly 10.0 km east of Hole 603C, where the drill string had parted during Leg 93 (van Hinte, Wise, et al., in press). The ship continued on this course for about 3 to 4 km while the streamed gear was retrieved. The ship was brought around to a reciprocal course, but satellite positioning suggested that the beacon had drifted 700 m to the southwest during its descent. Assuming that the beacon sank at 1 m/s, and that a mean current of 15 cm/s (Western Boundary Undercurrent?) carried it southwest throughout its descent, this is a reasonable amount of drift. The ship was offset to the northeast to account for this beacon drift, and Hole 603D was spudded in at the presumed beacon drop point. Subsequent satellite positions acquired during drilling at Hole 603D placed the hole slightly off line 77, roughly 500 m northeast of shot point 855 (1736 hrs. on 23 September 1977).

The vessel left Hole 603F at 0305 on 16 September. Gear was streamed by 0415, and the ship maintained speeds of 8 to 10 knots on the northwest leg back to the New Jersey margin. Although the pass across potential Site NJ-12 on 31 August had provided encouraging signs that the Miocene sands could be avoided along the uppermost rise, three more slope-parallel lines were laid out to assure a successful drilling effort. These strike lines were run at roughly 7 knots, and each crossed dip lines USGS 25 and USGS/BGR 218 and earlier lines from Leg 95. In a manner similar to that used on the previous tie-in surveys on the margin, shipboard satellite navigation has been adjusted to agree with both the LORAN bridge plots and the preexisting seismic grid (Fig. 3). Shipboard examination of Leg 95 seismic profiles suggested that an ideal target lay just downslope of the point crossed at 0700 on 17 September. On the third slope-parallel strike line (heading northeast), the beacon was dropped at 0845, immediately downslope of this position. The ship continued northeast until 0902, when the gear was retrieved and the course reversed. The eventual spud-in point for Site 613 was between the second and third strike lines, 100 m downslope from 0702 hrs. and 400 m upslope from 0845 hrs.

The ship left Site 613 at 0852 on 21 September. Gear was streamed, and an average speed of roughly 10 knots was maintained on the transit southwest along the continental rise to the Blake Plateau. Once in the Straits of Florida, we retrieved the gear for the last time at 1930 on 25 September.

BATHYMETRY

Underway 3.5-kHz echo-sounding records and 12-kHz precision depth recorder (PDR) measurements were maintained throughout Leg 95. Bathymetry measured using the PDR is shown against distance along track in Figure 4.

The Grand Banks were crossed during the first day out of St. John's, and the shelfbreak was passed at 0930 on 22 August. Numerous canyons of the Laurentian Fan system and the continental slope off Sable Island were crossed until 1800 of 23 August. From there southwest to the Grand Banks, the vessel was over the upper rise seaward of the 2000-m isobath, and seafloor topography was greatly subdued. Shortly before crossing Cor-

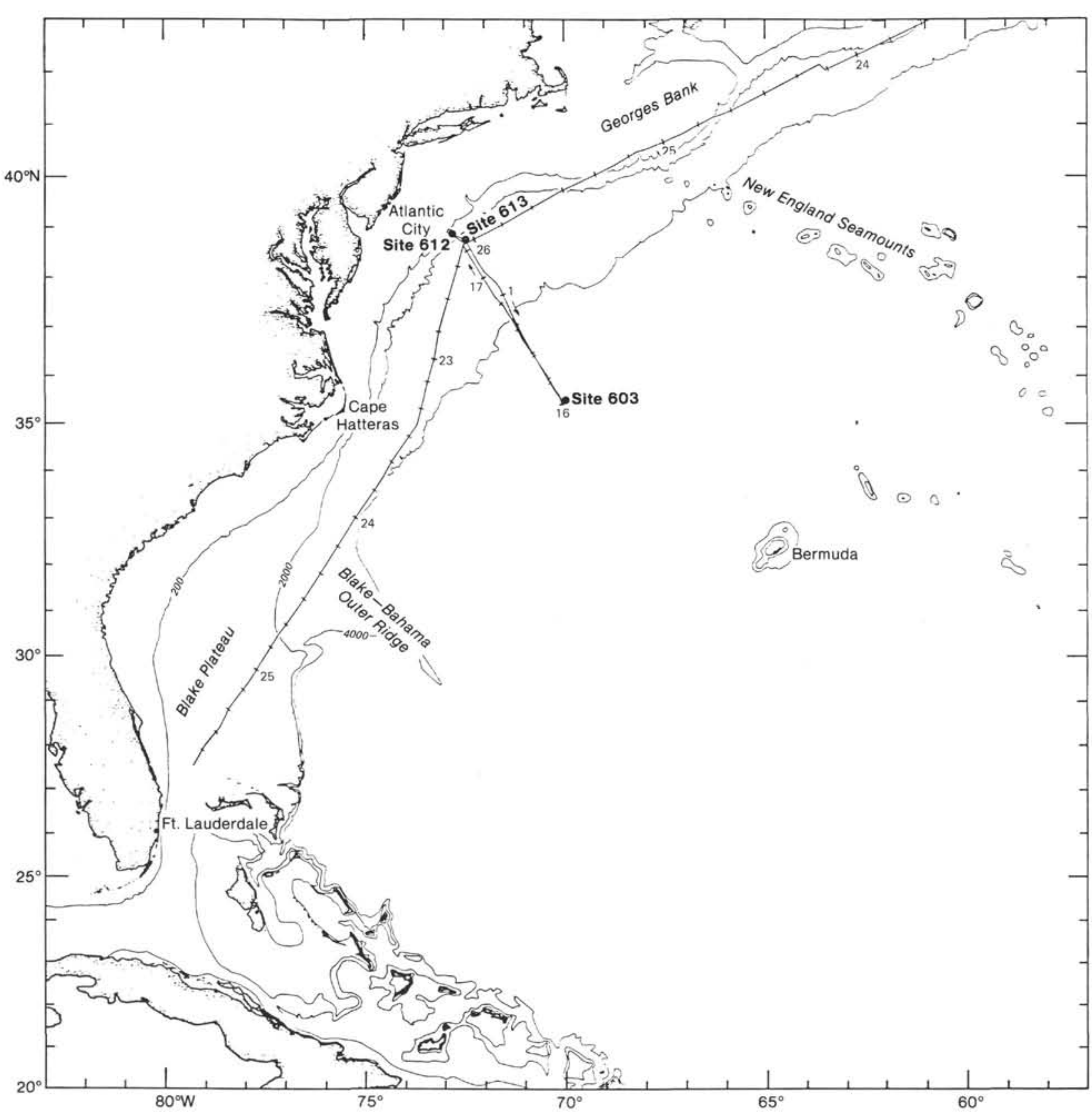

Figure 2. Southern continuation of Leg 95 track chart. Day of month, time, and isobaths marked as in Figure 1.

sair Canyon at 1600 on 24 August, the vessel again encountered the continental slope, and reached the shelfbreak due east of Nantucket at 1745.

We traversed Georges Bank in about 15 hours, and at 0900 on 25 August once again crossed the shelfbreak, then the vessel headed out over the slope south-southeast of Nantucket. Topography on the upper rise off New York was generally subdued, interrupted only by the Hudson Canyon. At the 2500-m isobath, this canyon is barely incised into the rise, and its southwestern bank stands more than 200 m higher than its northeastern bank. This is probably due to the Coriolis force (Menard, 1955) and to the southwesterly flow of the Western Boundary Undercurrent (Heezen et al., 1966), both of which enhance sediment accumulation on the southwestern bank.

During the survey approaching Site 612 off New Jersey, the lower portion of Carteret Canyon was crossed on the middle slope at 0305 on 26 August. Site 612 was located 4.5 km southwest of the axis of this canyon. During the postsite survey the vessel crossed several nameless canyons and smaller "tributary gullies" (Robb et al., 1981; Farre et al., 1983), all of which originate on the middle slope. Carteret Canyon, by contrast, indents the shelf edge where it was crossed at 1255 on 31 August.

The upper rise terrace comprising the buried Chesapeake Drift (Mountain and Tucholke, 1985) was crossed

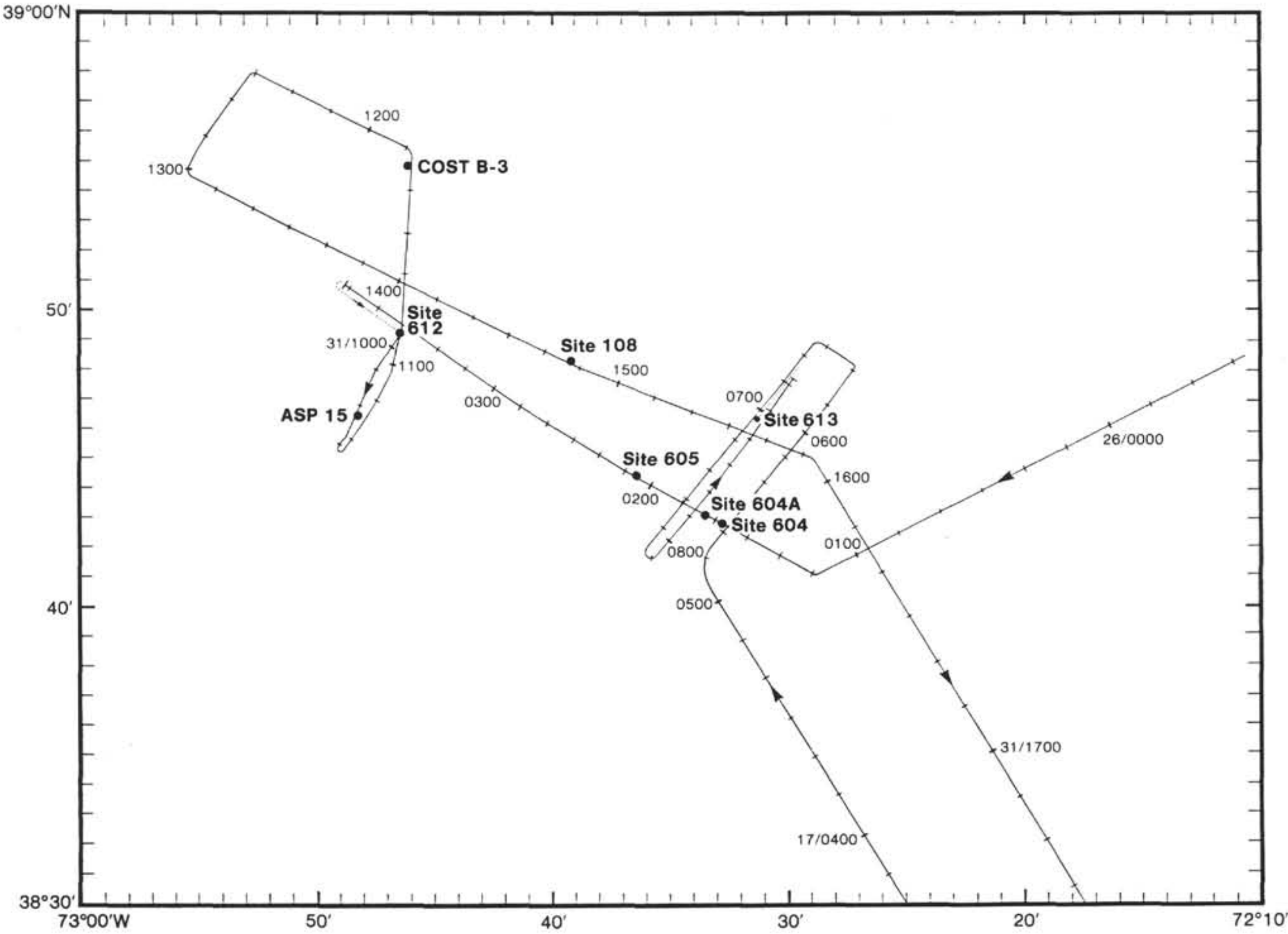

Figure 3. Detailed Leg 95 track chart on the New Jersey margin. Satellite, LORAN-C, and dead-reckoning positioning adjusted as described in the text. Day of the month, hour of the day (GMT), and tick marks every 10 min. are shown along the track.

en route to Site 603 between 1800 on 31 August and 0245 on 1 September. At this point the vessel crossed over the lower Hudson Fan sediments banked up behind the Hatteras Outer Ridge (Tucholke and Laine, 1983). The crest of the Hatteras Outer Ridge represents the seaward limit of these fan deposits, and was crossed at 1452 on 1 September. Hole 603D was located in the first swale of the sediment waves that are exposed seaward of this crest.

A nearly reciprocal northwesterly course was followed during the return to the New Jersey margin. At 0507 on 17 September, the vessel turned northeast to begin the first of the three strike lines of the pre-Site 613 survey along the uppermost rise. Several broad, gentle depressions were crossed seaward of the extensions of lower slope canyons.

After completion of work at Site 613, the vessel made directly for Ft. Lauderdale. The track traversed the continental rise as far south as due east of Cape Romain, reaching a maximum depth of approximately 4300 m. Numerous small canyons that cut into the rise off Cape Hatteras were crossed during the day of 23 September. The northeastern flank of the Blake–Bahama Outer Ridge was encountered shortly after 2300 on 23 September, and the crest of this drift deposit was crossed at 0545 on 24 September. The Outer Ridge is banked up against the foot of the Blake Escarpment in this region, and this latter feature was crossed between 1645 and 1900 of the same day. The Blake Plateau, a carbonate platform at a moderately uniform depth of 850 to 900 m, was crossed until 1600 on 25 September. The vessel then entered the Straits of Florida, and the underway watch was secured at 1930 in preparation for arrival in Ft. Lauderdale.

MAGNETICS

Except for the shallow-water regions of the Grand Banks and Georges Bank, underway measurements of the total magnetic field were recorded throughout the underway geophysical watches of Leg 95. The regional field was subtracted, and residual values are shown against distance along track in Figure 4. For the transit between the Grand Banks and Georges Bank, the vessel remained entirely landward of the East Coast Magnetic Anomaly (ECMA). This is a broad magnetic feature (Klitgord and Behrendt, 1979), and it was approached closely enough to result in the 250-gamma anomalies at 0645 and 1200 on 23 August, as well as the broader and larger anomalies observed throughout 24 August.

The ECMA was completely crossed at 1300 on 25 August, reaching a maximum value of roughly 750 gam-

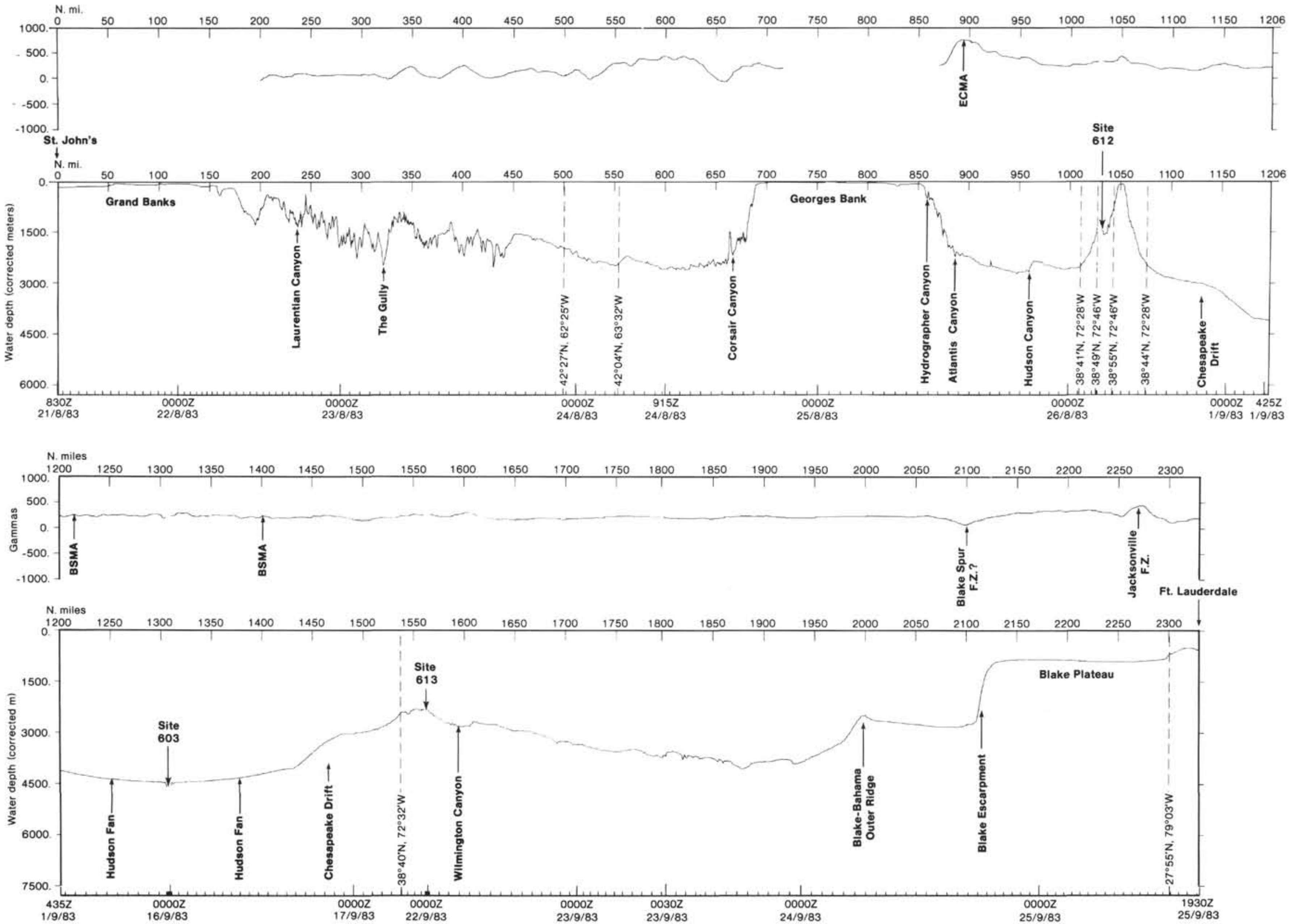

Figure 4. Summary plot of underway magnetic anomalies and 12-kHz PDR measurements of water depth (Matthews, 1939). Both sets of underway data are plotted against distance along track. Date and time of day (GMT) are annoted along the bottom.

mas. The asymmetry of this feature (steeper on the landward side) is typically observed along the North American margin (Klitgord and Behrendt, 1979). Because of this and other arguments, many have hypothesized that the ECMA is an "edge effect" marking the seaward limit of continental crust.

From the continental slope south-southeast of Nantucket to the end of the underway watch in the Straits of Florida, the vessel remained seaward of the ECMA, supposedly above oceanic or at least "transitional" crust (Talwani and Alsop, 1984). With few exceptions, the calculated magnetic field (observed minus regional) throughout this latter two-thirds of the cruise remained at roughly 200 gammas; few deviations were greater than a few tens of gammas. This is not surprising, since all measurements were made within the "Jurassic Quiet Zone" (Larson and Pitman, 1972); even the most seaward part of Leg 95 at Hole 603D was roughly 70 km landward of Anomaly M-25. The Blake Spur Magnetic Anomaly (BSMA) was crossed twice: en route to Hole 603D at about 0530 on 1 September, and on the return leg to Site 613 at 1430 on 16 September. Both crossings revealed a very minor anomaly of a few tens of gammas. The calculated field landward of the BSMA as far south as the Blake Escarpment, not surprisingly, was found to be especially quiet (Rabinowitz, 1974).

Two large (200-gamma) anomalies were calculated near the end of Leg 95. One is a broad, symmetric low centered at 1530 on 24 September; the other is a more complicated positive feature that peaks at 1215 on 25 September. The nature of the underlying crust in this region is uncertain, and the possibility of mafic intrusions generating very localized anomalies cannot be discounted. Nonetheless, both of these anomalies coincide with features mapped by Klitgord et al. (1985): the northern one is the Blake Spur Fracture Zone and the southern one is the Jacksonville Fracture Zone. If these anomalies indeed mark the crossing of two fracture zones, then two things must be true. First, the underlying crust must be oceanic; and second, the significantly different character of the two anomalies must be explained by abrupt changes in depth to basement and/or by Jurassic polarity changes and different age contrasts across the two fracture zones.

SEISMICS

As with streaming the magnetometer, underway seismics were collected throughout Leg 95, except during the shelf crossings en route to the first drill site. Data were acquired with a single 120-in.^{3} air gun from the slope off the Grand Banks to Georges Bank. When the gear was redeployed after passing Georges Bank, a single 80-in.^{3} water gun was used for the remainder of the cruise. The shot interval was a constant 10 s. All data were collected with a 100-m single-channel streamer. Most profiles were acquired at 10 knots or more, though for the presite and postsite surveys on the New Jersey margin (Fig. 3) speed was lowered to 7 or 8 knots to reduce towing noise. Real-time data were filtered and displayed on two analog shipboard recorders at 2.5- and 5.0-s sweeps. In addition, all seismic data were digitized at 1 ms and recorded on the shipboard HP-1000A computer. Copies of these tapes were reformatted at Lamont-Doherty and displayed using the Data General Nova 840 computer that constitutes the single-channel and multichannel processing facility at Lamont-Doherty. Spectral analysis of noise recorded on the streamer after the recording delay but before the seafloor return (effectively the towing noise) revealed a peak at about 15 Hz and a rapid decrease above 45 Hz. A water gun generates signals in the range of 30 to 250 Hz, so as a compromise all traces were filtered from 60 to 240 Hz. In addition, time-varying gain was applied to each trace in order to enhance weak, sub-bottom returns. Only the profiles of greatest interest to Leg 95 were digitally processed, and these are displayed in Figure 5. All processed profiles are 2.0-s displays with a constant horizontal spacing between shots. The remainder of the profiles in Figure 5 are photographs of the shipboard 2.5-s analog records. In the following discussion, references to specific features in Figure 5 are located by two-way traveltime and time of day.

Because of ship's speed, sea state, and the scattering effects of very rugged seafloor, air-gun records across the Laurentian Fan system are not very revealing. Data quality improved significantly as the vessel approached Georges Bank late in the day of 23 August. One-half second of acoustically laminated sediments can be seen in this region. Channels on the seafloor and in the upper 0.25 s cut into these strata. A major canyon between 1600 and 1730 on 23 August shows multiple episodes of cut and fill. The decreased penetration into the irregular but subdued topography of the uppermost rise on 24 August, as well as the discontinuous and erratically reflective sub-bottom reflectors, contrasts with the finely laminated intercanyon strata observed previously.

Digitally processed water-gun records shown in Figure 5 begin after the vessel crossed the shelfbreak south-southeast of Nantucket. Acoustic penetration of a water gun is highly dependent on the air pressure maintained by the compressor. Values near the beginning of Leg 95 were between 1500 and 1700 psi; later these were increased to nearly 2000 psi. These pressure changes account in part for the slight variations in penetration observed during water-gun recording.

Several weakly reflective mounds appear above 3.5 s on the rise south of Long Island, near 1400 on 25 August. The reflector immediately beneath these features can be traced to the Site 613 region, and indicates that they are Pliocene. Their moundlike shape and the continuity of underlying reflectors demonstrate that they are not "wash-out zones" that can result from acoustic masking by shallower reflectors. The correlative unit off New Jersey is marked by slumped and homogenized sediment, and suggests that these features south of Long Island are mud diapirs originally deposited in the Pliocene as highly liquified slumps.

This same basal reflector can be traced to beneath the Hudson Canyon at 1945 of the same day. The exaggerated southwestern bank of this canyon continues along track for another 45 km. All the irregular and mutually truncating reflectors within this bank lie above the key

Pliocene reflector, proving that this major canyon formed in the latest Neogene. Although an ancestral Hudson River existed long before this time, it apparently did not lead to a submarine canyon across the upper continental rise until the onset of North American glaciation. The weakly reflective core of the southwestern bank at 3.6 s and 2030 hrs. may be another liquified slump deposit like the several described previously.

A 5-km-wide, 100-m-deep cut into the Pliocene marker was crossed at 2330 on 25 August. This same characteristic can be seen on strike lines along the base of the slope off New Jersey (e.g., 0710 on 16 September), and in all instances is interpreted as bedding-plane slump scars (Farre, 1985).

The deepest reflector visible along the rise en route to the New Jersey slope is early Paleogene in age; Reflector A^u (Tucholke and Mountain, 1979) is the relatively strong and level event at 4.4 s at 2300 on 25 August.

Discussions and line-drawing interpretations of the digitally processed water-gun profiles on the New Jersey margin can be found elsewhere in this volume, and will not be duplicated here. Further, the tracks followed to and from Site 603 on the lower continental rise were so similar that only the outgoing, downslope profiles are shown in Figure 5.

The broad, gently seaward-dipping terrace of the upper rise off New Jersey is the buried top of the largely Miocene Chesapeake Drift (Mountain and Tucholke, 1985). The moderately high organic-carbon accumulation rates in these sediments and their localized landward dip resulted in a well-defined clathrate boundary that has formed a bottom-simulating reflector at about 0.6 s sub-bottom (Tucholke et al., 1977). Truncation of reflectors in the upper few tenths of the steep, seaward flank of the Chesapeake Drift (e.g., 0100 on 1 September) has been interpreted as resulting from middle to late Pliocene bottom-current erosion (Mountain and Tucholke, 1985). This erosion cuts progressively deeper into the section as it is traced seaward, and overlying strata thin considerably until a Pliocene outcrop appears near the 3500-m isobath. The Hudson Canyon has cut through the upper portion of the Chesapeake Drift, and has fed shallow-water sands and silts to the lower rise terrace. This latter feature constitutes the Hudson Fan. The highly reflective sediments of this fan onlap the underlying Pliocene surface, suggesting that the Hudson Canyon (noted earlier as developing on the upper rise during the Pliocene) cut at least as far seaward as the lower rise over a relatively short period of time. Nearly 0.5 s of highly reflective sediments make up this fan, crossed between 0300 and 1400 on 1 September. Sediment waves of the Miocene to Pliocene Hatteras Outer Ridge–Chesapeake Drift system can be seen at about 6.5 s beneath much of this fan. Fan strata onlap the contourite deposits at the crest of the Outer Ridge, suggesting that the waves constituting the seaward flank of the Hatteras Outer Ridge predate the Hudson Fan. In limited places the fan turbidites have breached the crest of the Ridge and flowed out onto the Hatteras Abyssal Plain (Shor, Flood, and Mountain, unpublished data).

Interpretation of the three seismic strike lines constituting the pre-Site 613 survey appears elsewhere in this volume and will not be duplicated here. The object of this survey was to locate a drill site near the feather-edge pinchout of the Miocene sands that had thwarted recovery attempts during Leg 93 (van Hinte, Wise, et al., in press). These deposits correlate with the strong reflectors that thicken and thin above a buried channel surface near 3.5 s, and which were crossed between 0700 and 0900 on 17 September.

After leaving Site 613, the vessel sailed southwest across the upper rise, crossing the Wilmington Canyon at an oblique angle near 1230 on 22 September. This canyon, like the Hudson Canyon, has an asymmetrically thick southwestern bank made up of irregular lenses of acoustically laminated sediment. The Pliocene marker near Site 613, exhibiting possible bedding-plane slump scars, can be traced southwest of Wilmington Canyon. One such scar was crossed at 4.1 s at 1430 on 22 September. This correlation indicates that as much as 0.6 s (roughly 500 m) of Pliocene and younger sediment makes up the southwestern bank of Wilmington Canyon.

Several canyons incise the central rise off Cape Hatteras. None appear to cut into sediment any older than Pliocene, but their steeply dipping, V-shaped cross sections suggest that they are presently active. Many probably coalesce to feed the Hatteras Transverse Canyon (Rona and Clay, 1967) that winds around the southwestern limit of the Hatteras Outer Ridge on the lower continental rise.

Sediment waves and Miocene outcrops can be seen beneath the steep northeastern flank of the Blake–Bahama Outer Ridge, crossed between 0000 and 0600 on 24 September. The bottom-simulating base of the clathrate zone (Tucholke et al., 1977) is clearly visible at 0.6 s sub-bottom, extending from near the Ridge crest southwest to 1100 on 24 September. The nearly level, continuous, acoustically laminated sediments of this "back-slope" setting (Mountain and Tucholke, 1985) are in marked contrast to most of the other shallow reflectors seen throughout Leg 95. These strata have accumulated rapidly since the Pliocene by fallout from the sediment-laden Western Boundary Undercurrent (Heezen et al., 1966); no canyons or fan deposits affected the region during this time.

The erosional origin of the Blake Escarpment is indicated by the outcrop of reflectors between 1730 and 1900 on 24 September. DSDP Sites 390 and 392 (Benson, Sheridan, et al., 1978) were drilled on the Blake Nose 50 km southeast of this location, and showed that strata as old as Early Cretaceous crop out along this steep carbonate margin (see also Dillon et al., 1985). The irregular reflector at 1.4 s at 1900 is probably at or near the eroded top of the Cretaceous section. This surface can be traced along track to the central Blake Plateau, where at 0300 on September 25 it is overlain by downlapping strata that probably lie at the base of the Cenozoic section (Dillon et al., 1979). Channels seen near 1300 of the same day and buried at about 15 s sub-bottom attest to "paleo-Gulf Stream" erosion (Pinet and Popenoe, 1982). Seismic profiling on Leg 95 ended in the Straits of Florida at 1930 on 25 September.

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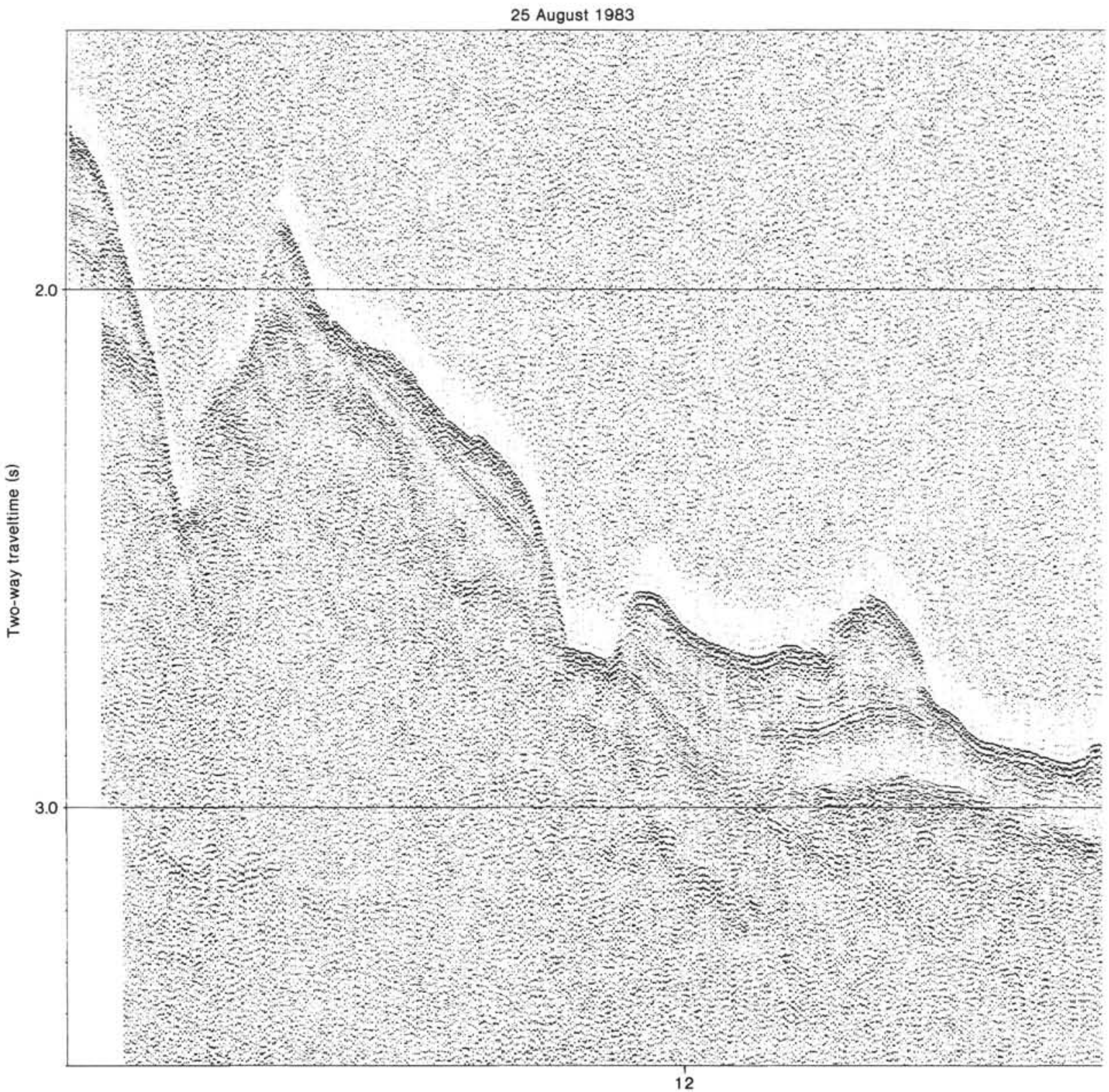
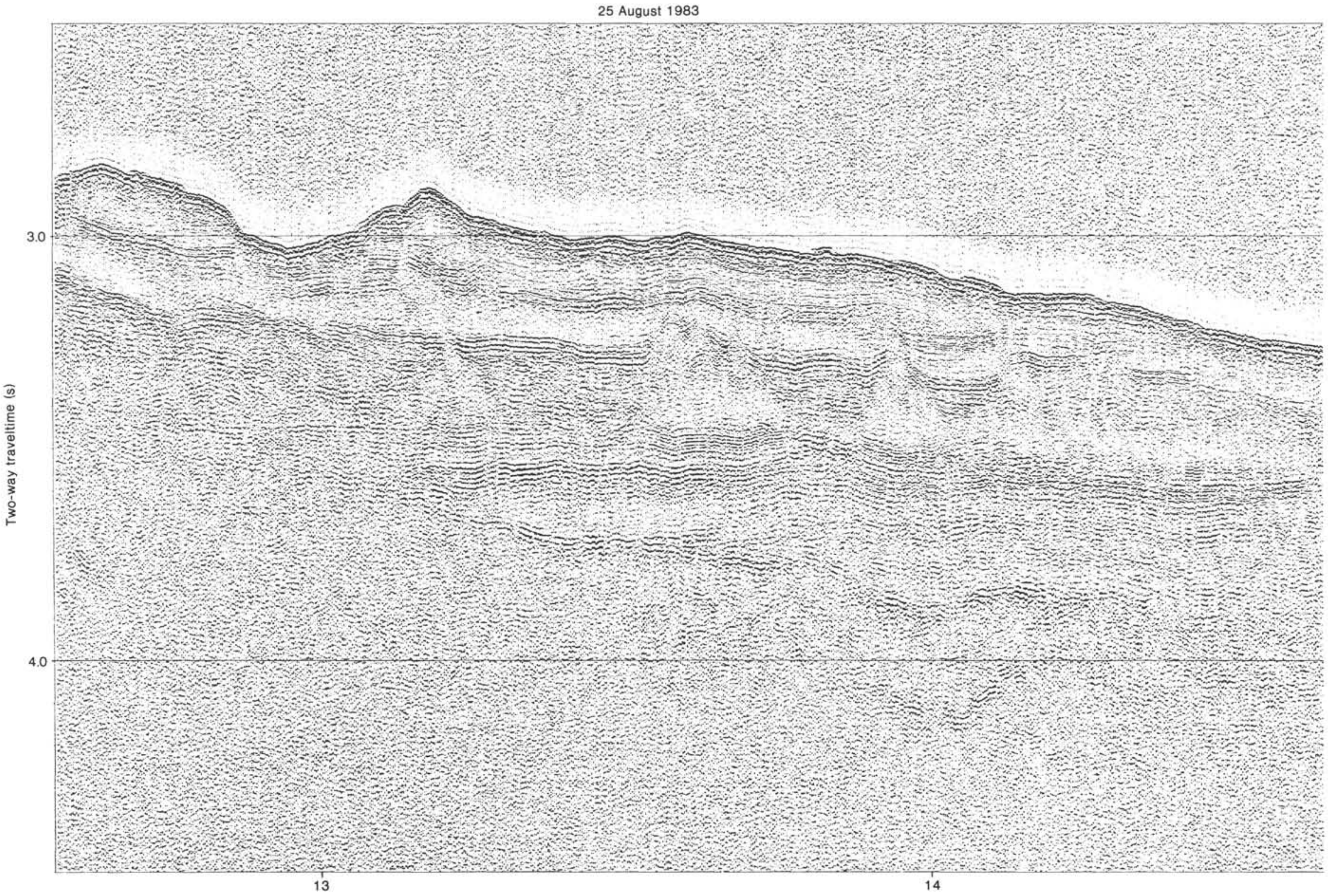


Figure 5. Seismic data collected during Leg 95. Photographs of 2.5-s analog shipboard records and digitally processed 2.0-s records are shown. See text for more complete description of display parameters.


25 August 1983
Two-way traveltime (s)
3.0
4.0
13
14

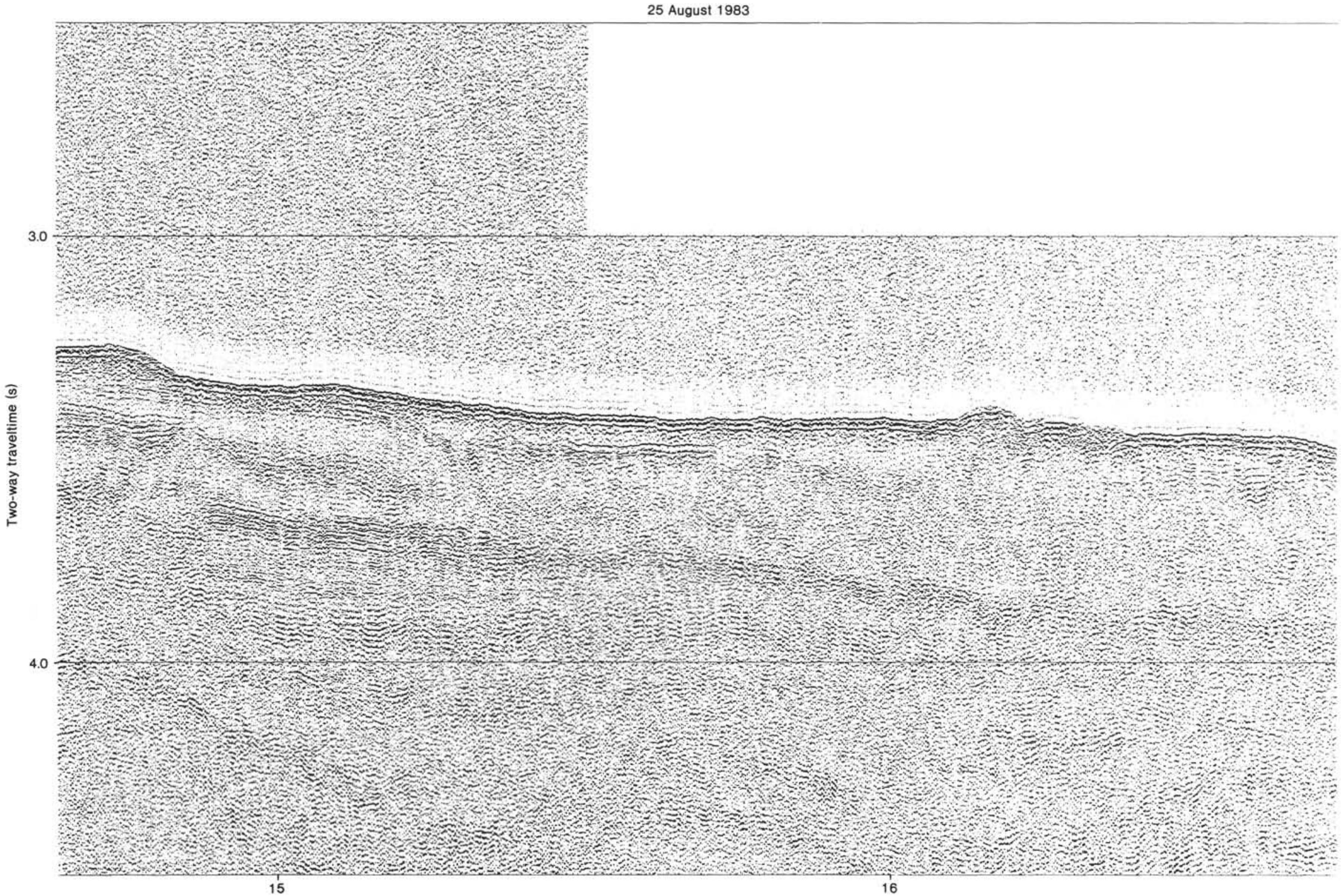


Figure 5 (continued).


25 August 1983
Two-way traveltime (s)
3.0
4.0
5.0
17:22
18
19

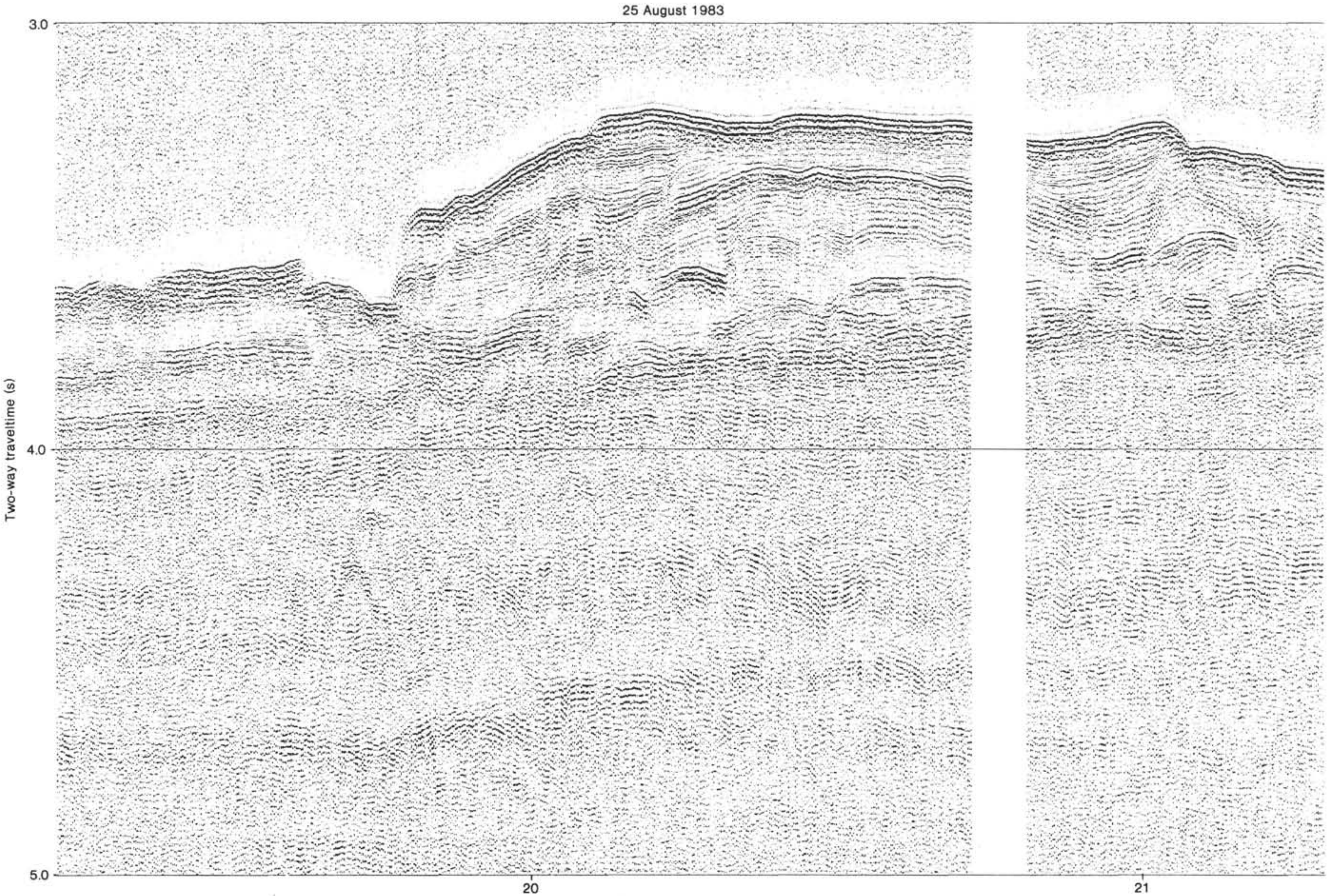
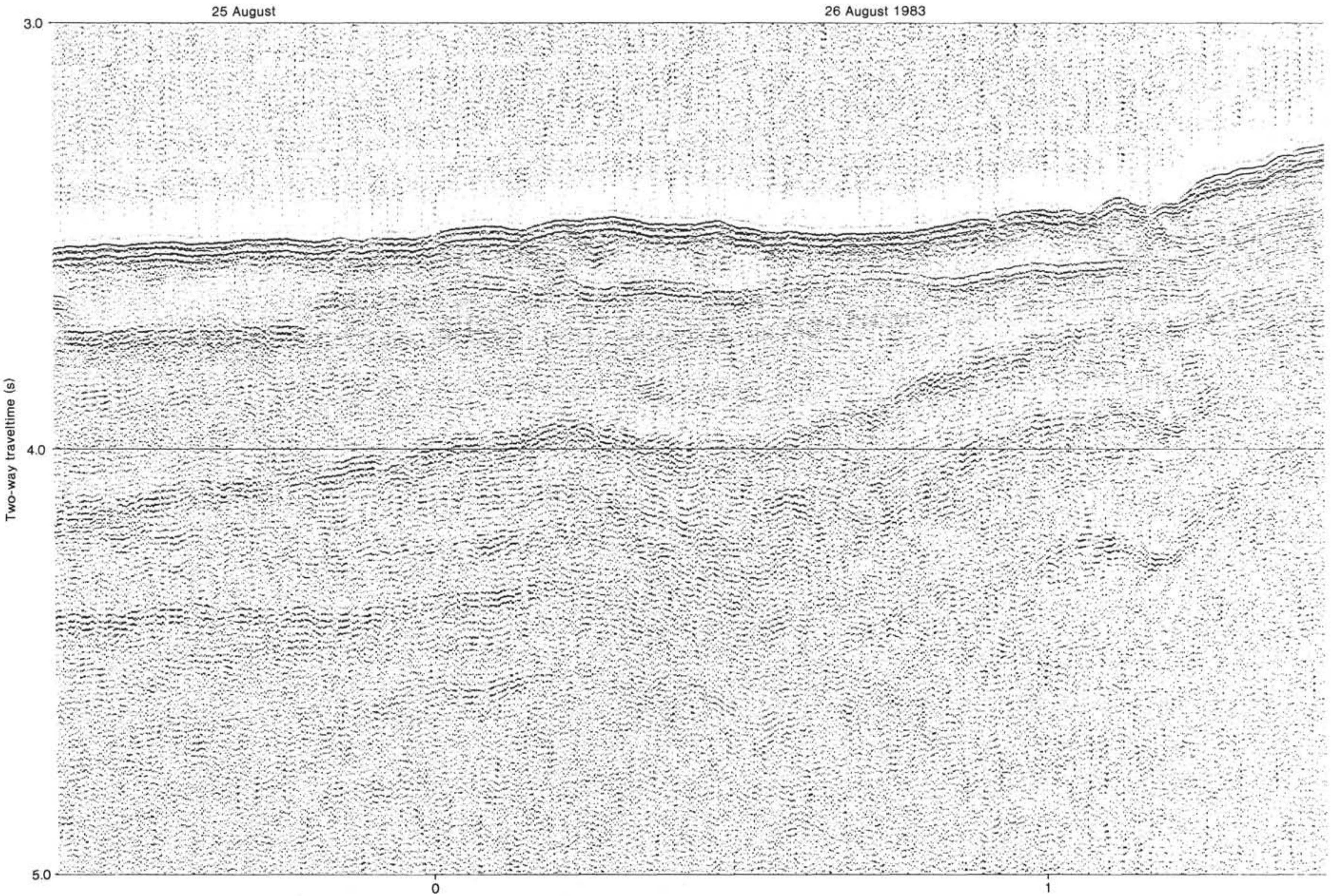


Figure 5 (continued).


25 August 1983
3.0
4.0
5.0
Two-way traveltime (s)
22
23



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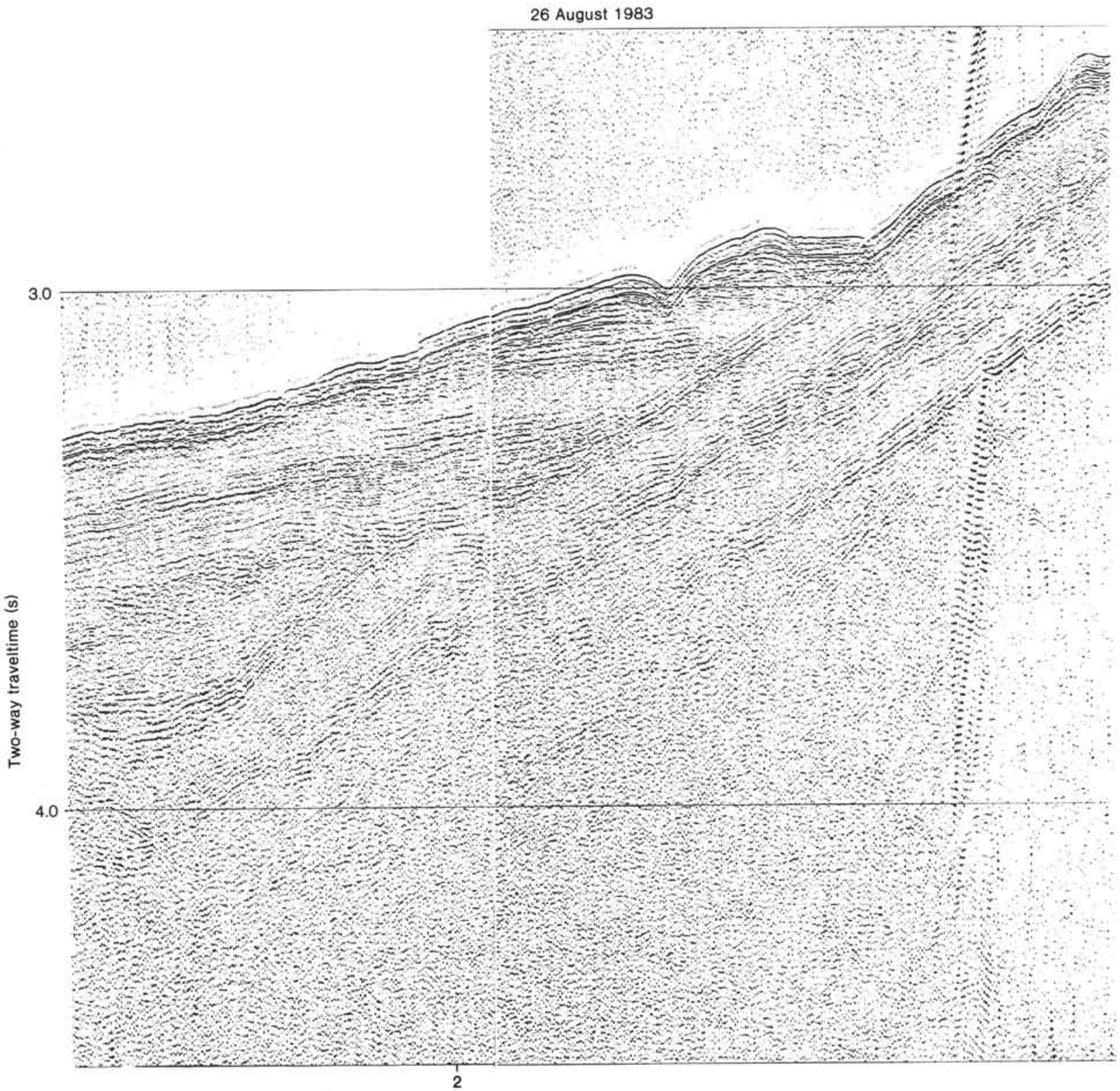
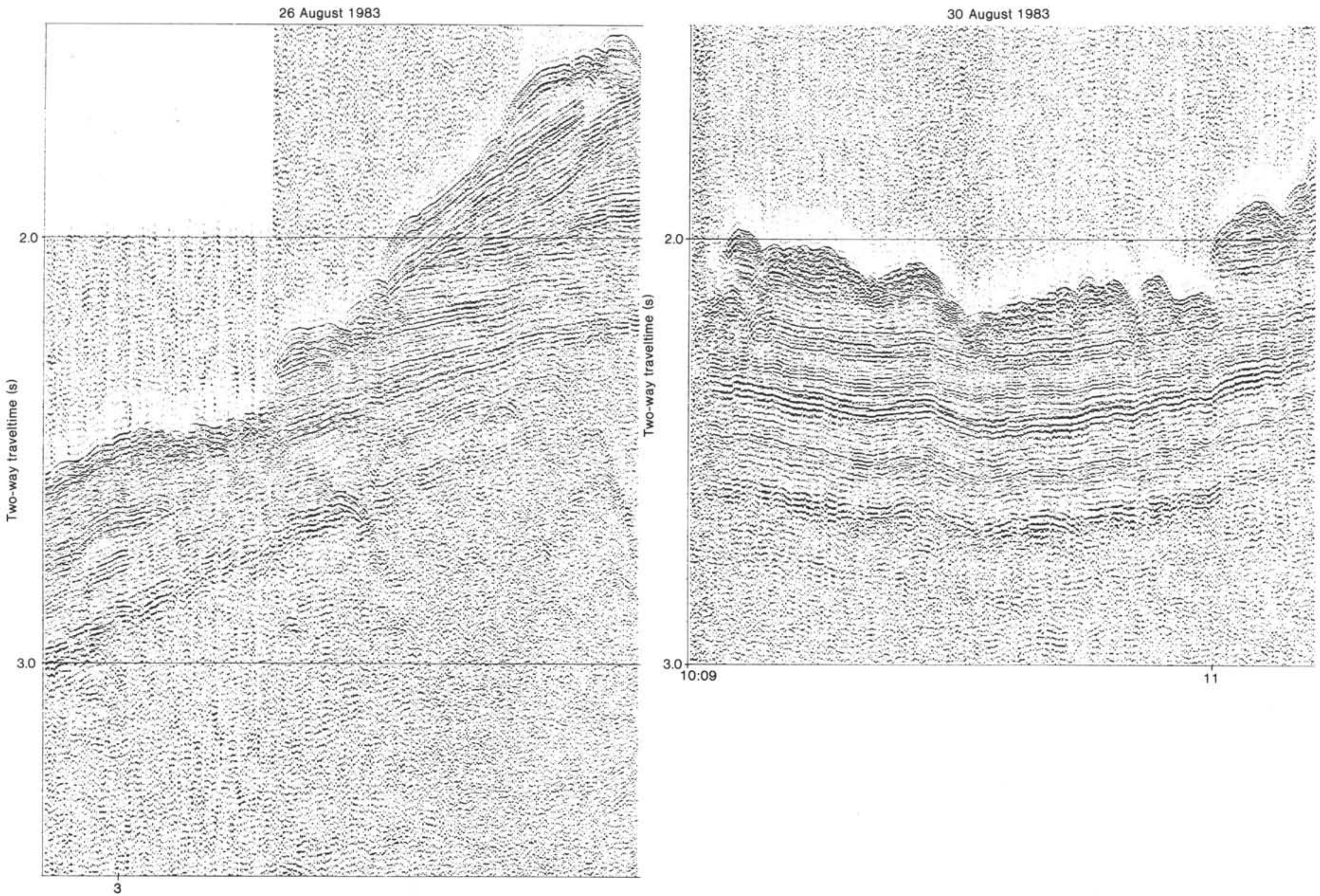

26 August 1983
3.0
4.0
Two-way traveltime (s)
2



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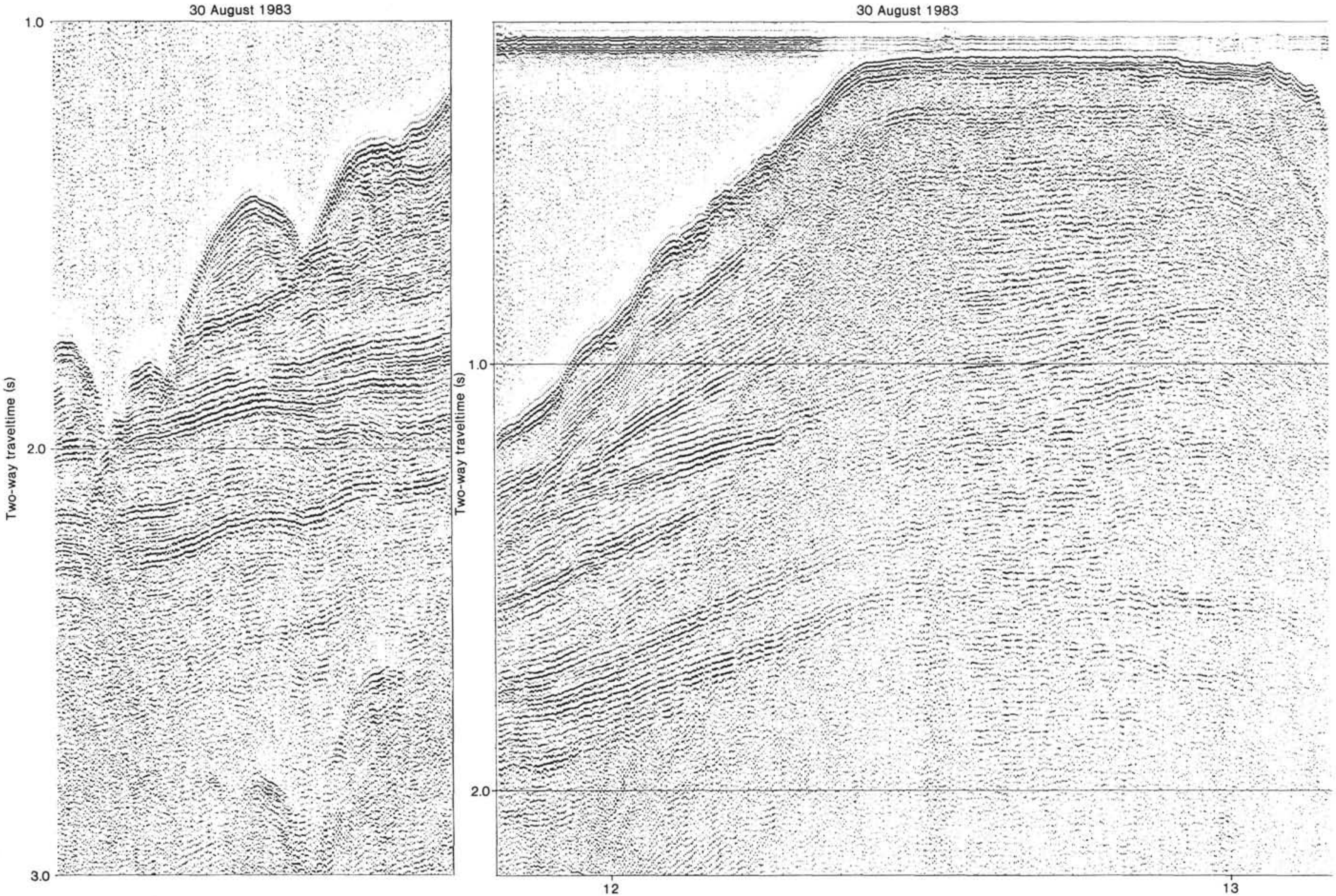
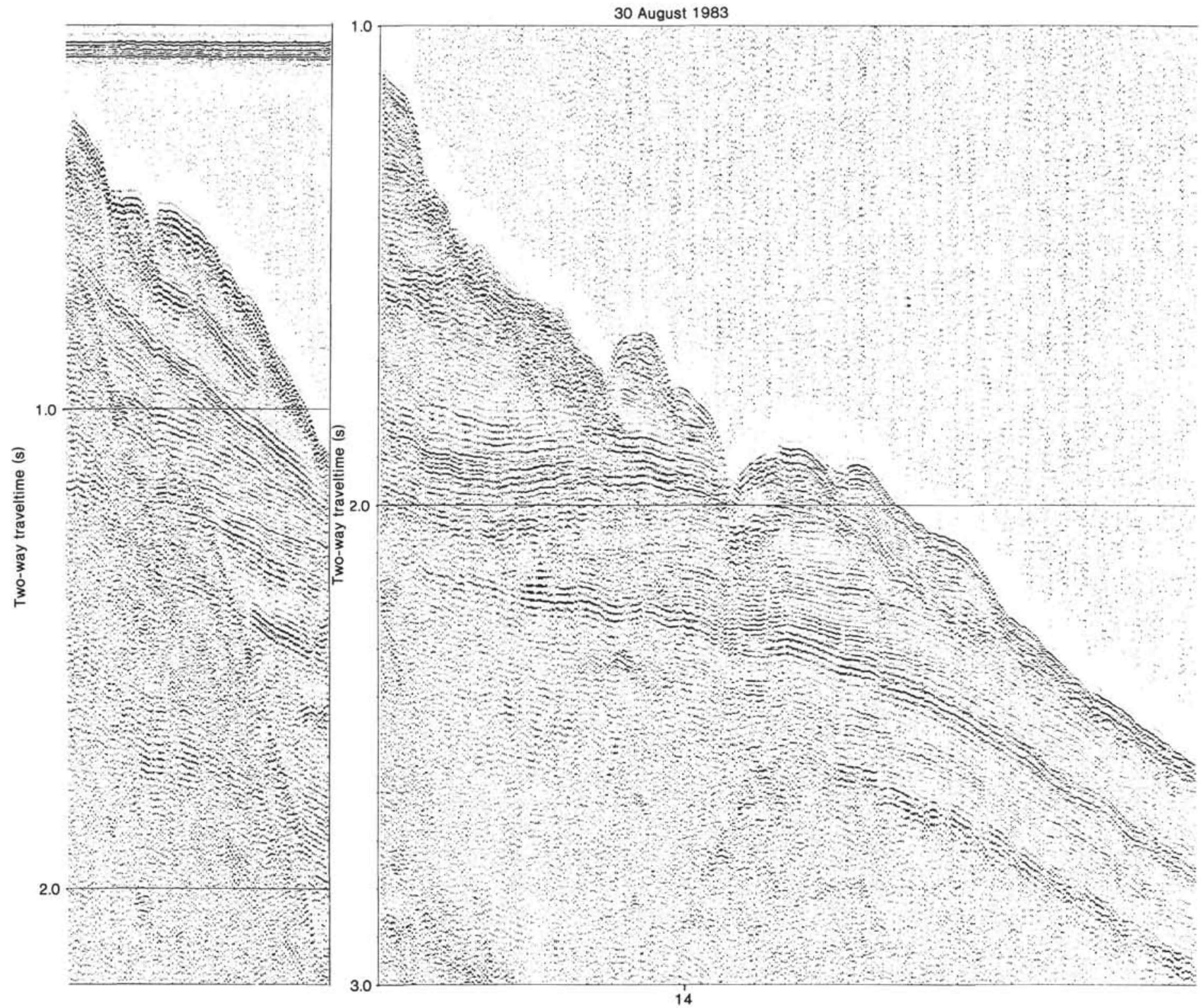

30 August 1983
1.0
2.0
3.0
Two-way traveltime (s)
30 August 1983
1.0
2.0
Two-way traveltime (s)
12
13



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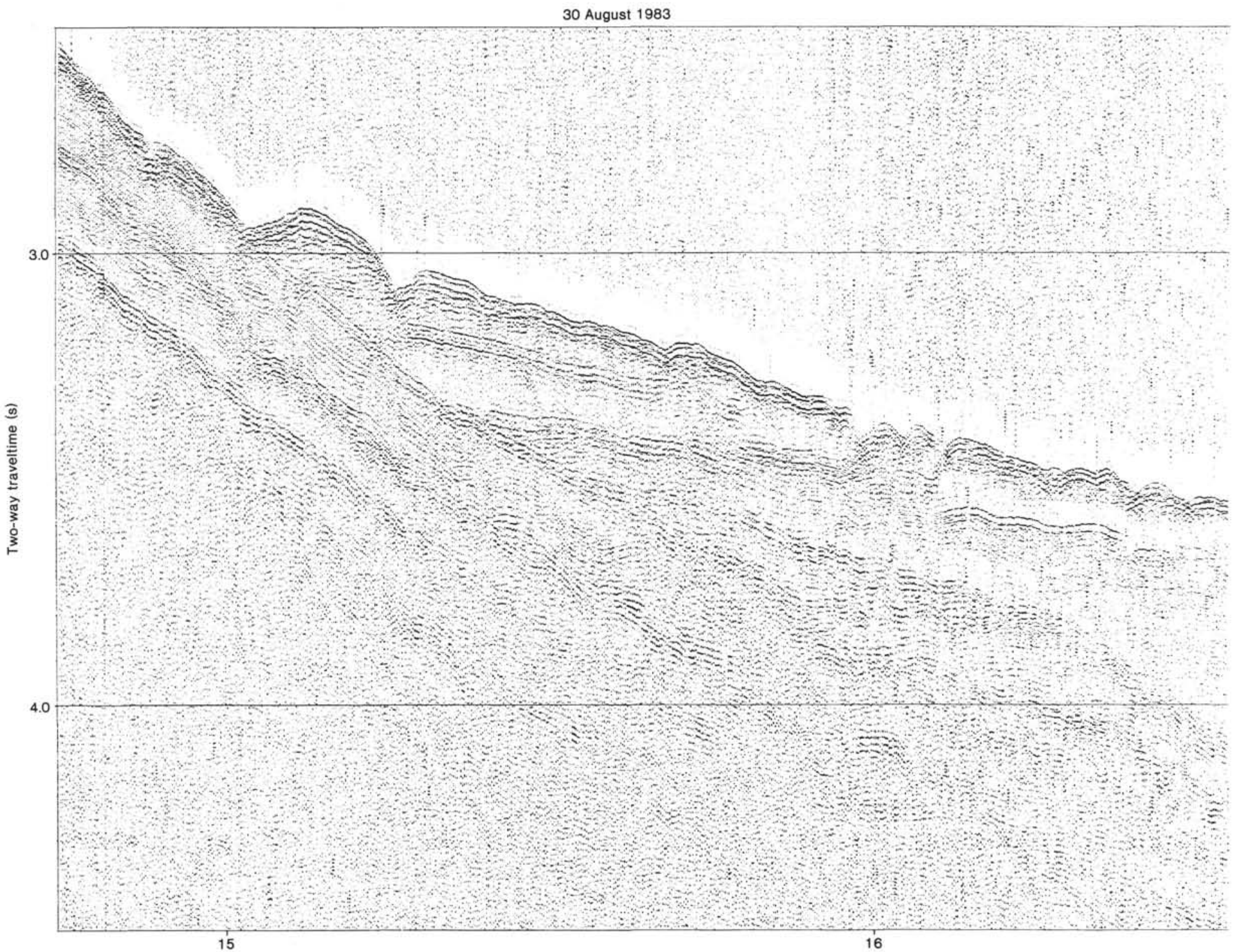
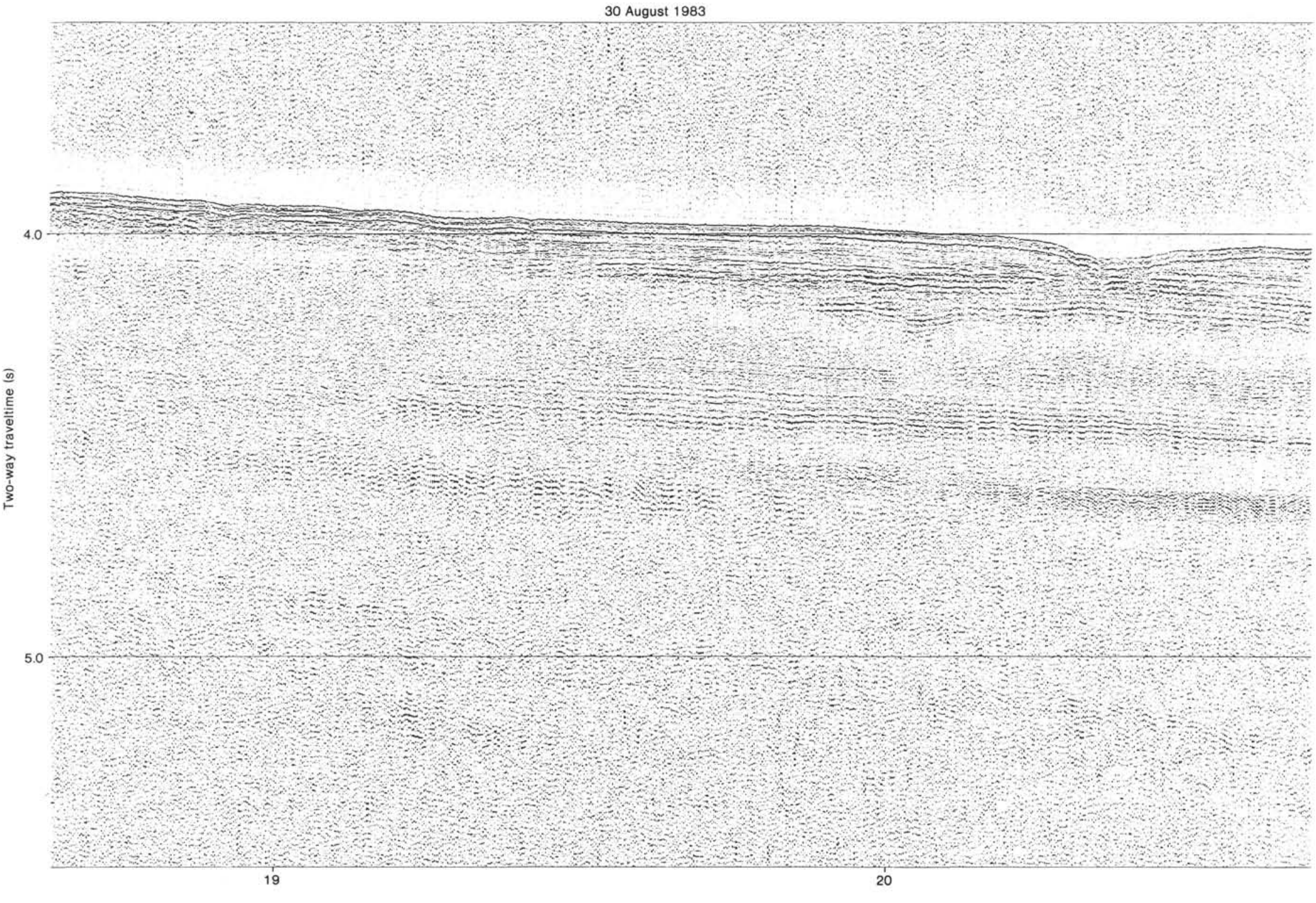
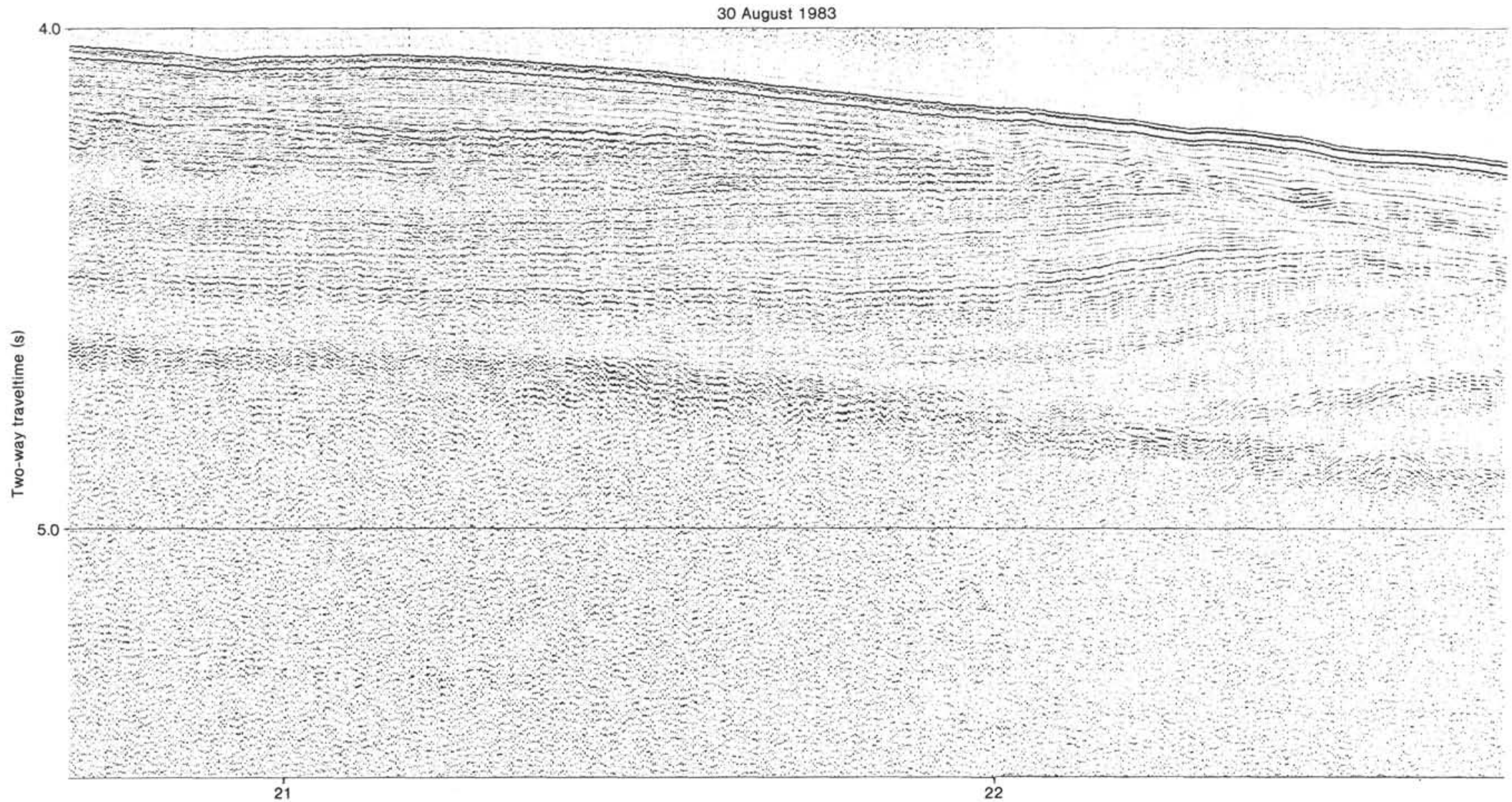

30 August 1983
3.0
4.0
Two-way traveltime (s)
15
16

Figure 5 (continued).


30 August 1983
Two-way traveltime (s)
4.0
5.0
19
20



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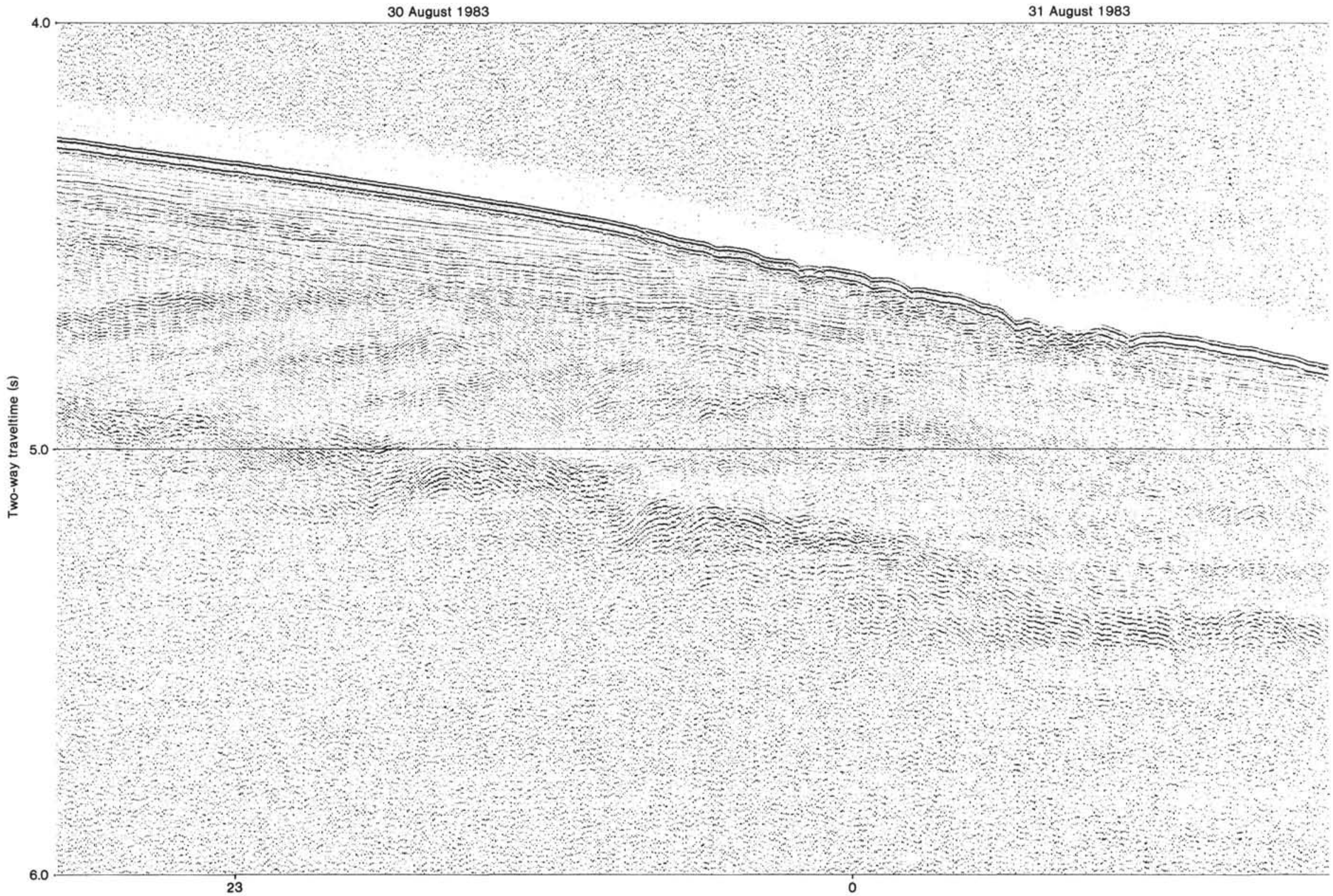
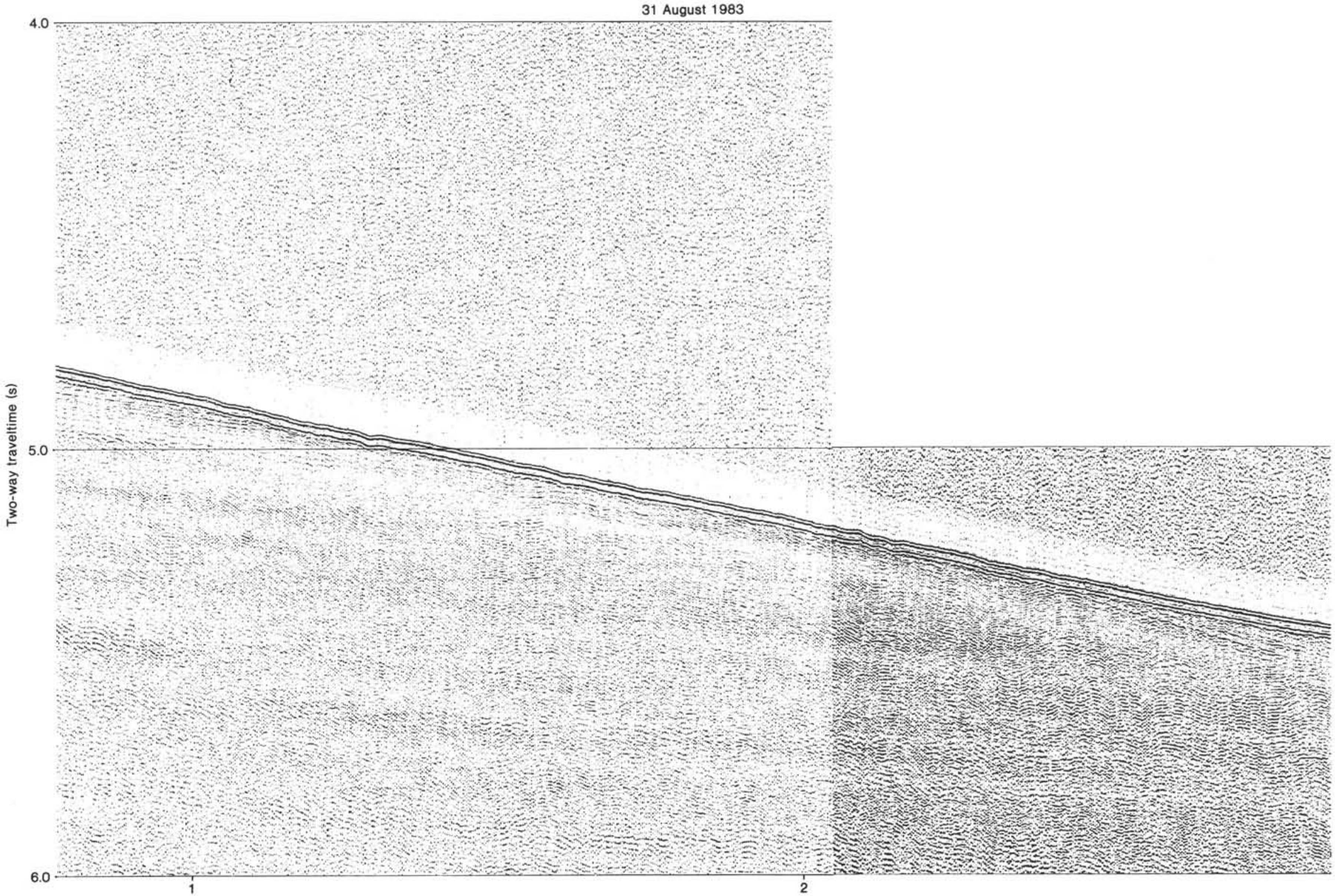

30 August 1983
31 August 1983
4.0
5.0
6.0
Two-way traveltime (s)
23
0



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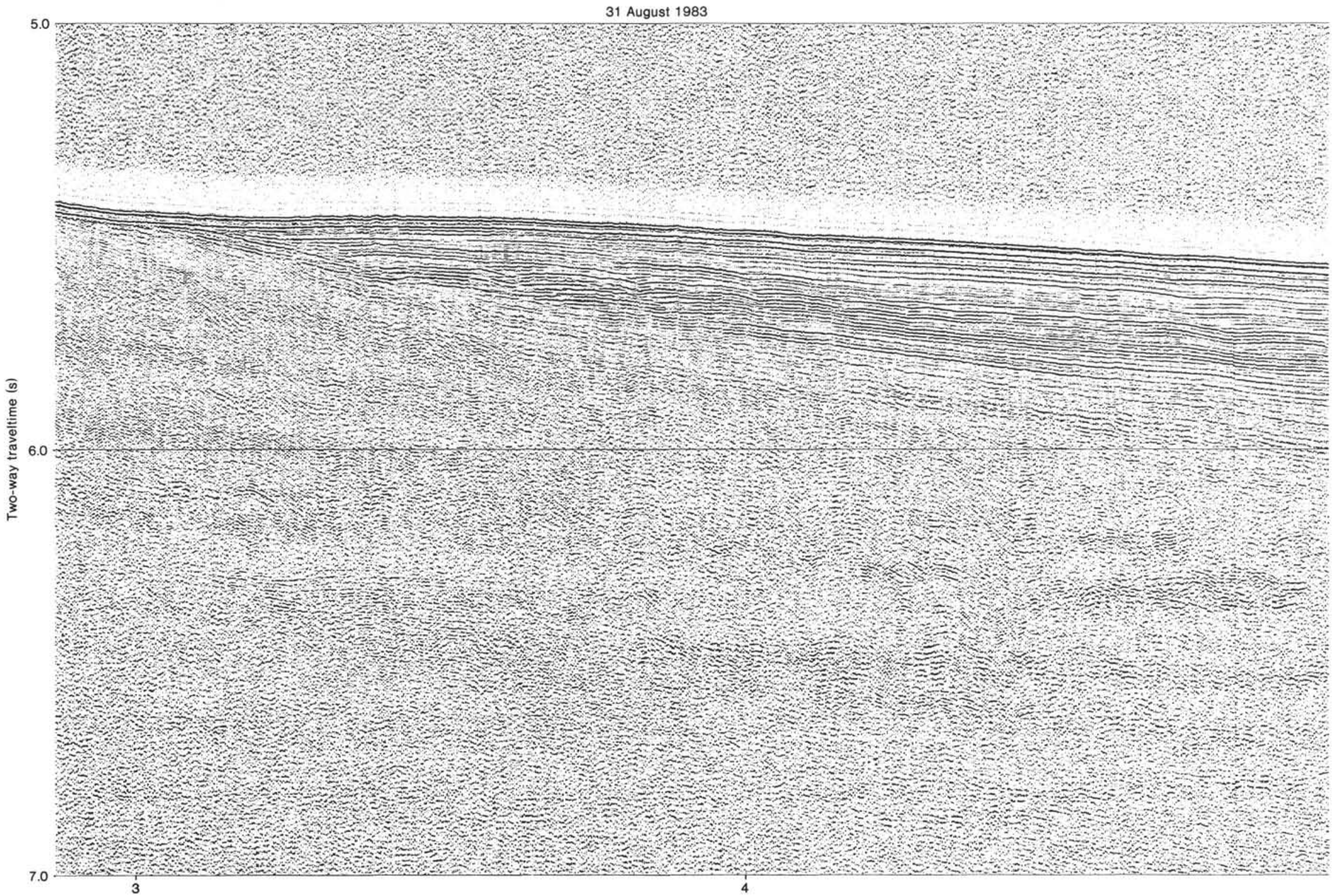
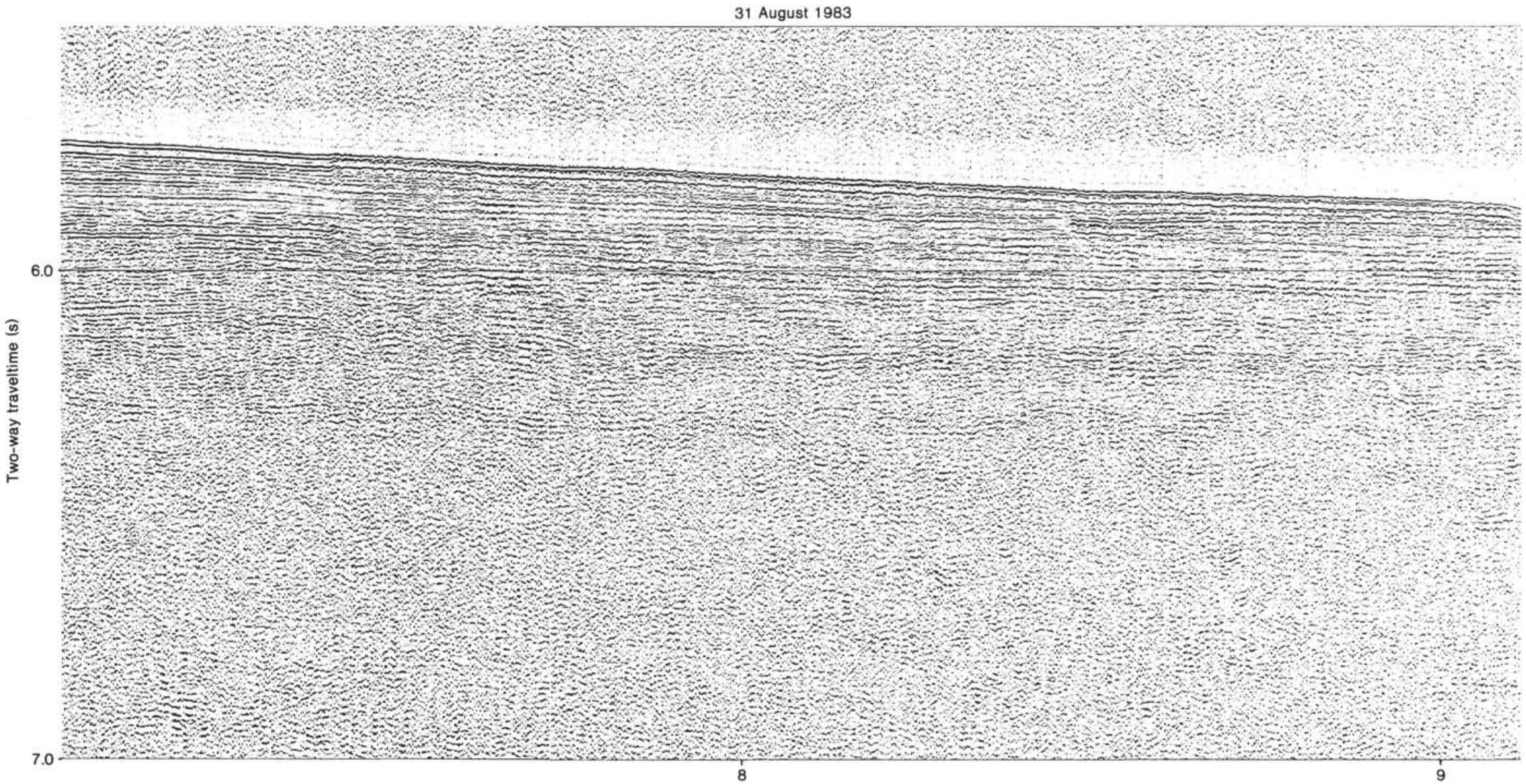
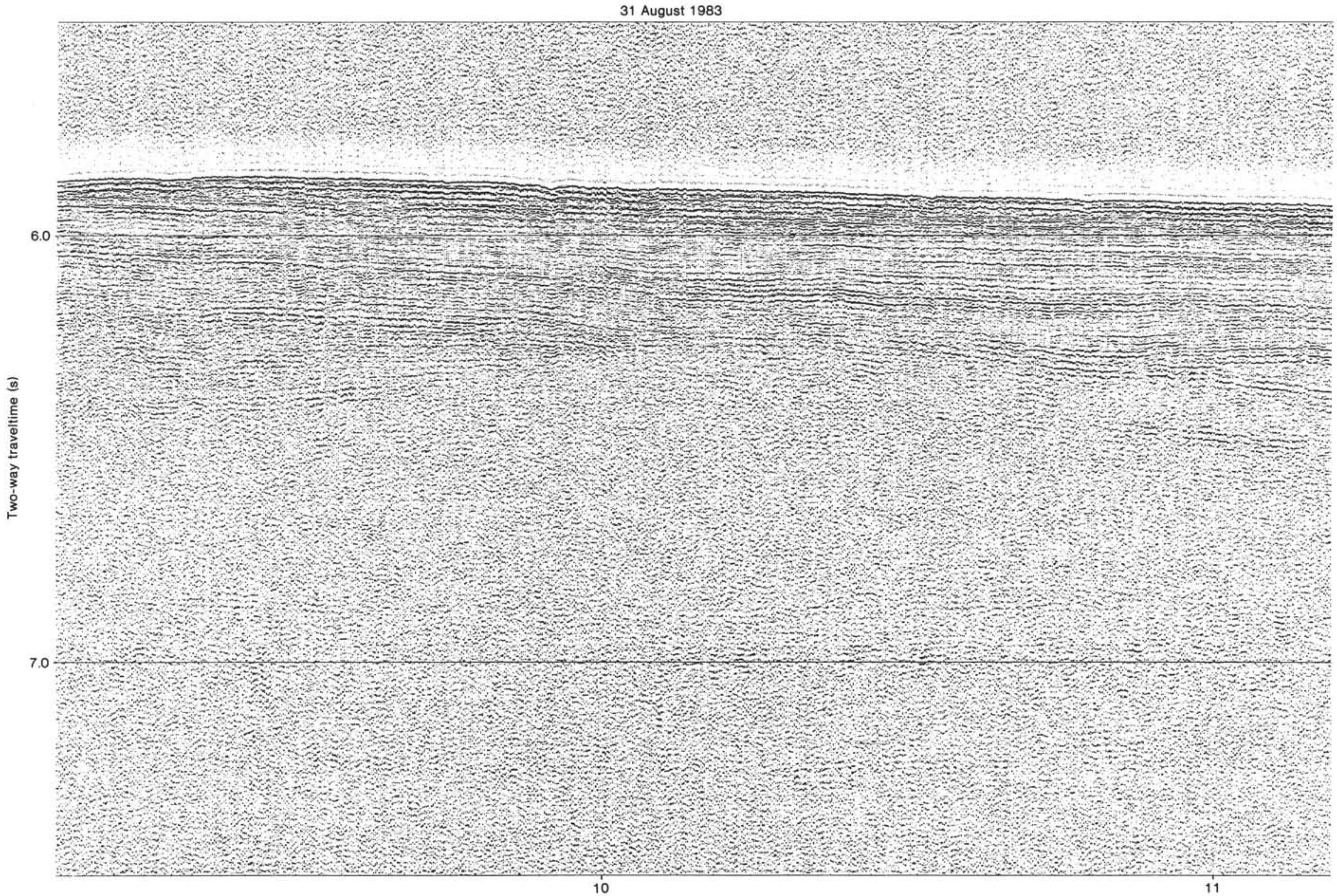

31 August 1983
5.0
6.0
7.0
Two-way traveltime (s)
3
4

Figure 5 (continued).


31 August 1983
Two-way traveltime (s)
6.0
7.0
8
9



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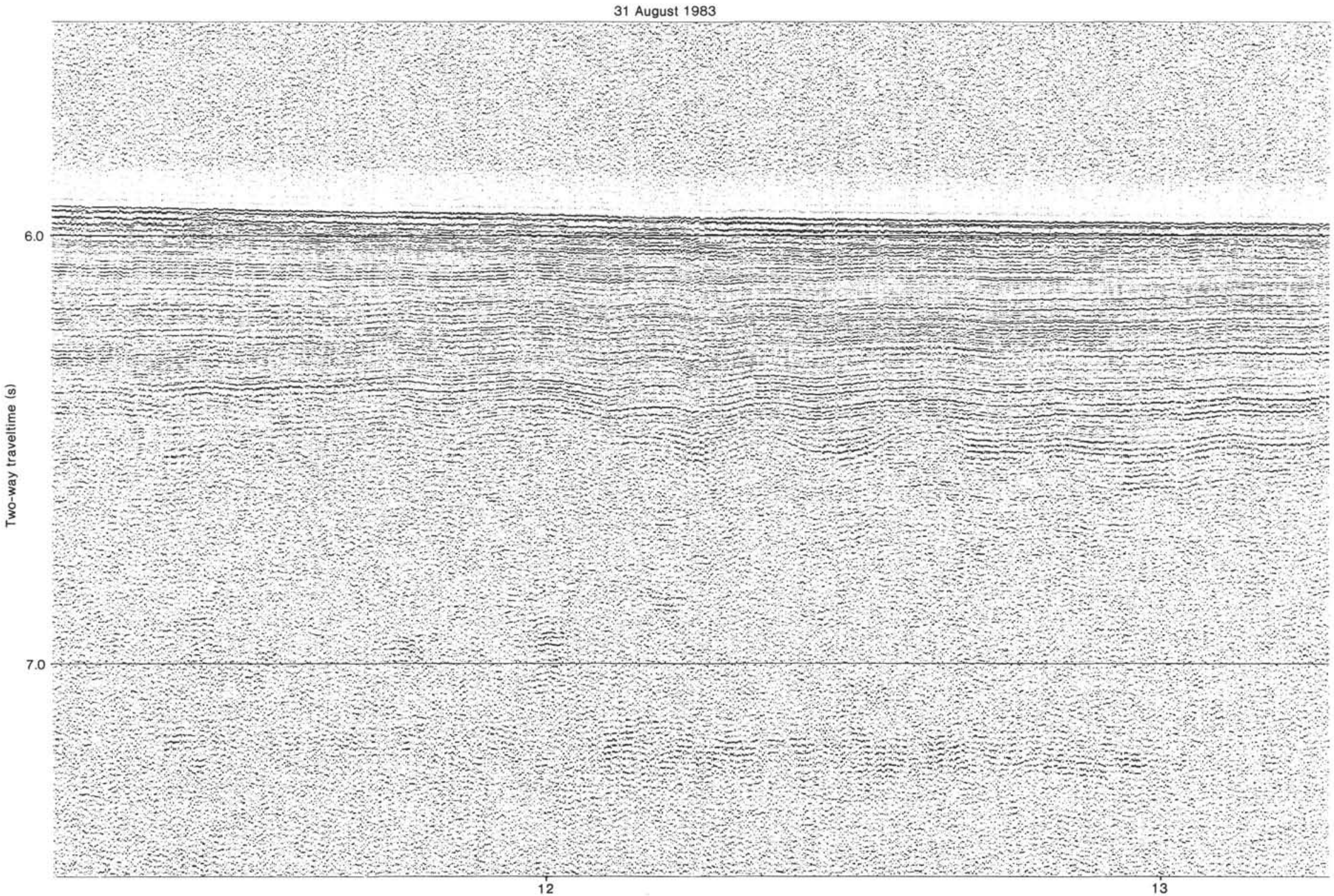
31 August 1983
Two-way traveltime (s)
6.0
7.0
12
13

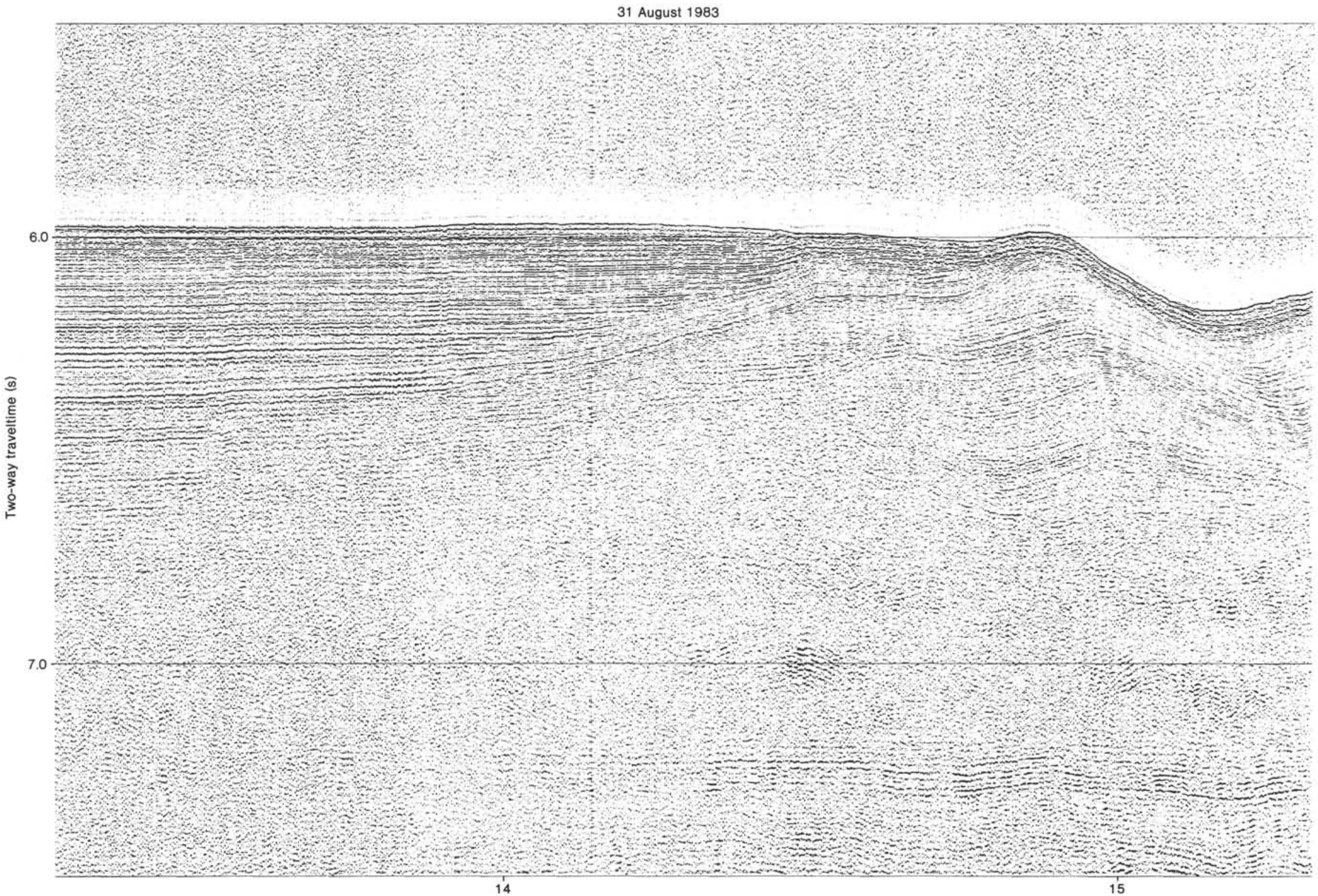

Figure 5 (continued).