Mayer, L., Pisias, N., Janecek, T., et al., 1992
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3. UNDERWAY GEOPHYSICS[1]

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INTRODUCTION

Geophysical data collected during Ocean Drilling Program (ODP) Leg 138 included 4900 nmi of bathymetric and magnetic data and 138 nmi of seismic data. A total of 5421 nmi was traveled between Balboa, Panama, and San Diego, with 22.1 days of the 60.2 days at sea spent in transit.

Shipboard geophysical instruments operating during this leg included a proton precession magnetometer, two precision echo-sounders (3.5 and 12 kHz), a single-channel seismic profiler, and a satellite navigation system. These instruments were operated and maintained by ODP marine technicians in cooperation with the shipboard scientific party and crew of the *JOIDES Resolution.*

NAVIGATION DATA

Navigation data were collected in the Underway Geophysics Laboratory by global positioning system (GPS) and Magnavox 1107 satellite navigation systems (SATNAV). During transit, navigation data were logged on the computer every 5 min; this generally increased to every minute during site surveys.

A plot of the general navigation for Leg 138 was generated from SATNAV, course-change, and speed-change information compiled from the shipboard bridge log, the underway geophysical log, the SATNAV sheets, and the digital seismic headers and is presented in Figure 1. The Geological Data Center at Scripps Institution of Oceanography produced this navigation compilation.

BATHYMETRIC DATA

Bathymetric data were obtained with 3.5 (EDO-248C recorder system) and 12 kHz (Raytheon recorder system) echo sounders. The 12-kHz echo sounder was operated with a CESP-III correlator to improve the signal-to-noise ratio. Sea-bottom depths were recorded manually in the underway geophysics log every 5 min. For Site 854, a careful 3.5-kHz survey was performed to locate the site.

MAGNETIC DATA

A Geometrics 801 proton-precession magnetometer was towed approximately 300 m astern during transits between sites. The data were recorded in analog format on a strip-chart recorder and manually every 30 min in the underway geophysics log. Digital recording of the magnetic data in the seismic header log varied from 1 min during transit to the repetition rate of the water guns (10–12 s) during site surveys. Field values were reduced to anomaly values by subtracting the 1985 IGRF value.

[1]Mayer, L., Pisias, N., Janecek, T., et al., 1992. *Proc. ODP, Init. Repts.,* 138: College Station, TX (Ocean Drilling Program).

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[3]Shipboard Scientific Party is as given in list of participants preceding the contents.

SEISMIC REFLECTION DATA

With the exception of Site 854, one single-channel seismic line was run across each site before being occupied.

The seismic sources used aboard the *JOIDES Resolution* during Leg 138 usually consisted of two synchronized 80-in.[3] Seismic Systems Inc. water guns at a depth of about 10 m and firing at a 10- to 12-s repetition rate.

The seismic receiver consisted of a 100-m-long Teledyne Model 178 streamer with 60 active sections. It was deployed from the fantail and was towed about 300 m behind the vessel at a depth of about 10 m. Hydrophone elements were combined to produce a single signal that was recorded in both analog and digital forms.

Seismic data were displayed in real time in analog format on two Raytheon 1807 LSR dry-paper recorders using only the streamer, amplifiers, and two band-pass filters. The data were also recorded digitally using a supermicro 561 Masscomp computer, which acted as the central unit for recording and post-processing the data. Raw data were recorded on 9-track tapes with a Cipher drive, using SEG-Y format and a density of 1600 bpi. The header for each shot contains the following information: shot number, date, time, wind speed, wind direction, ship's speed, ship's gyro heading, cumulative distance travelled, streamer and gun depth, and information about the timing of the guns.

Digital data were displayed in real time on a 15-in.-wide Printronix, high-resolution graphic printer (160 dpi). The digital profiles were post-processed at the site using the Masscomp computer on a 22-in. Versatec electrostatic plotter (200 dpi).

SINGLE-CHANNEL SEISMIC REFLECTION PROFILES

The single seismic-channel seismic reflection profiles with their corresponding track segments are shown in Figures 2 through 21. The digital data were analog, band-pass filtered and collected with a data window of 5 s/shot at a rate of 1000 Hz. Quality of data was variable, with the data for the western transect sites (848–853) generally better than those from the eastern transect sites. For Sites 844 through 846, the depth transducer signal interfered with the streamer signal, and produced noise of 240 Hz, 20 to 40 dB higher than the seismic signal. At Site 845, poor shielding of cables produced strong noise, with frequencies of 60 Hz and its multiples. Because of these problems and the desire to enhance higher frequency information, further filtering was applied to the data. A three-trace, center-weighted running mix was applied to all traces. The signal was muted to the seafloor on all of the profiles. In Table 1, we list all the parameters used for collecting and reprocessing the seismic data. A brief description of each of the 10 seismic lines collected follows.

Seismic Line 1

Seismic Line 1 was collected during the approach and survey of Site 844 (Julian Day [JD] 128/1622 Universal Time Coordinated [UTC] to JD 128/2048 UTC). The ship's track for this survey is shown in Figure 2. Computer and manual collection of navigation data in the Underway Laboratory stopped at 2030 UTC, 7 min prior

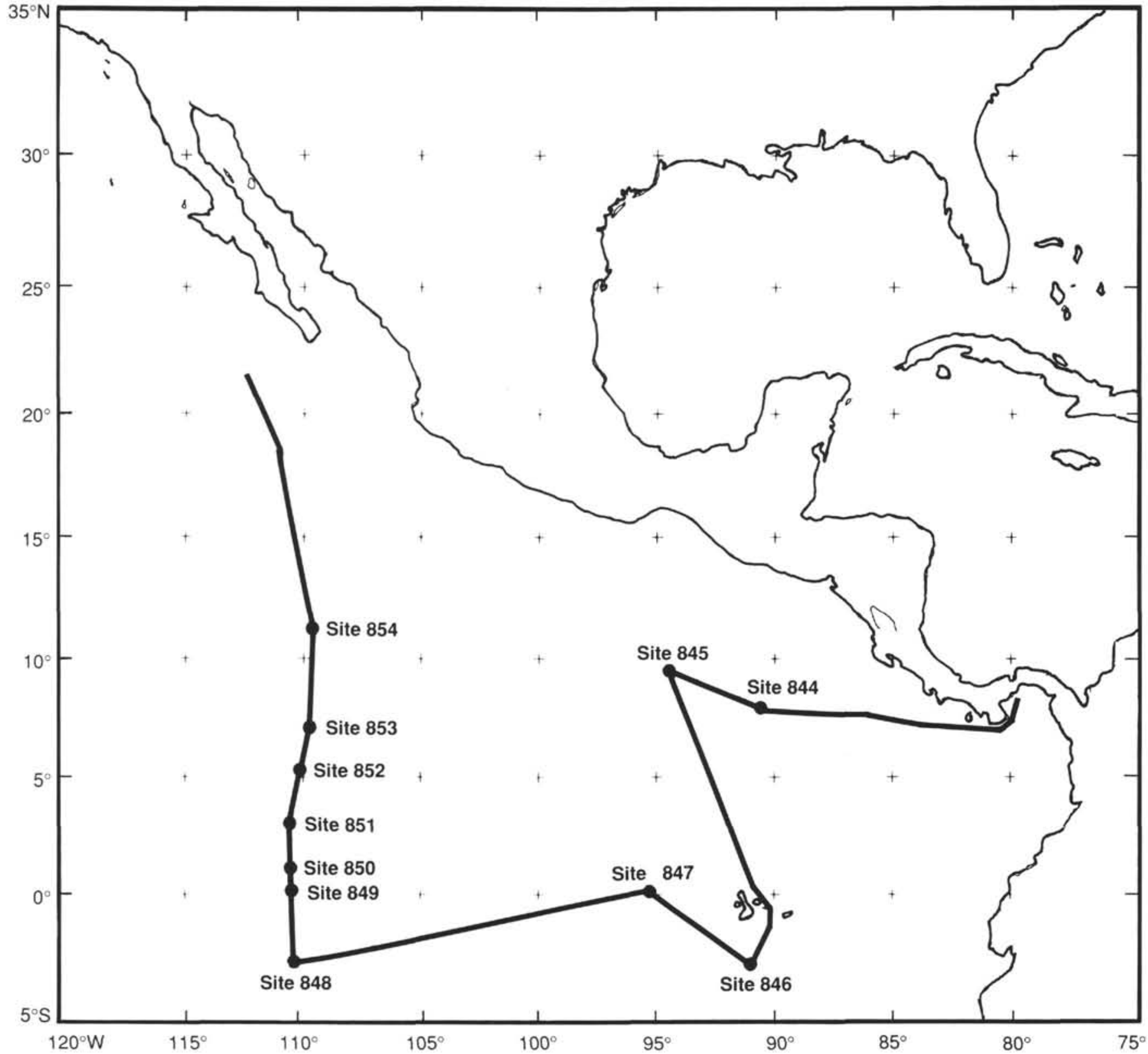

Figure 1. Leg 138 track line in the eastern equatorial Pacific Ocean.

to our dropping the beacon. Fortunately, the final east-west line of the site survey followed the same line as that followed by the *Thomas Washington* during its site survey. Shortly after entering the survey area for this site, we crossed a seamount that rose about 475 m above the seafloor. A beacon was deployed near the proposed site location, where a digital seismic profile (Fig. 3) showed that a thick and reasonably undisturbed sedimentary section had accumulated. The thickness of the sedimentary section at this location is 0.36 s (two-way traveltime [twt]).

Seismic Line 2

Seismic Line 2 was collected during the approach and survey of Site 845 (JD 133/2252 UTC to JD 134/0046 UTC). The *JOIDES Resolution* approached this site from the south and then followed the east-west track line of the pre-cruise site survey (Fig. 4). Unfortunately, computer navigation was collected only every half hour during the site survey. Figure 4 was compiled from the existing computer navigation data and a manual navigation plot compiled during the survey. Because of problems with cable shielding, noise with frequencies of 60 Hz and its multiples contaminated the seismic data. By using the pre-cruise seismic sections, the site was chosen slightly west of the proposed site location in an area of continuous, relatively undisturbed seismic reflections and away from an area where the basement surface was rough and where we found scattering and incoherence in the seismic record. Seismic data collected with this line were filtered from 70 to 110 Hz, which produced a poor quality section that was dominated by low frequencies (Fig. 5). The thickness of the sediment for this line varied from 0.25 to 0.38 s; at the site location, the section thickness is 0.36 s twt.

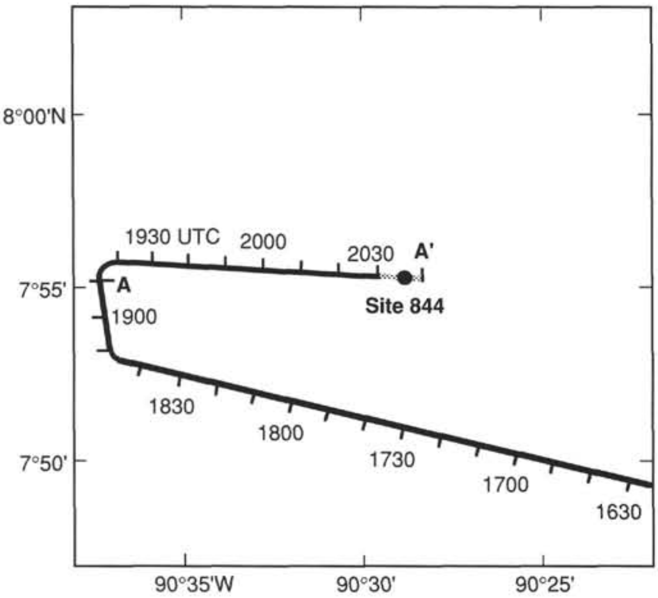

Figure 2. Ship's track for single-channel seismic Line 1, including the location of profile A–A' shown in Figure 4. Seismic coverage is complete for the track shown. Shaded region represents approximate ship's track because recording of navigation ceased after 2030 UTC.

Seismic Line 3

Seismic Line 3 was collected during the approach and survey of Site 846 (JD 141/1420 UTC to JD 141/1558 UTC). The ship's track for this survey is shown in Figure 6. The *Resolution* approached the site from the northeast, turned to the south to pass over a trough that runs subparallel to the north-south track line, and then turned east for the final approach to the site. A beacon was deployed slightly east of the proposed site location, where a digital seismic profile (Fig. 7) showed that a thick and reasonably undisturbed sedimentary section having numerous flat-lying reflectors had accumulated. The thickness of the sedimentary section at the site location is 0.53 s twt.

Seismic Line 4

Seismic Line 4 was collected during the approach and survey of Site 847 (JD 147/2053 UTC to JD 147/2255 UTC). The *Resolution* approached the site from the southeast, turned to the east at the start of the seismic survey, and then turned north for the final approach to the site (Fig. 8). This site was chosen slightly south of the proposed site, in a region of extremely flat-lying reflectors that mirror basement (Fig. 9). The thickness of the sedimentary section at the site location is 0.38 s twt; the thickness of sediment to a strong reflector (identified as chert during drilling) is 0.32 s twt.

Seismic Line 5

Seismic Line 5 was collected during the approach and survey of Site 848 (JD 155/1349 UTC to JD 155/1532 UTC). The ship's track for this survey is shown in Figure 10. The *Resolution* approached the site from the east and turned back sharply onto a line slightly farther south for her final approach to the site. The beacon was deployed on the crest of a gentle topographic rise, where a digital seismic profile (Fig. 11) showed an area having numerous reflectors mirroring basement. The thickness of the sedimentary section at the site location is 0.13 s twt.

Seismic Line 6

Seismic Line 6 was collected during the approach and survey of Site 849 (JD 158/2046 UTC to JD 158/2354 UTC). The ship's track for this survey is shown in Figure 12. The *Resolution* approached the site from the south and passed the originally proposed site at approximately 2255 UTC. The final site was chosen about 7.5 km from the original site, where no diffractions from erosional channels appeared in the seismic record (Fig. 13). The thickness of the sedimentary section at the site location, which is composed of numerous reflectors that mirror basement, is 0.44 s twt. This sedimentary section is also slightly thicker than that at the originally proposed site (0.43 s twt).

Seismic Line 7

Seismic Line 7 was collected during the approach and survey of Site 850 (JD 164/0415 UTC to JD 164/0600 UTC), a supplementary site that was added as a result of additional time accumulated during the cruise. The ship's track for this survey is presented in Figure 14. The ship approached this site from the south and crossed over a small (150 m) seamount. The site was chosen in a region having a local maximum in sediment thickness and flat basement. Figure 15 shows the processed seismic section for this survey. The thickness of the sedimentary section at this site location is 0.505 s twt; the sediment thickness in the region of the site beyond the flanks of the seamount ranges from 0.48 to 0.505 s twt.

Seismic Line 8

Seismic Line 8 was collected during the approach and survey of Site 851 (JD 167/2105 UTC to JD 167/2210 UTC). The ship's track for this survey is shown in Figure 16. The ship approached the site from the south; the site was chosen near the initially proposed site. A beacon was deployed on a local high, where a digital seismic profile (Fig. 17) showed that an area having smooth basement was overlain by numerous parallel reflectors. The thickness of the sedimentary section at the site location is 0.40 s twt.

Seismic Line 9

Seismic Line 9 was collected during the approach and survey of Site 852 (JD 173/0714 UTC to JD 173/0943 UTC). The ship's track for this survey is presented in Figure 18. The ship approached this site from the south, turned east to cross over a trough, and then sailed back to the north to cross over the final site. The *Resolution* then turned back along line, where a beacon was dropped on a broad high south of the originally proposed site. The processed seismic section (Fig. 19) shows many reflectors that mirror basement. The thickness of the sedimentary section at the site location is 0.15 s twt.

Seismic Line 10

Seismic Line 10 was collected during the approach and survey of Site 853 (JD 176/1007 UTC to JD 176/1311 UTC). The ship's track for this survey is shown in Figure 20. The ship approached the site from the south. Because of the poor quality of seismic data, the port gun was turned off, and the gain was increased at 1105 UTC. This, indeed, improved the quality of the seismic data.

A site was chosen near the initially proposed site on top of a small regional high. A digital seismic profile (Fig. 21) shows an area having a few, relatively smooth reflectors that mirror basement. The thickness of the sedimentary section at the site location is 0.10 s twt.

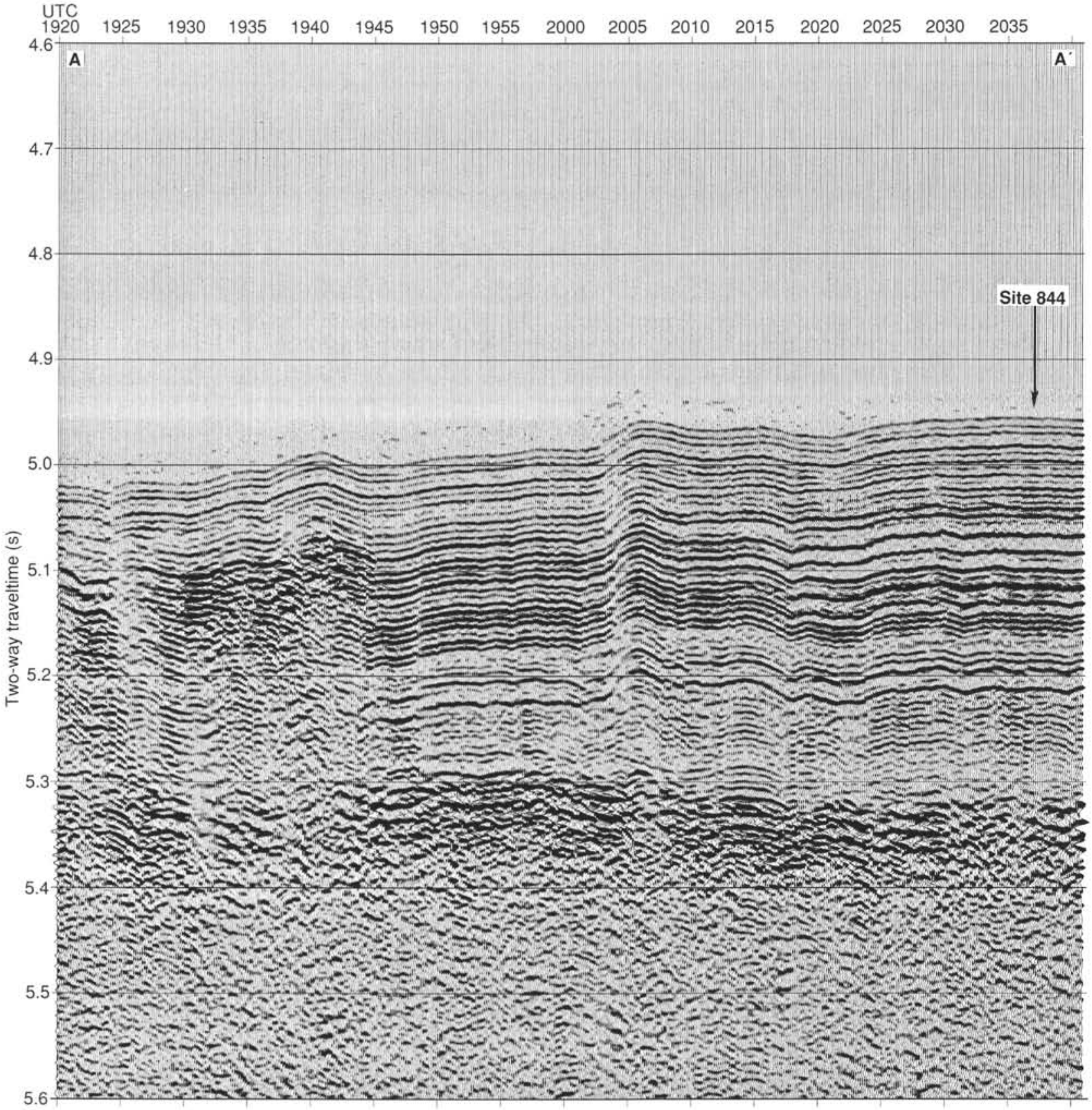

Figure 3. Profile A–A′ of processed single-channel seismic reflection Line 1 shown in Figure 2. Times are UTC throughout for each processed seismic profile.

Table 1. Seismic data, real-time recording, and reprocessing parameters for Leg 138 site surveys.

Line number: Location:	Line 1 Site 844 survey	Line 2 Site 845 survey	Line 3 Site 846 survey	Line 4 Site 847 survey	Line 5 Site 848 survey	Line 6 Site 849 survey	Line 7 Site 850 survey	Line 8 Site 851 survey	Line 9 Site 852 survey	Line 10 Site 853 survey
Time (UTC)										
Start:	128/1622	133/2252	141/1420	147/2053	155/1349	158/2046	164/0415	167/2105	173/0714	176/1007
End:	128/2048	134/0046	141/1558	147/2255	155/1532	158/2354	164/0600	167/2210	173/0943	176/1131
Shotpoints										
Start:	4219	1416	5818	2498	5634	877	359	632	833	594
End:	5717	2080	6356	3149	6145	1812	883	974	1582	1014
Distance (nmi):	708.1–736.4	1012.7–1023.2	1932.8–1943.7	2352.3–2365.1	3527.3–3539.7	3743.5–3763.2	3927.6–3938.9	4035.5–4042.2	4253.4–4267.0	4412.6–4421.2
Analog 1										
Range(s):	4.4–5.4	4.0–5.0	4.2–5.2	4.2–5.2	5.0–6.0	4.8–6.8	4.8–6.8	4.8–6.8	4.8–6.8	4.8–6.8
High cut (Hz):	150	150	150	150	400	400	400	400	400	400
Low cut (Hz):	30	30	30	30	30	30	30	30	30	30
Gain (dB):	80	80	70	70/65	70	80	80	80	80	80/85
Analog 2										
Range(s):	4.0–6.0	4.0–6.0	4.0–6.0	4.0–6.0	5.0–7.0	4.8–5.8	4.8–5.8	4.8–5.8	4.8–5.8	4.8–5.8
High cut (Hz):	150	150	150	150	400	400	400	400	400	400
Low cut (Hz):	30	30	30	30	30	30	30	30	30	30
Gain (dB):	80	80	70	70/65	70	80	80	80	80	80/85
Digital										
Range(s):	3.0–8.0	3.0–8.0	3.0–8.0	3.0–8.0	3.0–8.0	4.0–9.0	4.0–9.0	4.0–9.0	4.0–9.0	4.0–9.0
High cut (Hz):	250	250	250	250	250	250	300	300	300	300
Low cut (Hz):	25	25	25	25	25	25	25	25	25	25
Gain (dB):	80	70	70	70/65	70	80	80	80	75	65/75
Rep. rate (s):	10.0–12.0	10.0–12.0	10.0–12.0	10.0/11.0	12	12	12	12	12	12
Digital (post-processing)										
Data window (s):										
From:	4.2	4.6	4.2	4.2	5.0	4.8	4.7	4.7	4.9	4.8
To:	5.2	5.6	5.2	5.2	6.0	5.8	5.7	5.7	5.9	5.8
Filter										
High cut (Hz):	210	110	220	250	220	250	250	270	270	270
Low cut (Hz):	70	70	70	70	70	70	70	70	70	70
Mix										
Traces:	3	3	3	3	3	3	3	3	3	3
Weights:	1-2-1	1-2-1	1-2-1	1-2-1	1-2-1	1-2-1	1-2-1	1-2-1	1-2-1	1-2-1
Avg. amplitude normalization										
Window (s):	None	0–0.24, 0.24–0.70 from w.b.	None	None	0–0.11, 0.11–0.70 from w.b.	None	None	None	None	
Amplitude:		7,000, 10,000			1,500, 10,000					
AGC										
Window (s):	0.5	None	None	0.5	None	0.5	0.5	0.5	0.3	None

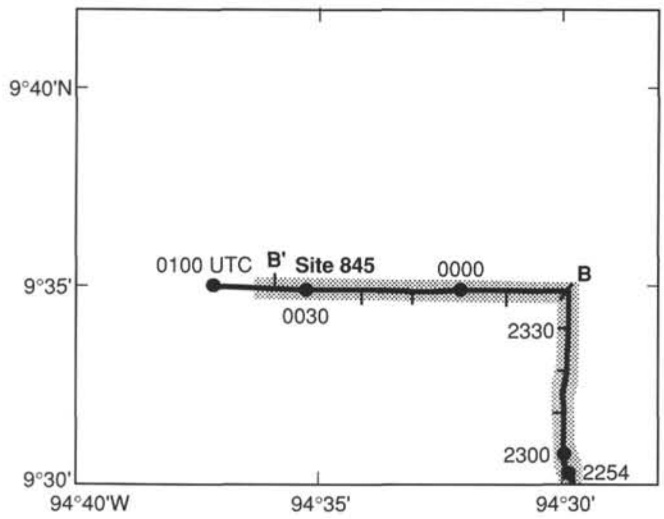

Figure 4. Ship's track for single-channel seismic Line 2, including the location of profile B–B′ shown in Figure 5. SATNAV points are labeled with bold circles. Note that navigation points not collected by satellite are approximate values from a map manually generated during the site survey. Shaded region represents the complete seismic survey.

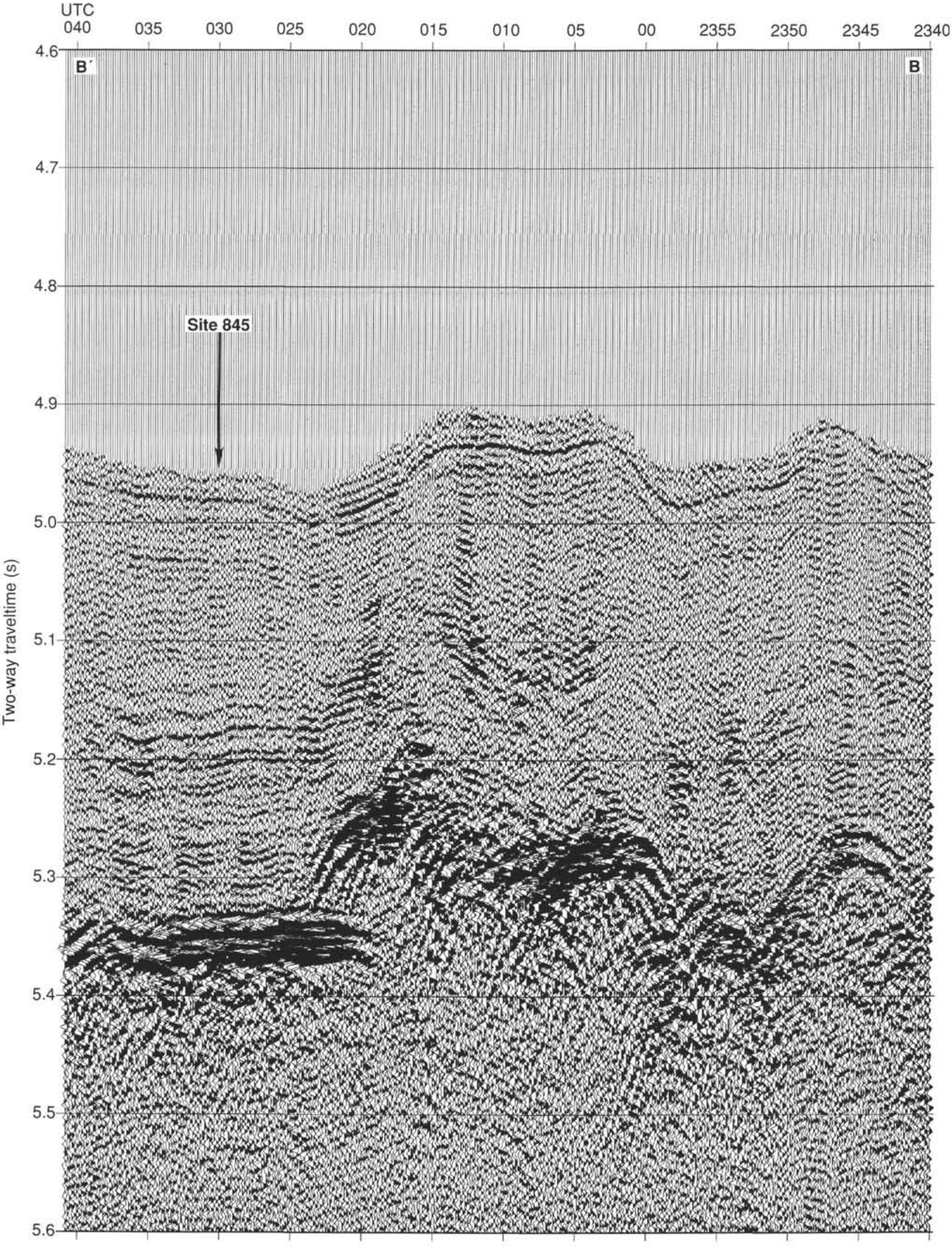

Figure 5. Profile B–B′ of processed single-channel seismic reflection Line 2 shown in Figure 4. The site was chosen away from an area to the east, where basement was rough, not flat-lying. The section is poor as a result of problems with shielding the seismic cable.

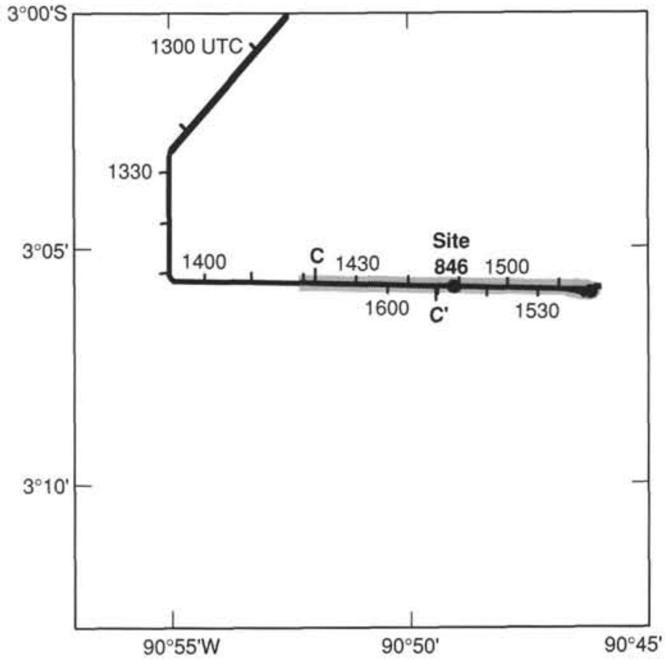

Figure 6. Ship's track for single-channel seismic Line 3, including the location of profile C–C′ shown in Figure 7. Shaded region represents the complete seismic survey.

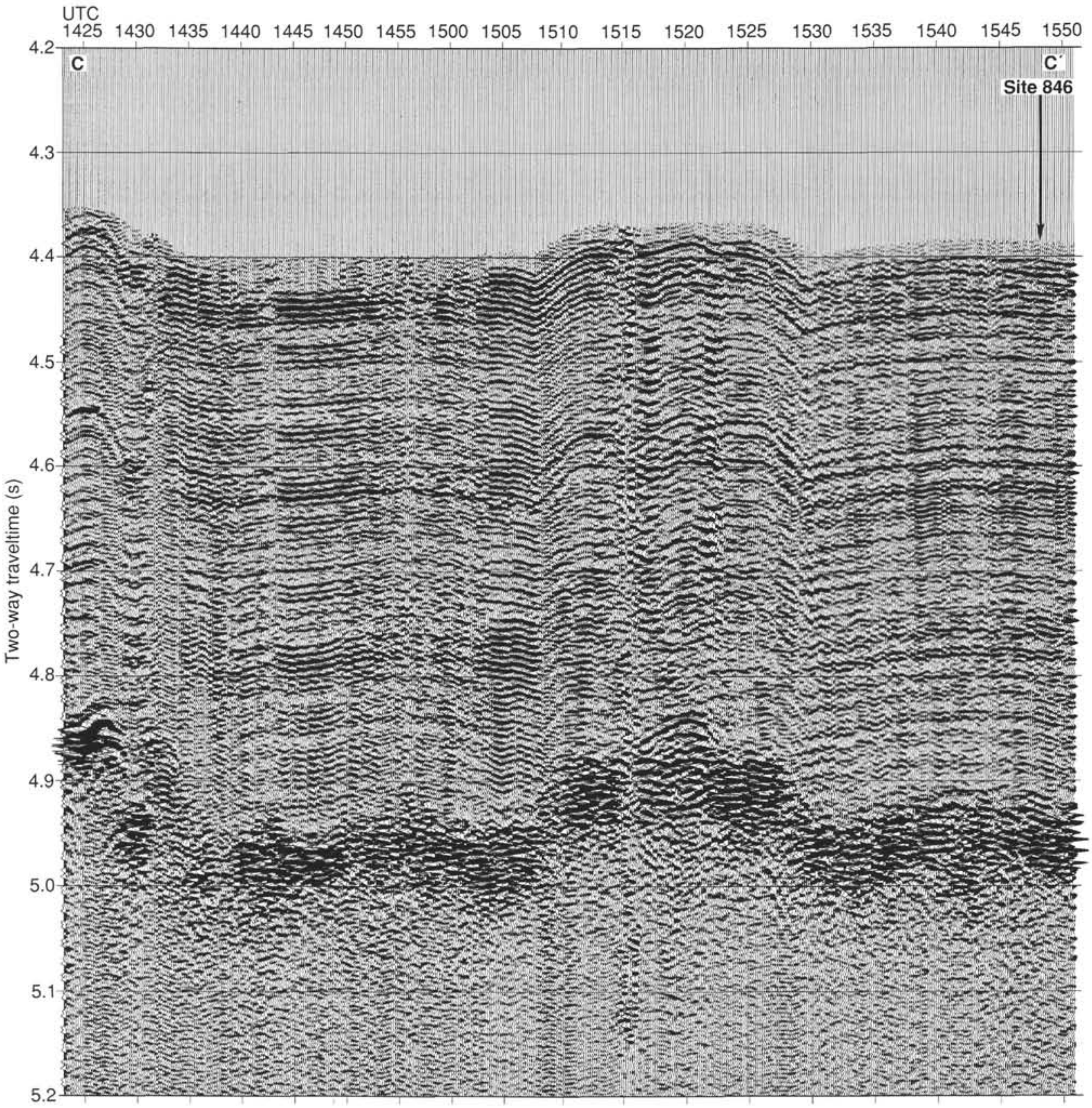

Figure 7. Profile C–C′ of processed single-channel seismic reflection Line 3 shown in Figure 6.

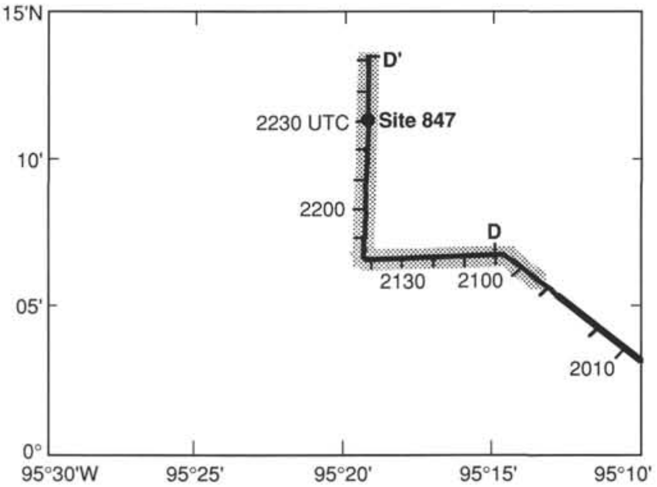

Figure 8. Ship's track for single-channel seismic Line 4, including the location of profile D–D′ shown in Figure 9. Shaded region represents the complete seismic survey.

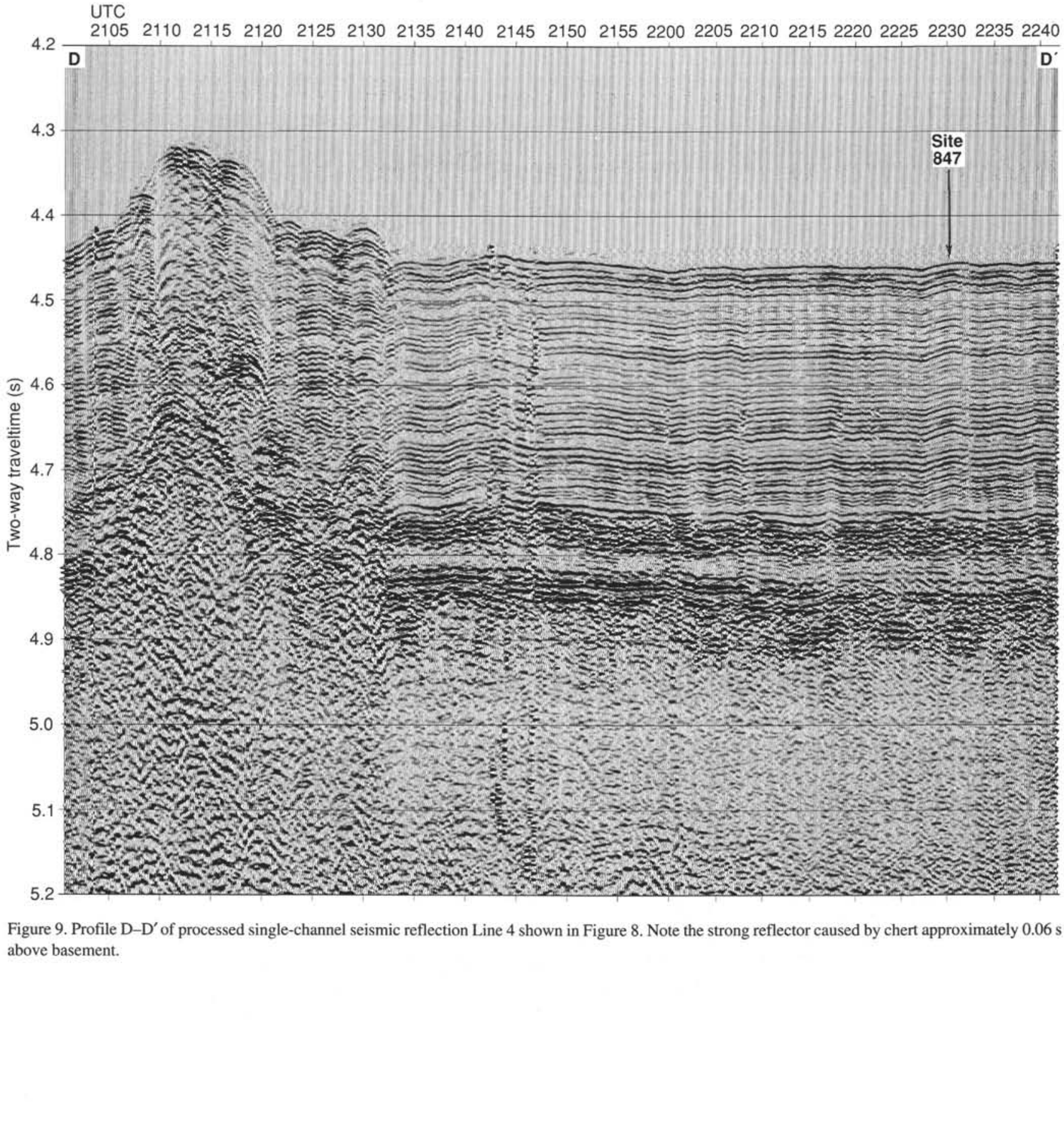

Figure 9. Profile D–D′ of processed single-channel seismic reflection Line 4 shown in Figure 8. Note the strong reflector caused by chert approximately 0.06 s twt above basement.

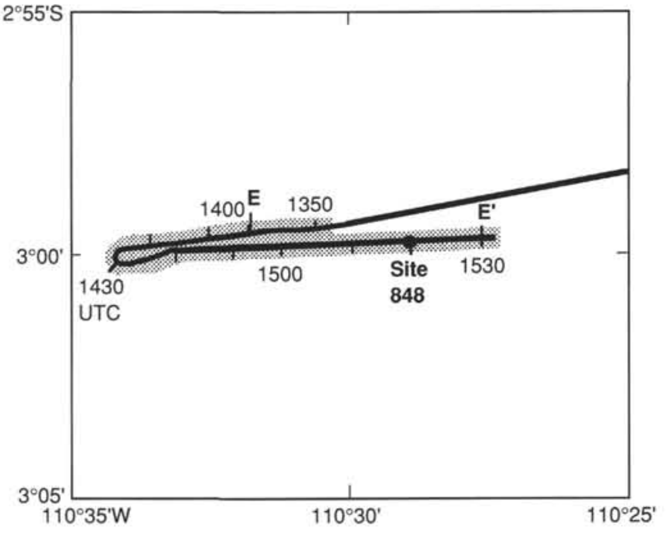

Figure 10. Ship's track for single-channel seismic Line 5, including the location of profile E–E′ shown in Figure 11. Shaded region represents the complete seismic survey.

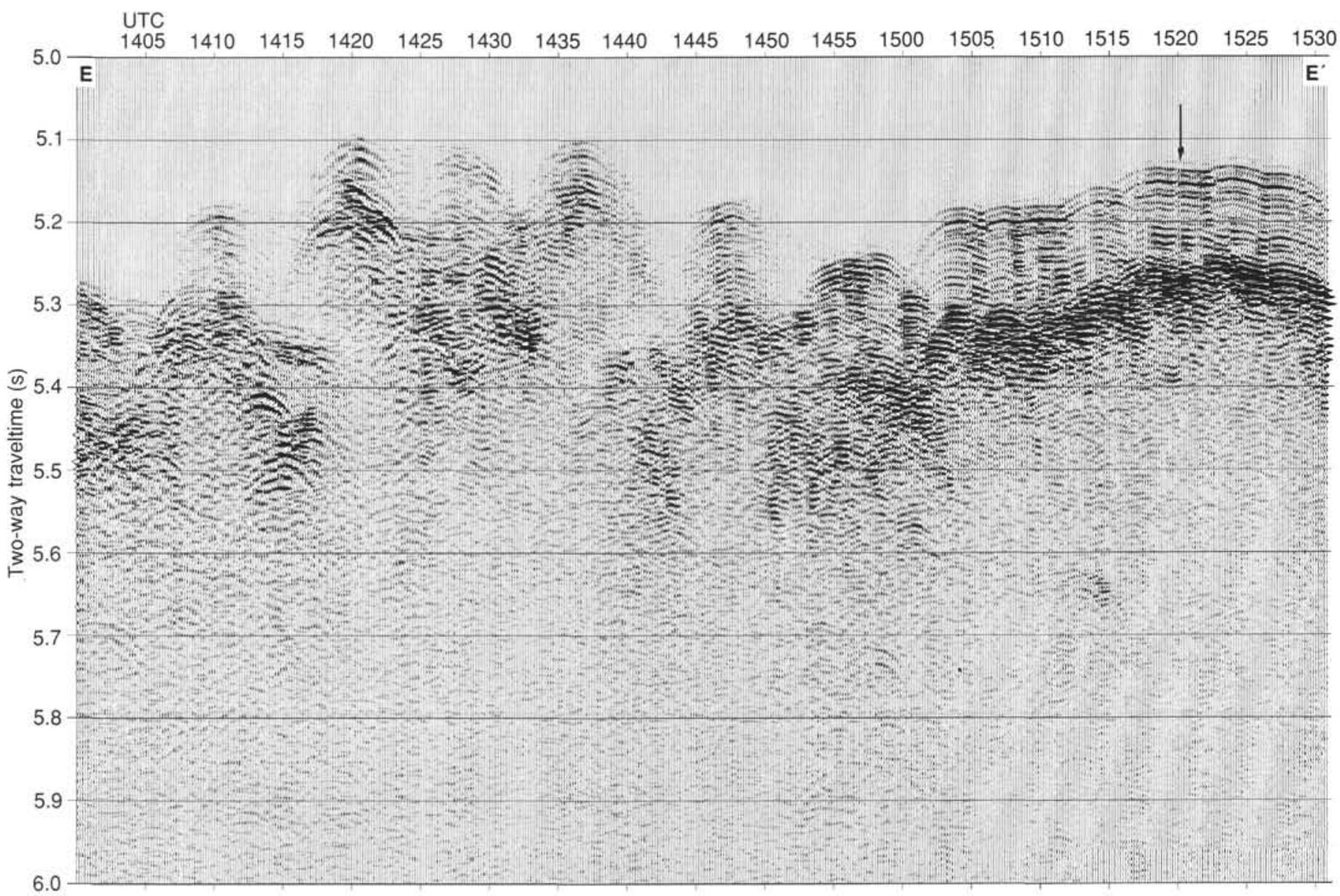

Figure 11. Profile E–E′ of processed single-channel seismic reflection Line 5 shown in Figure 10.

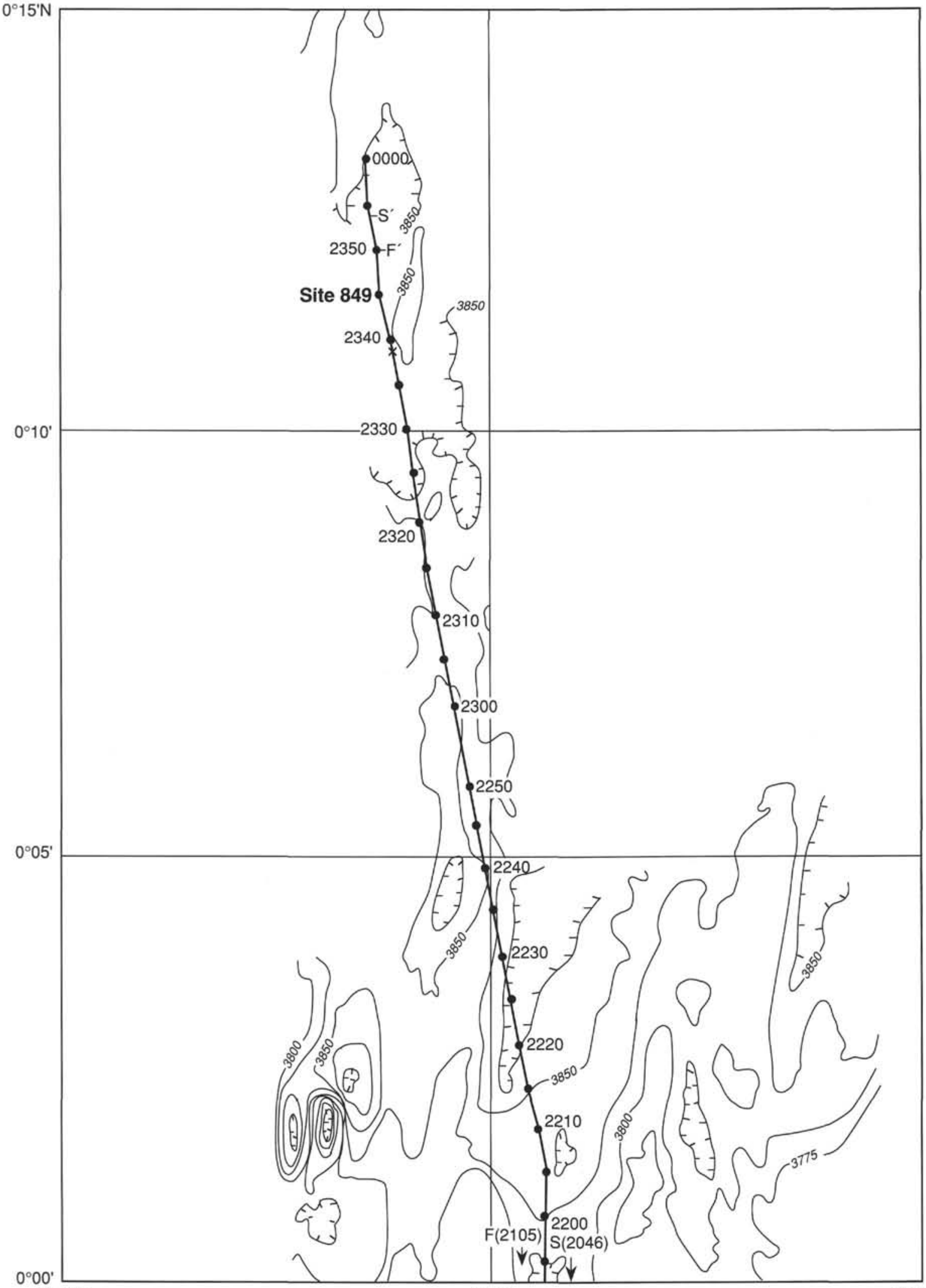

Figure 12. Bathymetric map for Site 849 from *Thomas Washington* site-survey cruise and ship's track for single-channel seismic Line 6, including the location of profile F–F′ shown in Figure 13. S–S′ represents the complete seismic survey. Note that F and S are off the map; times for the start of the survey and the seismic section are 2046 and 2105 UTC, respectively.

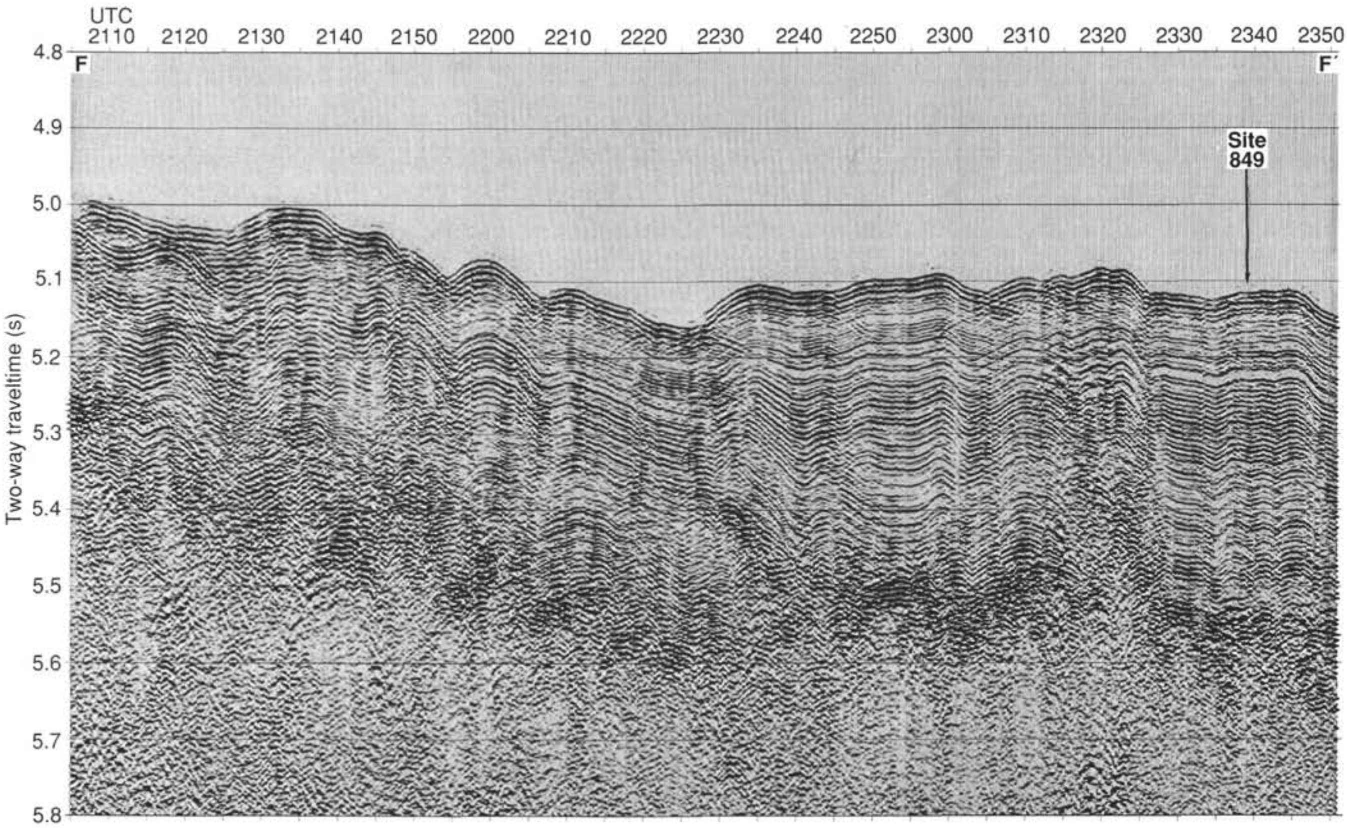

Figure 13. Profile F–F′ of processed single-channel seismic reflection Line 6 shown in Figure 12. This site was chosen in an area where no diffractions from erosional channels were present.

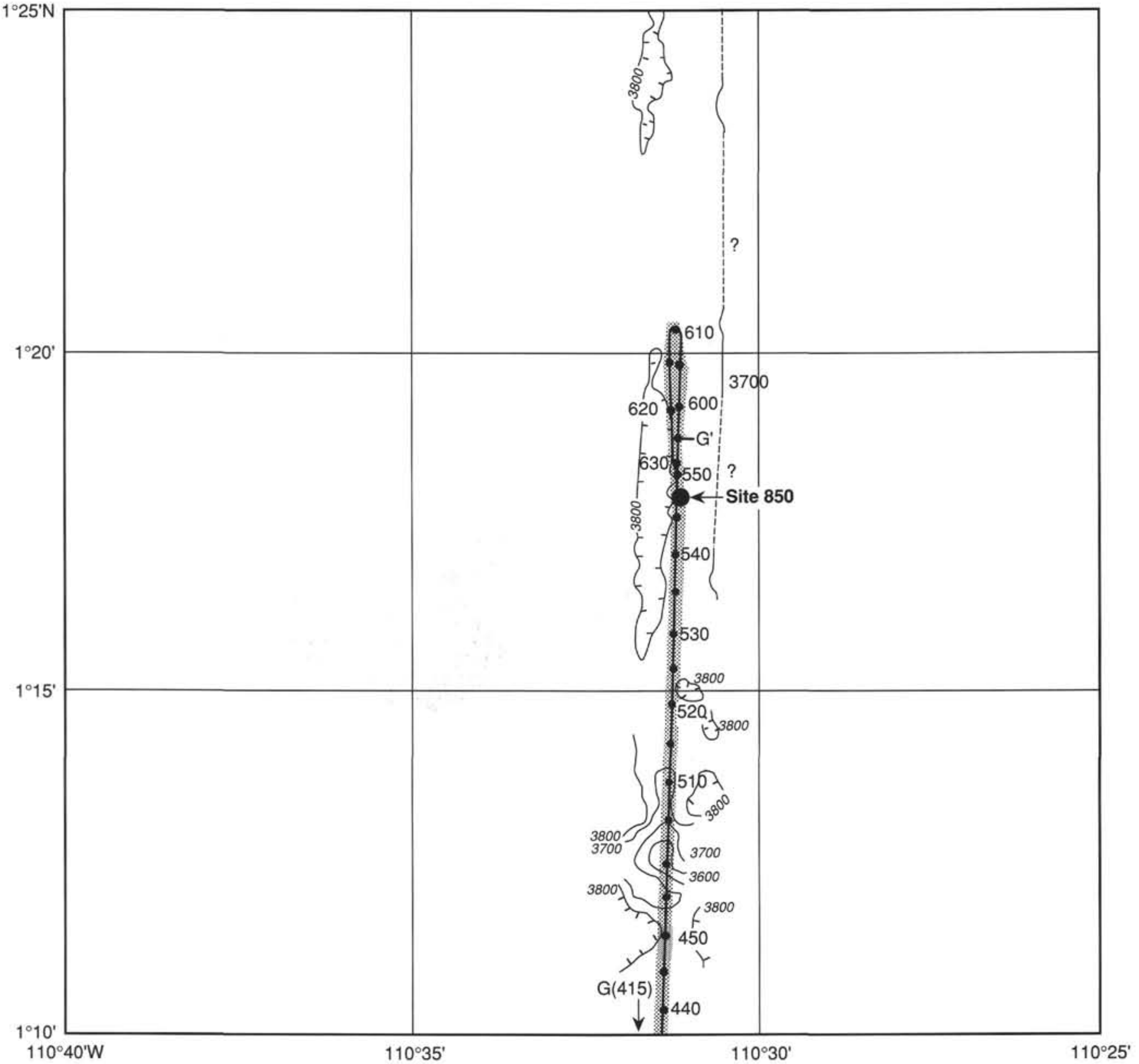

Figure 14. Site 850 regional bathymetry from *Thomas Washington* site-survey cruise and ship's track for single-channel seismic Line 7, including the location of profile G–G′ shown in Figure 15. Shaded region represents the complete seismic survey. Note that the start of the survey (0415 UTC) is off the map.

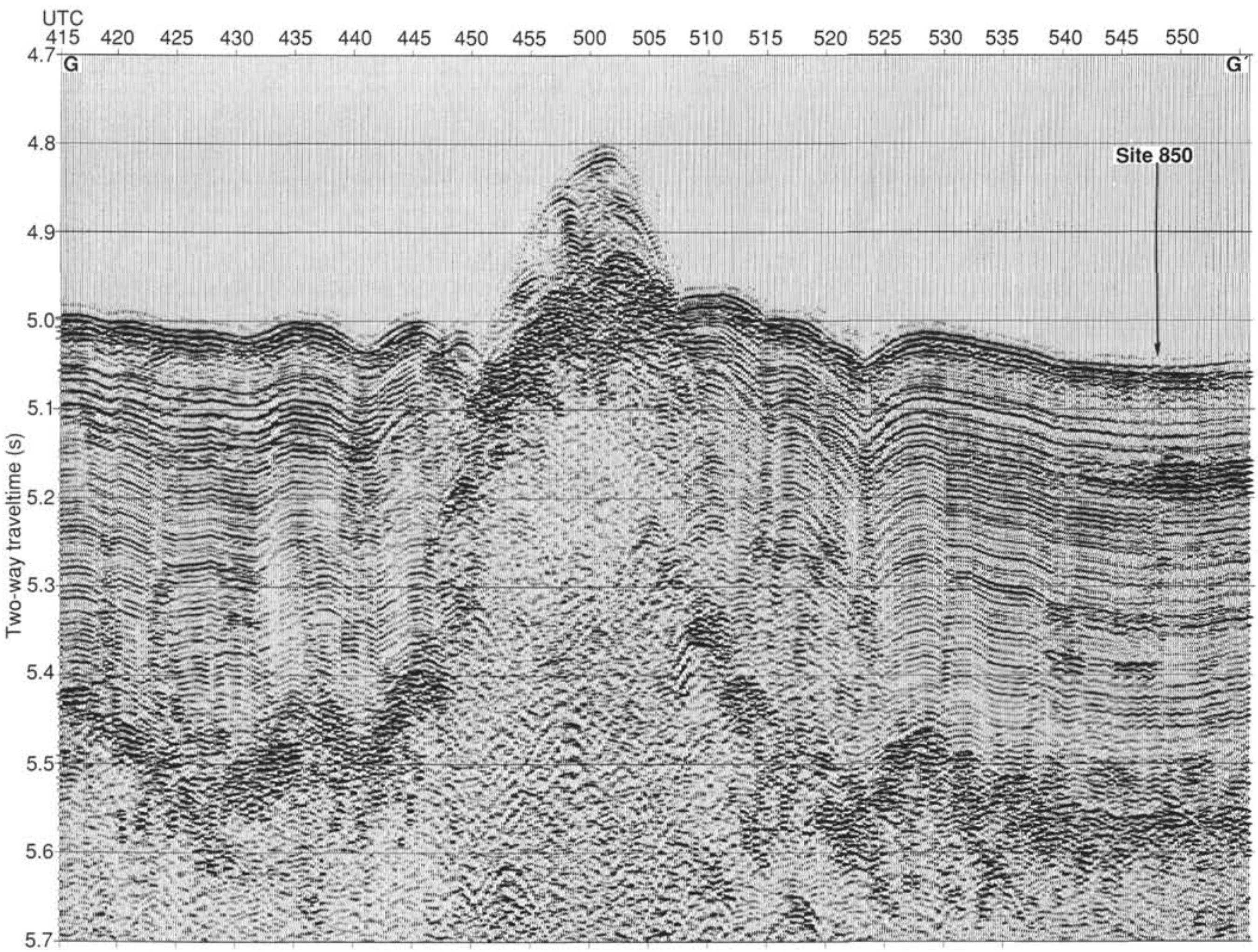

Figure 15. Profile G–G′ of processed single-channel seismic reflection Line 7 shown in Figure 14. The site was chosen in an area beyond the flanks of the seamount shown in a section where sediment was maximally thick (0.505 s twt).

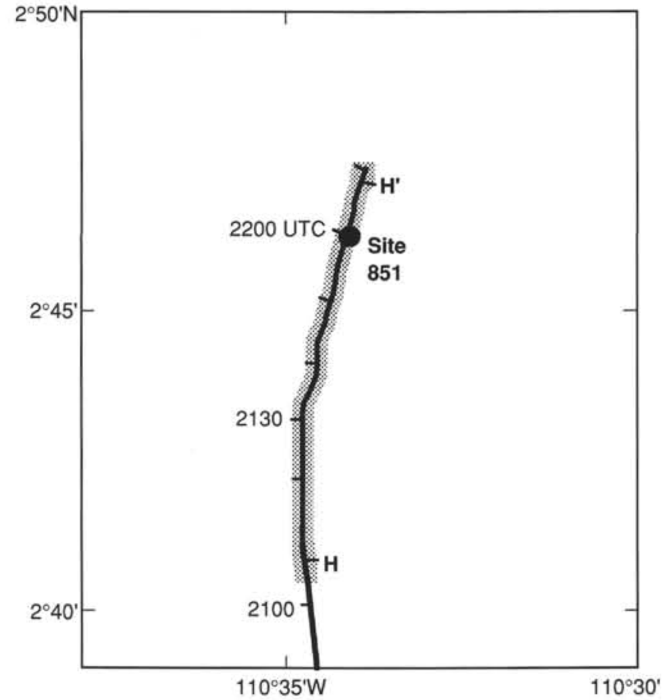

Figure 16. Ship's track for single-channel seismic Line 8, including the location of profile H–H′ shown in Figure 17. Shaded region represents the complete seismic survey.

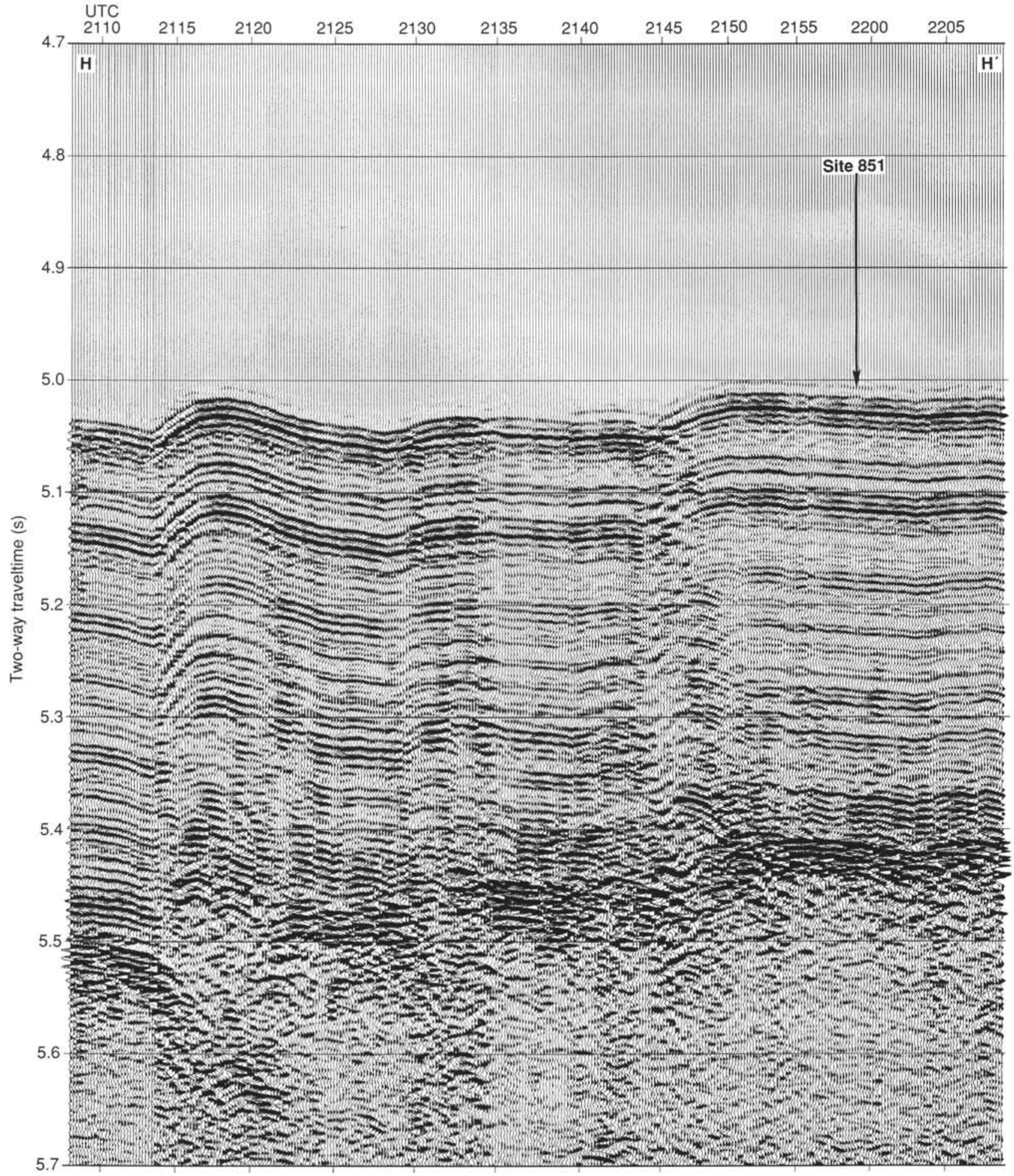

Figure 17. Profile H–H′ of processed single-channel seismic reflection Line 8 shown in Figure 16.

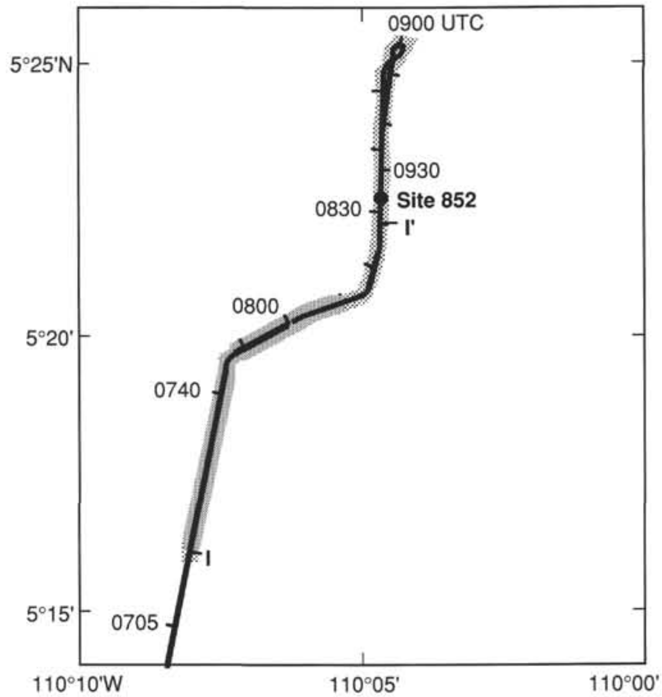

Figure 18. Ship's track for single-channel seismic Line 9, including the location of profile I–I′ shown in Figure 19. Shaded region represents the complete seismic survey.

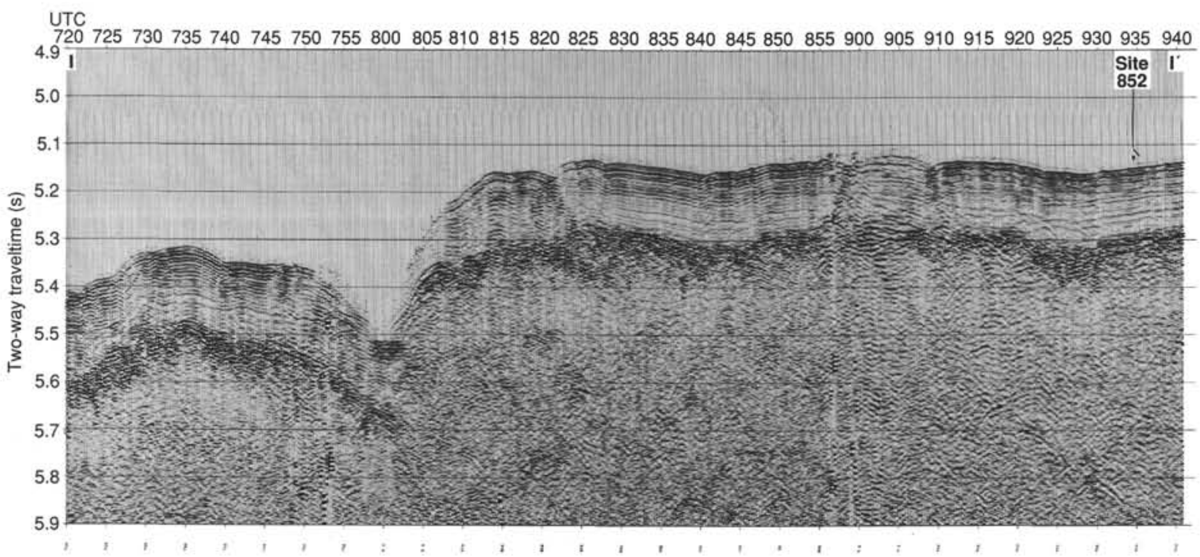

Figure 19. Profile I–I′ of processed single-channel seismic reflection Line 9 shown in Figure 18.

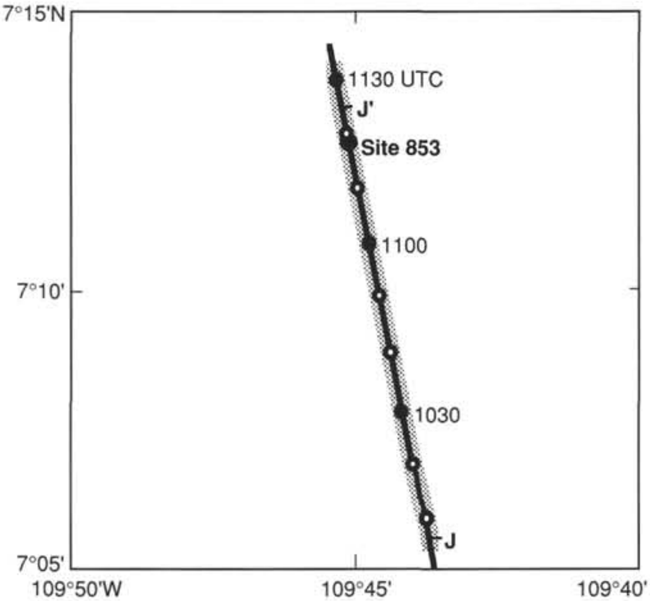

Figure 20. Ship's track for single-channel seismic Line 10, including the location of profile J–J' shown in Figure 21. Shaded region represents the complete seismic survey.

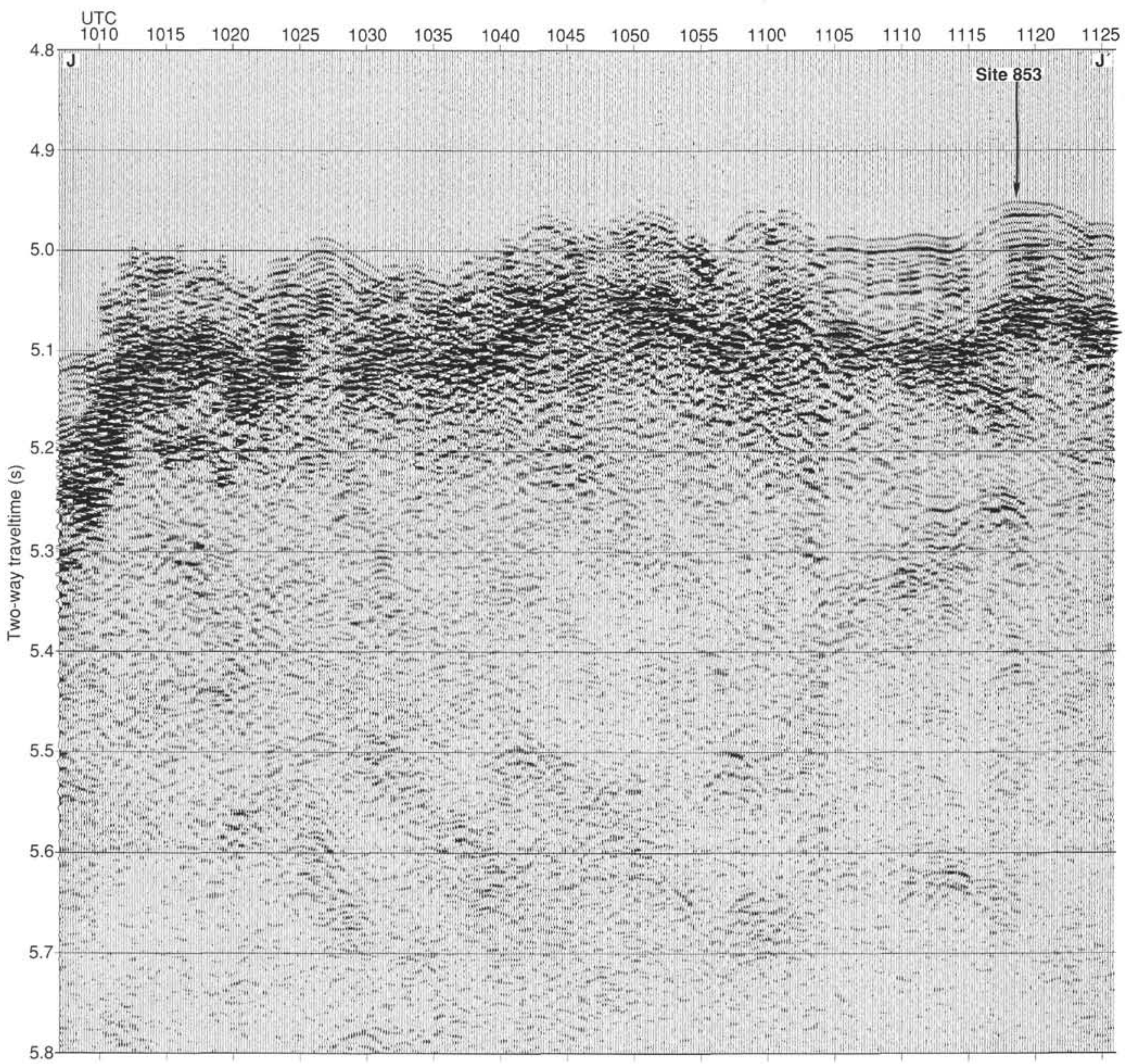

Figure 21. Profile J–J′ of processed single-channel seismic reflection Line 10 shown in Figure 20.