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CRUISE REPORT: HUNTEC® 3-D SURVEY, NEW JERSEY SHELF

Research Vessel: Cape Henlopen, University of Delaware

Dates: September 17-October 11, 1989 (inclusive).
-except for the period September 21-September 27, a delay caused by the approach and passage of Hurricane Hugo.

Port: embarkation and disembarkation at Lewes, Delaware.

Scientific Party:
University of Texas Institute for Geophysics (UTIG)
J. Austin, Chief Scientist
M. Wiederspahn, MASSCOMP digital acquisition system technician
D. Dean, u/w marine observer
W. Kessinger, "
A. Roberts, " (September 17-20 only)
Woods Hole Oceanographic Institution (WHOI)
J. Ewing, guest investigator - oblique reflection/refraction
E. Young, Huntec technician
John Chance and Associates, Inc.
Jim Williams, STARFIX navigation system operator

56 lines @ 2400 shots 170-225 6 KM 1.075 GB
7 lines @ 3600 shots 100-160 9 KM

399 km 1.276 Gb

215 NM

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September 17

Scientific parties from UTIG and WHOI arrive, late afternoon. (STARFIX gear unloaded and installed September 16-17.) UTIG MASSCOMP computers, tape drives, etc. unloaded and set up. Interfacing with STARFIX begins.

Weather outlook good - Hugo at this time in the vicinity of Puerto Rico, with future track uncertain. Expected departure still September 19, early morning.

September 18

Huntec gear arrives by truck from WHOI, mid-morning. Winch, electronics van and fish aboard and secure by late afternoon. Electrical problems with fish force operation to splice cable outboard of its termination. STARFIX/MASSCOMP interfacing continues, including referencing STARFIX UTM grid to known geoid and pre-surveyed position on the dock in Lewes.

Hugo track more ominous - east coast U.S. landfall probabilities increasing. Decision made to stay at the dock (at no vessel expense to the project) during September 19 to continue to monitor weather situation.

September 20

By 1200 hrs, Hugo track clear enough to force a decision to postpone for 10 days. Fortunately, Henlopen schedule flexible enough to allow for the delay, at no cost to the project, other than for extra travel. Kravitz (ONR) and John Chance & Associates, Inc. informed of the decision. [STARFIX remained aboard during the delay, powered down, at no cost to the project. The only additional expenses were for operator travel.] Preparations made for group departure, afternoon.

Huntec fish electrical problem apparently solved, so decision made to leave splice in place rather than re-terminate cable. [Note: This was a group decision which we had cause to regret later on, when we were forced to re-terminate. See October 2.]

Entire scientific party departs after lunch, to return September 28.

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September 28

Shipboard party returns, late afternoon. Weather forecast for SW winds 10-15 kts, becoming NE 15-20 kts. Seas 2-4'. Cloudy, but no precipitation forecast.

Anticipated departure 0730 hrs, 29 September.

September 29

0738 hrs: Depart the dock. Enroute to Site 6010 (39° 03.29'N, 73° 06.8'W). Weather as predicted. Transit speed 10-11 kts without paravanes, approximately 8 kts with paravanes deployed.

1210-1430 hrs: Huntec fish deployed and tested. Firing on distance at 2.2 kts with fire point trigger from the lab. 2kV and 4kV power settings. Everything apparently functioning normally. Approximately 400' of polypropylene line to be used for oblique reflection measurements streamed to remove kinks.

1830 hrs: Arrival at 6010. Fish deployed for test line, shooting (5 kV) at 1-sec intervals E to W along northern boundary of grid.

(One purpose of the first test, which was to be collected downwind, was to determine whether or not shooting both upwind and downwind was desirable/possible. The second goal was to establish geological similarity with the Huntec lines collected aboard the Atlantic Twin in 1988, which relied on LORAN C navigation (see Figure 1). [Note: The convention developed for shooting the 3-D grid was to call the northernmost line 225, the next line 10 m to the south 224, and so on, with the southernmost line in the prospective grid area to be designated line 100. See Figure 2.])

2030 hrs: No signal from the fish. Electrical continuity disrupted.

2045 hrs: Fish aboard and secure. Water found in junction box. Decision made to run new electrical cable from the winch to the fish outside the existing armored cable, bypassing some of the previously spliced electrical connections.

During repairs, bridge personnel practice precision line navigation using STARFIX bridge display.

30 September

1530 hrs: Huntec fish re-assembled with new lead-in cable, but weather too rough for immediate deployment: ~20 kts SE, seas 4-6'. Bridge continuing to practice line navigation with STARFIX.

1 October

1040 hrs: Huntec fish going in the water for testing. Begin shooting test line 225 downwind (i.e., to the W), on distance.

1154 hrs: End test line 225. Geology looks similar to 1988 coverage. Proceeding to E end of line 100 for another test.

1315 hrs: Begin shooting line 100 downwind (i.e., E to W) at 2.0-2.5 kts.

1405 hrs: End test line 100. Poor phase coherence of signal along the line: 1-2 ms jitter of sea floor and subsurface horizons. (We believed that this must be related either to weather, insufficient/improper body motion compensation, or the slow tow speed. A decision made to bring fish aboard for further checking.

1515 hrs: Fish on deck. In order possibly to improve phase correlation and reduce noise, decision made to shorten external hydrophone leader from 300" to 172" (distance from fish transducer to mid-point of 10-hydrophone cable), and to raise its tow point 63" above fish mid-line.

1730 hrs: Fish back in the water. Shooting downwind, at 1-sec firing rate, ~2.5 kts. Same problem encountered.

1808 hrs: Speeding up to ~3.5 kts. Record improved.

1825 hrs: Speeding up to ~4.5 kts. Record still better.

1920 hrs: Transiting back to 6010 site. Based upon the speed test, the following decisions were made:

1.) Shoot on distance, but increase nominal shot spacing from 1.25 m to 2.5 m and increase tow speed to 4.0-4.5 kts, while scrutinizing integrity of towing arrangement made sensitive because of attached external cable.

2.) Increase long (i.e., E-W) dimension of prospective survey rectangle to 6 km from 3 km (Figure 1).

3.) To minimize relative fish movement at the higher tow speeds and to minimize wear and tear on bridge personnel, shoot only in one direction, downwind. [Note: This turned out to be from W to E for almost the entire 3-D survey.]

2107 hrs: Begin line 225.

2148 hrs: End line 225.

2250 hrs: Begin line 224.

2255 hrs: Abort line 224. No signal.

2345 hrs: Huntec fish aboard. Some external damage to tow body from undefined cause, but no obvious electrical problem. However, no chance to diagnose on deck, because of rain and rising winds (15-25 kts) from the S.

2 October

0200 hrs: Decision made to return to Lewes for fish repairs.

1035 hrs: Arrive the dock, Lewes. Decision made to re-terminate armored cable connection to the fish, in order both to remove unwieldy external cable and to remedy possible short-circuits created by multiple cable splices.

3 October

1700 hrs: Re-termination completed, after a total of 173' of heavily used cable removed from the drum. Fish in the water at the dock for testing. Electrical source for persistent leak alarm not found, but everything else apparently functioning normally. Alarm turned off.

Decision made to depart the dock at ~2130 hrs with the tide for further testing in 35+m of water in Delaware Bay.

2112 hrs: Depart the dock for Delaware Bay. Weather poor: ~25 kts NW, seas 6'.

2235 hrs: Fish in the water, Delaware Bay ship channel. Shooting downwind at ~4.8 kts.

2345 hrs: Test successful. Fish aboard and underway for 3-D survey area.

4 October

1030 hrs: Arrive survey area. Winds 25 kts NW, seas 8'. After running a navigation test downwind with ±10 m deviations, decision made to delay deployment and heave to until weather improves. (Unfortunately, NW winds only got stronger during the day, and were blowing 30-40 kts by 2300 hrs.)

5 October

1200 hrs: Still too rough for deployment. Decision made to give bridge personnel additional navigation practice on lines 224-222.

1800 hrs: After some weather moderation, fish in the water. Distance from fish to mid-point of external hydrophone shortened to 156", with tow point 50" above the fish mid-line. After raising fish slightly, at a speed of ~4.6 kts, tow wire angle steady at 35-40°. [Note: Wire angles were observed and recorded throughout the cruise, although they are not reported here.] Lining up for line 224, to be shot downwind (i.e., W to E).

1824 hrs-end of day: shooting 3-D grid, from W to E and progressing N to S (Figure 2).

6 October

0000-2359 hrs: Continue to shoot 3-D grid (through line 208, see Figure 2).
[Note: After line 214, we begin triggering digital and analog recording using navigation closure, not fire point trigger, in order to take advantage of Huntec's body motion compensation (BMC) feature. This was a misconception about the operation of the system, which was rectified when we realized from the analog records that the sea-floor was not being corrected for rapid changes in fish depth caused by fantail and wave motion. Fortunately, both triggers were being recorded, so static corrections for the digital data from lines 225-214 should be possible, at least to the nearest ms.]

7 October

0000-2359 hrs: Continue shooting 3-D grid (through line 194).
[Note: Throughout this period, winds were 20-25 kts, first from the SW and then from the NW, seas 3-6'. Despite the weather, however, navigation of the Henlopen remained consistent (see Figure 2), a tribute both to STARFIX and to the skill of the bridge crew in navigating the aluminum-hulled, shallow-draft vessel in quartering winds and seas.]

8 October

0000-0555 hrs: Continue shooting 3-D grid (through line 191).

0608 hrs: Stop the ship enroute to line 190 to calibrate fish pressure (depth) transducer by actually measuring the cable while surfacing the fish. Weather excellent: winds less than 10 kts from the NW, seas 2'.
[Note: This exercise showed the fish depth read-out on the Huntec body motion compensator (BMC) to be in error, as had already been surmised by John Ewing from estimates of the fish depth using the analog recordings and spot checks of water depth taken with the ship's fathometer. Earl Young discovered that part of the problem (a differential of ~9 m) was a modification to the BMC made by the U.S. Geological Survey during its use of the WHOI system, and that was corrected. However, even after that correction, fish depths were in error by ~6 m, for no apparent reason. Fortunately, BMC depths were recorded for each line. Therefore, systematic corrections to obtain actual fish depth (corroborated by the analog records) could be made, which will be important for determining average fish location behind the fantail for each line.]

0738 hrs-end of day: Continue shooting 3-D grid (through line 181).

9 October

0000-1756 hrs: Continue shooting 3-D grid (through line 170).

1800 hrs: Turn downwind for oblique reflection work.

1820 hrs: Oblique reflection data acquisition complete. Enroute to line 160.
[Note: By 5 October, we knew that we could not complete all of the originally proposed grid in 3-D. Consequently, we followed a suggestion by John Ewing and spent some of the remaining day completing the originally proposed grid at a 100 m spacing, in order to expand our true 3-D coverage (about 50% of that originally proposed) and in the process pin down spatial orientations of the outcrop of the "R" unconformity and adjacent channels (see Figure 3). The plan was to shoot lines 160, 150, 140, and so on, ending with line 100. With any time remaining, we could then proceed back to line 169 for continued N to S 3-D operations at a 10 m line spacing.]

1921 hrs: Begin line 160. Problem with pressure compensation. Decision made to finish the line, then check the BMC and pull the fish for further checks.

2130 hrs: Line 160 completed and fish on deck. Pressure reading on deck looks OK.

2145 hrs: Fish back in the water to same depth. Enroute to re-shoot line 160.

2230 hrs: Same problem, apparently becoming progressively worse as tow speeds increase to 5-6 kts.

2330 hrs: Fish back out of the water to check pressure transducer/power source.

10 October

0110 hrs: Fish back in the water again. Underway for beginning of line 150.

0125 hrs: Same problem with the fish.
(As the boomer sound source appeared to be functioning properly, and the weather was good, the decision was made to remove the BMC for the remainder of lines 150 through 100, which would also each be extended 3 km to the E (for a 9 km total length).

0306-1441 hrs: Shoot lines 150 through 100. Weather beautiful: NW winds less than 10 kts, seas 1-2'.

1500-2010 hrs: Further oblique reflection/refraction work carried out along line 188, one of the best examples of a well-navigated line within the 3-D portion of the grid. Results with hydrophone both floating (for oblique reflection) and stationary on the sea floor (for refraction) apparently successful.

2120 hrs: Fish on board. Enroute to Lewes.

11 October

0730 hrs: Arrive the dock, Lewes. End of cruise.

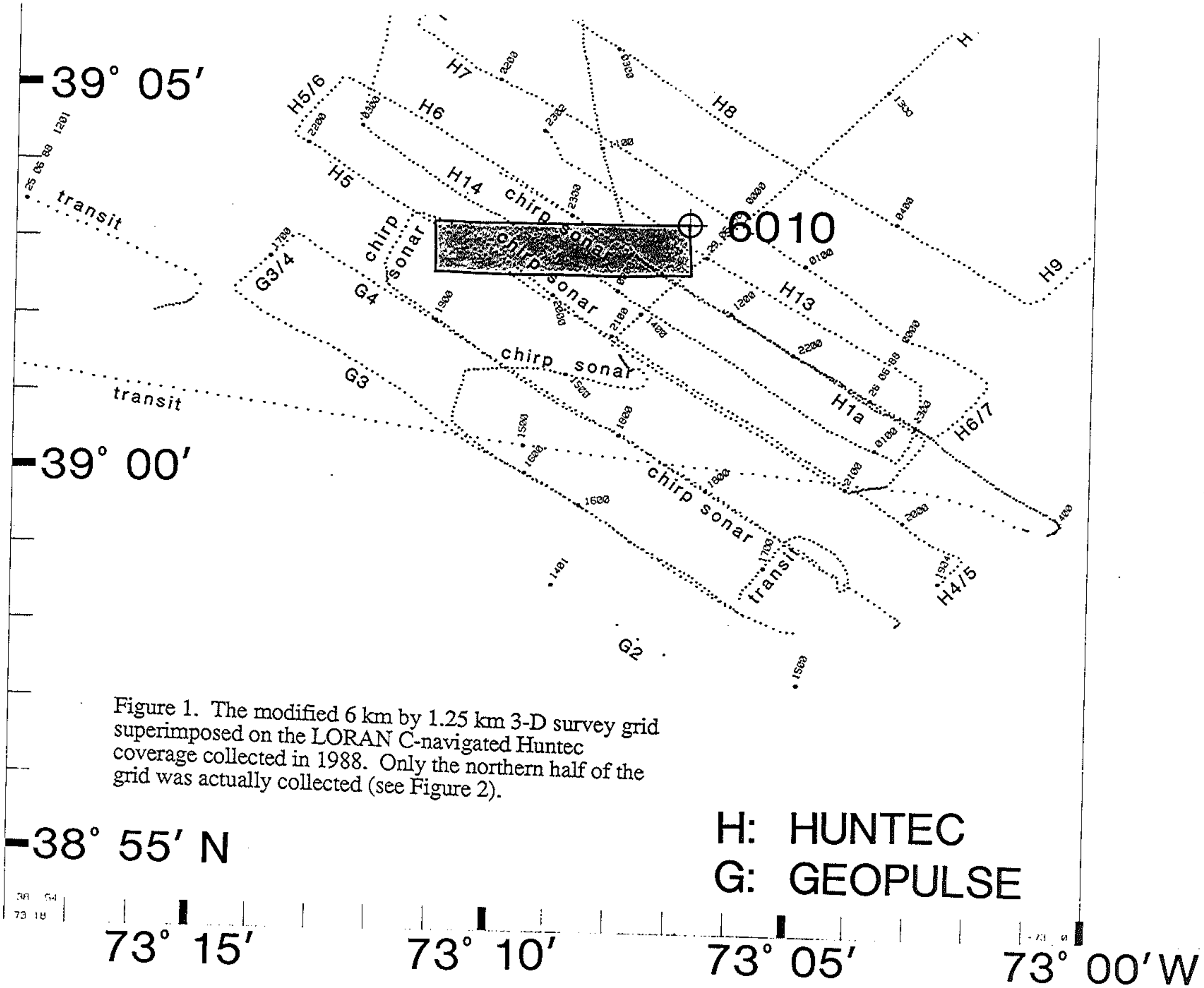

Figure 1. The modified 6 km by 1.25 km 3-D survey grid superimposed on the LORAN C-navigated Huntec coverage collected in 1988. Only the northern half of the grid was actually collected (see Figure 2).

DATE OF RUN: 12/ 1/89/ 846.00
CNR CRUISE ATLANTIC TWIN 88-01 "6010"

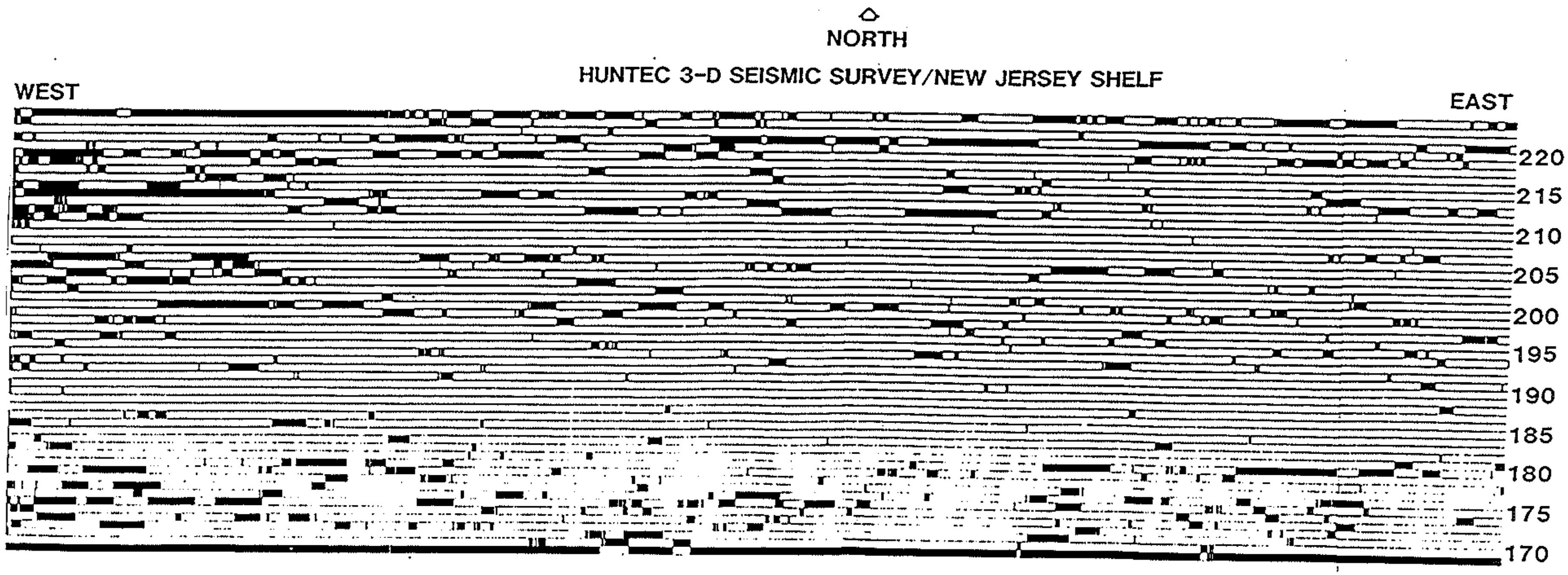

Figure 2. A shot/bin plot for the true 3-D portion of the survey. Each horizontal track is 10 m wide, and the rectangle is 6 km long east-west. For the purposes of this plot, a bin was defined as being 2.5 m (the shot distance) long along the line and 10 m wide (± 5 m either side of each track's mid-line). A bin was considered "filled" when a shot occurred within it. All filled bins are white. An unfilled bin is black, an occurrence almost invariably caused by a > 5 m deviation from the mid-line while steering the Henlopen downwind. (This was particularly true near the west end of the grid, because lining up the ship for each line was one of the most challenging tasks which faced the bridge.) However, occasional bad STARFIX positions account for some of the individual unfilled bins, and long, unfilled portions of lines 224 and 214 are periods when the binning program was not operative. Line 169 is unfilled because it was never shot, and it is included only to complete coverage for line 170.

Note that improved weather conditions (i.e., lines 180-195) generally meant more complete coverage, particularly near the beginning (i.e., west end) of lines. Fortunately, there were few instances of unfilled bin intervals along immediately adjacent lines, so processing should allow closure of most of the visible gaps in coverage.

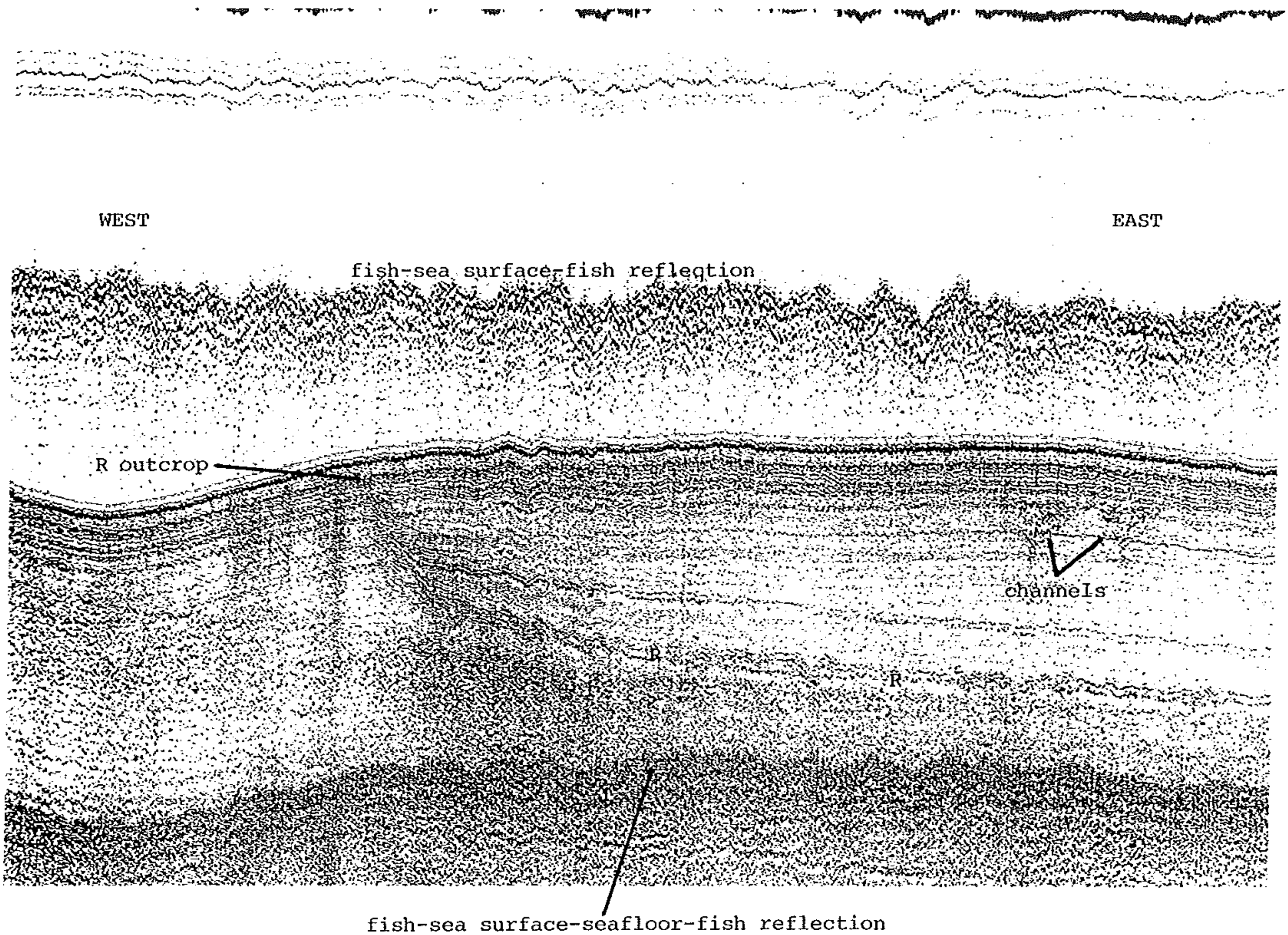

Figure 3. Line 189, an example of the analog data collected within the 3-D grid. Note the outcrop of the "R" unconformity, and the small channels to the east. Subtle changes in these channels can be discerned from line to line, even though the lines are only 10 m apart.