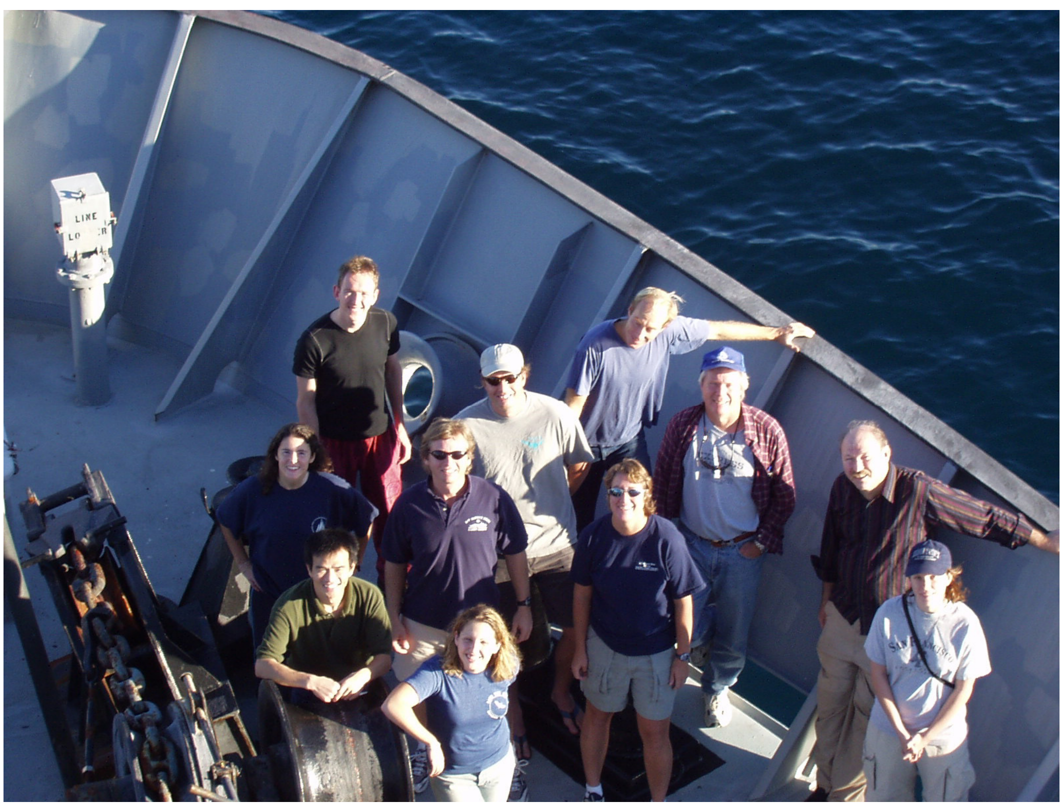
Blanco Transform Seismic Cruise

Cruise Report
October 20 – November 3, 2004
R/V *Maurice Ewing*



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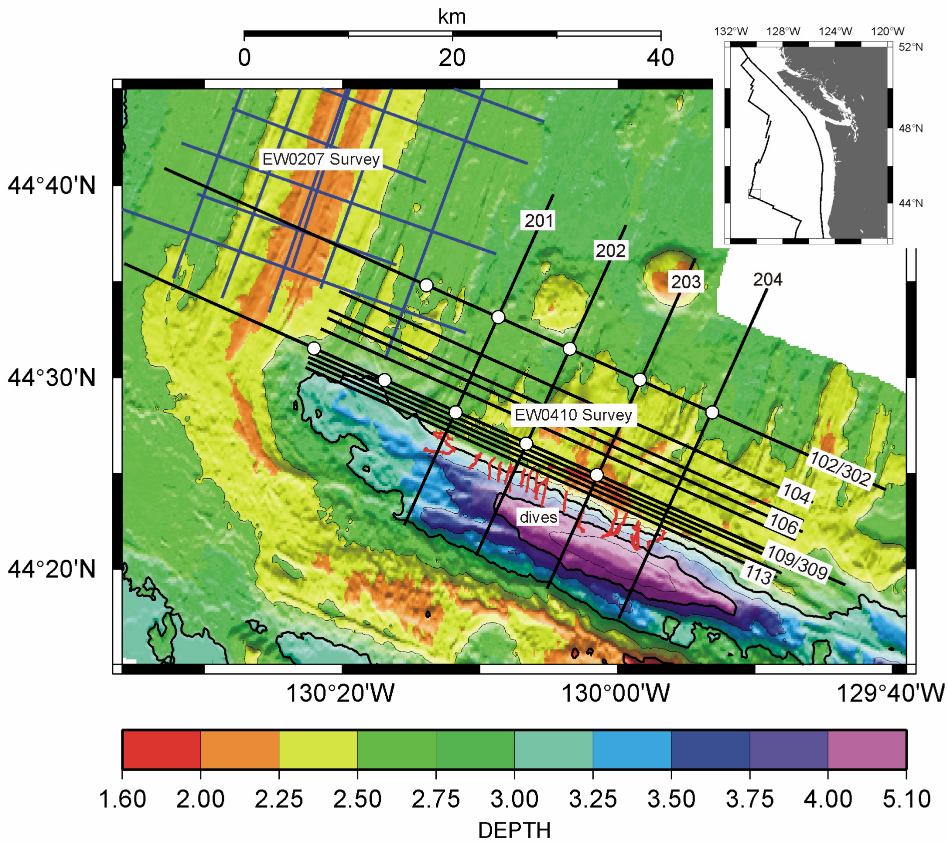
Cruise Summary

The Blanco Transform Seismic cruise acquired marine seismic reflection and refraction data October 20 - November 3 at the Blanco Transform in the Pacific Ocean. The 360-km-long Blanco Transform links the Gorda Ridge to the south and the Cleft segment of the Juan de Fuca Ridge to the north. The northern wall of the transform fault is stair-stepped with major cliff faces providing continuous outcrops up to hundreds of meters high; submersible dives along these cliff faces have been able to map the uppermost 2 km of the exposed oceanic crust over a lateral distance of tens of kilometers. The program acquired seismic data on the plateau adjacent to the exposed wall at the transform; the primary objective of the cruise is to make a direct link between the geologic and seismic structure of intermediate-spreading oceanic crust. A companion program took place in July 2003 where fast-spreading oceanic crust is exposed at Hess Deep. Primary questions that should be addressed by the seismic experiments include: 1) Is there a correlation between seismic and geologic structure at the Blanco Transform? 2) Is the seismic structure at the Blanco Transform typical of intermediate-spreading crust? 3) What is the evolution of the shallow velocity structure from zero-age rise-axis crust to the 0.65-1.65 Ma crust in the study areas?



The program acquired 10 scarp-parallel MCS profiles and 4 scarp-perpendicular MCS profiles. OBSs were located along 2 of the scarp-parallel profiles, and these lines were reshot with a longer shot interval in order to minimize previous shot noise. Three planned profiles were not acquired because of a 2-day shutdown during bad weather. All 12 OBSs were recovered and 10 provided useable data.

Preliminary stacks indicate that the layer 2A reflector is located on average ~400 ms below the seafloor, with an average interval velocity of ~3300 m/s. This corresponds to a layer 2A thickness of 660 m. Lavas exposed at the Blanco Transform Fault have been mapped by 27 submersible dives and have a thickness of 1000-1500 m. The lavas consist of a 200-500 m upper unit of undeformed or weakly fractured basaltic lavas underlain by 300-900 m of intensely fractured basaltic lavas. Thus our preliminary seismic results indicate that seismic layer 2A is located within the lava unit, perhaps near the boundary between the upper and lower lava units. This is in contrast to the results we found at Hess Deep, where seismic layer 2A was located near the extrusive – dike boundary at this region of fast-spreading crust.

Hess Deep Cruise Crew and Scientist List

<u>Science Party (23 Persons):</u>
Gail Christeson – Chief Scientist
Kirk McIntosh – Co-Chief Scientist
Ben Yates – OBS Operations
John Gerboc – OBS and Computer
Steffen Saustrup – OBS and Computer
Janet Baran – Watchstander
John Hillier – Watchstander
Garrett Kramer – Watchstander
Meagan Pollock – Watchstander
Gillian Rosen – Watchstander
Ting Yang – Watchstander
Karl Hagel – Science Officer
Richard Oliver-Goodwin – Systems Manager
Dietmar Kathmann – Electronics Tech
John DiBernardo – Gunner
Carlos Gutierrez – Gunner
Justin Walsh – Gunner
Mari Smultea – Marine Mammal Observer
Sarah Stoltz – Marine Mammal Observer
Howie Goldstein – Marine Mammal Observer
Joseph Beland – Marine Mammal Observer
Thomas Norris – Marine Mammal Observer

<u>Crew List (20 Persons):</u>
Mark Landow – Master
David Wolford – Chief Mate
Robert J Lyons, Jr – 2nd Mate
Elliott Gabbert – 3rd Mate
David Philbrick – Bosun
David Guinn – A/B
Jeremy Beckett – A/B
Eugene Otto, Jr – A/B
Brandon McBride – O/S
Roger Strimback – O/S
Stephen Pica – Chief Engineer
Matthew Tucke – 1st Engineer
Bradford McDermott – 2nd Engineer
Jieu Nguyen – 3rd Engineer
Dean Scallenkamp – Oiler
Rodolfo Florendo – Oiler
George Mardones – Oiler
Gary Brodock – Steward
Ricardo Rios – Cook
Victoria Montgomery – Utility
John Schwartz - Electrician

Science Lab Watch Schedule

8-12 – Gail Christeson, Janet Baran, and John Hillier
12-4 – Kirk McIntosh, Meagan Pollock, and Garrett Kramer
4-8 – Steffen Saustrup, Gillian Rosen, and Ting Yang

Cruise Diary

October 20 – Our initial plan was to leave port in the morning of Oct 20, but instead we plan an after-dinner departure as we wait for the IHA permit to come through. In the early afternoon the IHA does come in, so we are able to sail at 17:30. Weather is chilly but clear.

October 21 – We arrive at our study area at ~2000 and begin deploying OBSs. One OBS has stopped working, but Ben is able to get it running again and thus all 12 OBSs are able to be deployed. Deployments are routine, except for OBS 2 that gets turned as the A-frame moves it over the side – when Steffen pulls the pins to drop it in the water one of them gets caught, but eventually the OBS does release from the pin.

October 22 – OBS deployments are completed at 0347, and the ship steams at a course of 140° for several hours prior to streamer deployment which begins at ~0830. The streamer was last used in a 1500-m configuration in the Gulf of Alaska; prior to that it was used as 6-km streamer in the Caribbean. During streamer deployment and balancing we have to: 1) remove the stretch section from the 1500-m configuration, 2) add 2 sections to replace 2 bad sections that had been removed during the Gulf of Alaska cruise, 3) replace a bad can, 4) remove weights from the Caribbean sections because the streamer is riding too deep (this requires bringing a large portion of the streamer back in), 5) replace a section that has some bad channels, and 6) replace a section that springs a leak during deployment. Streamer deployment is completed and the first shot of BL 111 is made at 20:00.

October 23 – Lines BL 111, 106, 113, and 105 are completed. A storm to the north is creating large swells, and the streamer periodically gets large waves that propagate along the streamer. These appear to diminish after we deepen the streamer from 8 m to 9 m after BL 106.

October 24 – Lines BL 109, 102, and 104 are completed. The seas have calmed down and the streamer looks excellent. However we get word via the captain that a weather system may hit the evening of the 25th and we may have to stop shooting.

October 25 – Line BL 107 is completed, but during BL 112 at 0945 we decide to pull in the gear to wait out the coming storm. Winds are already gusting over 40.

October 26 – Winds are in the 40s gusting to the low 50s, but barometric pressure is rising and we think that the low has now moved to our south. We are hopeful that we can start acquiring data again tomorrow.

October 27 – Calm weather greeted us in the morning, and we were able to start deploying the gear. By early afternoon we were again acquiring data. We decided to change our line order slightly and start data acquisition with the 2 OBS profiles shot at 200 m shot spacing (BL 302 and 309).

October 28 – BL 309, 201, and 202 are completed.

October 29 – BL 203, 204, 112, and 110 are completed. Because of the 2-day shutdown for weather we do not have time to shoot BL 108, 103, or 101. Our last shot is at 2202, and we begin pulling in the guns and streamer.

October 30 – The tail buoy is onboard at 0147, and we begin recovering the 12 OBSs. OBS recovery is completed at 2100 and we start our transit to San Diego.

Detailed Summary, Cruise Activities

Task	Time (local time)
Leave Astoria	10/20/2004 17:30
Deploy OBS 06	10/21/2004 20:09
Deploy OBS 05	10/21/2004 20:56
Deploy OBS 04	10/21/2004 21:34
Deploy OBS 03	10/21/2004 22:17
Deploy OBS 02	10/21/2004 23:03
Deploy OBS 01	10/21/2004 23:49
Deploy OBS 07	10/22/2004 0:39
Deploy OBS 08	10/22/2004 1:19
Deploy OBS 09	10/22/2004 1:56
Deploy OBS 10	10/22/2004 2:33
Deploy OBS 11	10/22/2004 3:09
Deploy OBS 12	10/22/2004 3:47
Deploy streamer, guns, transit	10/22/2004 20:00
Acquire BL111	10/23/2004 1:41
Transit	10/23/2004 2:22
Acquire BL106	10/23/2004 8:23
Transit	10/23/2004 9:06
Acquire BL113	10/23/2004 15:07
Transit	10/23/2004 16:03
Acquire BL105	10/23/2004 22:02
Transit	10/23/2004 22:43
Acquire BL109	10/24/2004 7:07
Transit	10/24/2004 8:27
Acquire BL102	10/24/2004 16:47
Transit	10/24/2004 17:32
Acquire BL104	10/24/2004 23:32
Transit	10/25/2004 0:15
Acquire BL107	10/25/2004 6:12
Transit	10/24/2004 6:56
Acquire BL112 (east)	10/25/2004 9:56
Weather delay	
Acquire BL302	10/27/2004 22:57

Transit	10/28/2004 0:25
Acquire BL309	10/28/2004 8:45
Transit	10/28/2004 12:24
Acquire BL201	10/28/2004 16:35
Transit	10/28/2004 17:41
Acquire BL202	10/28/2004 21:52
Transit	10/28/2004 23:05
Acquire BL203	10/29/2004 3:16
Transit	10/29/2004 4:22
Acquire BL204	10/29/2004 8:35
Transit	10/29/2004 10:32
Acquire BL112 (west)	10/29/2004 14:25
Transit	10/29/2004 16:03
Acquire BL110	10/29/2004 22:02
Recover streamer, guns, transit	10/30/2004 2:38
Recover OBS 12	10/30/2004 3:33
Recover OBS 11	10/30/2004 5:18
Recover OBS 10	10/30/2004 6:50
Recover OBS 9	10/30/2004 8:32
Recover OBS 8	10/30/2004 10:14
Recover OBS 7	10/30/2004 11:55
Recover OBS 1	10/30/2004 13:29
Recover OBS 2	10/30/2004 14:55
Recover OBS 3	10/30/2004 16:28
Recover OBS 4	10/30/2004 18:08
Recover OBS 5	10/30/2004 19:32
Recover OBS 6	10/30/2004 20:59

First and last recorded shots for each seismic profile

Line	First Shot	Latitude	Longitude	Last Shot	Latitude	Longtitude
111*	121	44.33543	-129.80743	1441	44.51772	-130.37467
106*	103	44.55140	-130.35140	1444	44.36552	-129.77637
113	9	44.32594	-129.80723	1336	44.50871	-130.37765
105	1	44.55845	-130.34916	1336	44.37496	-129.77459
109	1	44.34139	-129.79344	1869	44.59863	-130.59717
102	1	44.68138	-130.54867	1869	44.42428	-129.74372
104	3	44.39128	-129.76323	1336	44.57462	-130.33704
107	1	44.54214	-130.35923	1336	44.35875	-129.78475
112E[§]	2	44.32946	-129.80143	621	44.41440	-130.06749
302	1	44.62976	-130.38718	311	44.40223	-129.67518
309	1	44.31920	-129.72468	311	44.54717	-130.43538
201	1	44.37126	-130.25830	934	44.65848	-130.07805
202	1	44.63202	-129.98987	934	44.34521	-130.17130
203	2	44.31636	-130.08538	934	44.60340	-129.90590
204	1	44.57726	-129.81887	934	44.29005	-129.99880
112W[§]	478	44.39606	-130.00534	1336	44.51304	-130.37501
110	1	44.52164	-130.37190	1336	44.33796	-129.79776

* Lines BL111 and 106 had a 100 shot run-in. This was removed for subsequent lines since the waypoints included a run-in.

[§] Line BL112 was shot in 2 sections due to a weather shut-down.

Source Array for Blanco reflection profiling

We made one modification to the typical R/V Ewing (Diebold), 10-airgun array for oceanic crustal profiling. We removed the 540 cu.in. airgun from y=-3.9 (position 9) and added a 585 cu.in. airgun at y=10.6m (position 16). We towed the array at 8 m depth using floats. This is the same array as that used at our 2003 Hess Deep survey, except that we increased the depth of the array from 7 m to 8 m.

Number of guns (Bolt 1500C): 10

Gun numbers relative to the R/V Ewing 20 airgun array:
(gun numbers increasing from starboard to port)

GUN	X(m)	Y(m)	Z(m)	VOL(cu)	PR(psi)
1	35.10	-16.80	7.00	145.00	2000.0
3	39.60	-13.70	7.00	305.00	2000.0
4	35.10	-12.20	7.00	235.00	2000.0
7	35.10	-7.60	7.00	80.00	2000.0
8	44.20	-6.10	7.00	850.00	2000.0
12	39.60	3.90	7.00	385.00	2000.0
14	35.10	7.60	7.00	120.00	2000.0
16	44.20	10.60	7.00	585.00	2000.0
17	35.10	12.20	7.00	200.00	2000.0
20	35.10	16.80	7.00	145.00	2000.0
SPARE:					
2	39.60	-15.30	7.00	850.00	2000.0

Shot spacing was 37.5 m, and we attempted to keep the ship speed over ground at ~4.5 knots. Recording length was 12 sec. The streamer was towed at 8 m for profiles BL 111 and 106. Streamer depth was increased to 9 m for the remaining profiles in an attempt to decrease the noise on the streamer. After the depth increase the streamer did appear to tow at a more constant depth and the shot gathers were less noisy.

Source Array for Hess Deep refraction shooting

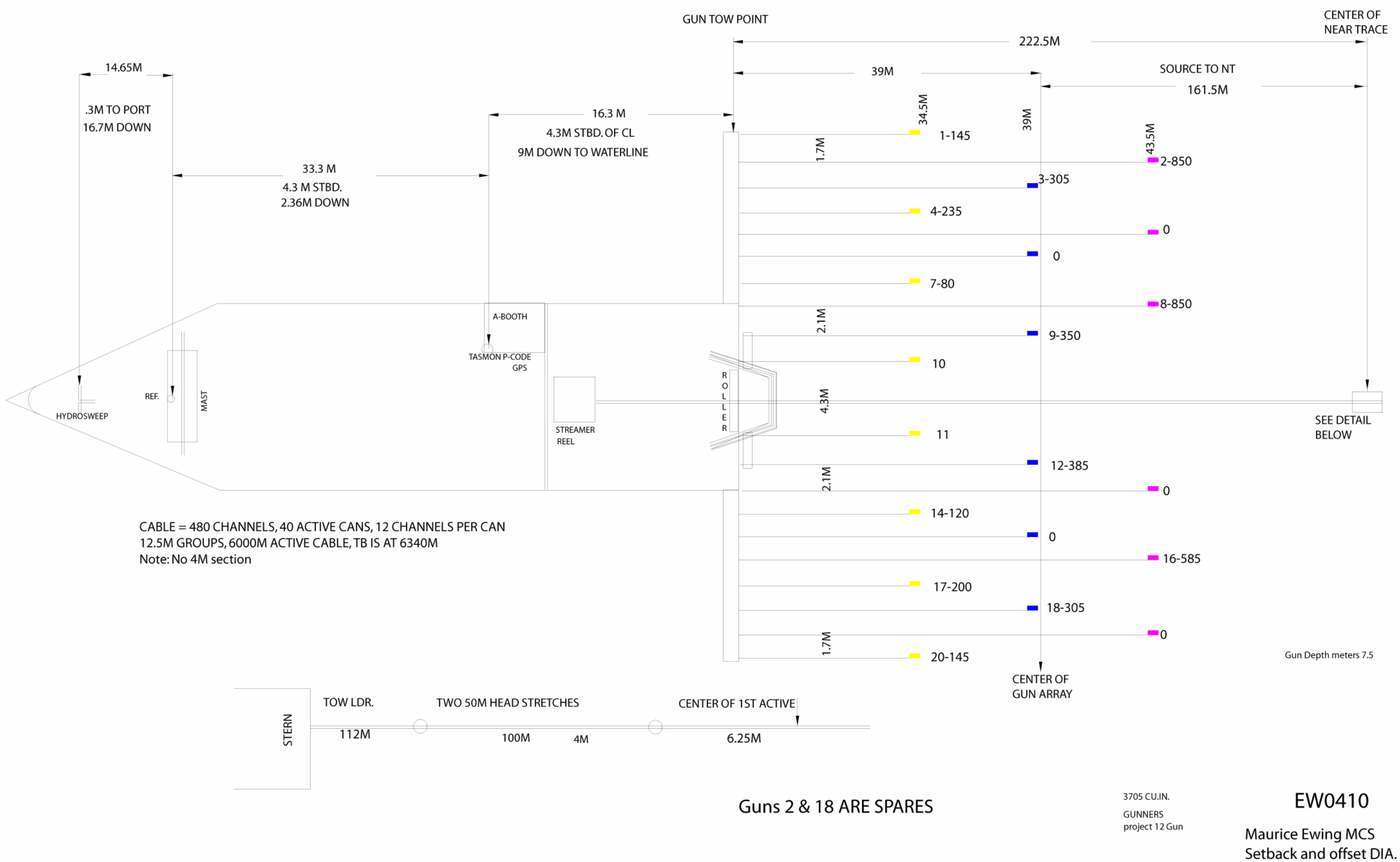
For **REFRACTION PROFILING**, we added **two additional airguns** to the MCS array in positions 9 and 18:

Number of guns: 12

GUN	X(m)	Y(m)	Z(m)	VOL(cu)	PR(psi)
1	35.10	-16.80	7.00	145.00	2000.0
3	39.60	-13.70	7.00	305.00	2000.0
4	35.10	-12.20	7.00	235.00	2000.0
7	35.10	-7.60	7.00	80.00	2000.0
8	44.20	-6.10	7.00	850.00	2000.0
9	**39.60**	**-3.90**	**7.00**	**350.00**	**2000.0**
12	39.60	3.90	7.00	385.00	2000.0
14	35.10	7.60	7.00	120.00	2000.0
16	44.20	10.60	7.00	585.00	2000.0
17	35.10	12.20	7.00	200.00	2000.0
18	**39.60**	**13.70**	**7.00**	**305.00**	**2000.0**
20	35.10	16.80	7.00	145.00	2000.0
SPARE:					
2	39.60	-15.30	7.00	850.00	2000.0

Shot spacing was 200 m, and ship speed was 4 knots.

MAURICE EWING MCS SETBACK AND OFFSET DIAGRAM



Seisnet and the data recording system (Saustrup)

EW0410 saw the recurrence of previously-observed problems in the Ewing's MCS data recording system. While the original SEGD 3490 tape recording system appeared to work flawlessly, our goal of walking off the boat with a complete set of SEGY field data on DDS3 tape was achieved only with considerable difficulty.

The process of getting data to DDS3 tape involves two steps, and both of these steps have problems. The first step involves the Seisnet system, which splits off a copy of the MCS data on its way to the 3490 drive and writes the data in Seisnet (pseudo-SEGD) format onto a RAID disk. EW0410 did not experience the numerous crashes of the entire Seisnet system seen during the EW0404 cruise, but we did experience periodic loss of data written to RAID disk for reasons unknown. Four of the 14 MCS lines acquired during EW0410 were missing shots in Seisnet format, ranging from ~2% to ~25% of each line. These data were later recovered from 3490 tape and written to DDS3 tape manually.

The Seisnet system, however, did prevent data loss in the one instance during which field data were not recorded to 3490 tape due to operator error (a locked tape was indvertantly loaded into a tape drive).

The second step in the SEGY-to-DDS3 process involves LDEO-written scripts that read the Seisnet files from RAID, convert them to SEGY format, and write them to DDS3, disk, and DLT tape. These scripts hang or crash often (perhaps on a daily basis or more often) and need to be restarted. This behavior has been observed consistently for several cruises now. These scripts are in need of maintenance.

The original hope was for the SEGY-to-DDS3 system to be fairly automated, requiring little more than occasional tape changes from watchstanders and regular note-keeping. As it is, the system requires significant attention from both the Ewing's Systems Administrator and the science party's processor/computer person and there is little that watchstanders can do to administer the process.

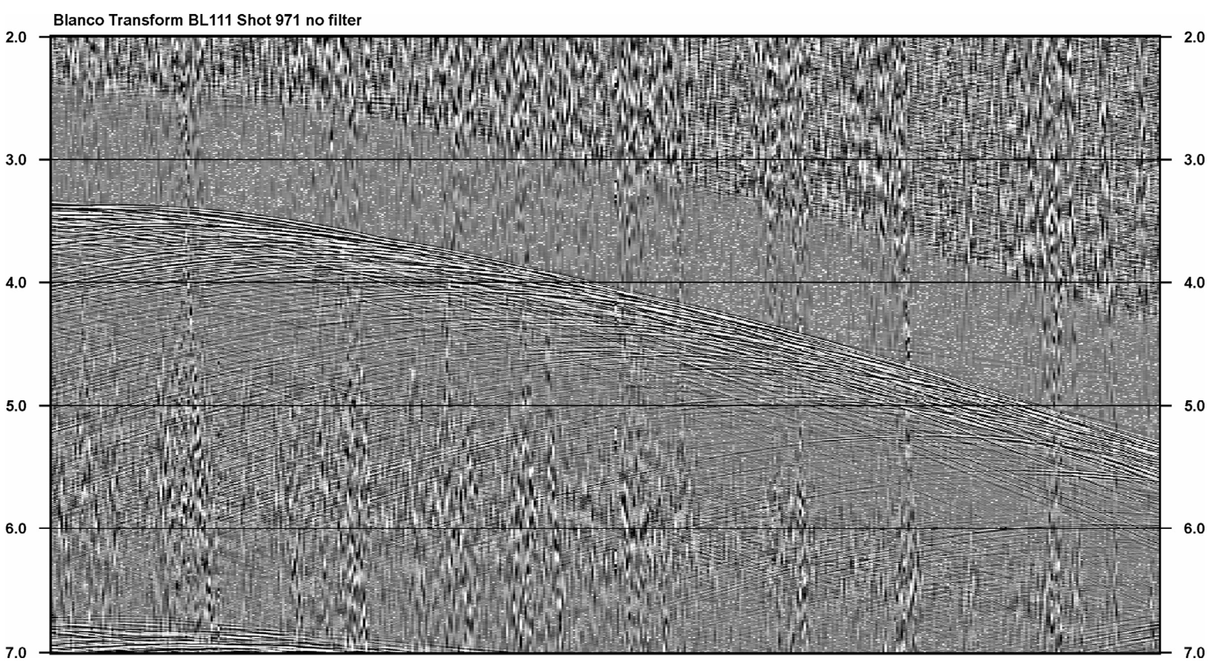
It's my opinion that unless some meaningful maintenance and testing can be performed on this system, future MCS cruises on the Ewing might be better served by abandoning the Seisnet system and scripts and simply copying 3490 tapes to DDS3 tape using sioseis. This process is slower and more tedious but can be performed by watchstanders as part of their normal duties. I think that Seisnet should still be run as a potential backup if data to 3490 tape are lost.

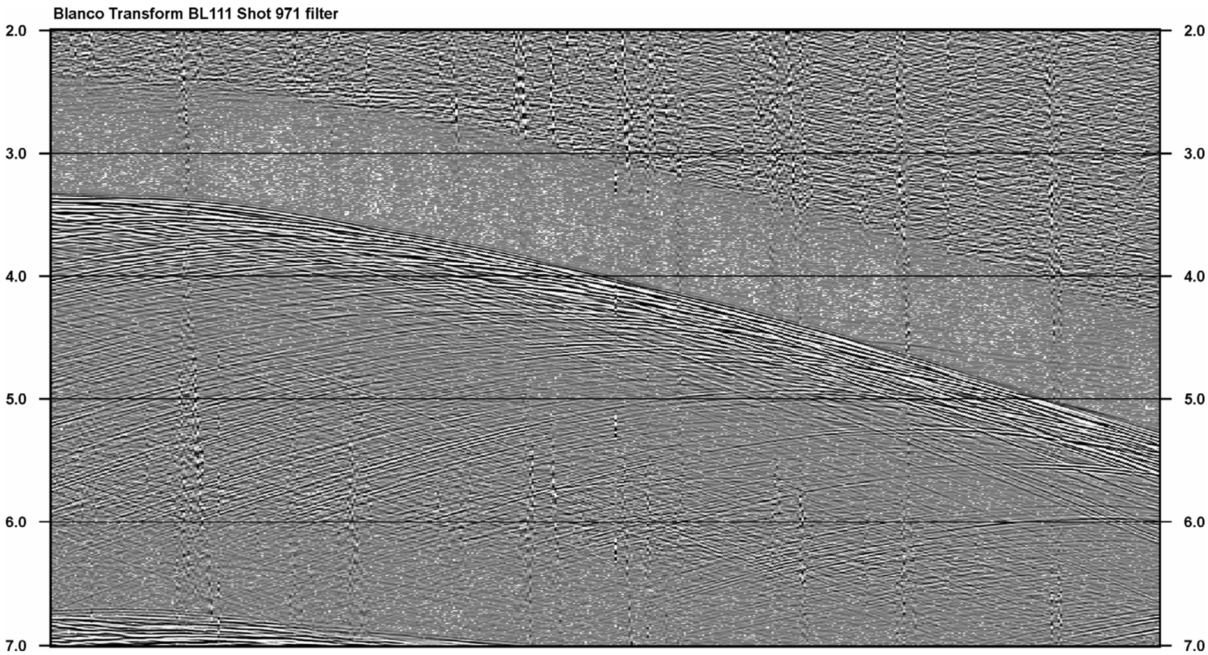
Despite the problems noted here, EW0410 did get its full dataset to DDS3 tape in SEGY format.

Streamer condition, weather, and noise

Due to the seasonally unfavorable timing of our cruise in late October/early November, we experienced elevated noise levels during MCS data acquisition. We had originally intended to tow the streamer at 7-8 m depth, but wind and sea conditions required towing at depths of 8-9 m instead, with significant noise still present. The typical weather during the cruise included winds at 20-30 nautical miles per hour and substantial swells. Whitecaps and spray were also common. A further cause of noise in the streamer came from the depth control/compass birds, which very often were canted at > 10º, generally working hard to keep the streamer from sinking. The streamer balancing was a compromise in that it was heavier than desired for good sea conditions, but with the typical swells we experienced the extra weight prevented the streamer from getting undesirably shallow. Thus the bird noise was probably unavoidable. During deployment we switched out several bad sections known from previous cruises, yet we still had several bad channels. When we redeployed the streamer, we also switched out a digitizing can in hopes of restoring the few bad channels; this did not solve the problem, but we proceeded with it anyway in the interests of data acquisition time.

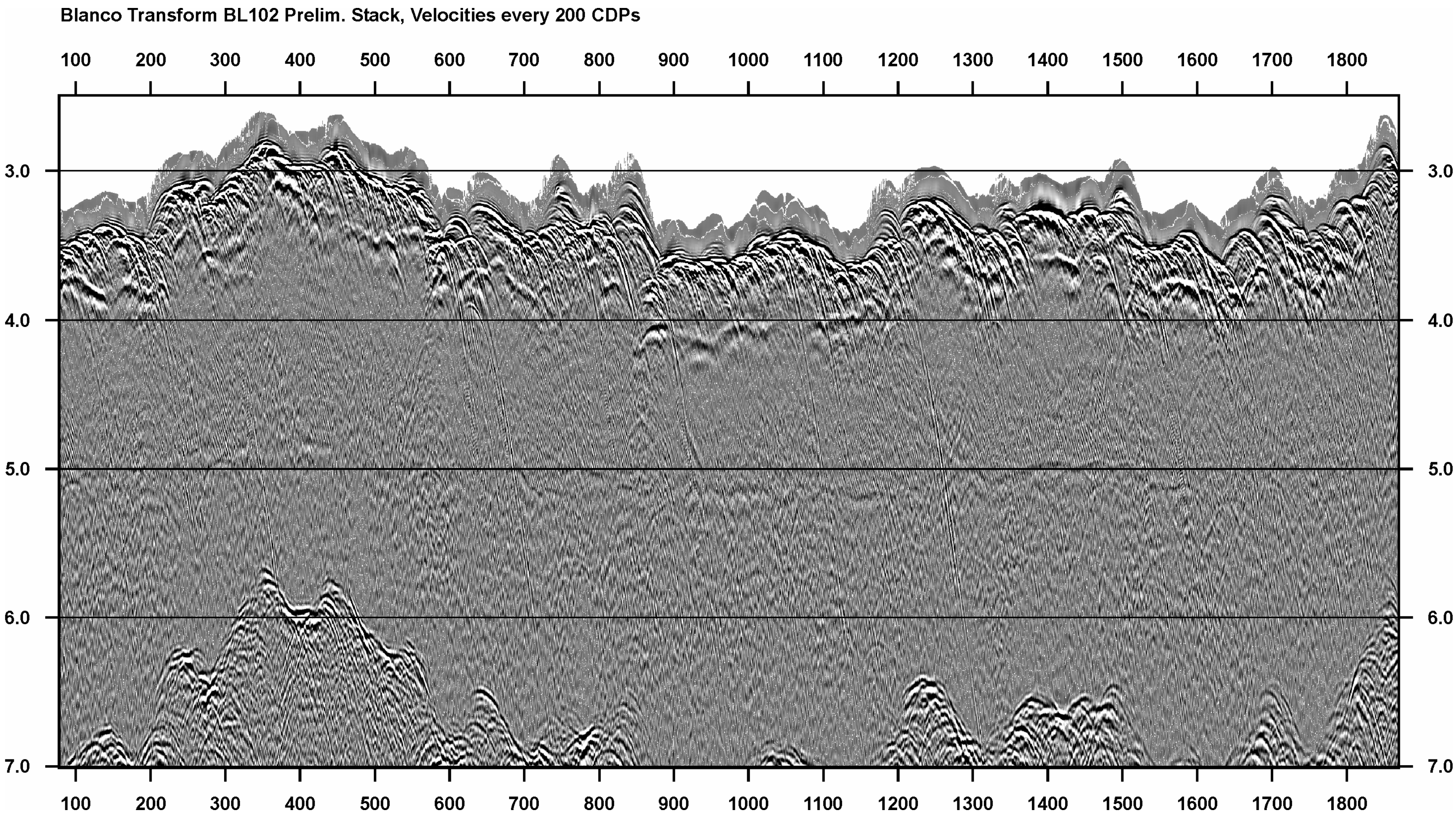
I include two figures to give an indication of the typical noisy conditions we experienced with the MCS streamer. Both of these are from BL111, shot #971, one without any bandpass filter and the other with a filter applied (these both include a 2000 ms AGC). The important thing to note is that signal to noise ratio is generally low except within the first 500 ms below the seafloor reflection. Fortunately our key target, the Layer 2A/2B caustic, falls within that range and so is generally imaged reasonably well.





MCS Preliminary Stacks

Preliminary stacks of all profiles were created on the ship, and are shown on the following pages. The x-axis label is in shot numbers, with 100 shots = 3.75 km. The y-axis label is in TWTT (sec).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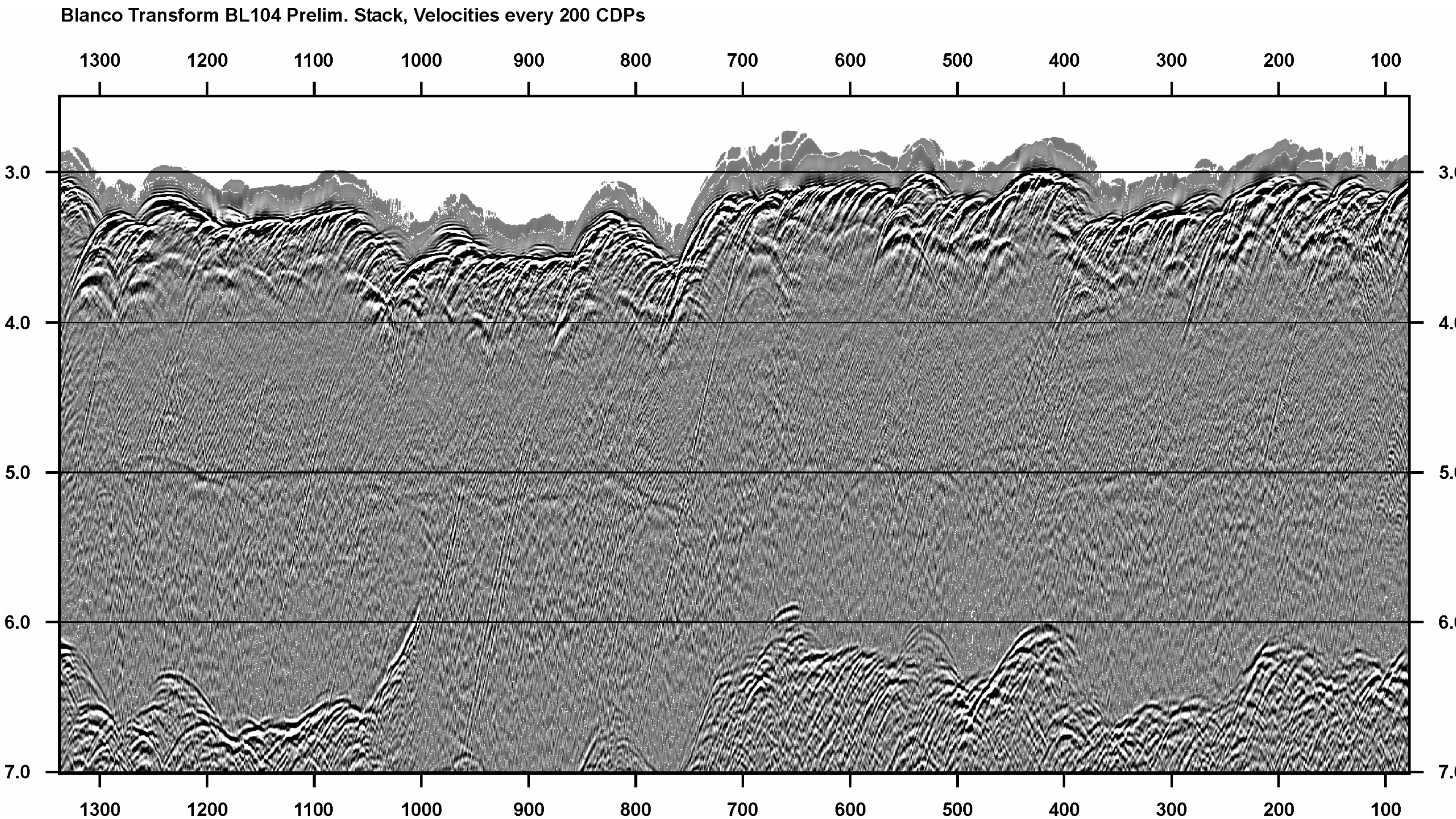
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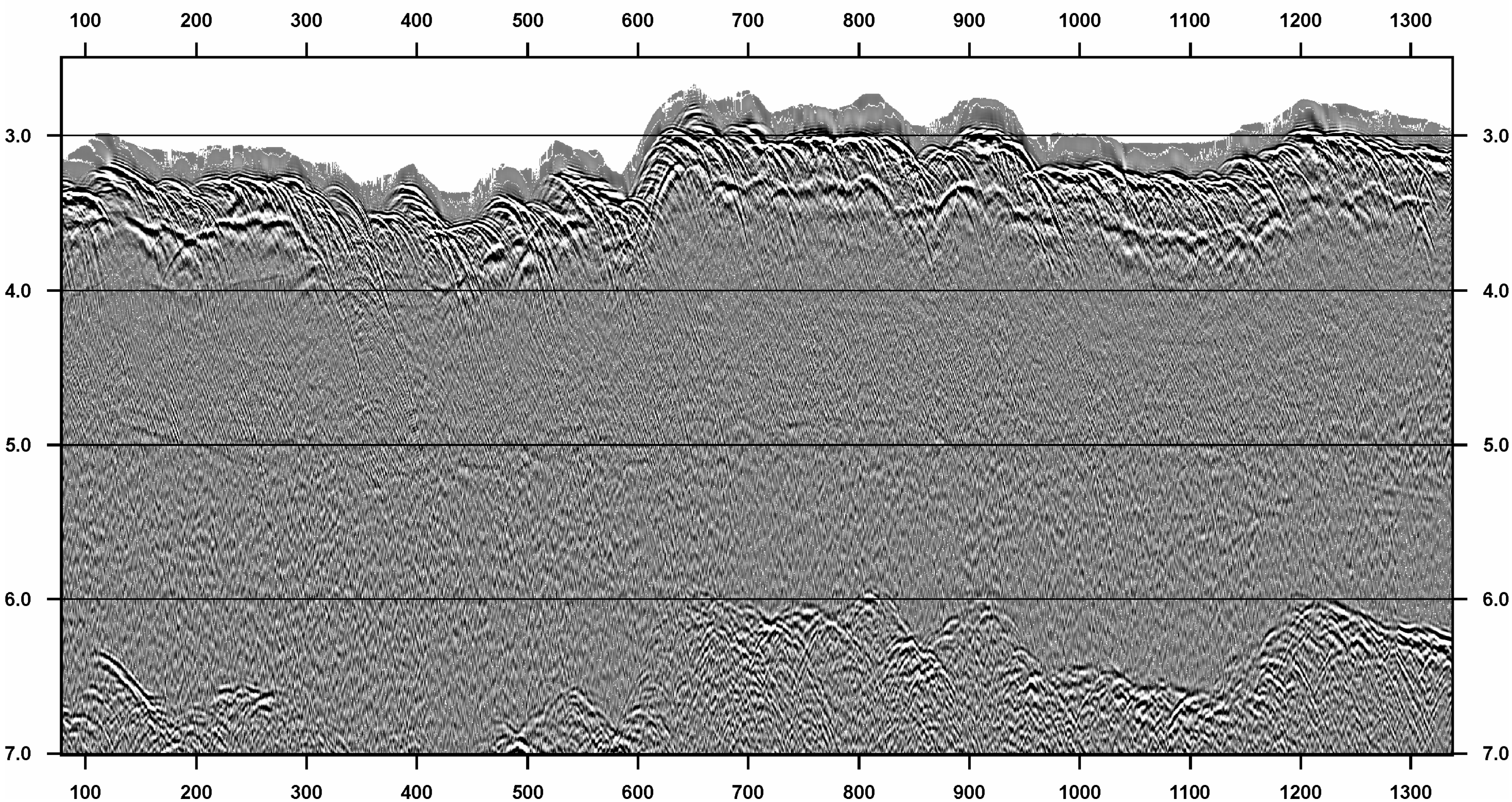
Blanco Transform BL105 Prelim. Stack, Velocities every 200 CDPs



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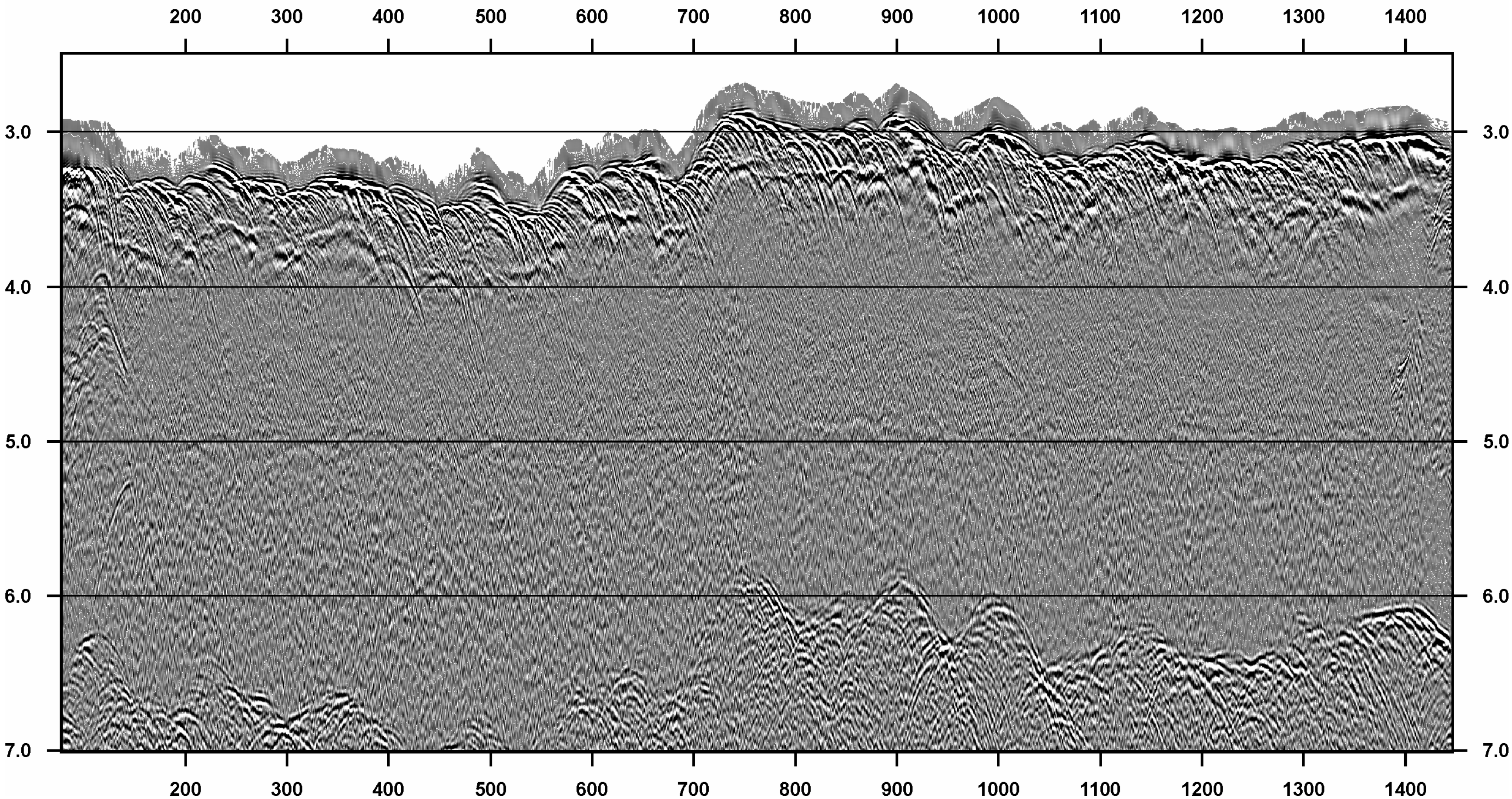

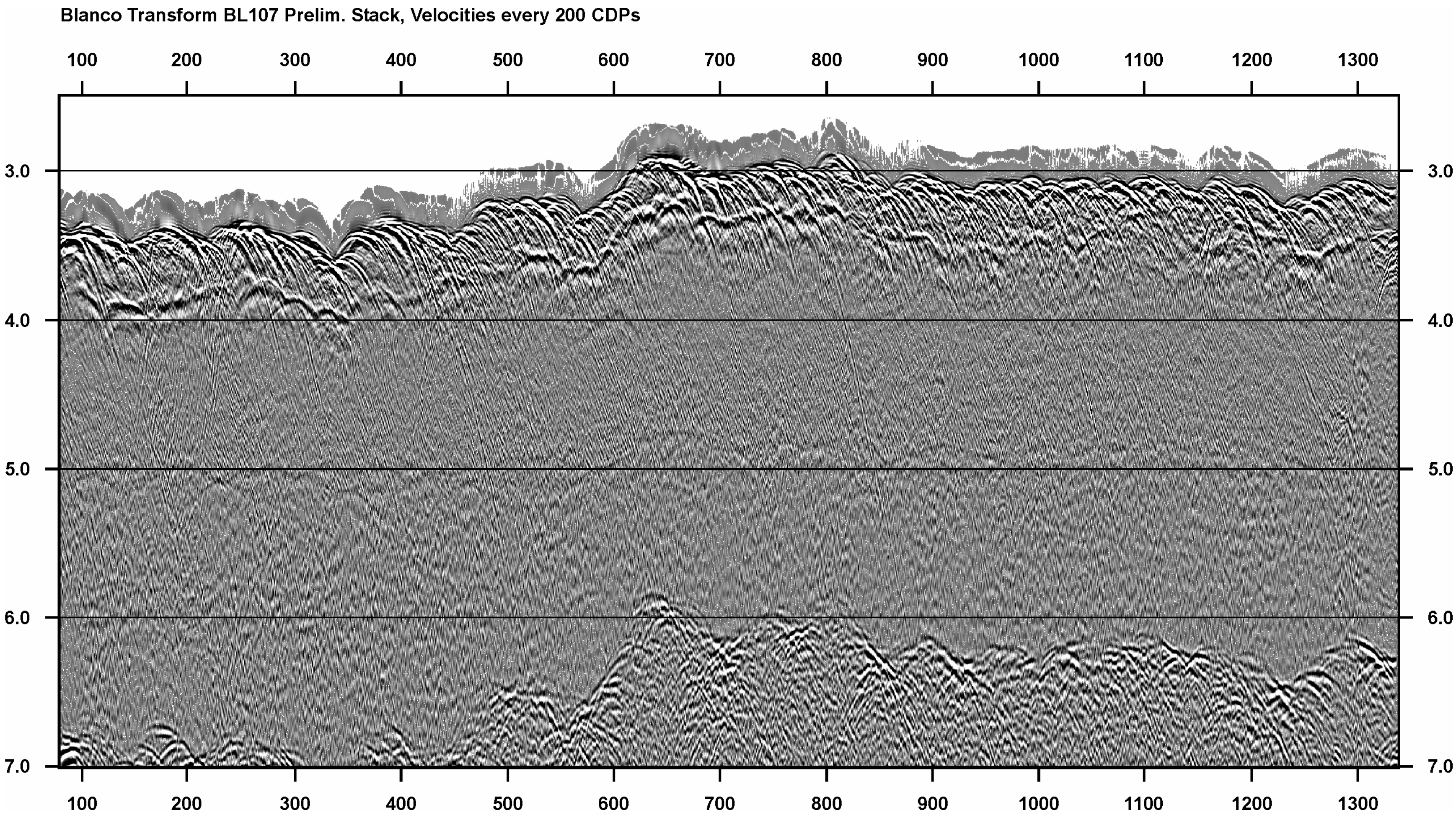
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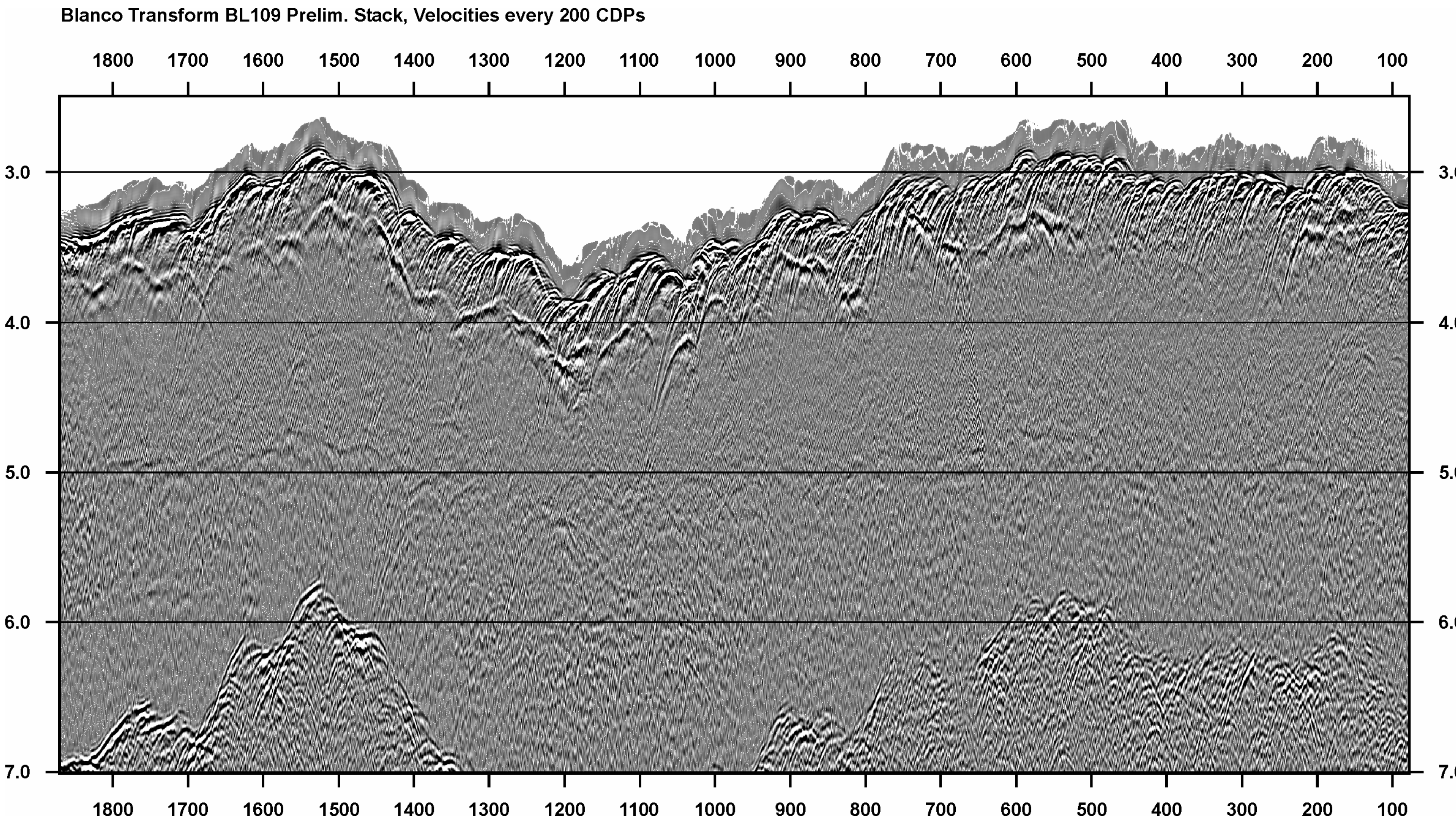
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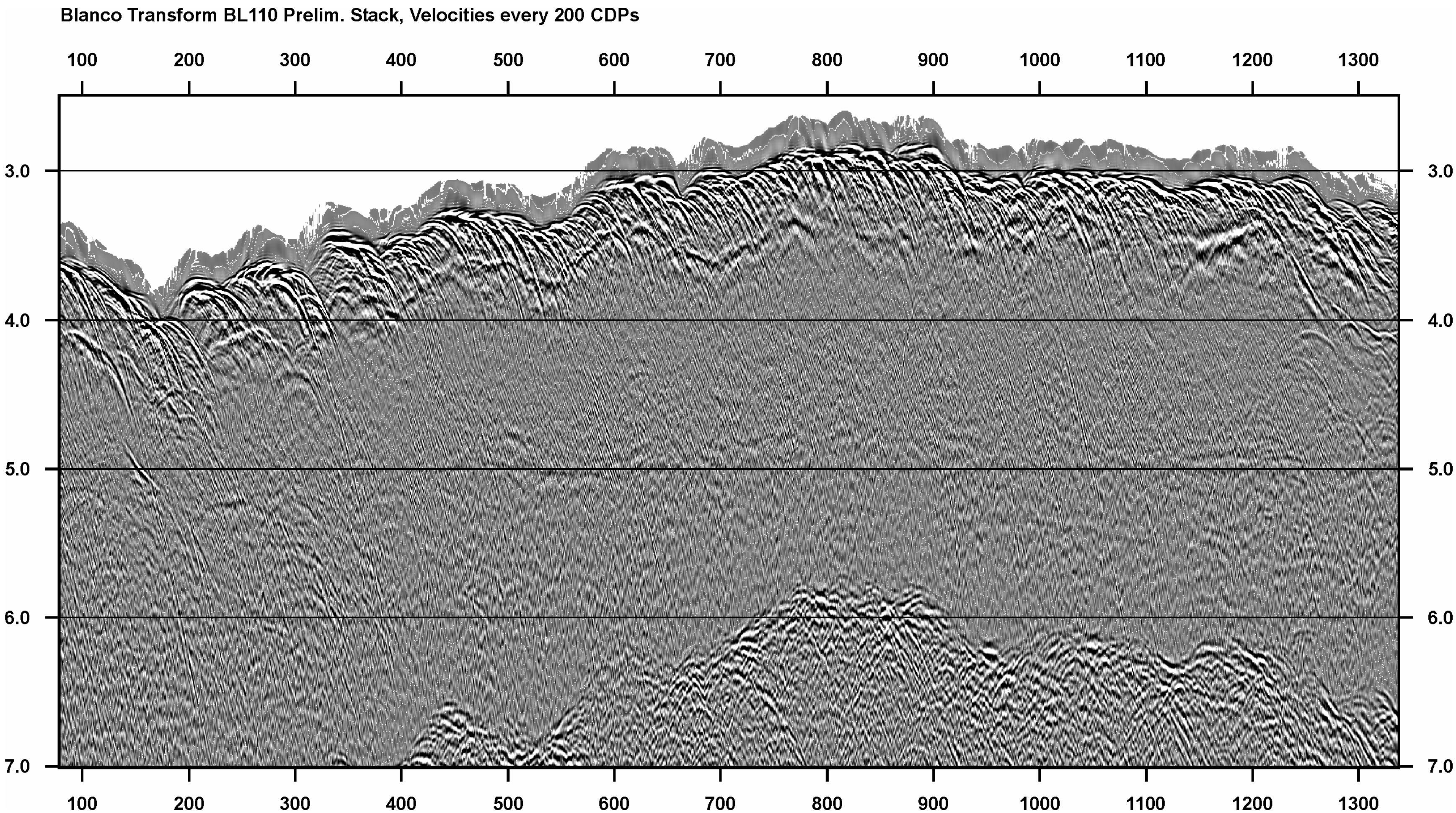
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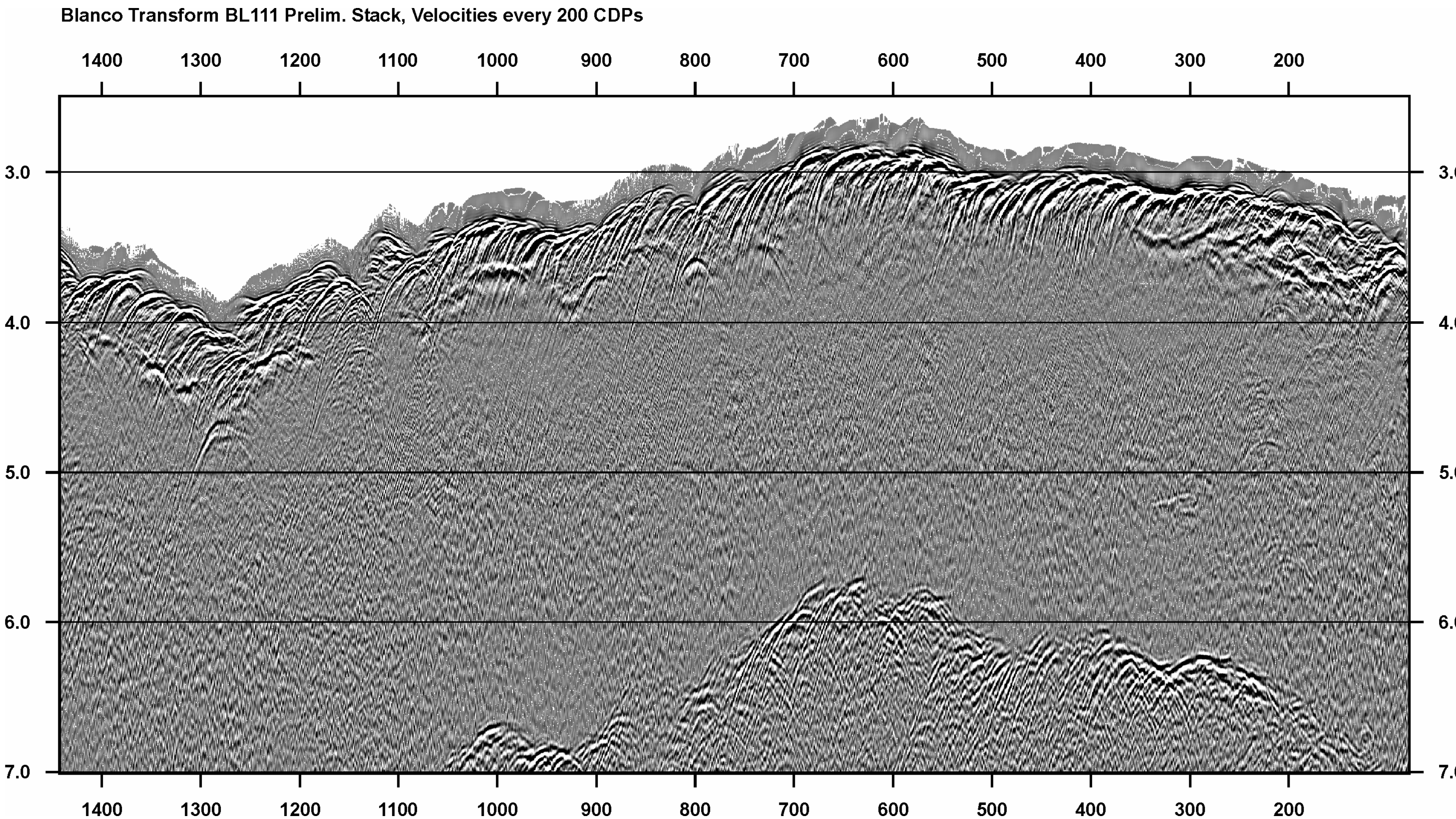
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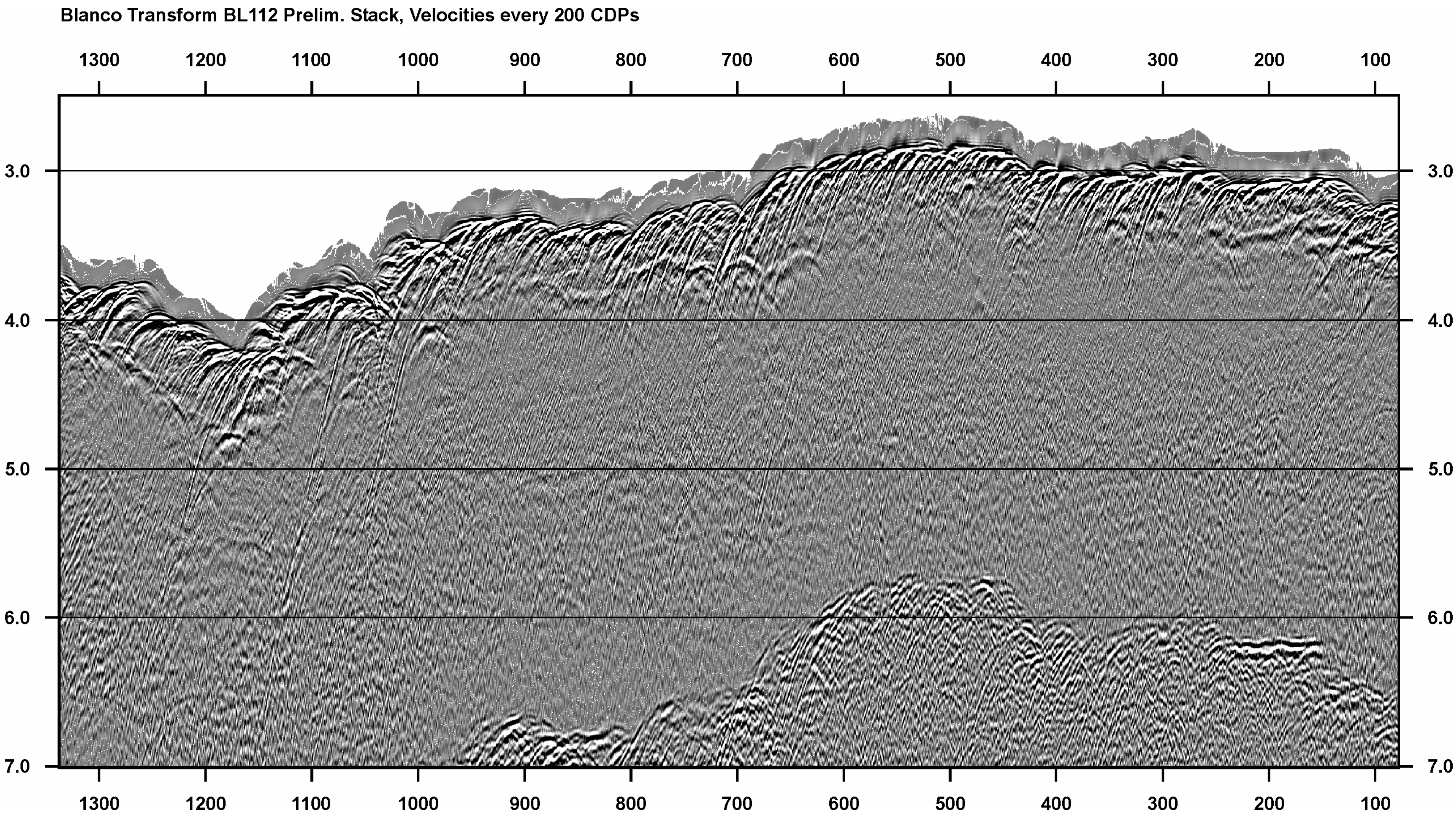
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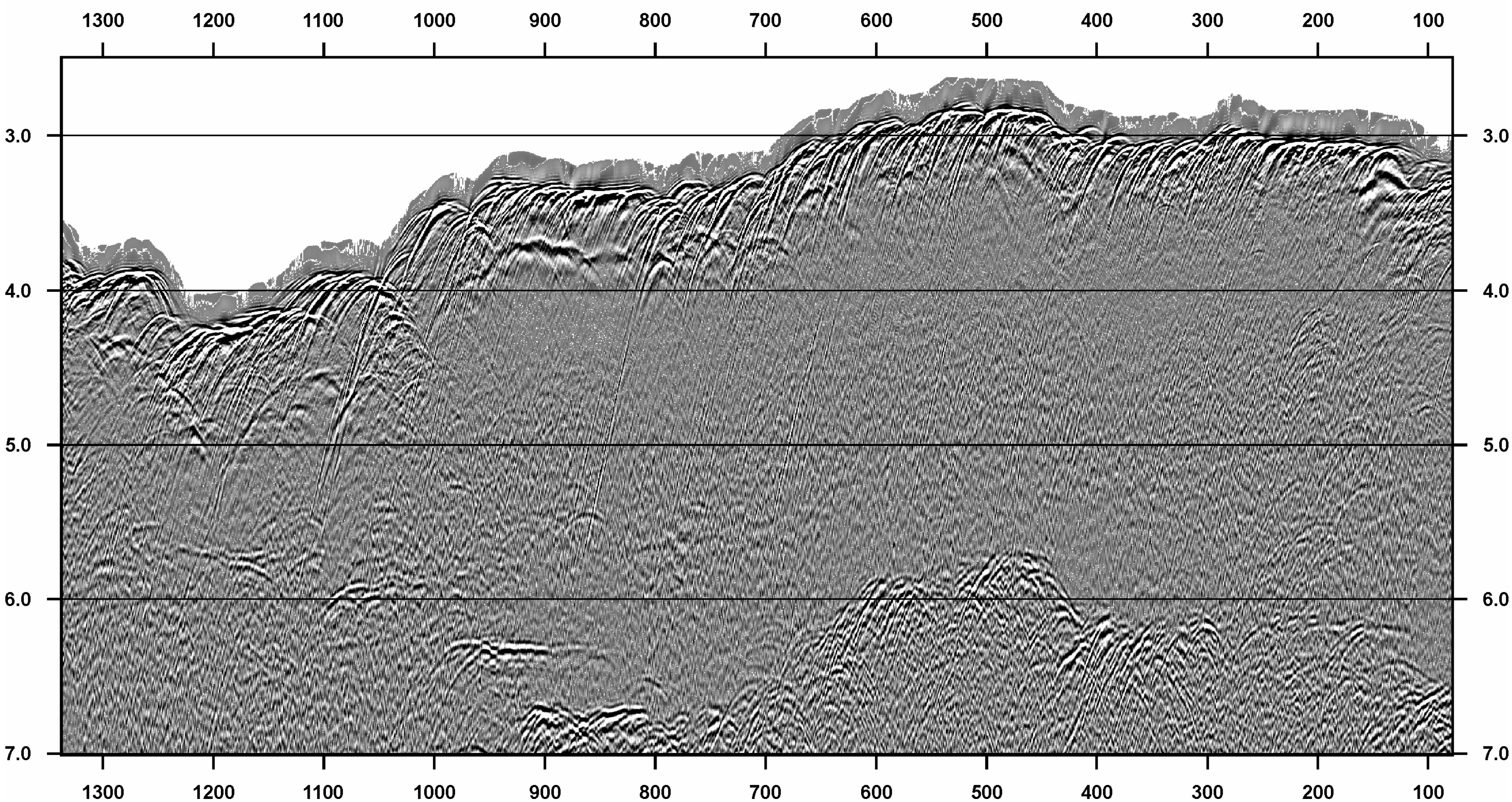
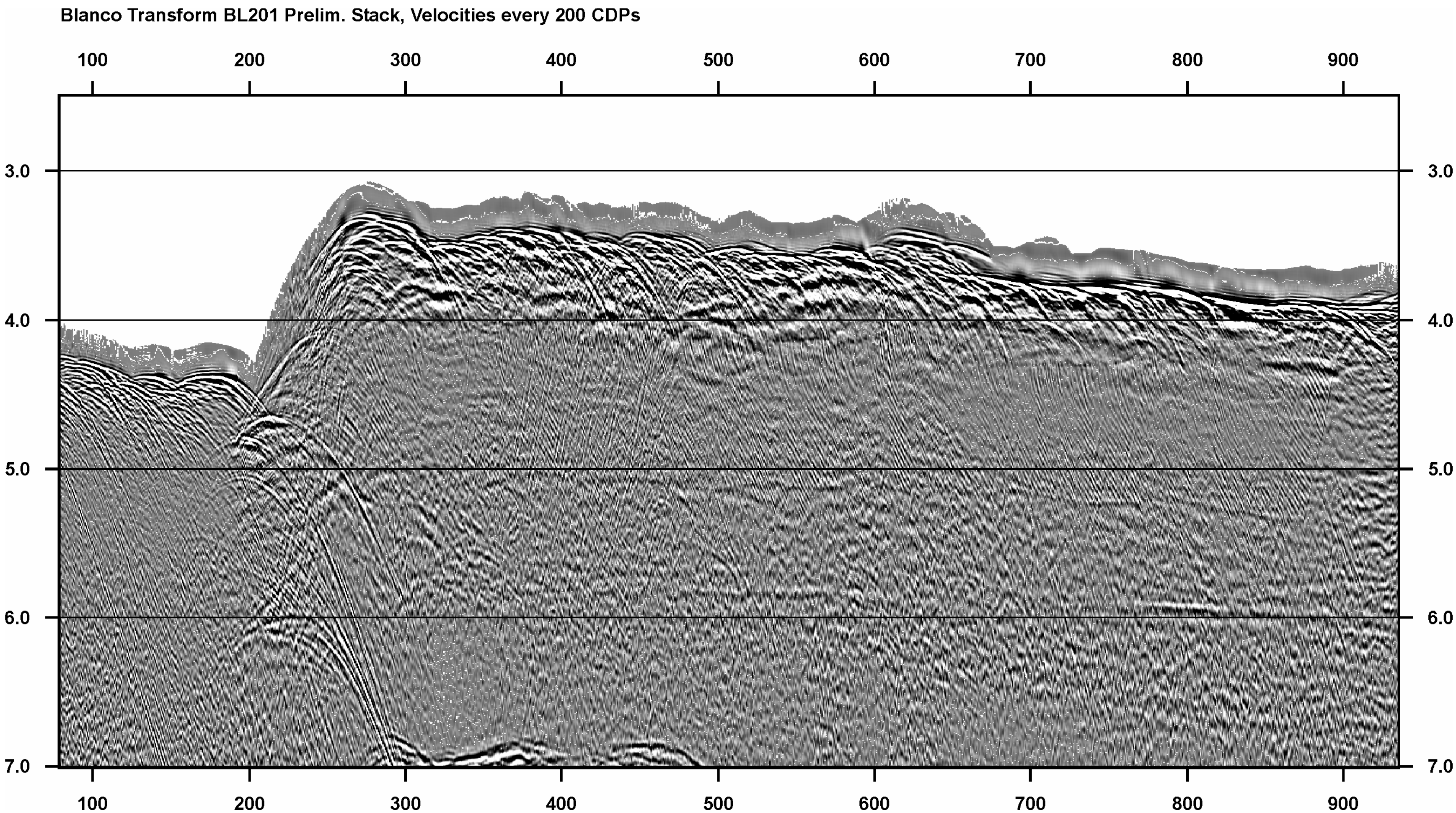
Blanco Transform BL113 Prelim. Stack, Velocities every 200 CDPs

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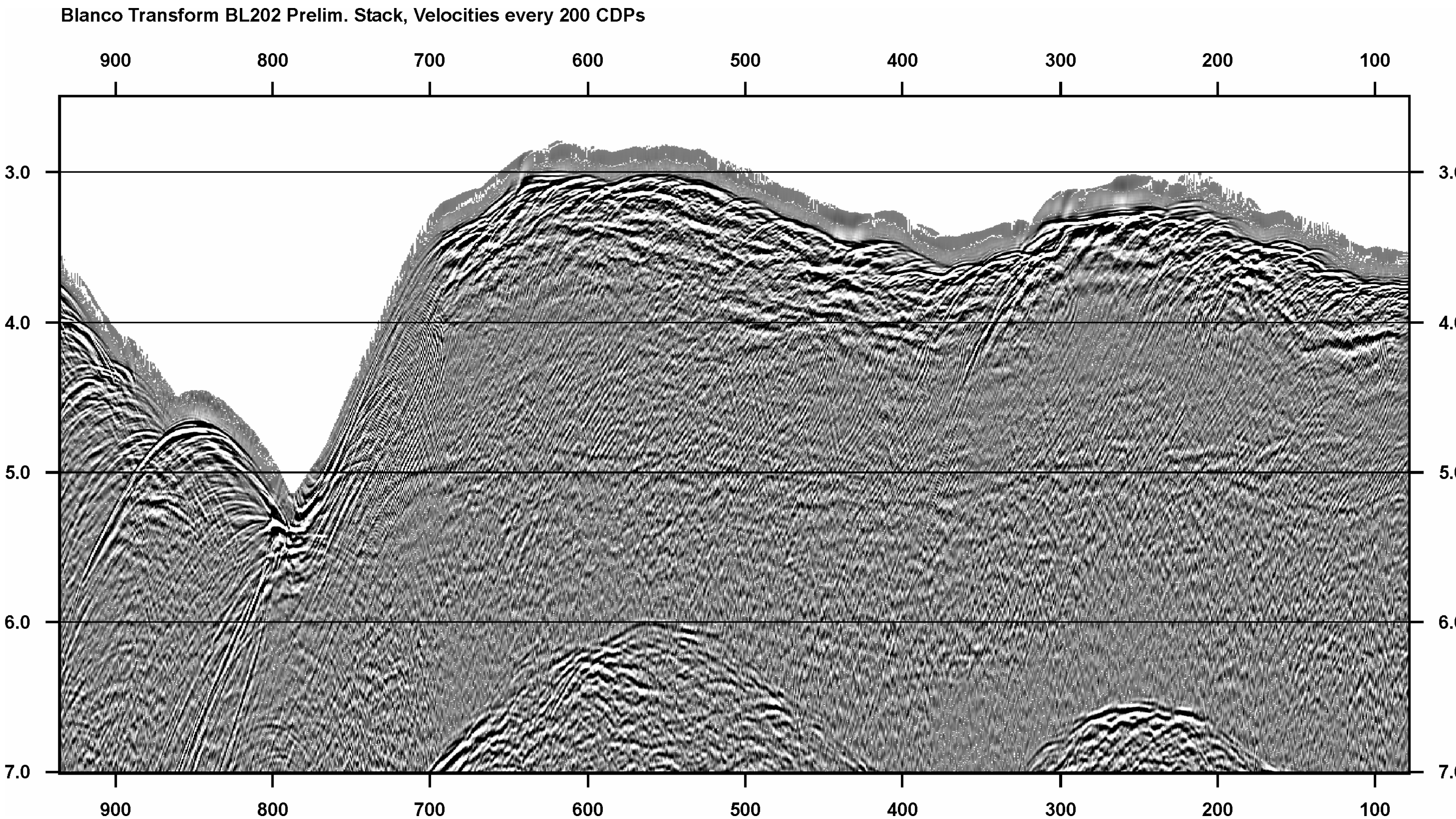
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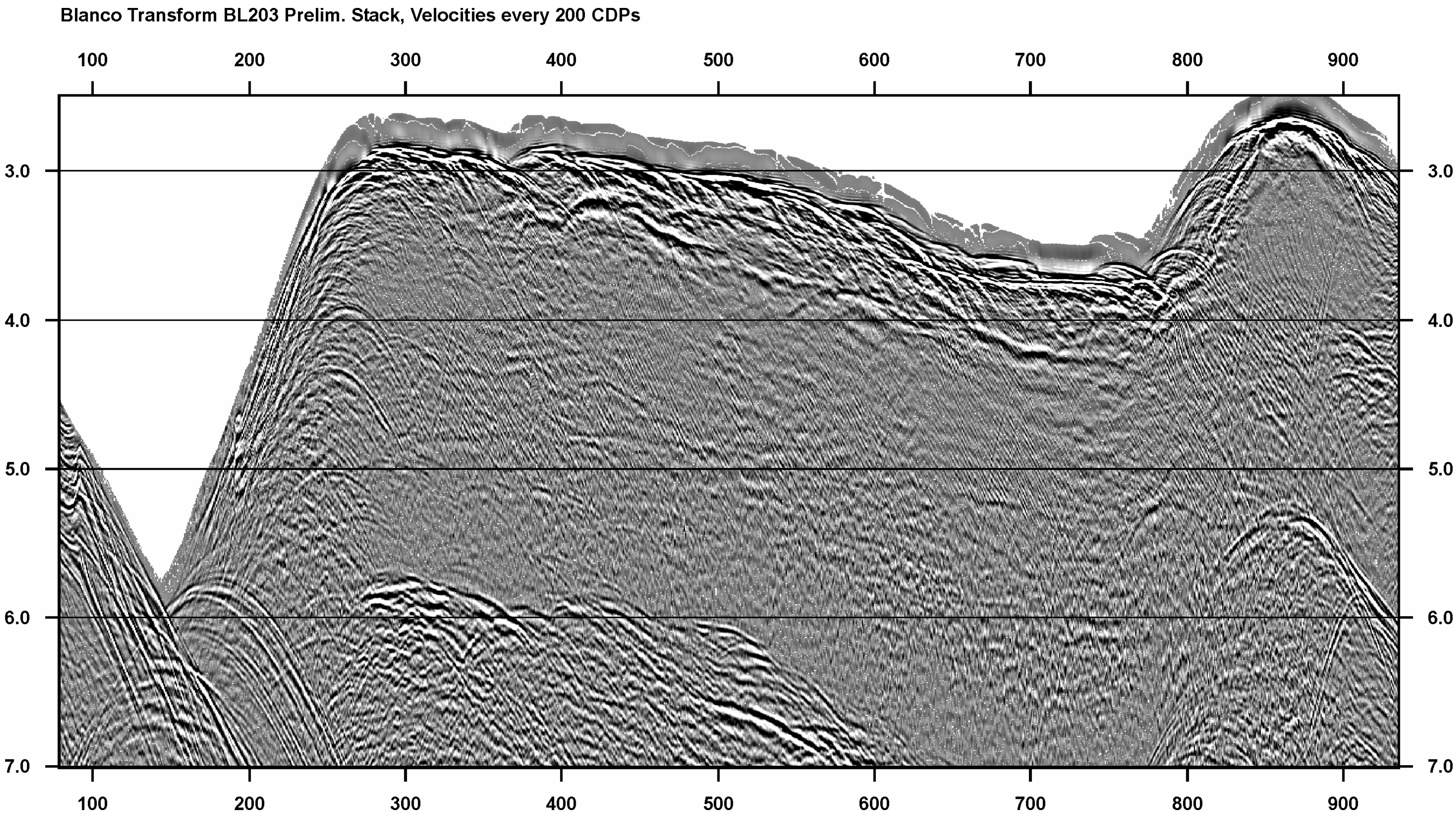
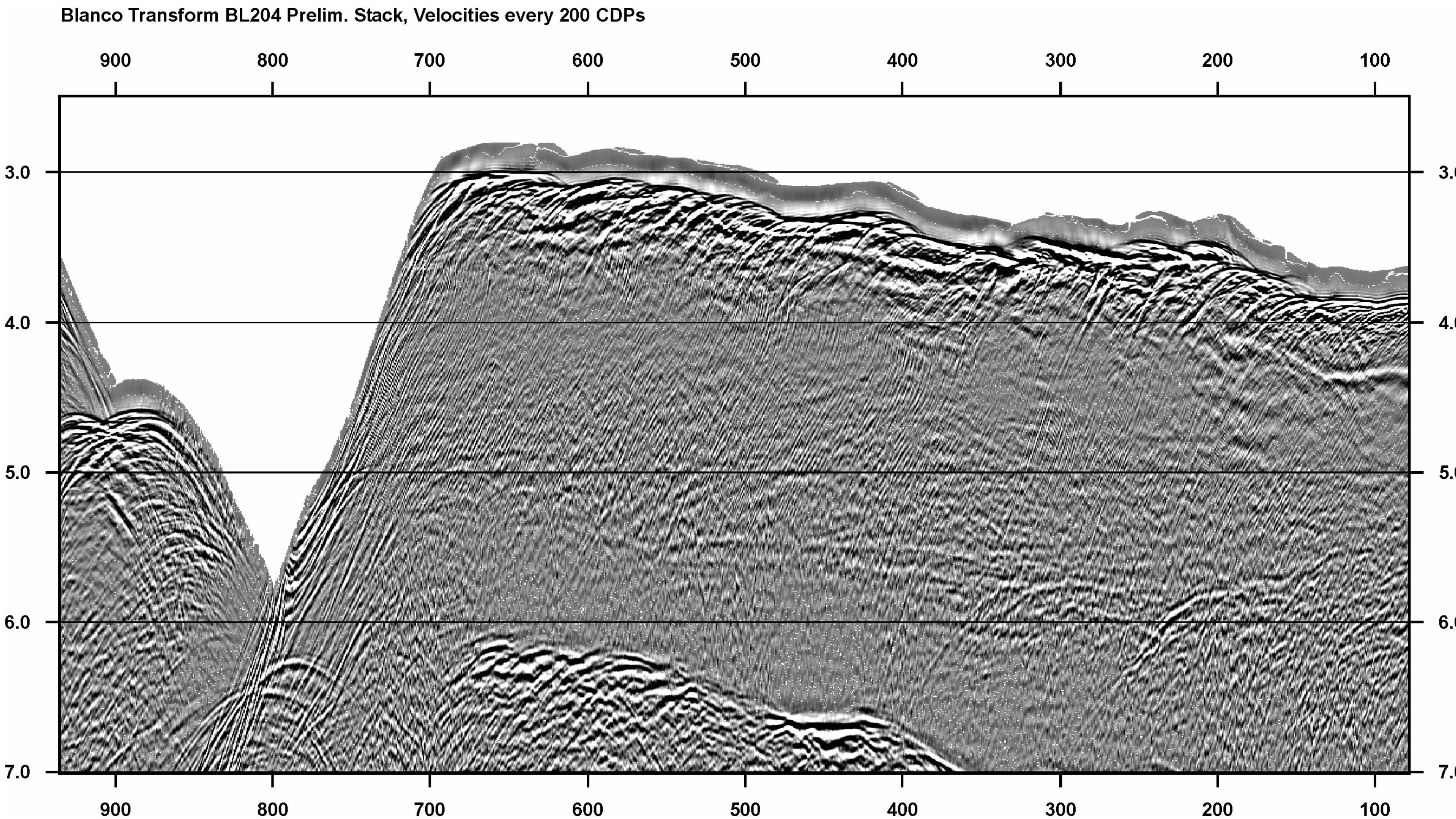
7.0


Blanco Transform BL203 Prelim. Stack, Velocities every 200 CDPs
100
200
300
400
500
600
700
800
900
3.0
4.0
5.0
6.0
7.0


Blanco Transform BL204 Prelim. Stack, Velocities every 200 CDPs
900
800
700
600
500
400
300
200
100
3.0
4.0
5.0
6.0
7.0

OBS Deployment, Recovery and Data Summary

Station	Chassis S/N	Sphere S/N	CF Ide/Scsi	Deployment			Recovery			Acquired Data			
				Time	Location	Depth m	Time	Location	Depth m	Channels	Period	Hrs.	Addr Mb
1	92-2	59368	1 1	295/23:49	44°36.457'N 130°19.074'W	2290	304/13:29	44°36.376'N 130°18.991'W	2294	1,2,3,4	None - Cpu batt dead	0	None 0
2	92-7	56962	2 2	295/23:03	44°34.786'N 130°13.882'W	2435	304/14:55	44°34.721'N 130°13.837'W	2407	1,2,3,4	10/22 10:00 10/30 14:00	196	20ec21 1104.7
3	93-11	?	3 3	295/22:17	44°33.136'N 130°08.670'W	2691	304/16:28	44°32.984'N 130°08.678'W	2685	1,2,3,4	10/22 10:00 10/30 15:29	197.5	213421 1114.1
4	94-8	52234	4 4	295/21:20	44°31.494'N 130°34.790'W	2703	304/18:06	44°331.366'N 130°03.430'W	2713	1,2,3,4	10/22 10:00 10/30 16:00	198	214821 1116.7
5	94-10	?	5 5	295/20:56	44°29.885'N 129°58.373'W	2556	304/19:32	44°29.739'N 129°58.292'W	2484	1,2,3,4	10/22 10:00 10/30 16:00	198	214c21 1117.2
6	94-11	?	6 6	295/20:09	44°28.177'N 129°53.138'W	2626	304/20:59	44°28.141'N 129°53.081'W	2889	1,2,3,4	10/22 10:00 10/30 16:00	198	215021 1117.8
7	94-12	44568	7 7	296/00:39	44°31.513'N 130°22.082'W	2576	304/11:55	44°31.471'N 130°22.065'W	2573	1,2,3,4	10/22 10:00 10/30 11:01	193	207421 1089.0
8	94-13	55454	8 8	296/01:19	44°29.859'N 130°16.949'W	2818	304/10:14	44°29.845'N 130°16.956'W	2751	1,2,3,4	10/22 10:00 10/30 09:13	191.2	202821 1079.0
9	94-15	62111	9 9	296/01:56	44°28.180'N 130°11.783'W	2608	304/08:32	44°28.121'N 130°11.735'W	2613	1,2,3,4	10/22 10:00 10/30 07:32	189.5	1fe031 1069.6
10	94-16	58709	10 10	296/02:33	44°26.534'N 130°06.640'W	2302	304/06:50	44°26.499'N 130°06.576'W	2318	1,2,3,4	10/22 10:00 10/30 05:57	188	1f9021 1059.1
11	93-10	?	11 11	296/03:09	44°24.902'N 130°01.505'W	2158	304/05:18	44°24.923'N 130°01.367'W	2185	1,2,3,4	10/22 10:00 10/30 04:14	186.5	1f4821 1049.6
12	94-7	59126	12 12	295/03:47	44°23.230'N 129°56.364'W	2318	304/03:33	44°22.775'N 129°56.235'W	2333	1,2,3,4	10/22 10:00 - ?	?	None 0.0

All times are in Local time.
Water depths are from Hydrosweep center beam and have been corrected for sound speed and transducer depth (5.5 m).

Blanco Cruise OBS Problems

This cruise was the first to use compact flash memory for data storage. This appears to have been a success - there were no data write problems as were commonly observed on the Hess Deep cruise. In addition, the large exponential voltage decay transient signal observed after a write had a duration of ~0.5-0.8 sec, compared to a previously observed duration of 1.5-3.8 sec when writing to the IBM or Toshiba hard disks. However, hydrophone data are poor on several units (3, 5, 8) and we suspect that the filters may not have been set correctly. We will check these units back at UTIG; these problems may have been detected if square wave calibration data had been recorded during instrument preparations on the ship.

Station 1: Cpu battery pack was dead upon recovery. Disk and hydro pre-amp batteries were not depleted so the failure is presumed to have occurred early on. In the lab with the batteries still cold, after cycling power to the cpu, the battery voltage was fine again. However, if the adc and pre-amp were turned on, thus demanding more power from the cpu batteries, the battery voltage died. From this, one can assume the failure occurred on the bottom as soon as the obs attempted to start recording. Inspection of the battery pack showed there was one bad battery within the pack. The Cpu voltage before deployment was lower than the other battery packs and this should have been detected and the pack replaced.

This sort of failure has occurred on other cruises as well where it was not possible to detect the battery problem before deployment. We have had single failures of this kind on some of our previous OBS cruises (Hess Deep OBS 5, possibly Bransfield Strait OBS 18, possibly Chicxulub OBS 5). One solution would be to use Lithium batteries for the cpu. The disadvantage is the much higher cost of the Lithium batteries. I don't know the cost of these batteries off the top of my head but it could perhaps add $100 or more to the cost of each obs (not each deployment, but each obs) per cruise (for a typical utig obs cruise).

The new Lithium batteries that are available have twice the power of the alkaline and the old Lithium. They are also much less dangerous than the old lithium batteries. They are not suited for high current (>200mA) applications, but would be fine for our cpu battery packs. Due to their double power capacity, one could also use 2 packs in parallel, further reducing the possibility of a failure of this sort, but of course doubling the extra cost. Since this cost is an expendable, the extra cost would need to be written in to the cruise proposals.

Station 8. The ADC board on this unit appears to be failing. Three data bits, the 6th and 7th most significant bits and the 14th, or the least significant, bit of each mantissa for all four channels were permanently cleared. The program test3.f, written by Yosio Nakamura, is a bit-error correction routine that was used to create a useable version of the data file.

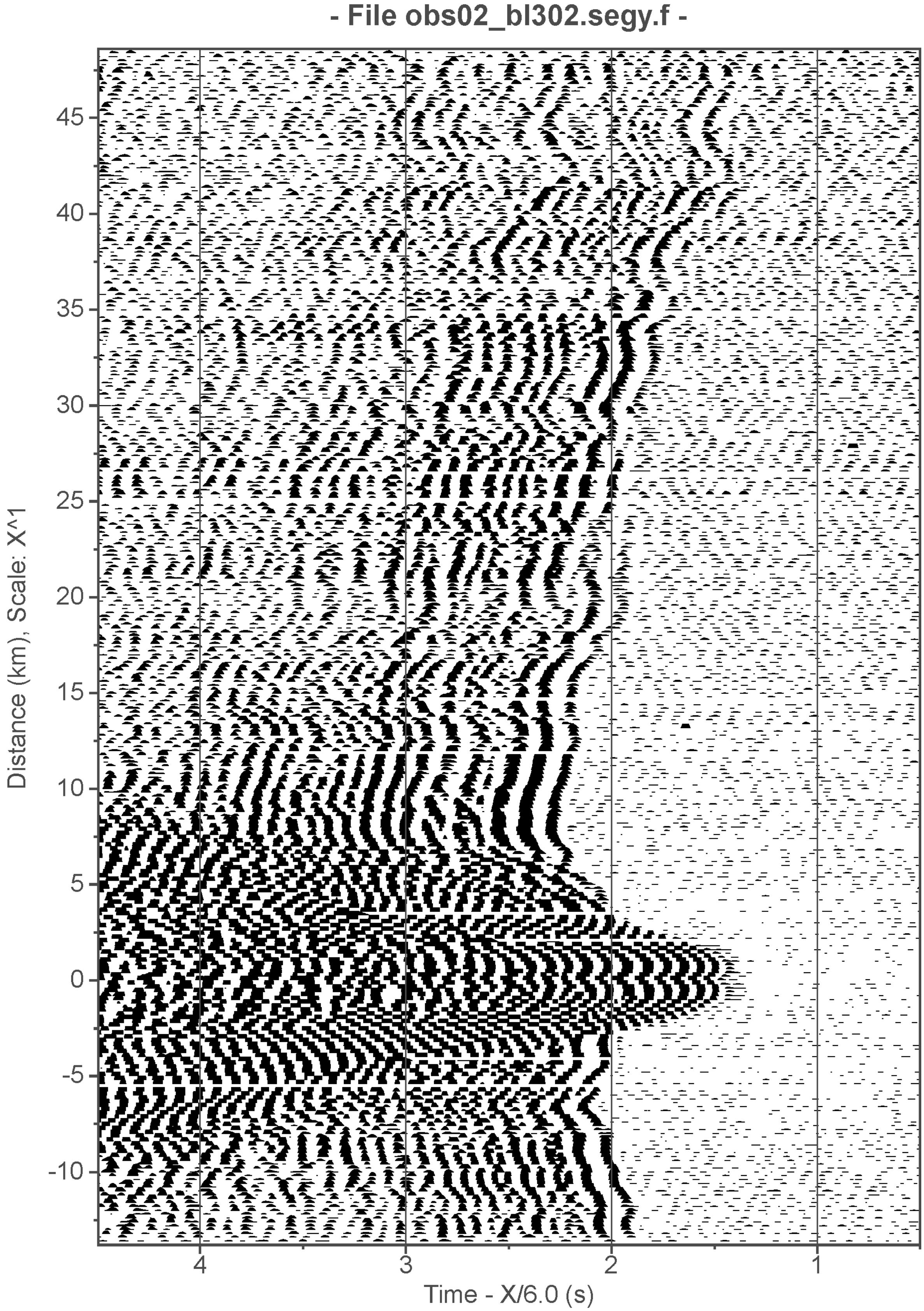
The clock calibration measured before deployment was -0.000937; the clock calibration measured after recovery was -0.893722 - this gives a drift rate of -0.108 sec/day. However, the secondary clock corrections from inversion of water wave arrivals indicate that the actual drift rate is -0.009 sec/day. This indicates that there was a jump in the clock after julian day 303, hr 17 (recovery was on julian day 304, hr 10).

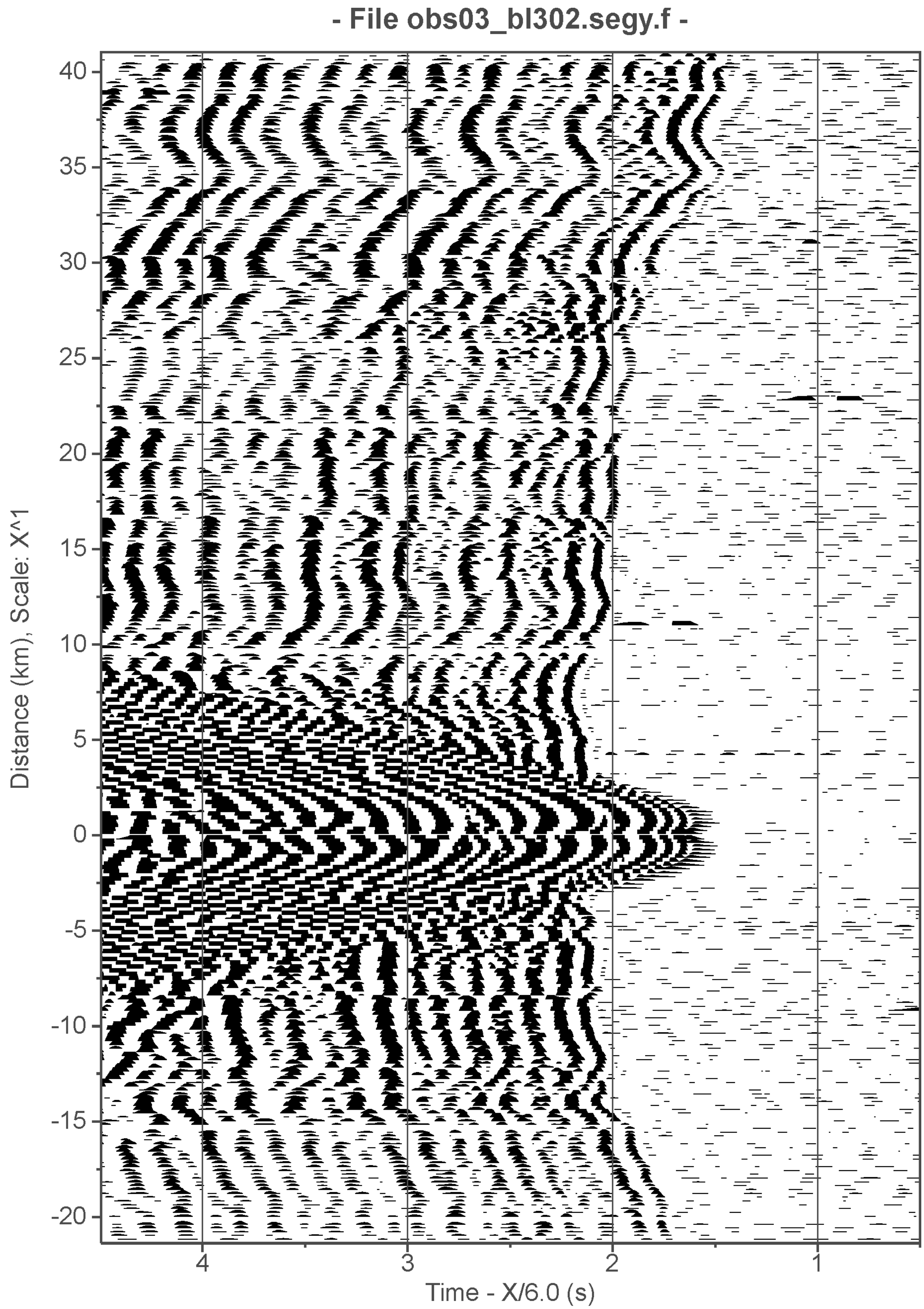
Station 11. The clock calibration measured before deployment was 13.0147617; the clock calibration measured after recovery was 13.7634836. The secondary clock corrections from inversion of water wave arrivals indicate that there was a jump in the clock after deployment. Deployment was on julian day 296, hr 3, and the secondary clock correction on julian day 298, hr 1 is 0.889 sec.

Station 12: This failure was due to a bad scsi/ide interface board – this board failed cold chamber tests but these failures were thought to be due to cable problems and the cable was replaced but apparently this unit never did complete a cold chamber test successfully and thus should not have been used.

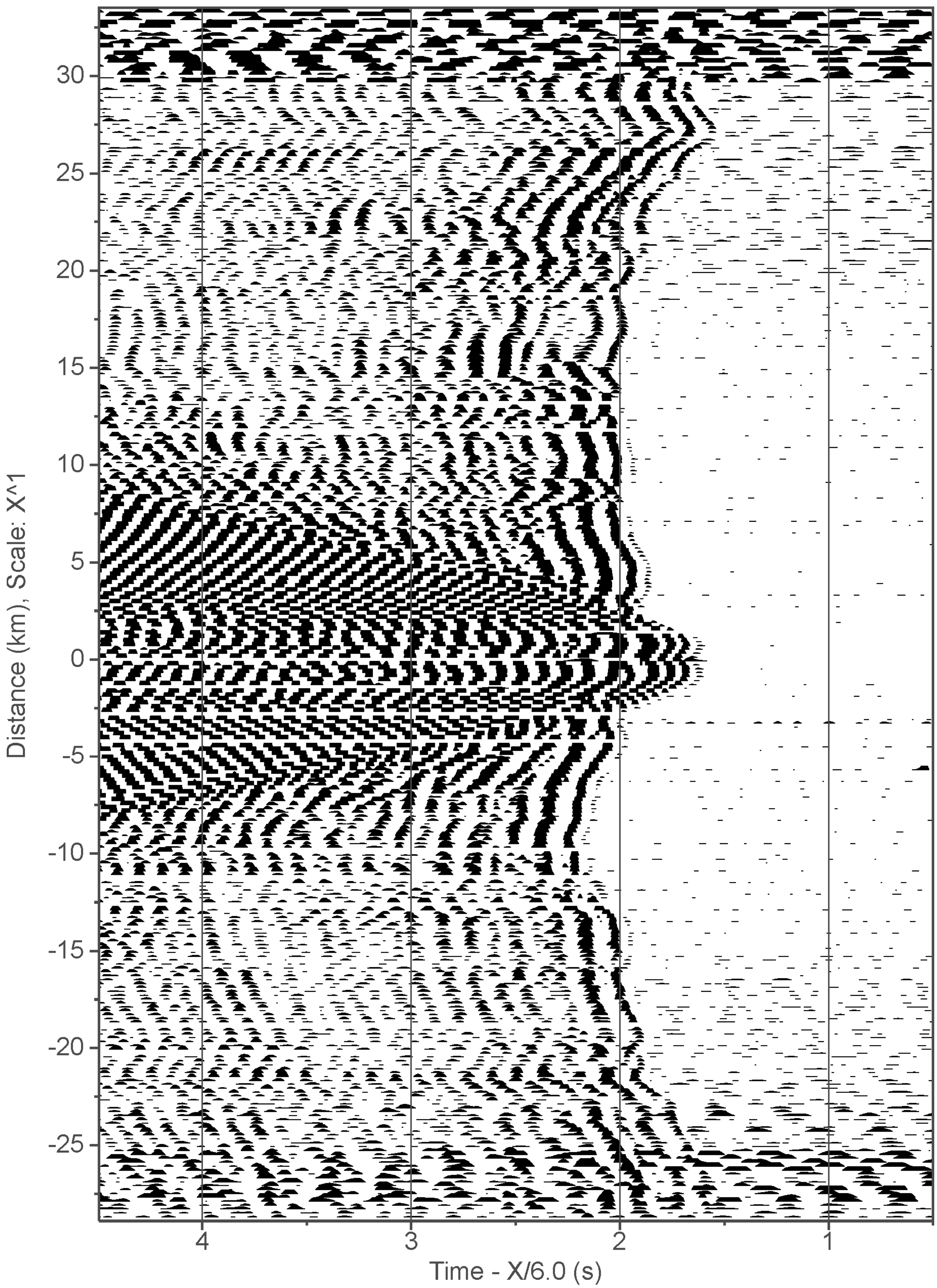
OBS Record Sections

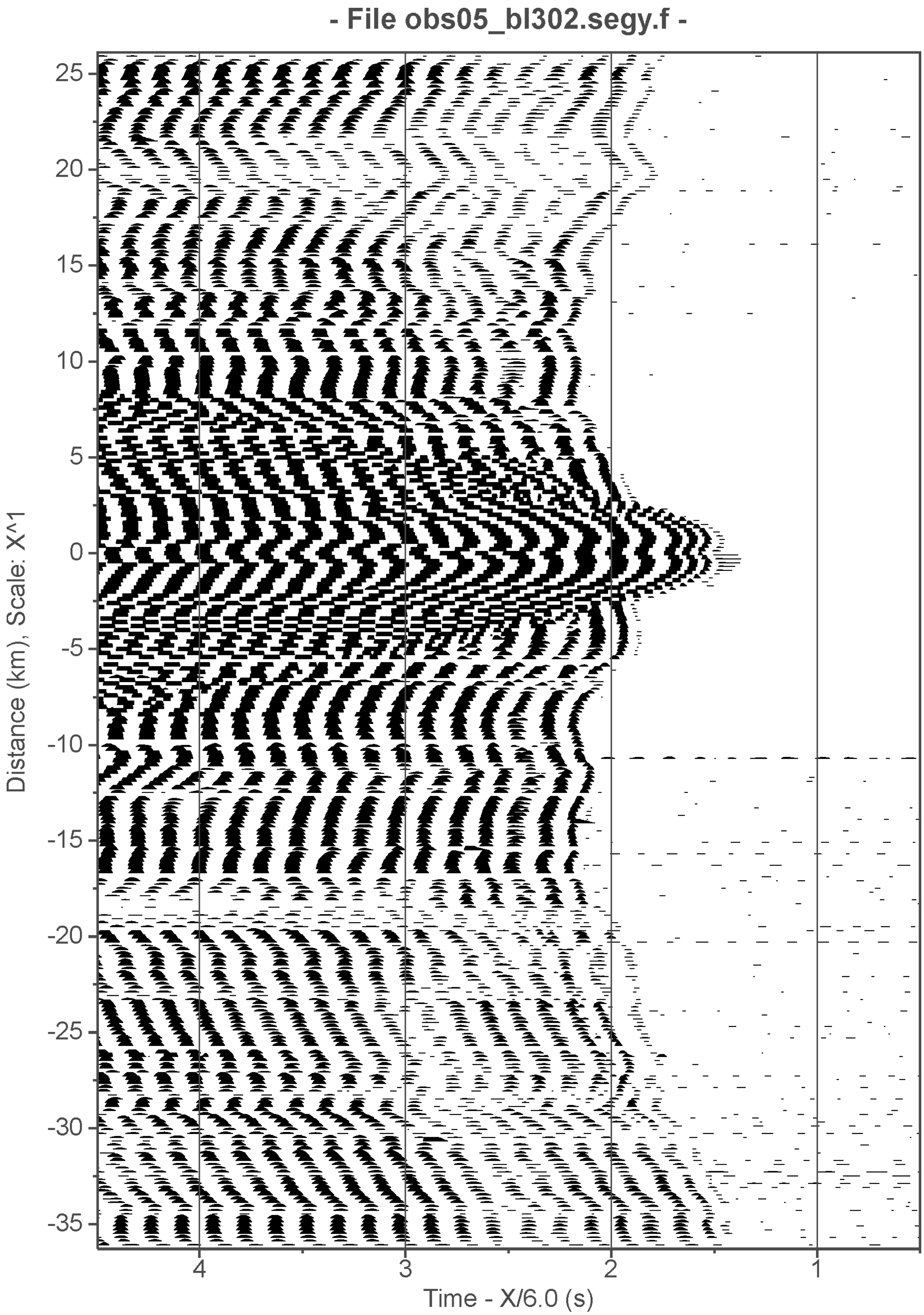
Record sections are shown for the vertical channel of OBSs 2-11 for the data from BL302 (OBSs 2-6) and BL309 (OBSs 7-11). All record sections are plotted with a reduction velocity of 6 km/s, and have been bandpass filtered with a low cut of 3 Hz, high cut of 15 Hz, and 48 dB/octave rolloff.

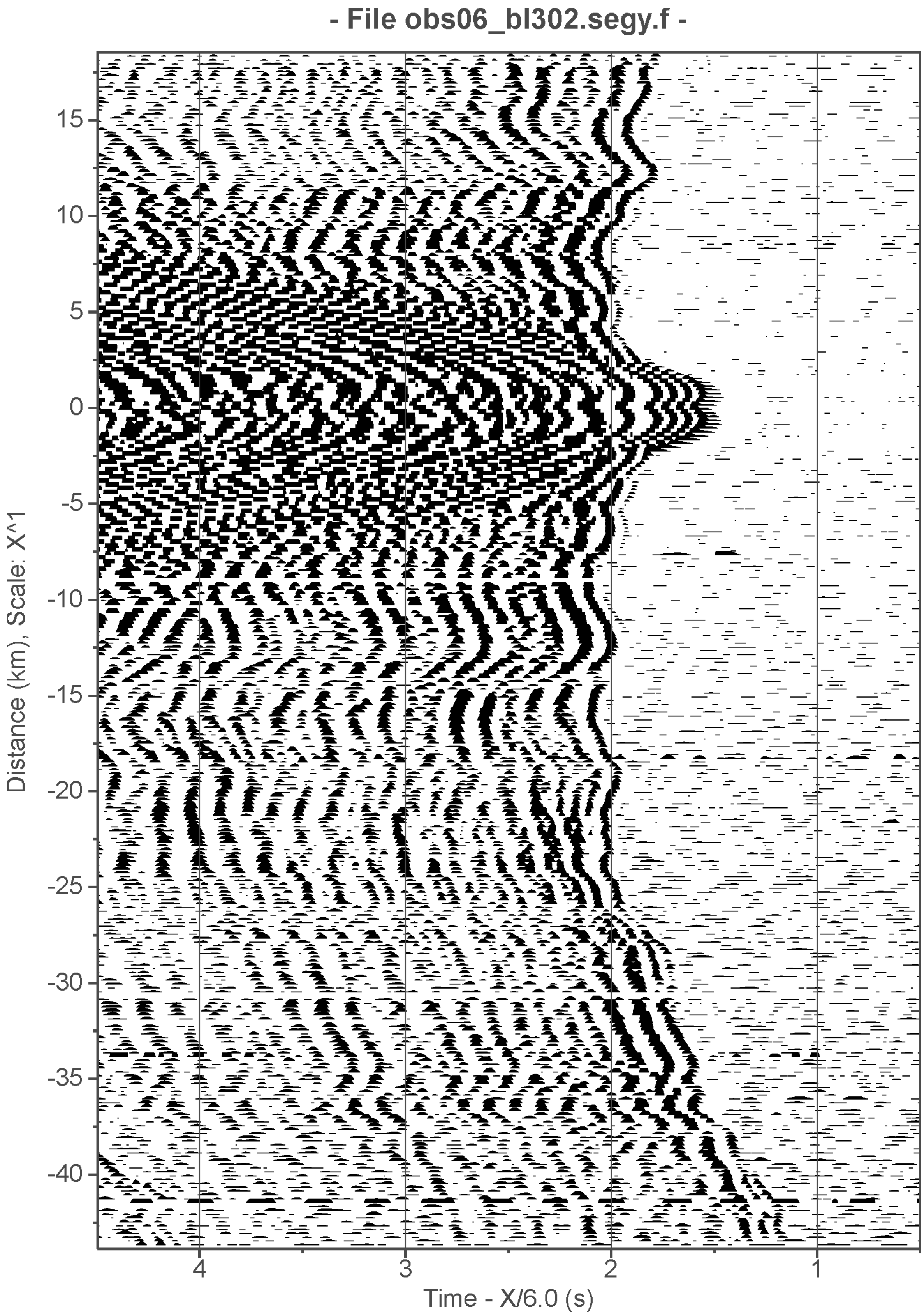

- File obs02_bl302.segy.f -
Distance (km), Scale: X^1
45
40
35
30
25
20
15
10
5
0
-5
-10
4
3
2
1
Time - X/6.0 (s)

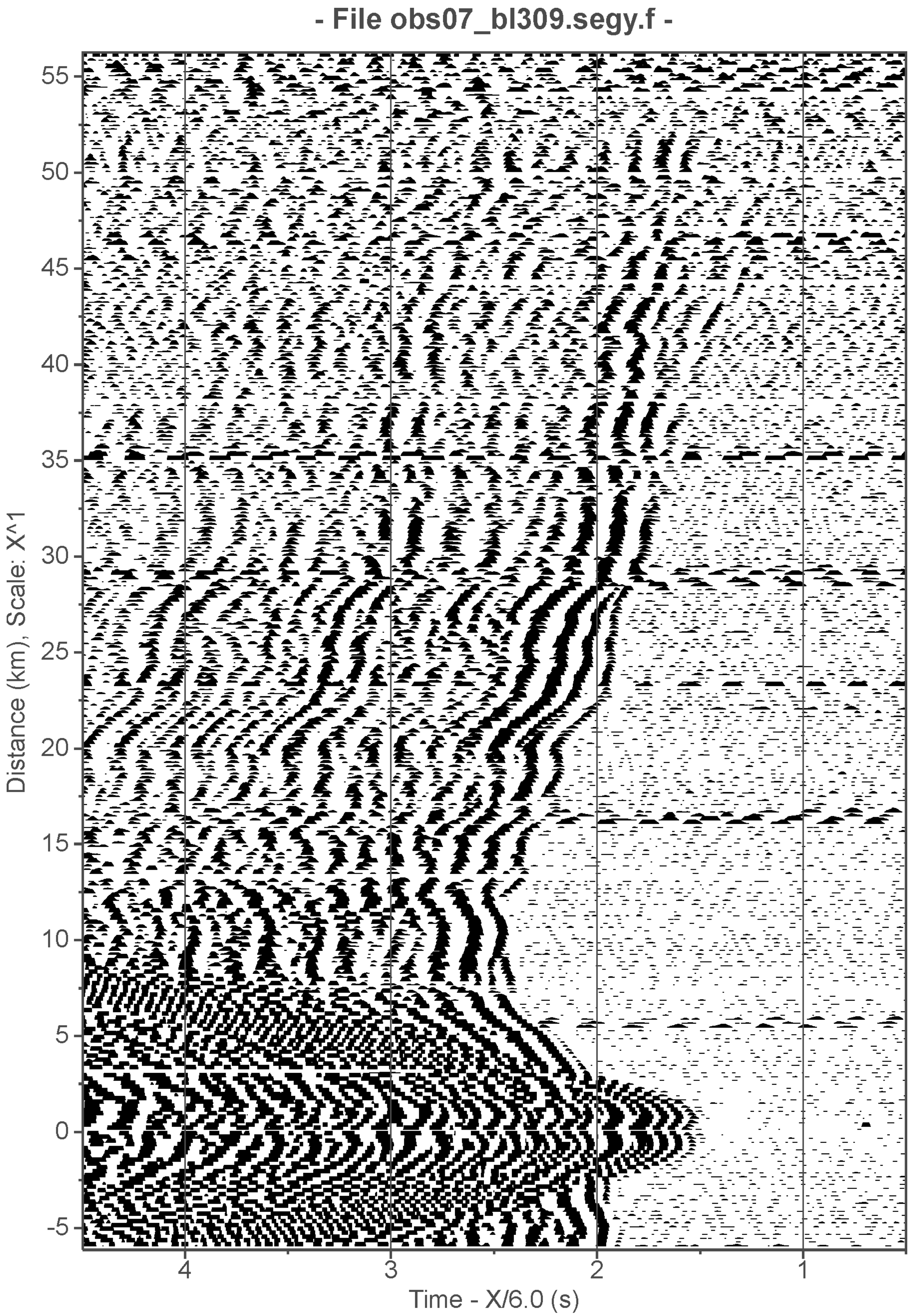

- File obs03_bl302.segy.f -
Distance (km), Scale: X^1
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
4
3
2
1
Time - X/6.0 (s)

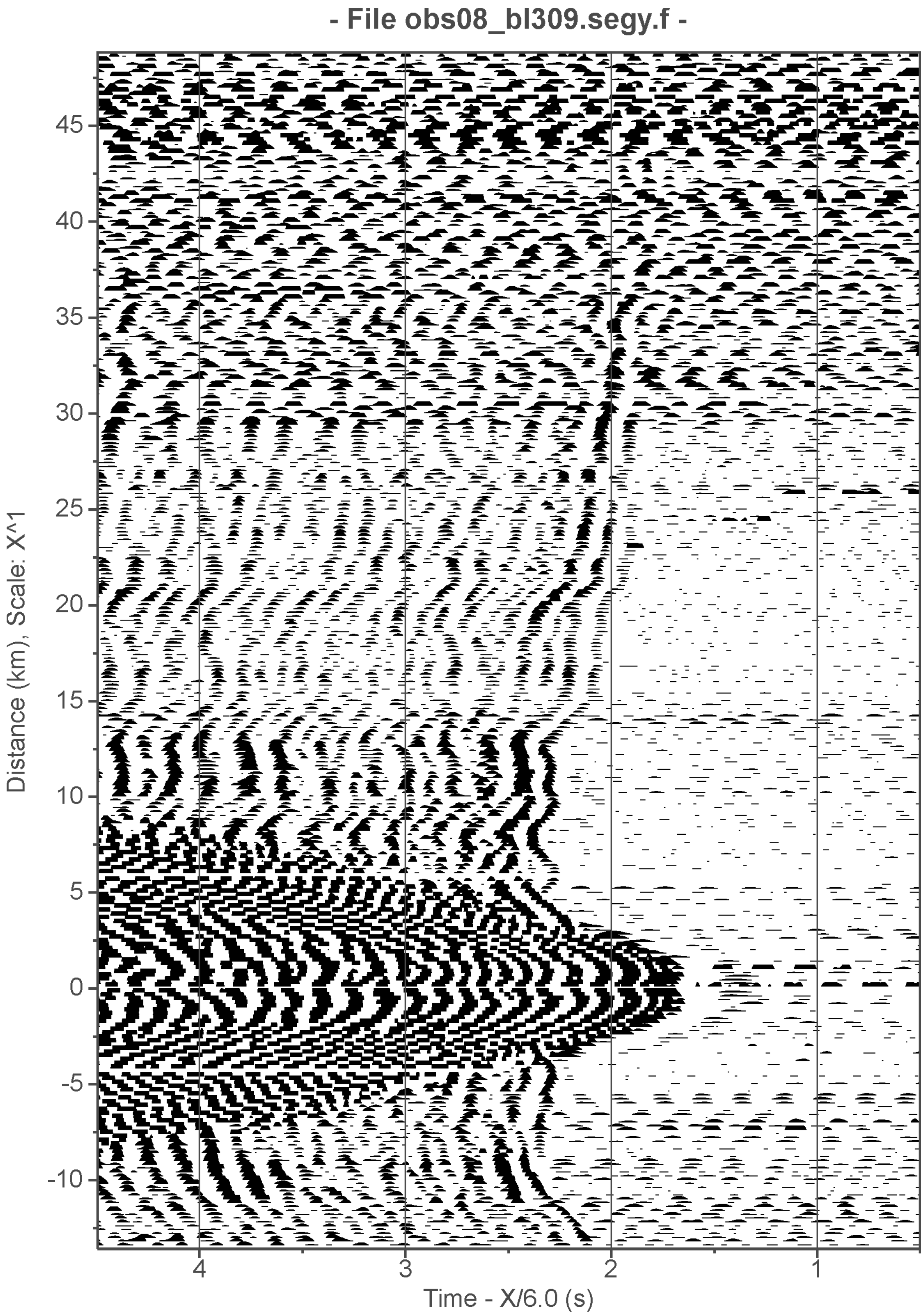
- File obs04_bl302.segy.f -

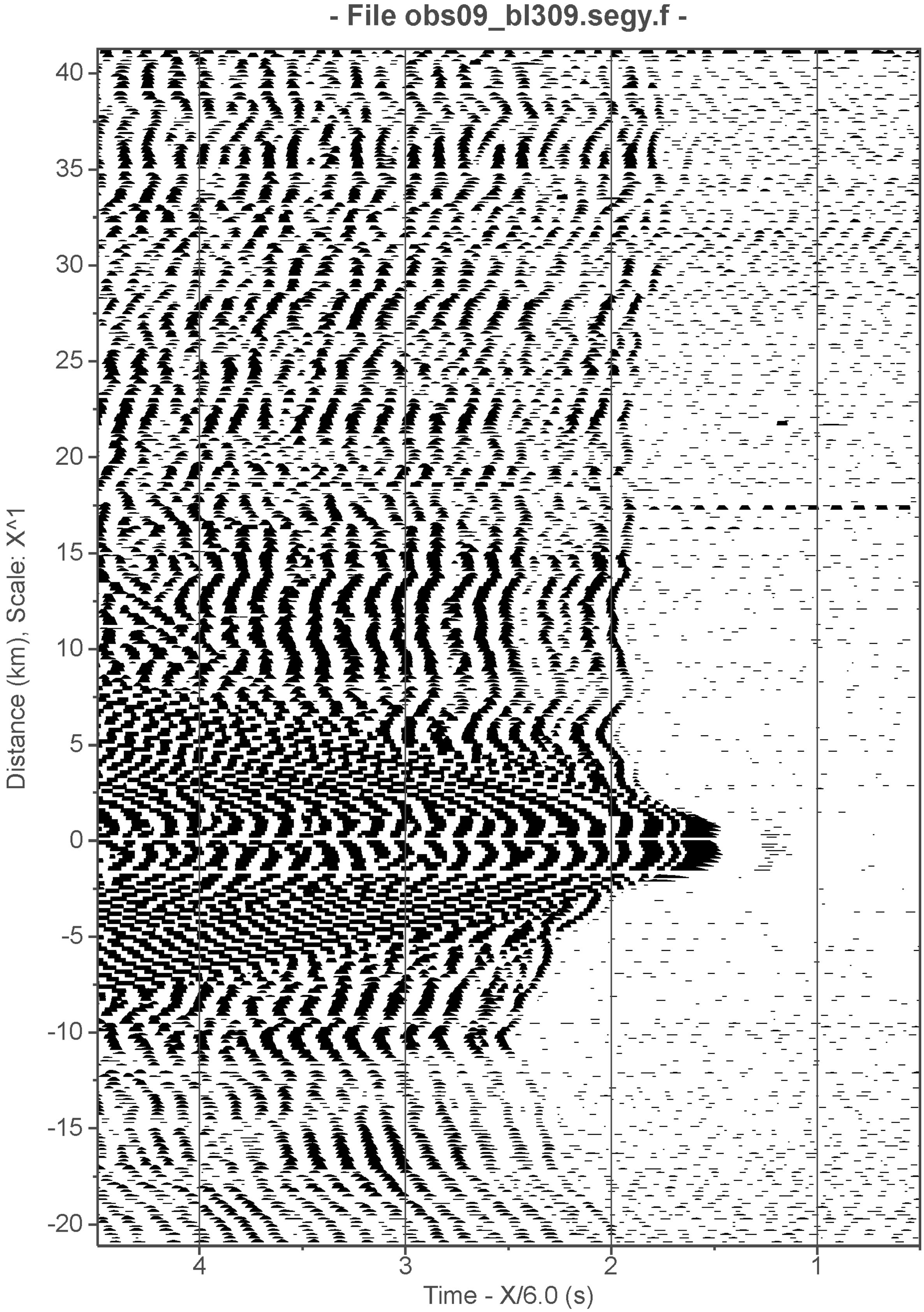



- File obs05_bl302.segy.f -
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
Distance (km), Scale: X^1
4
3
2
1
Time - X/6.0 (s)


- File obs06_bl302.segy.f -
Distance (km), Scale: X^1
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
4
3
2
1
Time - X/6.0 (s)


- File obs07_bl309.segy.f -
Distance (km), Scale: X^1
55
50
45
40
35
30
25
20
15
10
5
0
-5
4
3
2
1
Time - X/6.0 (s)


- File obs08_bl309.segy.f -
Distance (km), Scale: X^1
Time - X/6.0 (s)
45
40
35
30
25
20
15
10
5
0
-5
-10
4
3
2
1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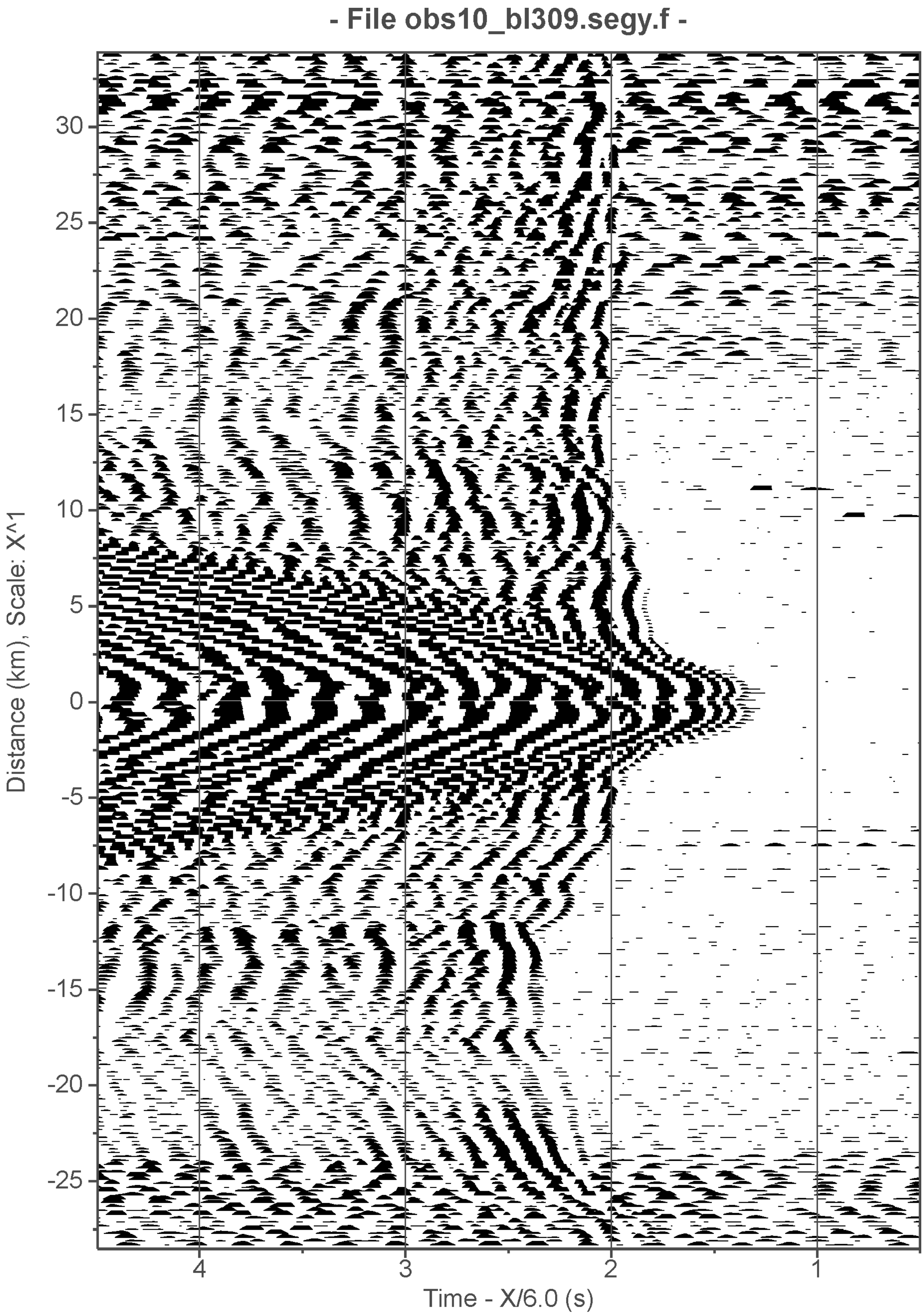
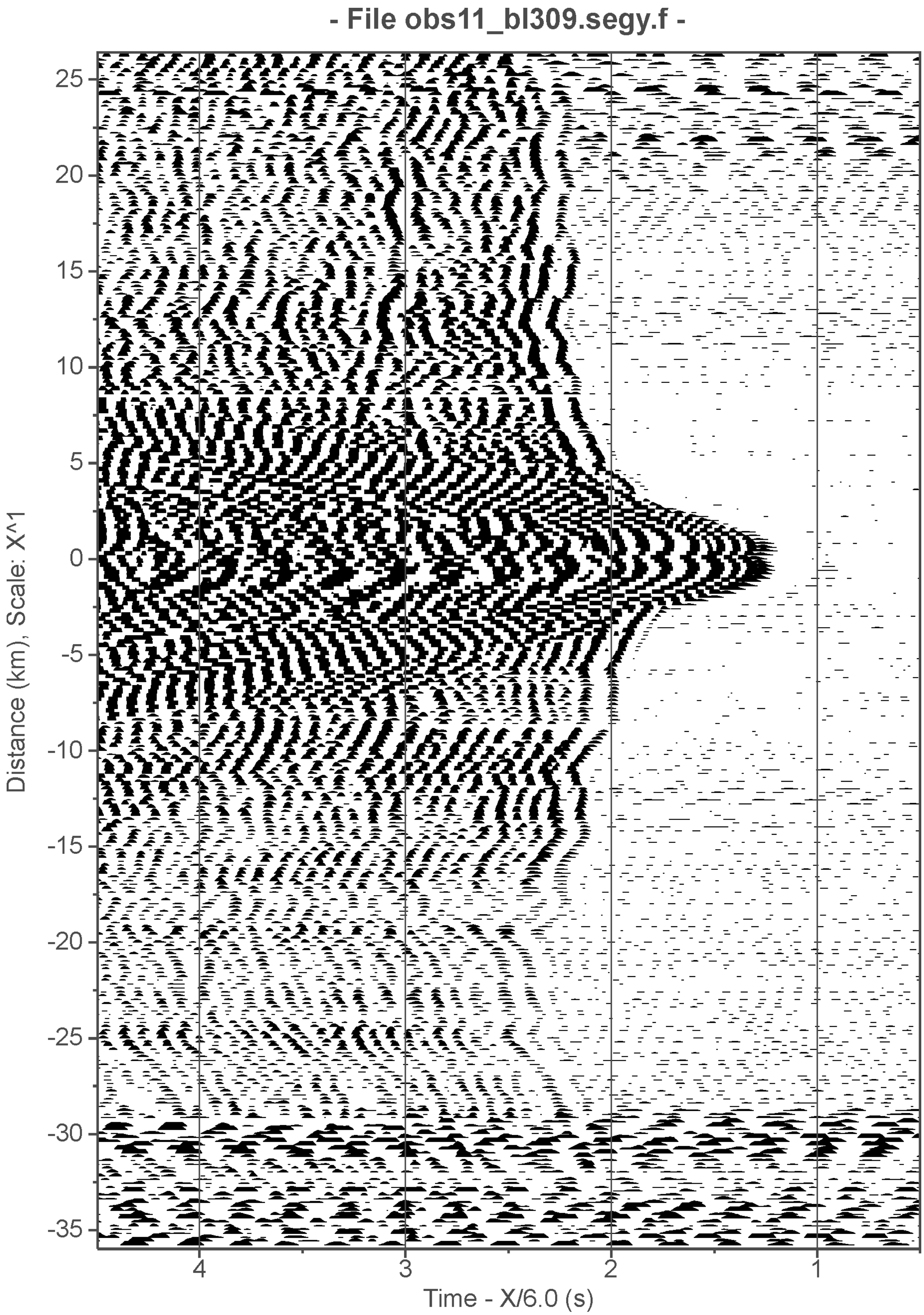
Distance (km), Scale: X^1
40
35
30
25
20
15
10
5
0
-5
-10
-15
-20
4
3
2
1
Time - X/6.0 (s)


- File obs10_bl309.segy.f -
Distance (km), Scale: X^1
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
4
3
2
1
Time - X/6.0 (s)


- File obs11_bl309.segy.f -
Distance (km), Scale: X^1
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
-35
4
3
2
1
Time - X/6.0 (s)

Incidental Harassment Authorization Mitigation Procedures

The IHA required the following mitigation procedures during our seismic program:

(a) (i) Establish and monitor the safety zone for cetaceans and sea turtles surrounding the 10-airgun array where the received level would be 180 dB re 1 μPa rms. This radius is estimated to be 550 m (1805 ft) from the seismic source.

(a) (ii) Establish and monitor the safety zone for cetaceans and sea turtles surrounding the 12-airgun array where the received level would be 180 dB re 1 μPa rms. This radius is estimated to be 600 m (1969 ft) from the seismic source.

(a) (iii) Establish and monitor the safety zone for pinnipeds surrounding the 10-airgun array where the received level would be 190 dB re 1 μPa rms. This radius is estimated to be at the 200 m (656 ft) from the seismic source.

(a) (iv) Establish and monitor the safety zone for pinnipeds surrounding the 12-airgun array where the received level would be 190 dB re 1 μPa rms. This radius is estimated to be at the 250 m (820 ft) from the seismic source.

(b) Immediately power-down the seismic airgun array and/or other acoustic sources, whenever any marine mammals or sea turtles are sighted approaching close to or within the area delineated by the 180 dB (re 1 μPa rms), or 190 dB (re 1 μPa rms) isopleth as established under condition (a) for the authorized seismic sources.

(c) Not proceed with powering up the seismic airgun array unless the safety zones described in condition (a) are visible and no marine mammals or sea turtles are detected within the appropriate safety zones; or until 15 minutes (for small odontocetes, pinnipeds or sea turtles) or a minimum of 30 minutes (for mysticetes/large odontocetes) after there has been no further visual detection of the animal(s) within the safety zone and the trained marine mammal observer on duty is confident that no marine mammals or sea turtles remain within the appropriate safety zone.

(d) Prior to commencing ramp-up in condition (f), cconduct a 30-minute period of observation by at least one trained marine mammal observer (i) at the commencement of seismic operations and (ii) at any time electrical power to the airgun array is discontinued for a period of 30 minutes or more;

(e) If the complete safety radii are not visible for at least 30 minutes prior to ramp-up in either daylight or nighttime, not commence ramp-up unless the seismic source has maintained a sound pressure level of at least 180 dB re 1 μPa rms during the interruption of seismic survey operations.

(f) If no marine mammals or sea turtles have been observed while undertaking mitigation condition (c), (d), and (e), ramp-up airgun arrays no greater than approximately 6 dB per 5-minute period starting with the smallest airgun (80 in^3) in the array and then adding additional guns in sequence, until the full array is firing: (1) At the commencement of seismic operations, and (2), anytime after the airgun array has been powered down for more than 4 minutes;

(g) (i) Secure the multi-beam and sub-bottom profiler sonars during the Ocean-Bottom Seismometer (OBS) deployments until approximately 10 minutes prior to deployment of each OBS. At 10 minutes prior to deployment, the multi-beam and sub-bottom sonars may commence operations to ensure that the depths and bottom topography are in accordance with the planned OBS location. (ii) Secure the multi-beam and sub-bottom sonars immediately after each OBS has been deployed until 10 minutes from the next OBS deployment site.

(h) (i) Reduce the volume of the airgun array during vessel turns while running seismic lines. (ii) Secure the multi-beam and sub-bottom profiler sonars during turns (unless there is a safety issue).

(i) Shut down the airgun array regardless of the distance of the whale from the airguns if a North Pacific right whale is sighted by the vessel-based observers;

(j) To the extent practical, whenever a marine mammal is detected outside the safety radius, and based on its position and motion relative to the ship track is likely to enter the safety radius, an alternative ship speed or tack will be calculated and implemented.

(k) Emergency shut-down. If observations are made or credible reports are received that one or more marine mammal or sea turtles are within the area of this activity in an injured or mortal state, or are indicating acute distress, the seismic airgun array will be immediately shut down and the Chif of the Permits, Conservation and Education Division, Office of Protected Resources or a staff member contacted. The airgun array will not be restarted until review and approval has been given by the Director, Office of Protected Resources or her designee.

(l) Use the SEAMAP Passive Acoustic Monitoring System to monitor for vocalizing marine mammals and to notify visual observers of nearby marine mammals. To the maximum extent possible, the SEAMAP system will be monitored continuously whenever the seismic airgun array is operating.

Condition (h) (i): At the start of the seismic program we were informed that we should switch from the full 10 or 12-gun array to 3 guns during turns. However, this did not prove to be feasible because the monitoring conditions designated that a marine mammal observer must be on active watch during nighttime power-ups of the airguns. The reduction in volume was thus authorized to be 7 guns, which did not require nighttime observers.

Condition (h) (ii). Hydrosweep was turned off during turns, but this appeared to cause the system to start behaving erratically and even fail. Richard Oliver Goodwin, the systems administrator for the cruise, reported the following: The fundamental problem with the multibeam mitigation effort from an operator's point of view is that it neglects to consider the considerable amount of electric current necessary to operate the system and the effects that frequently cycling power has on both the hardware/software and the quality of the data. Almost immediately after employing the multibeam mitigation procedures, we began to see the following problems with the hydrosweep: 1) the hydrosweep system "froze" on a couple of occasions, reporting neither center beam depth nor the multibeam swath profile, necessitating a reboot of the entire system. 2) the hydrosweep often reported incorrect or "multiples" of the true centerbeam depth both immediately and well after the turn was completed. It's also worth noting that since center beam depth tracking is depth dependent (and this of course changes over the course of the survey), it became difficult to standardize what point we should turn the hydrosweep back on to ensure that reliable data would be present before we resumed the survey. During the cruise we received permission to keep hydrosweep on for the duration of the cruise.

Blanco Pacific Double's Ping Pong Championship