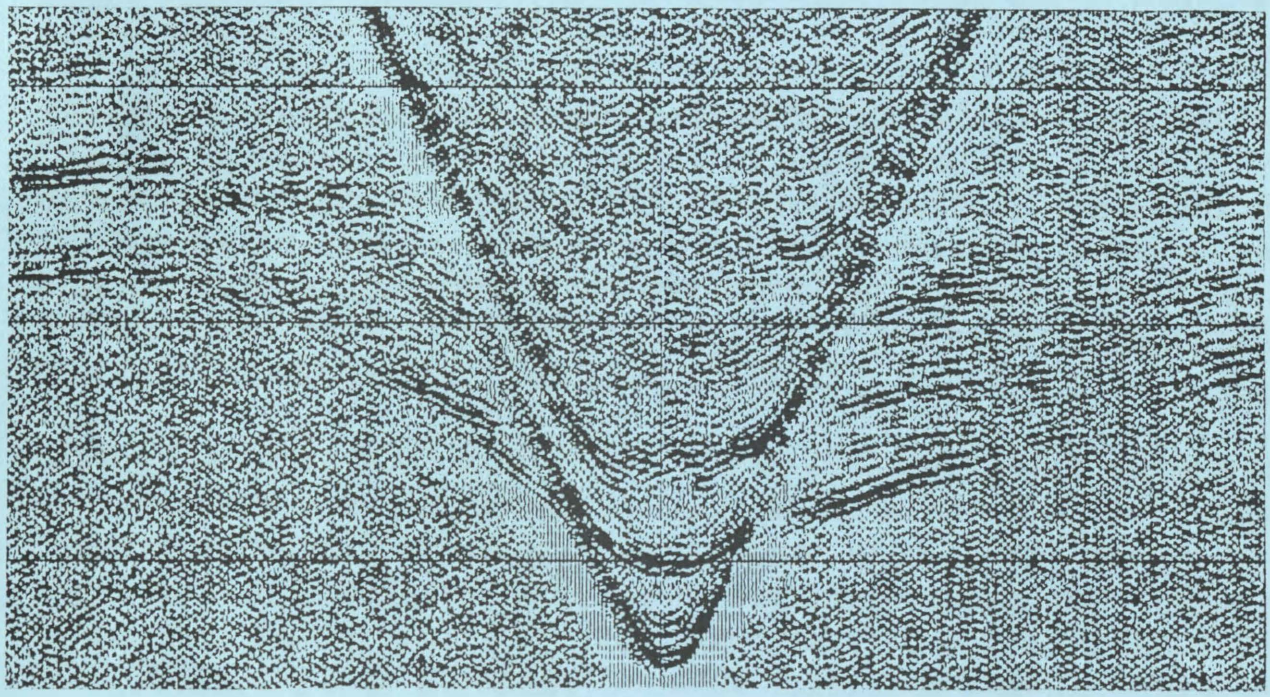
PACOMAR

SONNE 81

Compilation of seismic wide-angle data



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and German Leandro

GEOMAR Data Report

Kiel, 1993

Introduction

The PACOMAR (PAcific COntinental MARgins) Project is a joint German Costa Rican research effort to study the tectonic processes and the nature of earthquakes in the convergent plate boundary along the Pacific coast off Costa Rica. It is mainly funded by the Bundesministerium für Forschung und Technologie (BMFT), Bonn through grants to GEOMAR, Kiel, the Bundesanstalt für Geowissenschaften und Rohstoffe, Hannover, the Geological Institut in Kiel and the Department of Earthsciences, Greifswald. Partners from Costa Rica are the ICE (Instituto Costarricense de Electricidad) , the Escuela Centroamericana de Geologia, Universidad de Costa Rica and RECOPE (Refinadora Costarricense de Petroleo). In Figure 1 all the partners are shown. The purpose of this report is to present the wide-angle seismic data recorded off Costa Rica during SO81 - from 18.08 - 15.09.1992.

Two cruises of the German research vessel FS SONNE were devoted to the PACOMAR Project. Activities are briefly summarized in Figure 2. More details can be found in the cruise reports (von Huene et al., 1992; Hinz et al., 1992) and subsequent publications (e.g. von Huene et al., 1993). In short, multibeam swathmapping, geologic sampling, seismic reflection and refraction observation (both offshore and offshore-onshore), magnetic and gravimetric measurements were accomplished.

During the cruise SO81 from 18.08. to 15.09.1992 mainly seismic reflection measurements were performed, and in total more than 1800 km of normal incident reflection data were collected (Hinz et al., 1992). Several wide-angle transects, utilizing both ocean bottom seismometers (OBS) and landstations complemented the reflection data. Two profiles (SO81-100 and SO81-200) were shot especially for wide-angle observations, and a third profile (SO81-300) was recorded coincident with a reflection line (SO81-21). Along these profiles up to seven OBS were in deployed between the Middle America trench and the coast. In Figure 3 the locations of the profiles and the instruments are shown and the exact positions of the recording instruments are also given in Table 1. All wide-angle record sections obtained along these profiles are presented in this report. In addition, the landstations recorded shots from several of the reflection lines. However, those data will be presented elsewhere.

PACOMAR

Working Group

B G R
Hannover

G E O M A R
Kiel

FGG
Geological Intstitute
Greifswald University

GPI
Geological Institute
Kiel University

I C E
Instituto Costaricense
de Electricidad

E G U C
Escuela Geologia
Universidad Costa Rica

R E C O P E
Refinadora
Costaricense
de Petroleo

Figure 1: The PACOMAR Working Group family

PACOMAR

PACific COntinental MARgins

SONNE 76 **20.12.91 - 25.01.92**

GEOMAR: swathmapping
magnetics
OBS refraction profiles
onshore-offshore refraction profiles

GPI: sampling

ICE: onshore-offshore refraction profiles
onshore reflection profile

EGUC: seismological network

SONNE 81 /1&2 **18.08.92 - 15.09.92**

BGR: reflection profiles
gravity

FGG: sampling

GEOMAR: swathmapping
OBS refraction profiles
onshore-offshore refraction profiles

ICE: onshore-offshore refraction profiles

EGUC: seismological network

Figure 2: The main activities within the PACOMAR Project

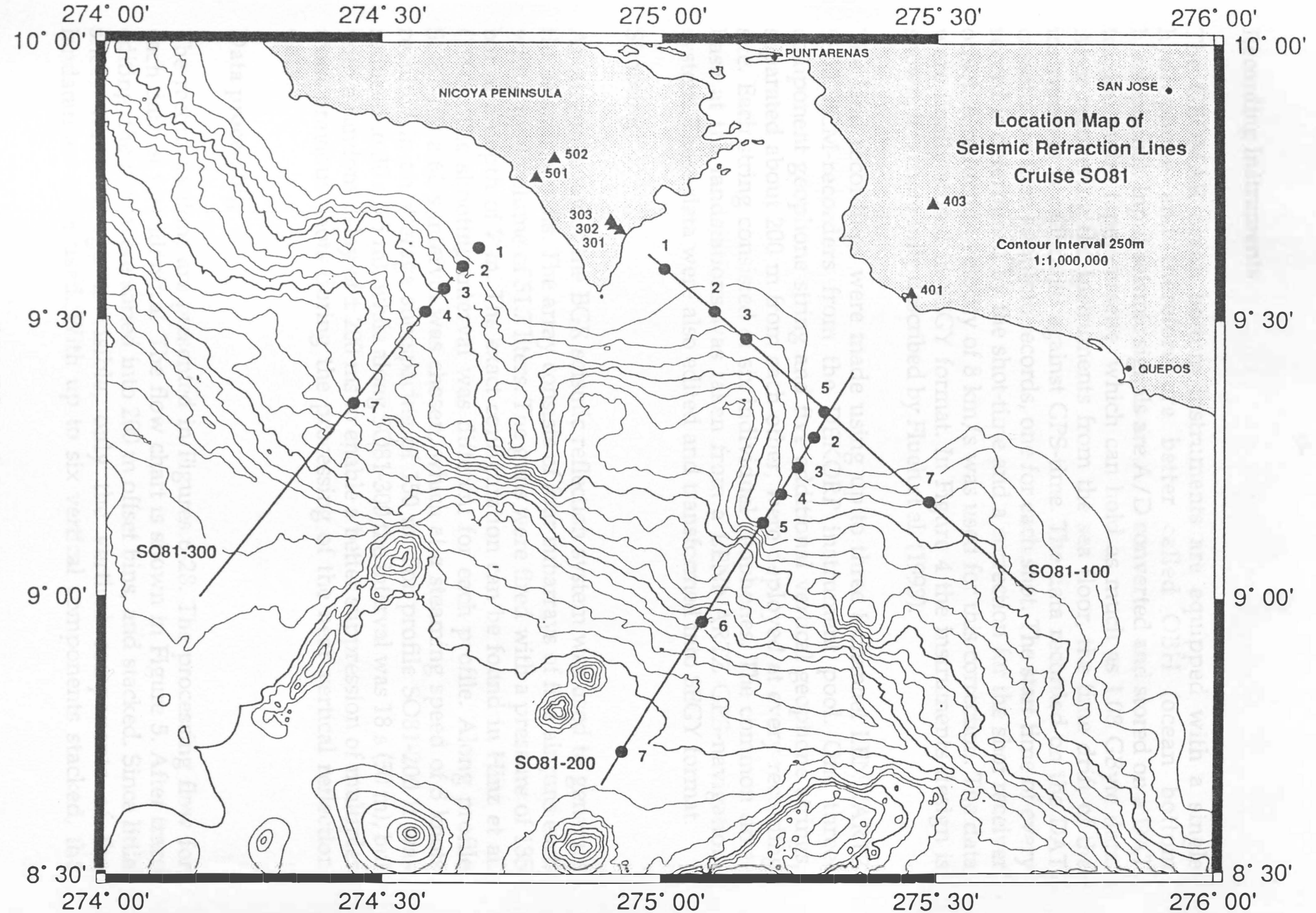

Figure 3: Location map of PACOMAR SO81 wide-angle seismic profiles and recorders

Recording instruments

The GEOMAR ocean bottom instruments are equipped with a single hydrophone and therefore are better called OBH (ocean bottom hydrophone). Input seismic signals are A/D converted and stored on a DAT (digital audio tape) cassette, which can hold as much as 1.08 GByte data. After recovering the instruments from the sea floor, the time drift of the instruments is calibrated against GPS-time. The data recorded on the DAT cassette are then split into records, one for each shot. The start time of every record is determined by the shot-time and a correction for the shot receiver offset. A reduction velocity of 8 km/s was used for this correction. The data were finally stored in SEGY format. In Figure 4 the instruments design is shown, it is more fully described by Flueh et al. (1993).

The land recordings were made using up to three 8-channel LENNARTZ 5800 PCM-recorders from the DEKORP instrument pool. One three-component geophone string and five additional vertical geophone strings, separated about 200 m from each other, were deployed at every recording site. Each string consisted of six individual geophones. The common time-base at the landstations was taken from a LENNARTZ GPS-navigation-system. These data were also edited and transformed into SEGY format.

Shooting

An airgun array of the BGR seismic reflection system was used to generate the seismic signals. The array consists of four subarrays of five airguns each with a total volume of 51.7 liters. The guns were fired with a pressure of 135 bar at a depth of 7 m. The exact configuration can be found in Hinz et al. (1992). The shooting interval was different for each profile. Along profile SO81-100 a 60 s interval was chosen, which at a steaming speed of 5 knots resulted in an average shotspacing of 150 m. For profile SO81-200 it was reduced to 30 s (75 m), while along SO81-300 the interval was 18 s (50 m), but with a random delay of ± 200 ms to enable a better suppression of multiples from previous shots during the processing of the near vertical reflection data.

Data processing

The record sections are presented in Figures 6-28. The processing flow for each dataset was identical. The flow chart is shown in Figure 5. After trace editing, the data were sorted into 200 m offset bins, and stacked. Since little shear wave energy is visible, only the vertical components of the landstations were used. With up to six vertical components stacked, the

Fundamentals of the OBH - System

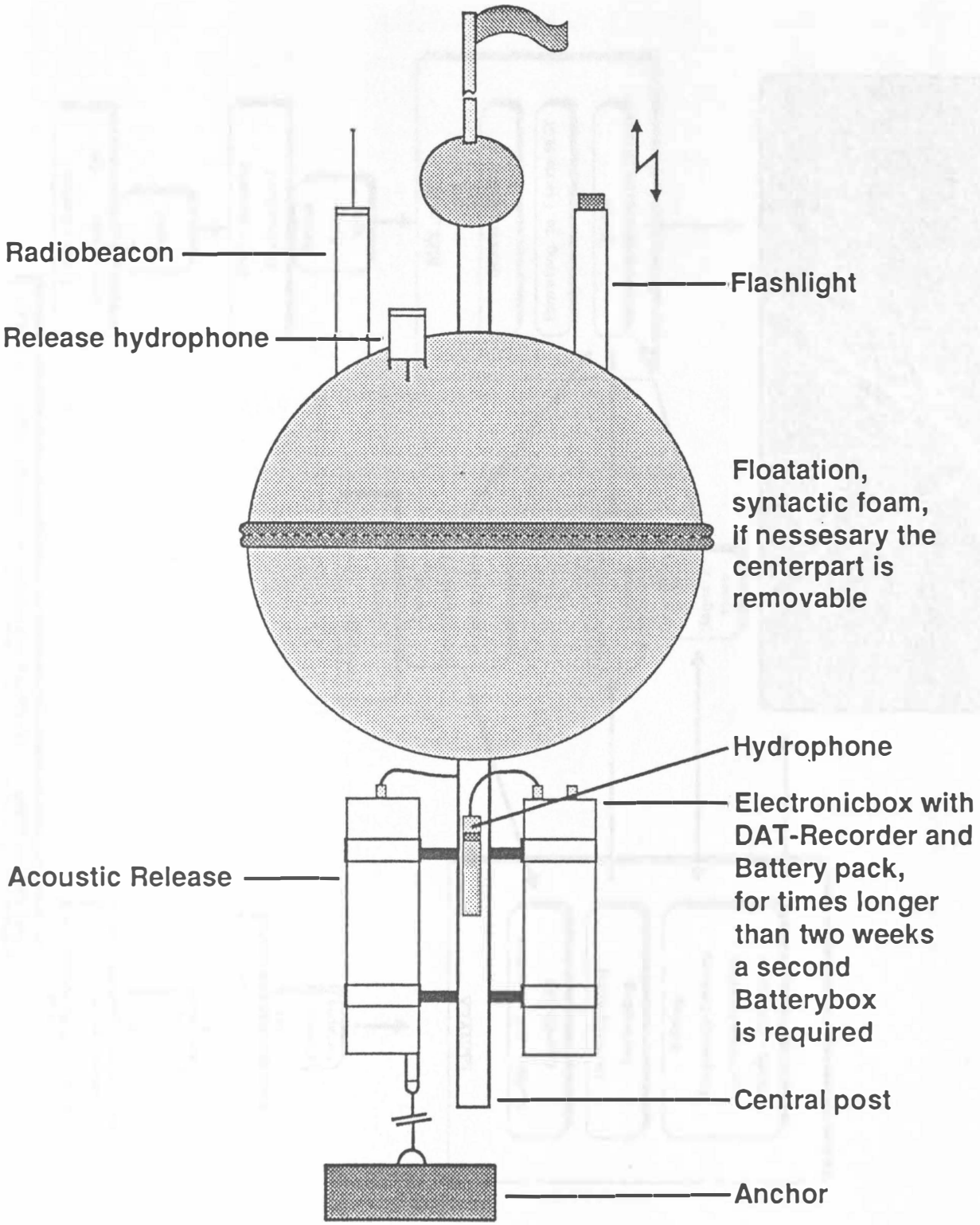

Figure 4: The principle design of the GEOMAR OBH

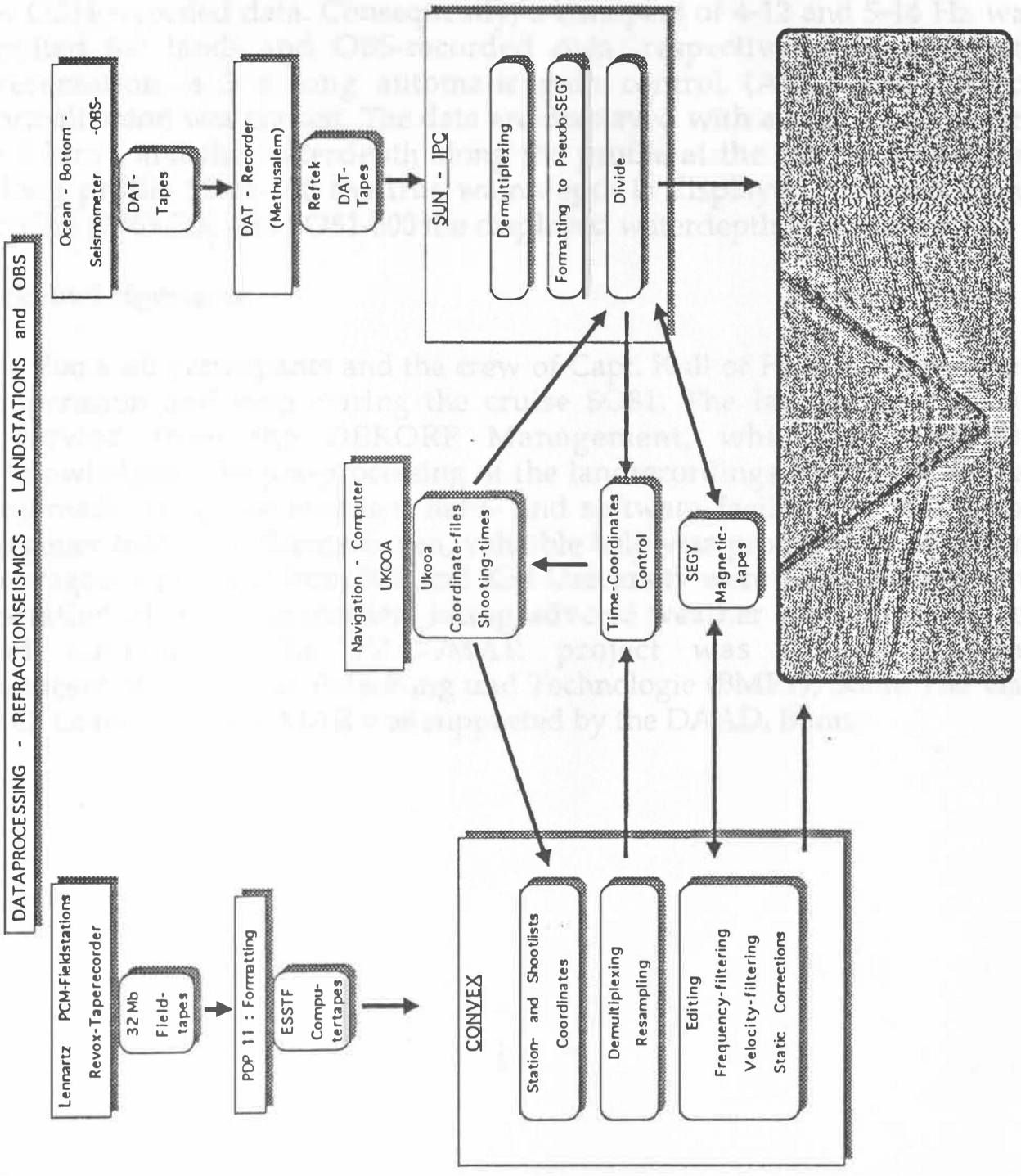

Figure 5: Processing flow chart

land-recorded data achieved a coverage between 3 and 9 fold with a five fold average. For the OBH data a lower coverage of 1-3 fold was obtained from the 200 m binning based on the average shotspacing of 50-150 m. Spectral analysis showed that the seismic energy is concentrated in a narrow band between 6 and 10 Hz for land-recorded data and between 6 and 12 Hz for OBH-recorded data. Consequently, a bandpass of 4-12 and 5-14 Hz was applied for land- and OBS-recorded data, respectively. For the data presentation, a 3 s long automatic gain control (AGC) and a trace normalization was chosen. The data are displayed with a reduction velocity of 8 km/s and the waterdepth along the profile at the top of the section. Along profile SO81-100 the true waterdepth is displayed, whereas along profiles SO81-200 and SO81-300 the displayed waterdepth is divided by 10.

Acknowledgements

We thank all participants and the crew of Capt. Kull of FS SONNE for their cooperation and help during the cruise SO81. The landrecorders were borrowed from the DEKORP Management, which is gratefully acknowledged. The pre-processing of the landrecordings into SEGY format was made using the excellent hard- and software facilities at the Alfred Wegener Institut in Bremerhaven, valuable help was provided by W. Jokat. Courageous personal from ICE and Kiel University were responsible for the operation of the landrecorders facing adverse weather conditions, snakes and landslides. The PACOMAR project was funded by the Bundesministerium für Forschung und Technologie (BMFT), Bonn. The visit of G. Leandro to GEOMAR was supported by the DAAD, Bonn.

References

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Hinz, K., u.a., 1992: Geoscientific investigations off Costa Rica - "PAKOMAR 2", SONNE cruise SO81/1 & 2, 18.08.-15.09.1992, Bericht BGR-110.148, 134 pp.

von Huene, R., Flueh, E.R., Bialas, J., Fabel, E., Hoffmann, J., and Emeis, K., 1992: PACOMAR 91/92 - Fahrtbericht SONNE 76, 20.12.91-25.01.92, GEOMAR Internal Report, 59 pp.

von Huene, R., Bialas, J., Flueh, E., Cropp, B., Csernok, T., Fabel, E., Hoffmann, J., Emeis, K., Holler, P., Jeschke G., C. Leandro M., I. Perez Fernandez, J. Chavarria S., A. Florez H., D. Escobedo Z., R. Leon, O. Barrios L., 1993: Morphotectonics of the Pacific convergent margin of Costa Rica. In: Mann, P., ed., Geologic and tectonic development of the Caribbean plate boundary in southern Central America: Geological Society of America Special Paper, in press.

Table 1

Coordinates of receivers

PACOMAR
Costa Rica August/September 1992

(from GPS-Data; World Geodetic Survey Ellipsoid 1984)

OBH positions

Locat	*Longitude*	*Latitude*	*Depth*
Profile 100			
OBH 1	-84.9960	9.59410	107
OBH 2	-84.9066	9.51690	409
OBH 3	-84.8489	9.46790	523
OBH 5	-84.7030	9.33690	96
OBH 7	-84.5146	9.17480	738
Profile 200			
OBH 2	-84.7250	9.29110	116
OBH 3	-84.7545	9.23650	460
OBH 4	-84.7846	9.18870	743
OBH 5	-84.8181	9.13600	909
OBH 6	-84.9267	8.95690	3222
OBH 7	-85.0699	8.71990	2940
Profile 300			
OBH 1	-85.3289	9.63190	114
OBH 2	-85.3576	9.59880	471
OBH 3	-85.3897	9.55780	942
OBH 4	-85.4238	9.51530	1150
OBH 7	-85.5523	9.35080	2094

PACOMAR
Costa Rica August/September 1992

(from GPS-Data; World Geodetic Survey Ellipsoid 1984)

Land positions

Locat	*Longitude*	*Latitude*	*Easting*	*Northing*	*Elev*
Profile 100					
Montezuma, Station 301					
K012	9.66400	-85.07570	711145	1068865	130
0003	9.66700	-85.07320	711418	1069199	105
0004	9.66250	-85.07450	711278	1068700	120
0005	9.66080	-85.07380	711356	1068512	115
0006	9.66550	-85.07700	711002	1069030	130
0007	9.66700	-85.07820	710869	1069195	135
Montezuma, Station 302					
K012	9.67230	-85.08750	709845	1069776	160
0003	9.67260	-85.08570	710042	1069810	160
0004	9.67200	-85.08570	710043	1069744	160
0005	9.67200	-85.08380	710251	1069745	160
0006	9.67390	-85.08810	709778	1069952	160
0007	9.67560	-85.08870	709711	1070140	160
Montezuma, Station 303					
K012	9.68056	-85.09234	709309	1070686	170
0003	9.68236	-85.09233	709309	1070886	155
0004	9.68090	-85.09422	709102	1070723	167
0005	9.68119	-85.09583	708925	1070754	163
0006	9.67960	-85.09069	709491	1070581	168
0007	9.67864	-85.08903	709673	1070476	172

PACOMAR
Costa Rica August/September 1992

(from GPS-Data; World Geodetic Survey Ellipsoid 1984)

Land positions

Locat	*Longitude*	*Latitude*	*Easting*	*Northing*	*Elev*
Profile 200					
Pto. Judas, Station 401					
K012	9.54898	-84.54833	769132	1056518	5
0003	9.55168	-84.55102	768835	1056815	5
0004	9.55019	-84.54686	769293	1056653	5
0005	9.55082	-84.54609	769377	1056724	6
0006	9.54736	-84.54949	769006	1056338	4
0007	9.54588	-84.55055	768891	1056174	4
Pto. Judas, Station 403					
K012	9.70980	-84.50950	773268	1074347	400
0003	9.70820	-84.51030	773181	1074169	360
0004	9.70920	-84.51120	773082	1074279	360
0005	9.70780	-84.51280	772907	1074123	340
0006	9.71070	-84.50800	773432	1074448	430
0007	9.71350	-84.50880	773342	1074757	440
Profile 300					
Pto. Coyote, Station 501					
K012	9.75630	-85.22730	694452	1078983	18
0003	9.75380	-85.22420	694794	1078708	25
0004	9.75480	-85.22870	694300	1078816	15
0005	9.75330	-85.22980	694180	1078649	10
0006	9.75800	-85.22620	694572	1079171	20
0007	9.76000	-85.22580	694615	1079393	28
Pto. Coyote, Station 502					
K012	9.79038	-85.19433	698050	1082772	25
0003	9.79041	-85.19410	698075	1082776	25
0004	9.78882	-85.19525	697950	1082599	25
0005	9.78726	-85.19617	697850	1082426	32
0006	9.79154	-85.19293	698203	1082901	25
0007	9.79263	-85.19159	698349	1083023	22

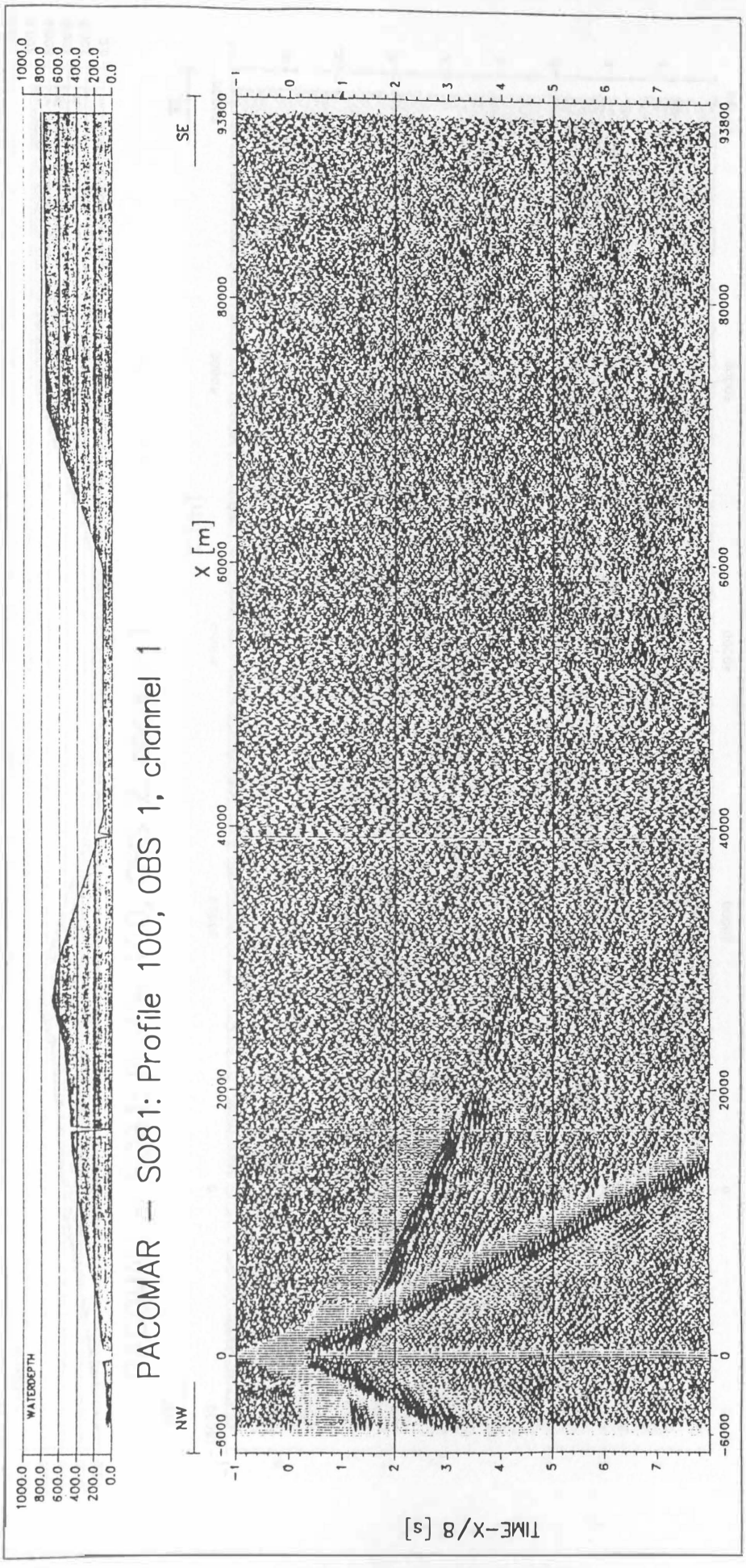


Figure 6: Record section of OBH-1, Profile SO81-100

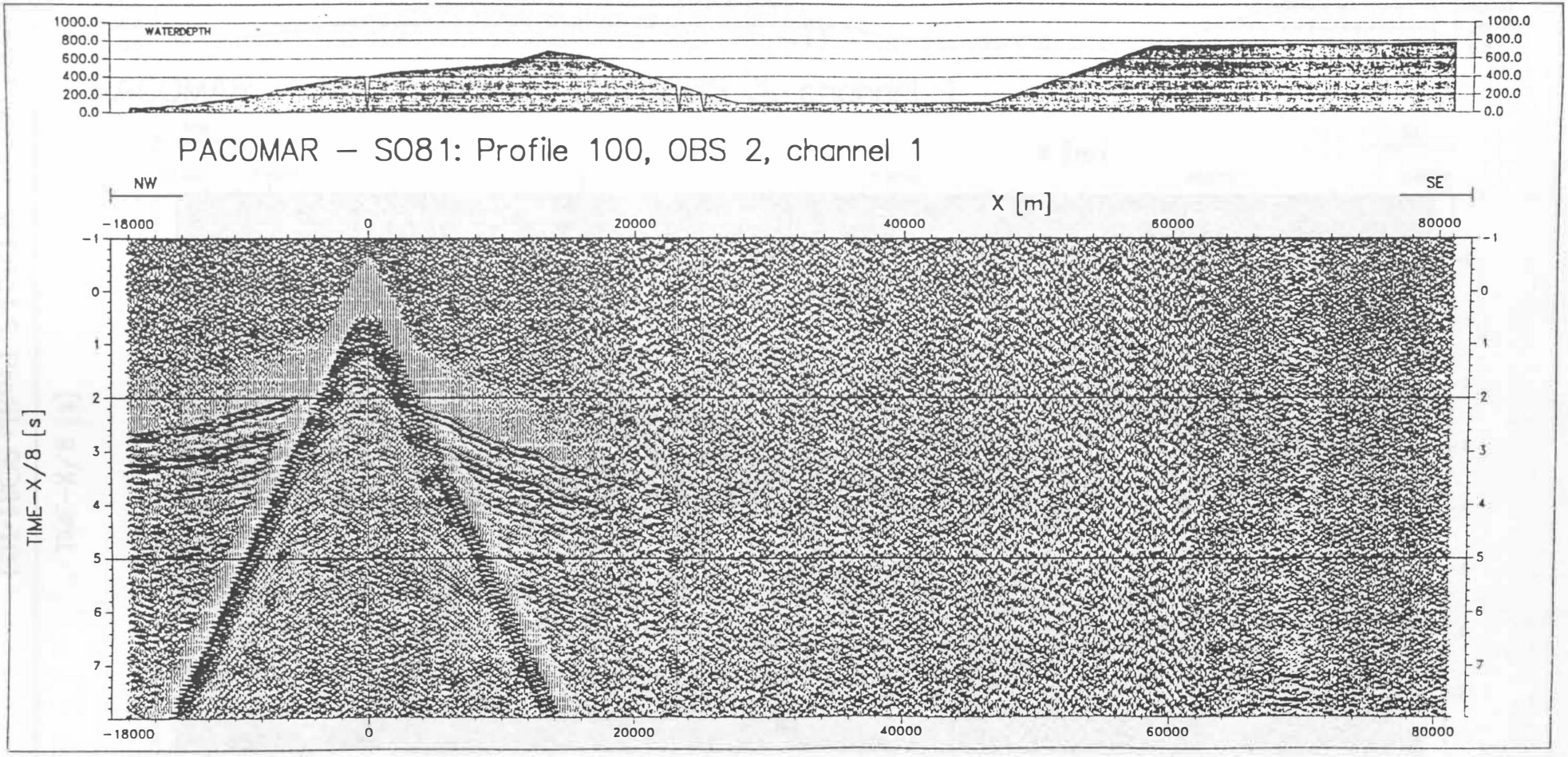


Figure 7: Record section of OBH-2, Profile SO81-100

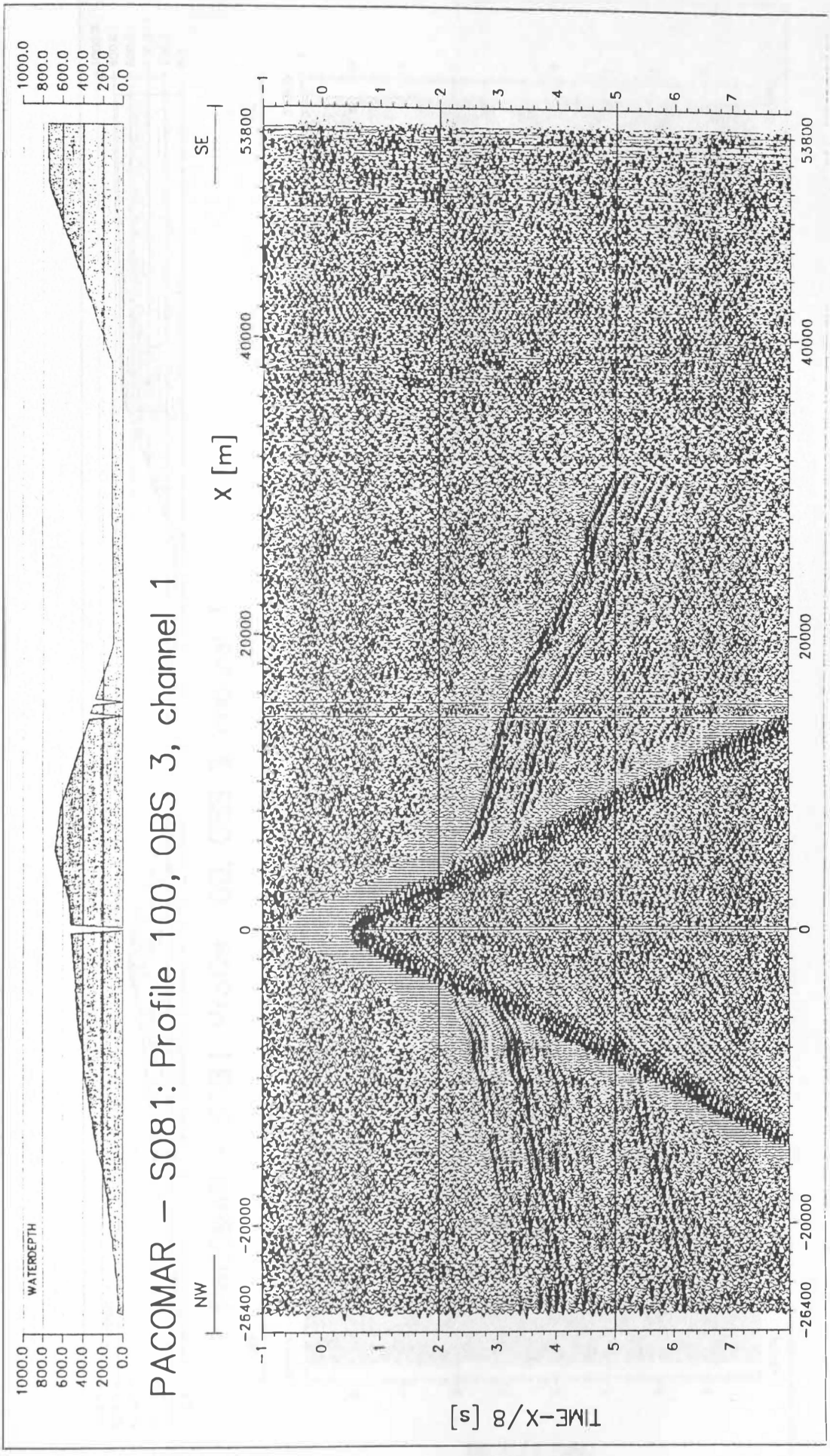


Figure 8: Record section of OBH-3, Profile SO81-100

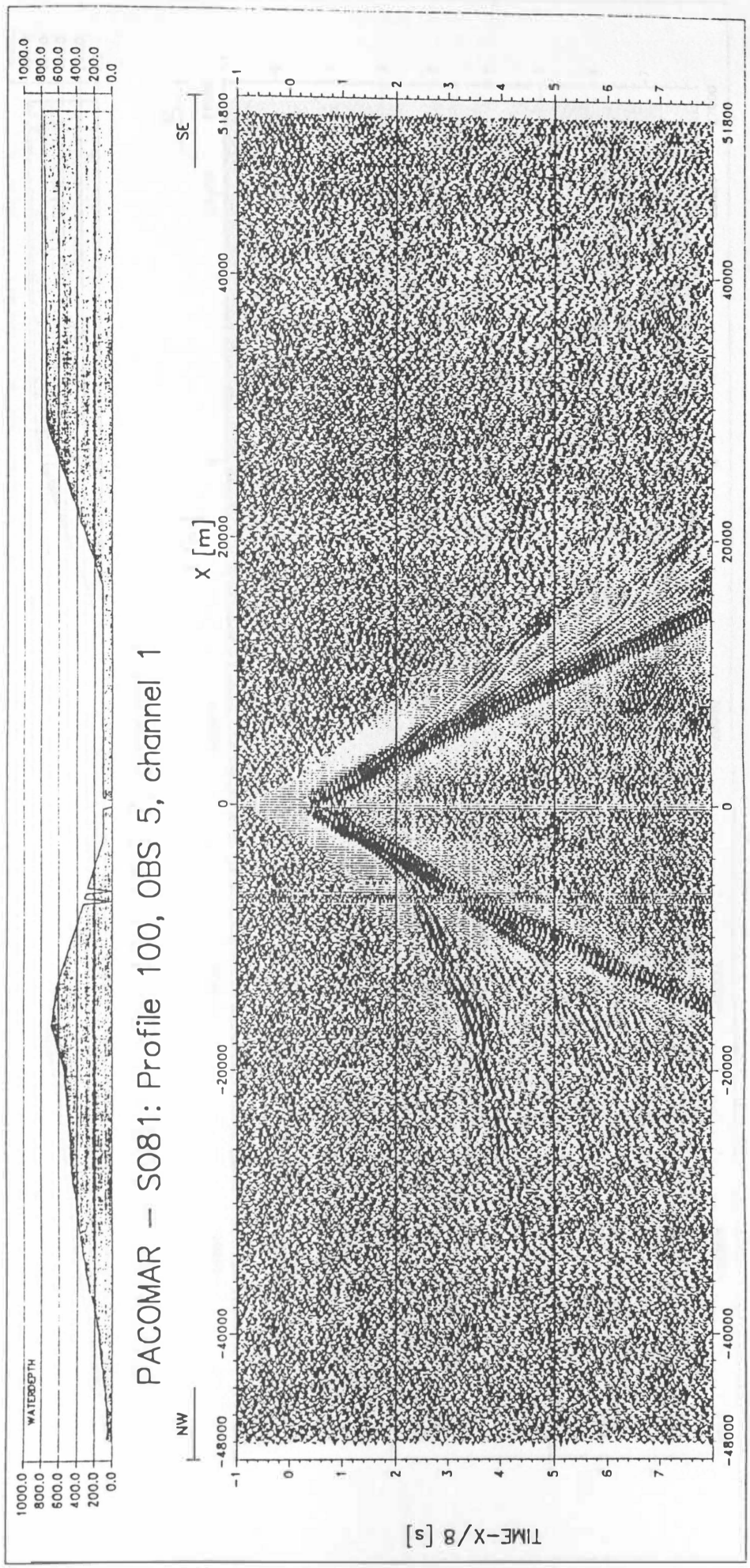


Figure 9: Record section of OBH-5, Profile SO81-100

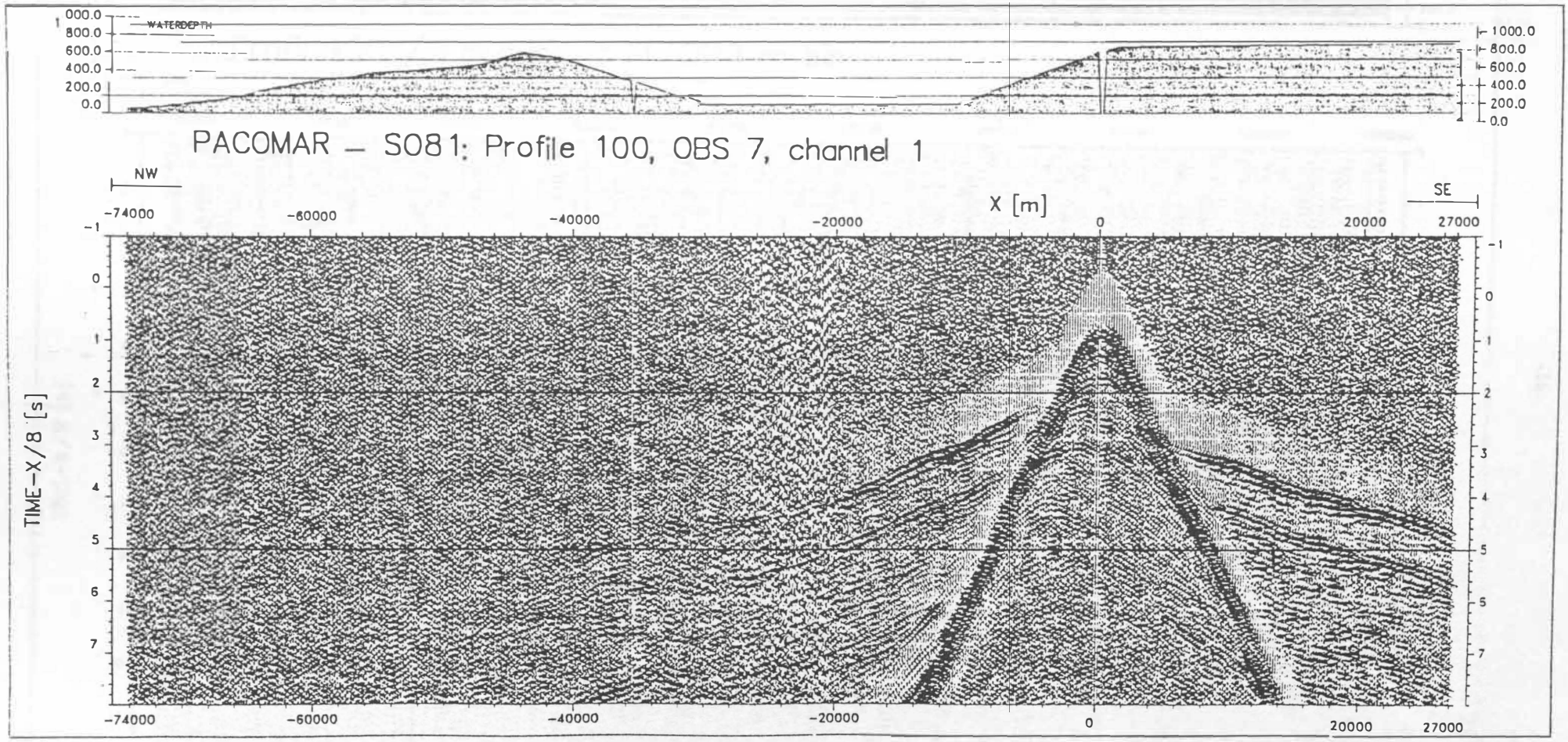


Figure 10: Record section of OBH-7, Profile SO81-100

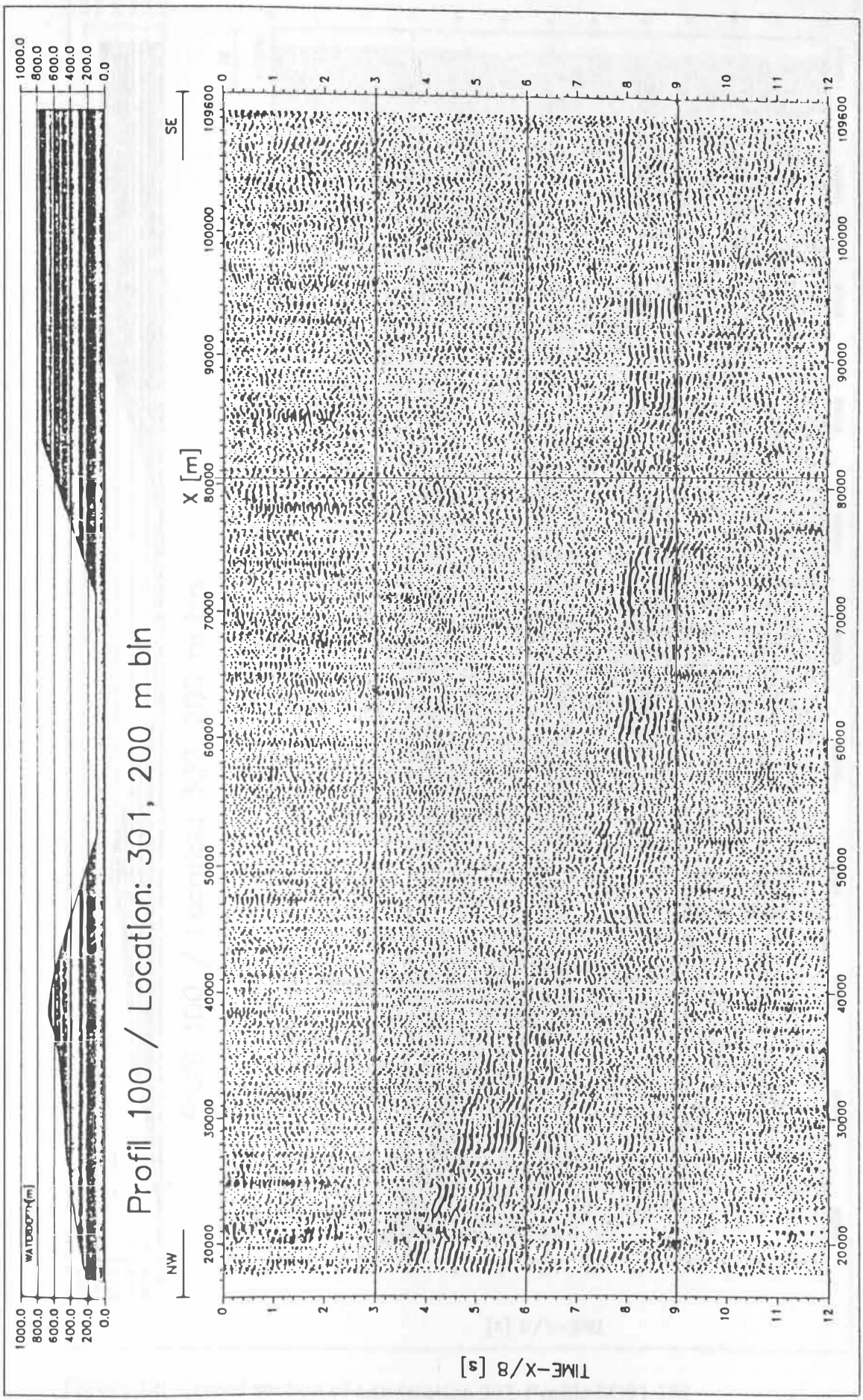


Figure 11: Record section of Landstation 301, Profile SO81-100

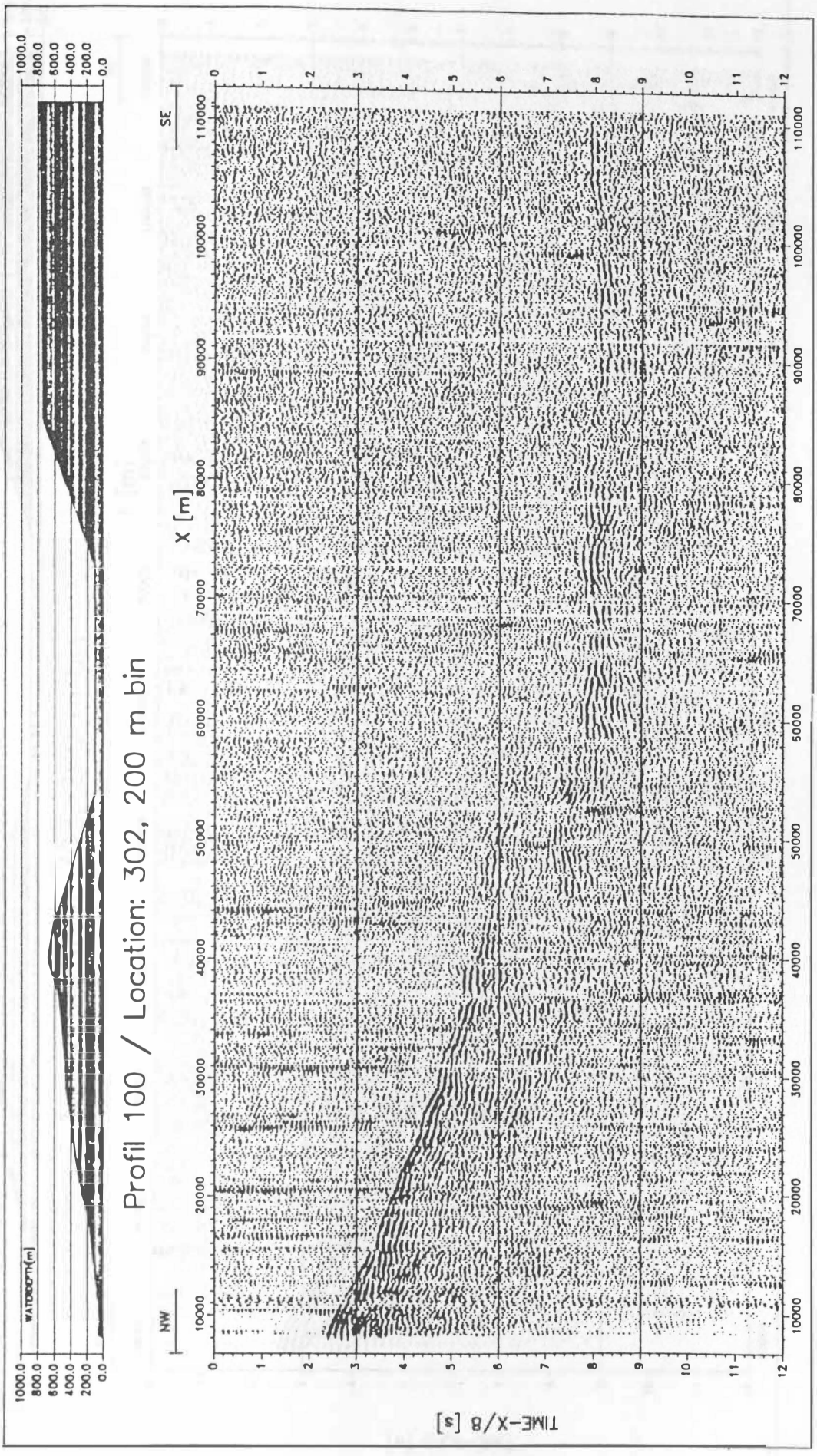


Figure 12: Record section of Landstation 302, Profile SO81-100

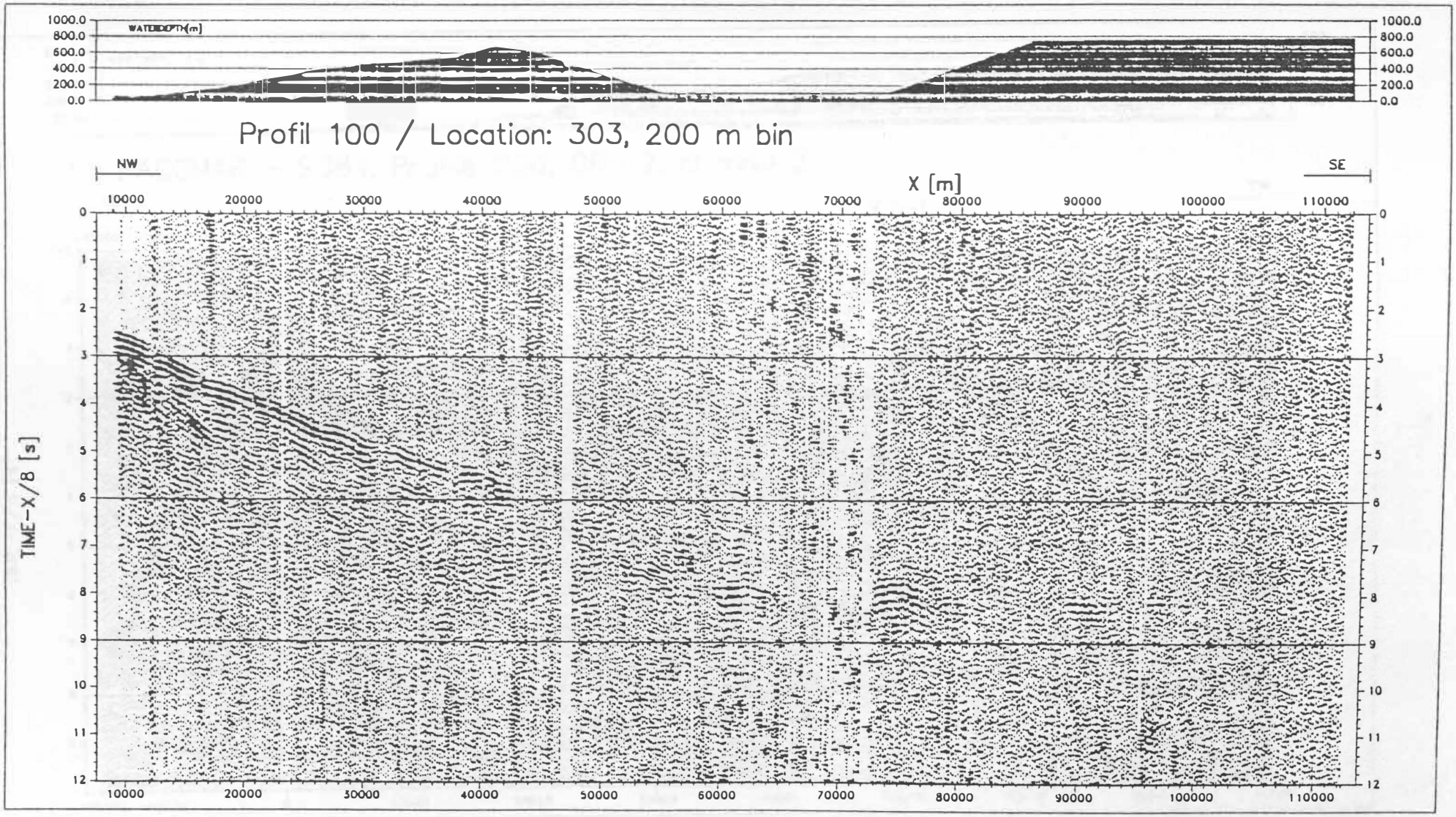


Figure 13: Record section of Landstation 303, Profile SO81-100

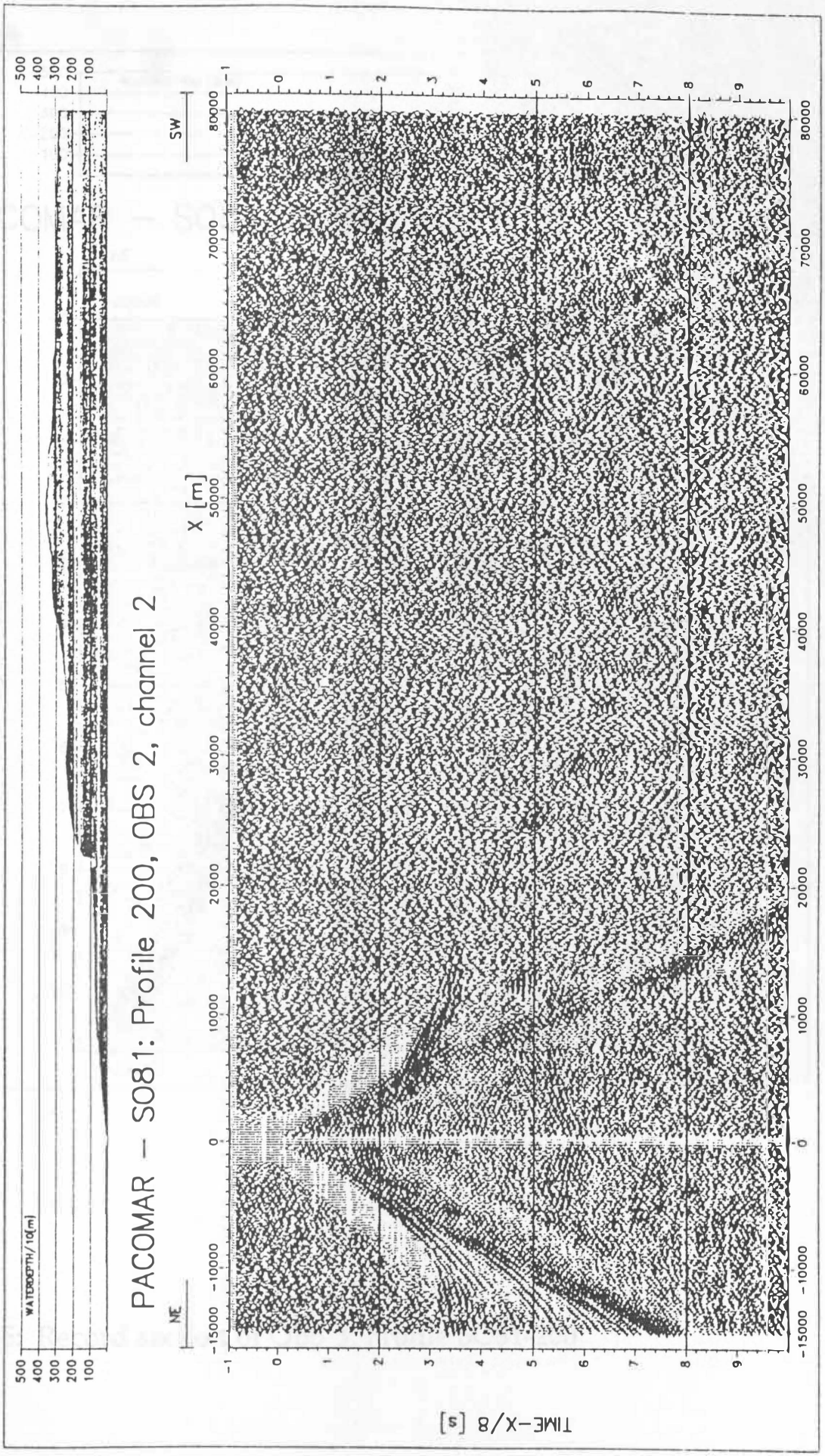


Figure 14: Record section of OBS 2, Profile SO81-200

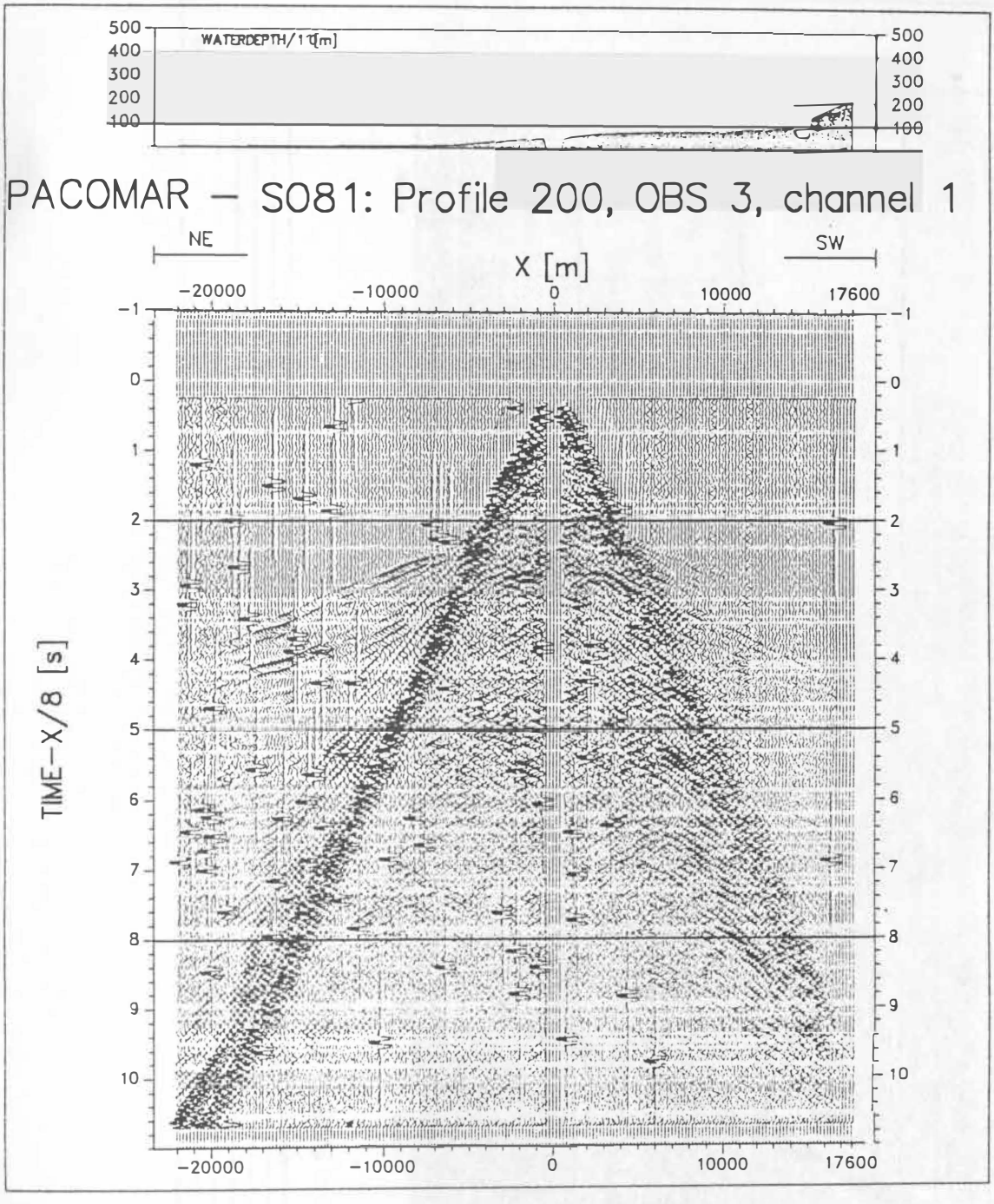


Figure 15: Record section of OBS 3, Profile SO81-200

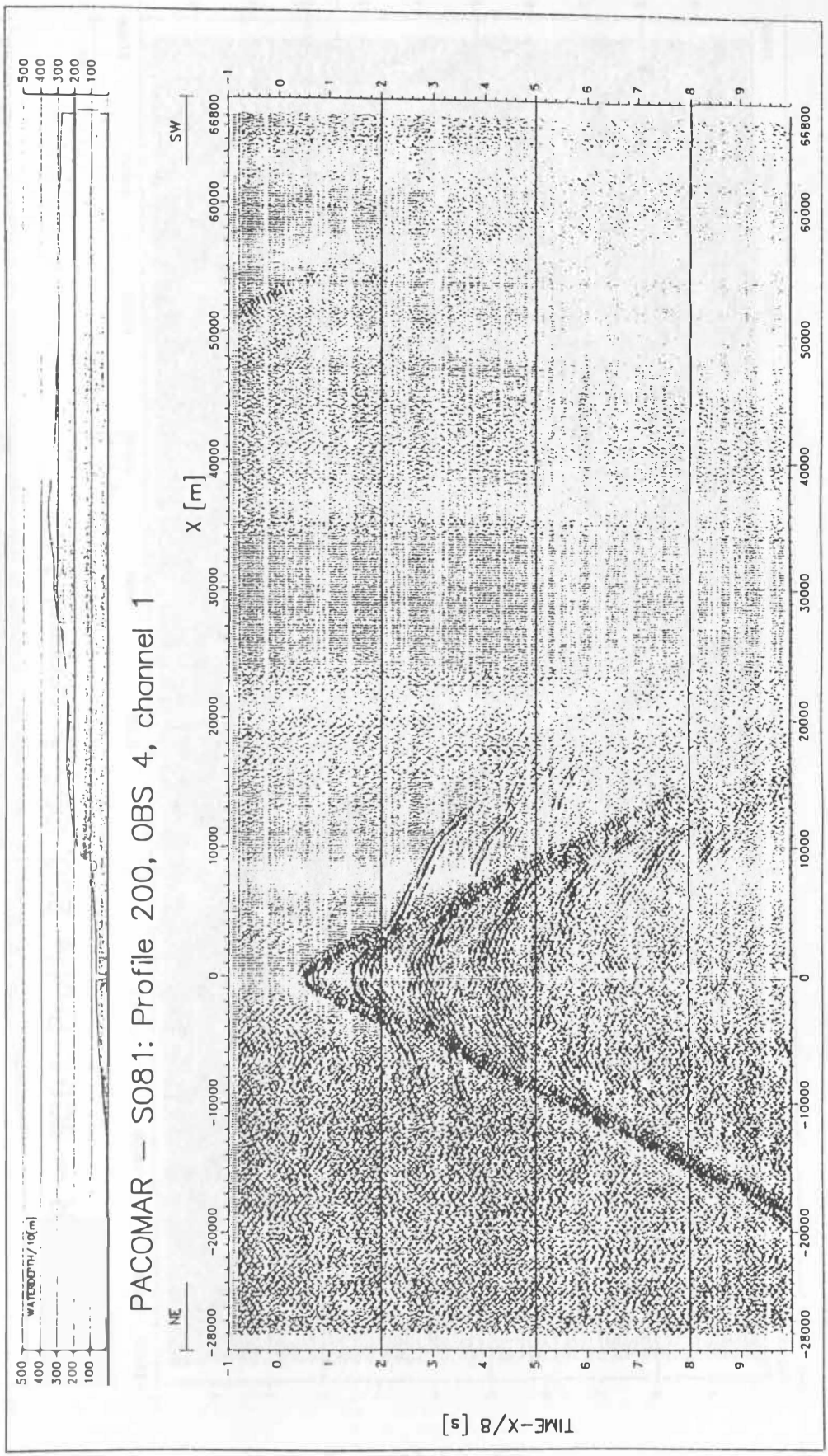


Figure 16: Record section of OBS 4, Profile SO81-200

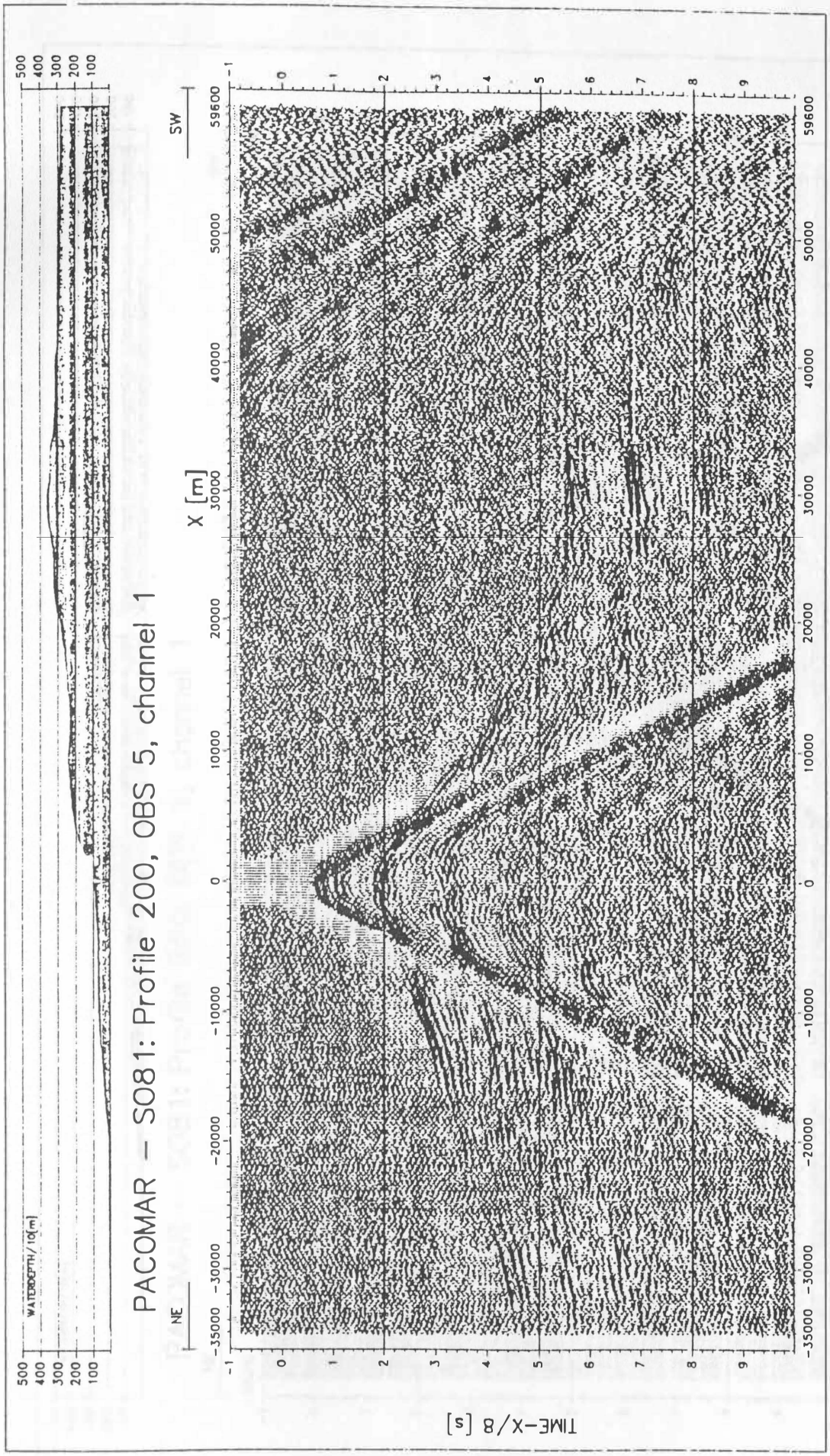


Figure 17: Record section of OBS 5, Profile SO81-200

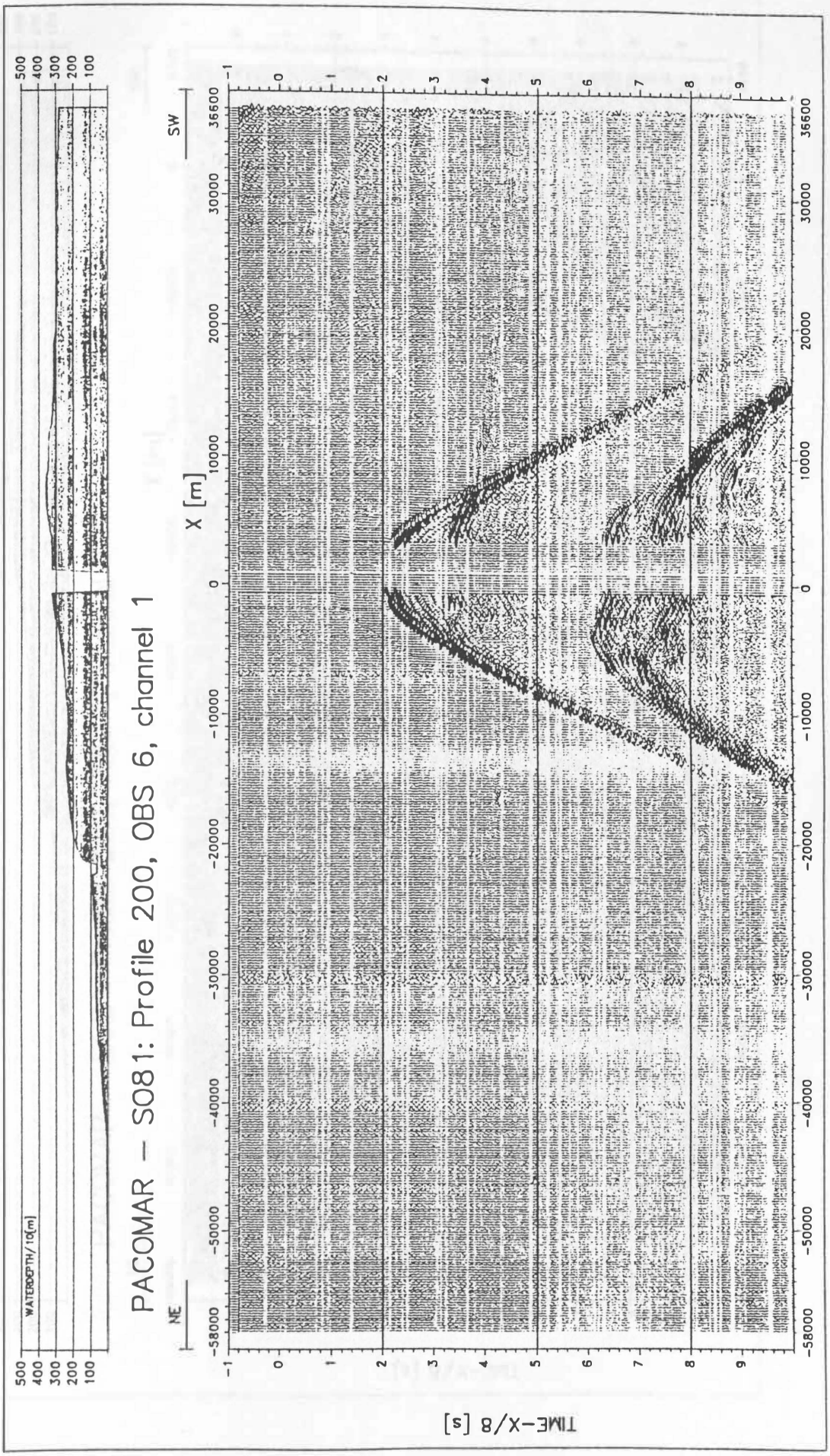


Figure 18: Record section of OBS 6, Profile SO81-200

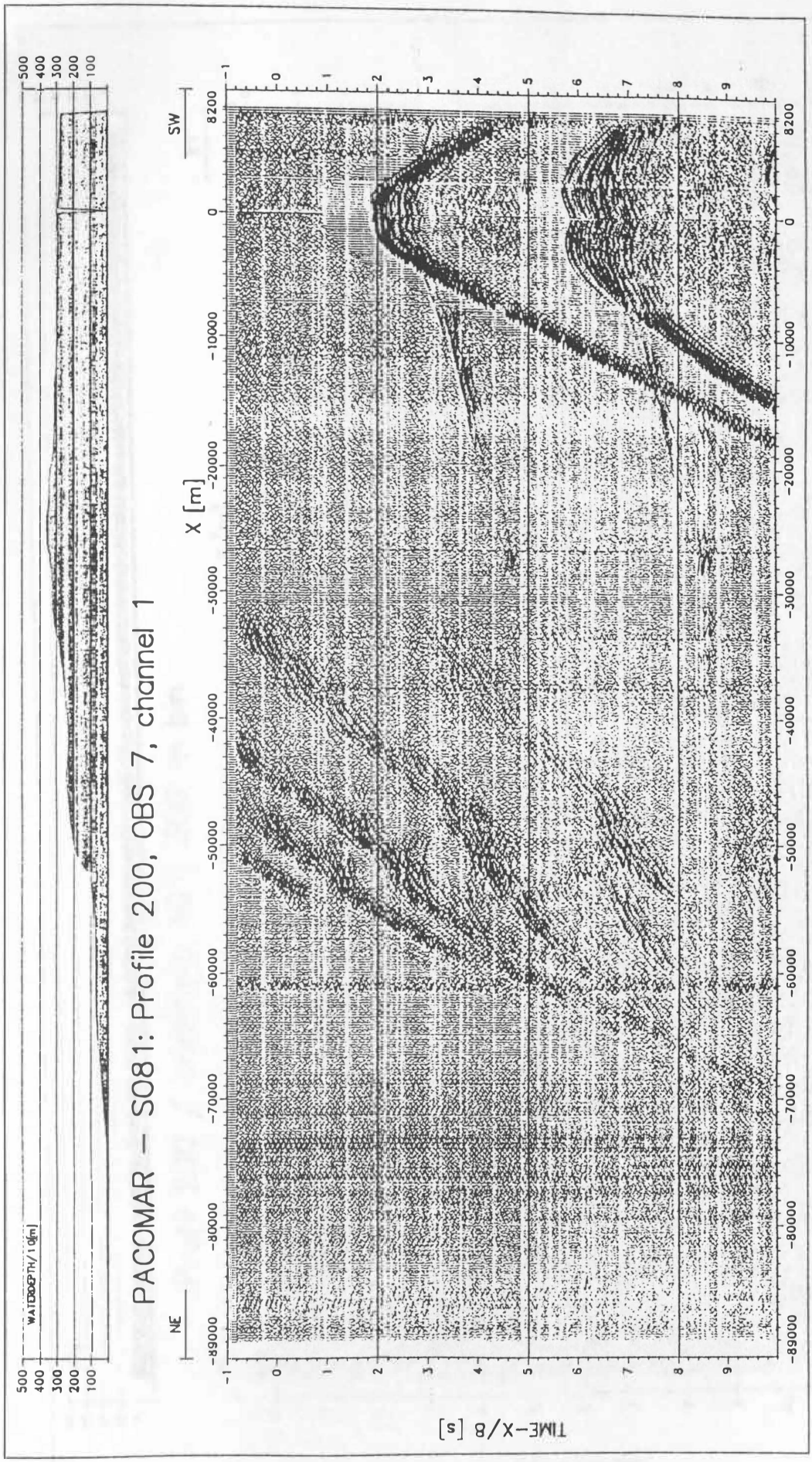


Figure 19: Record section of OBS 7, Profile SO81-200

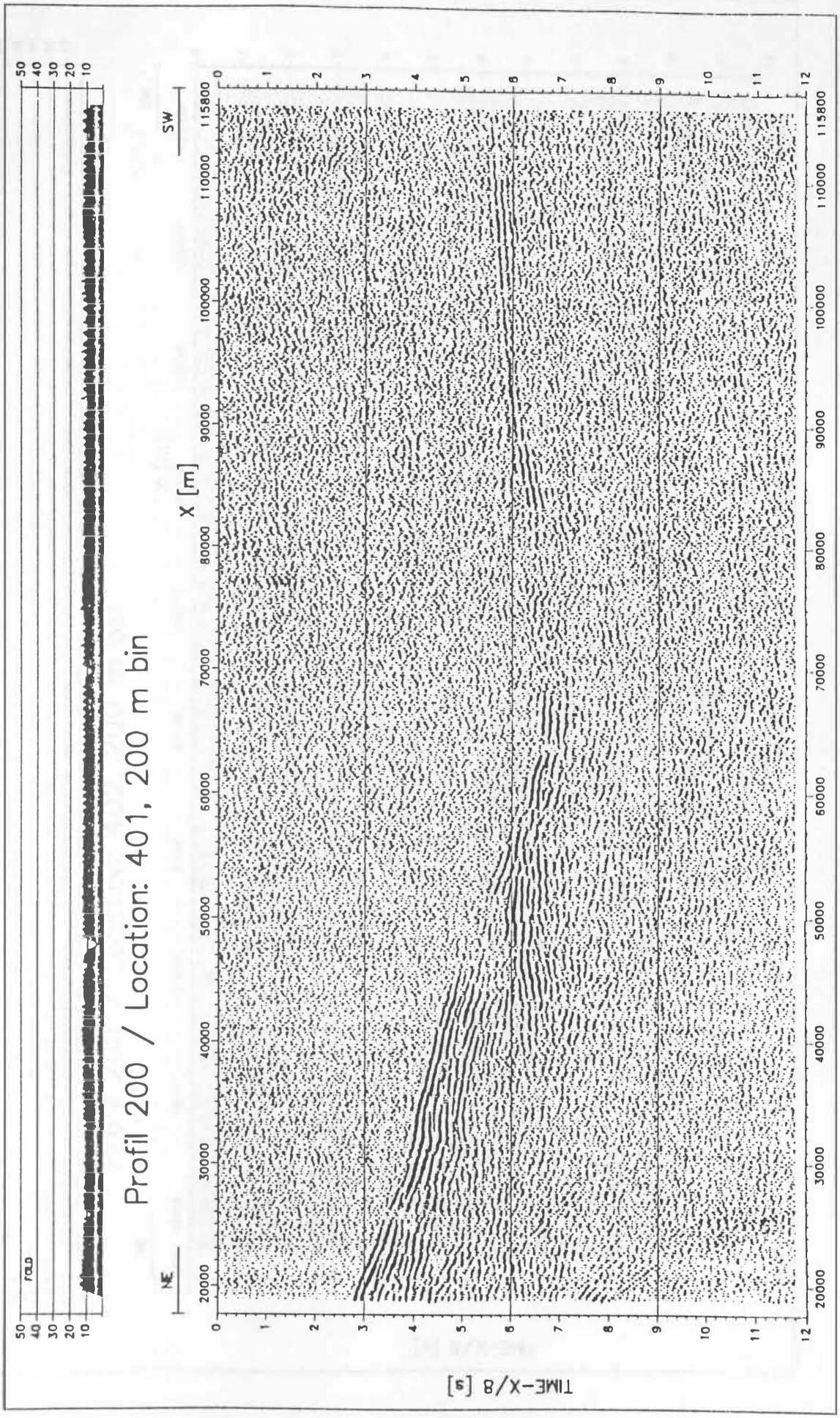


Figure 20: Record section of Landstation 401, Profile SO81-200

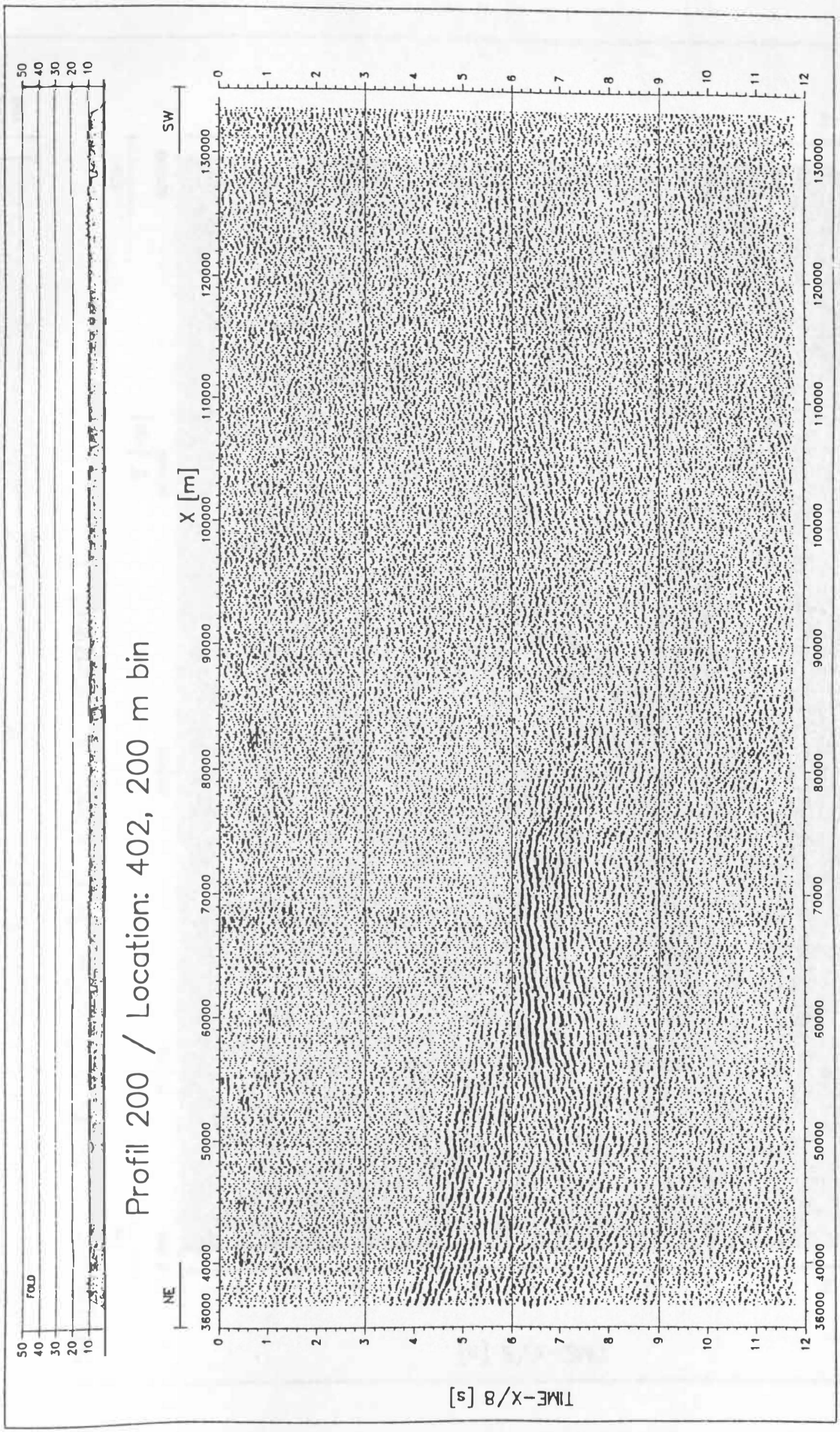


Figure 21: Record section of Landstation 402, Profile SO81-200

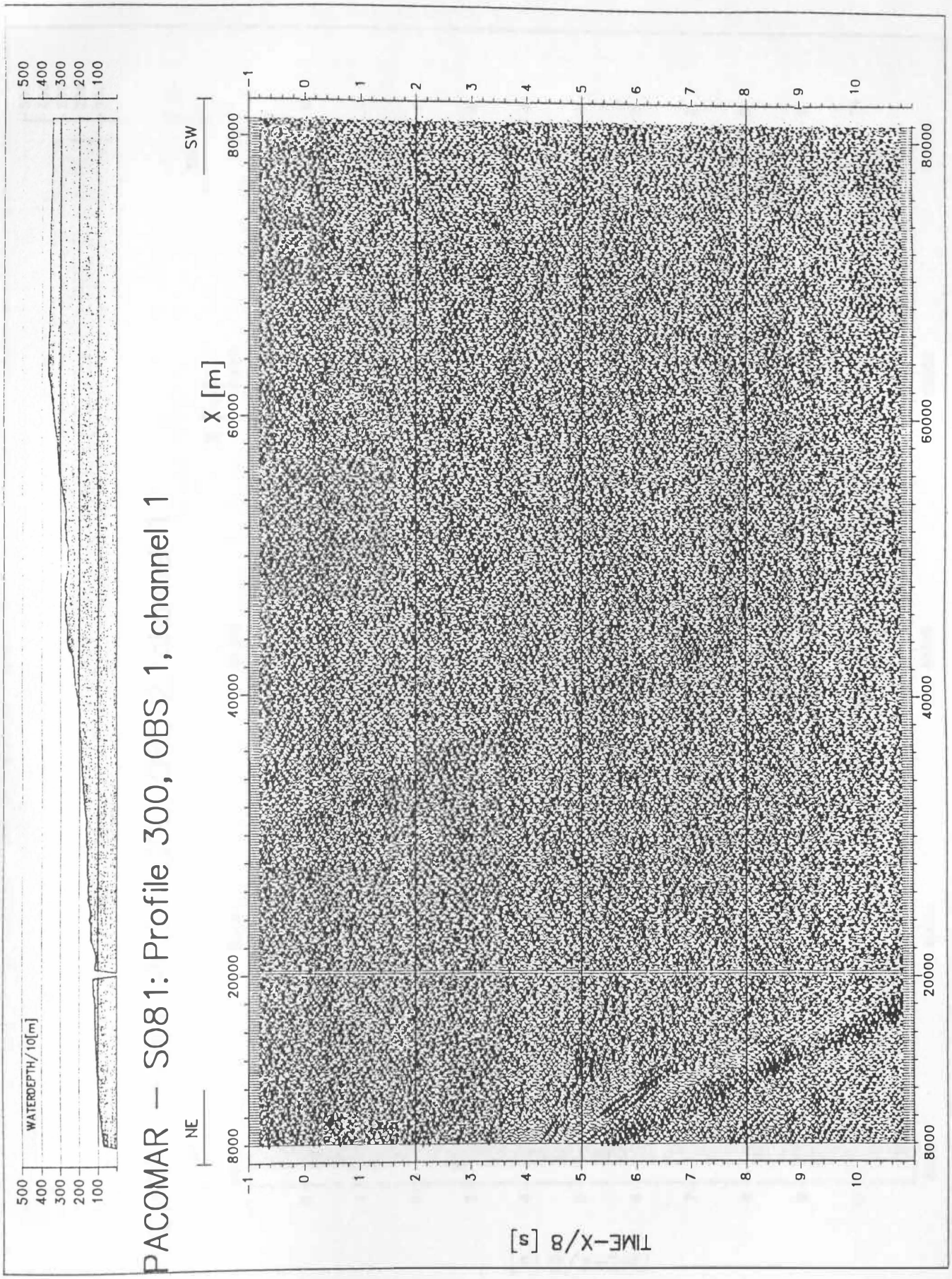
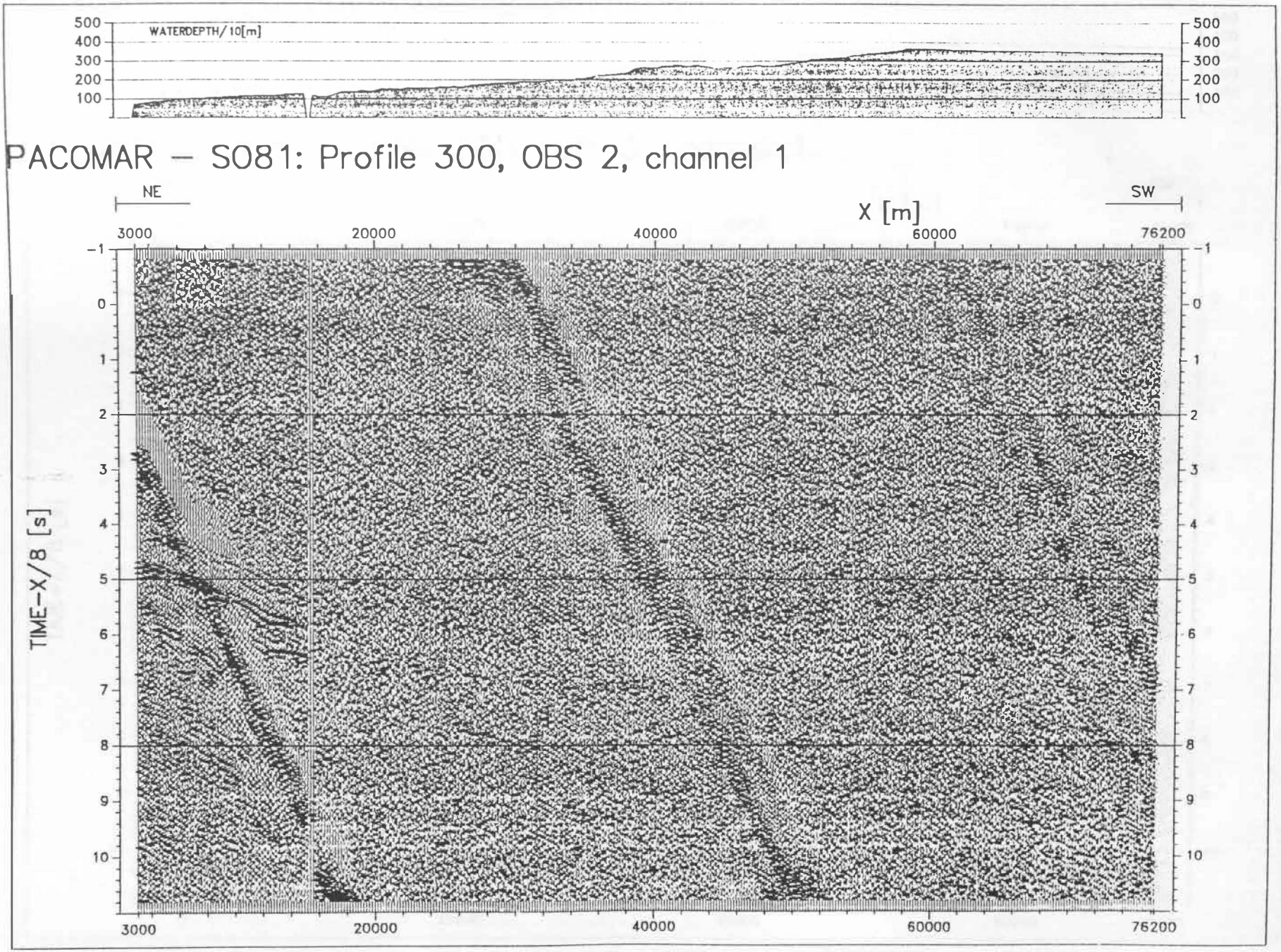


Figure 22: Record section of OBS 1, Profile SO81-300



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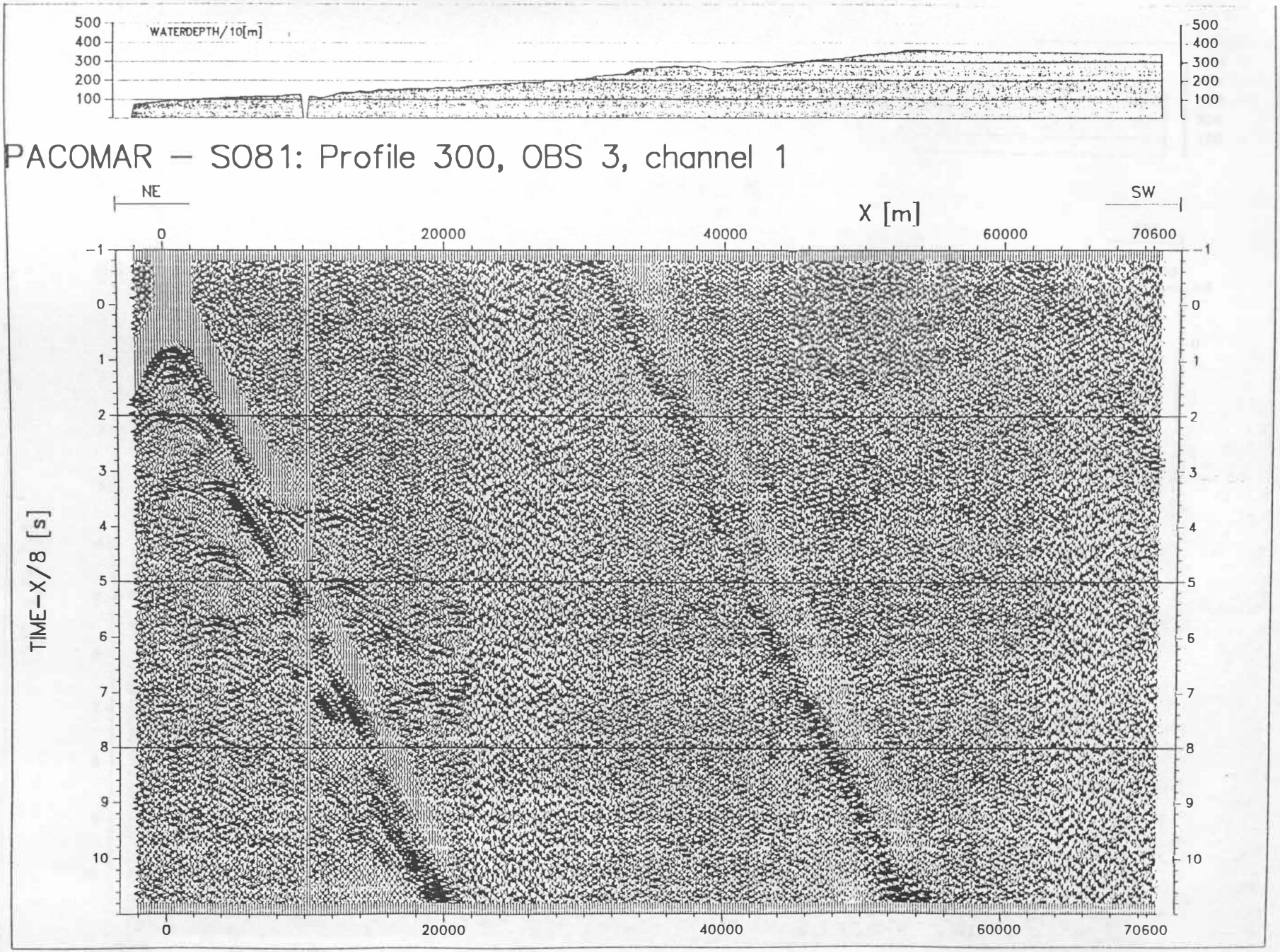

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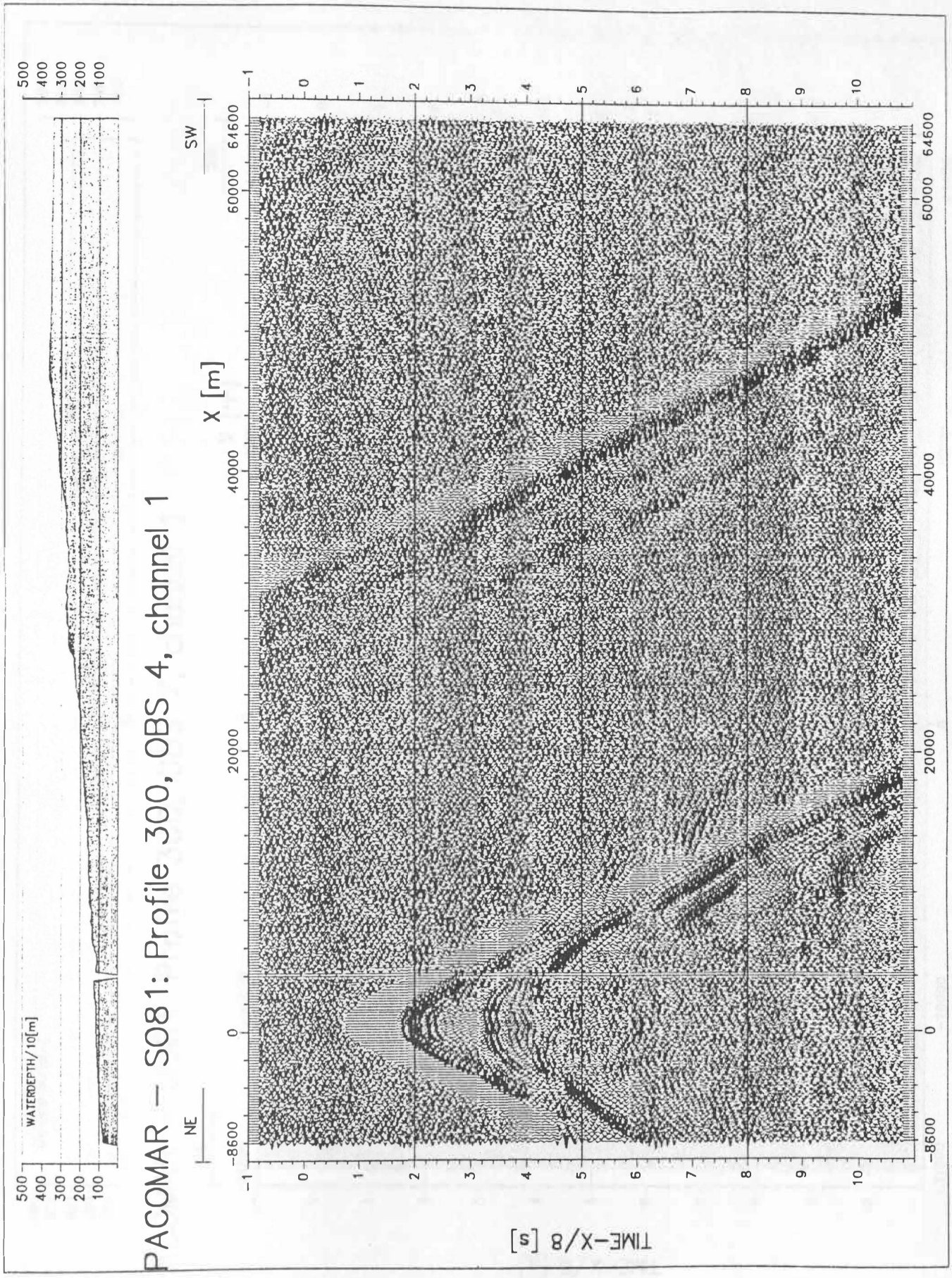

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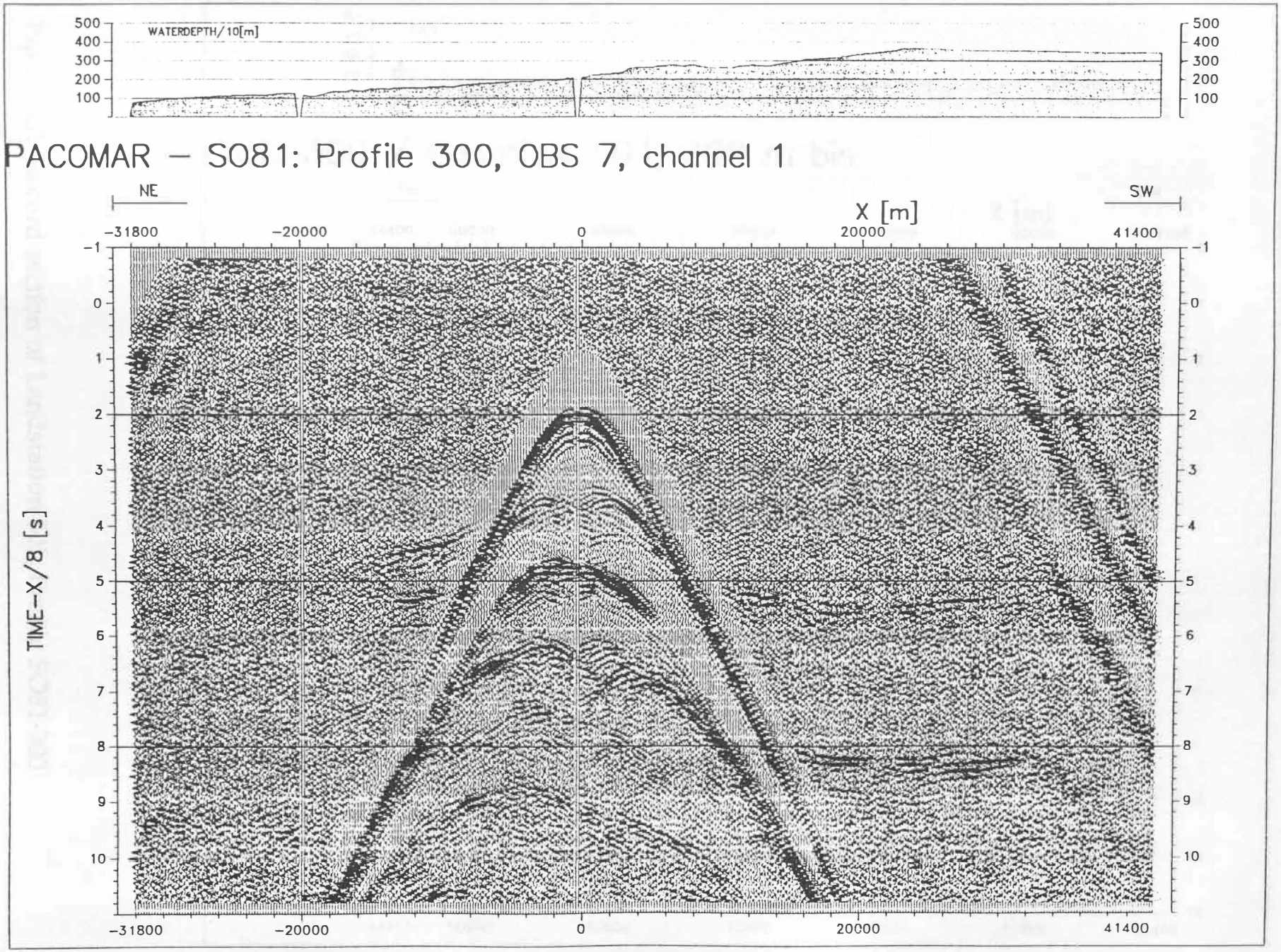

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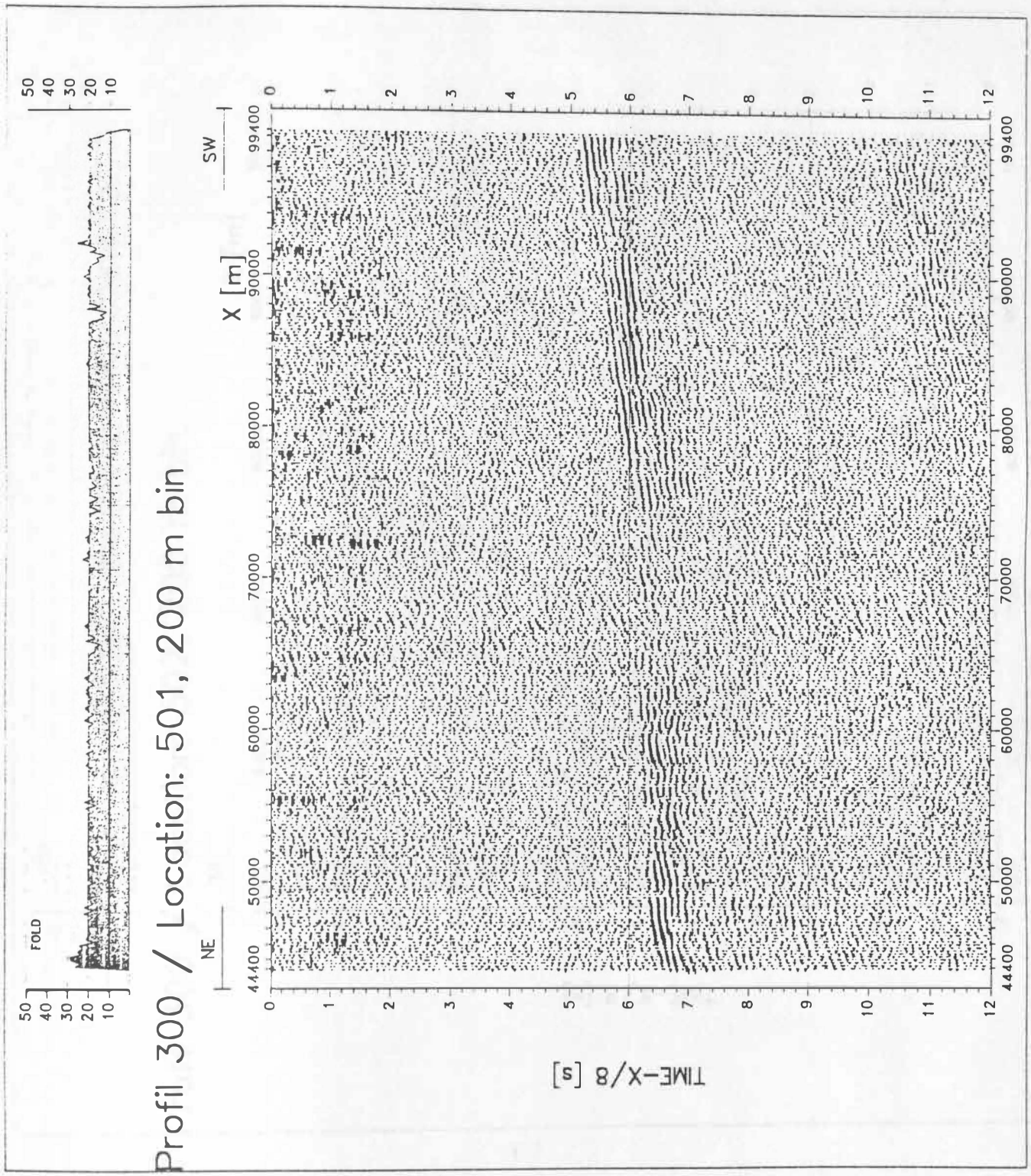

Figure 27: Record section of Landstation 501, Profile SO81-300

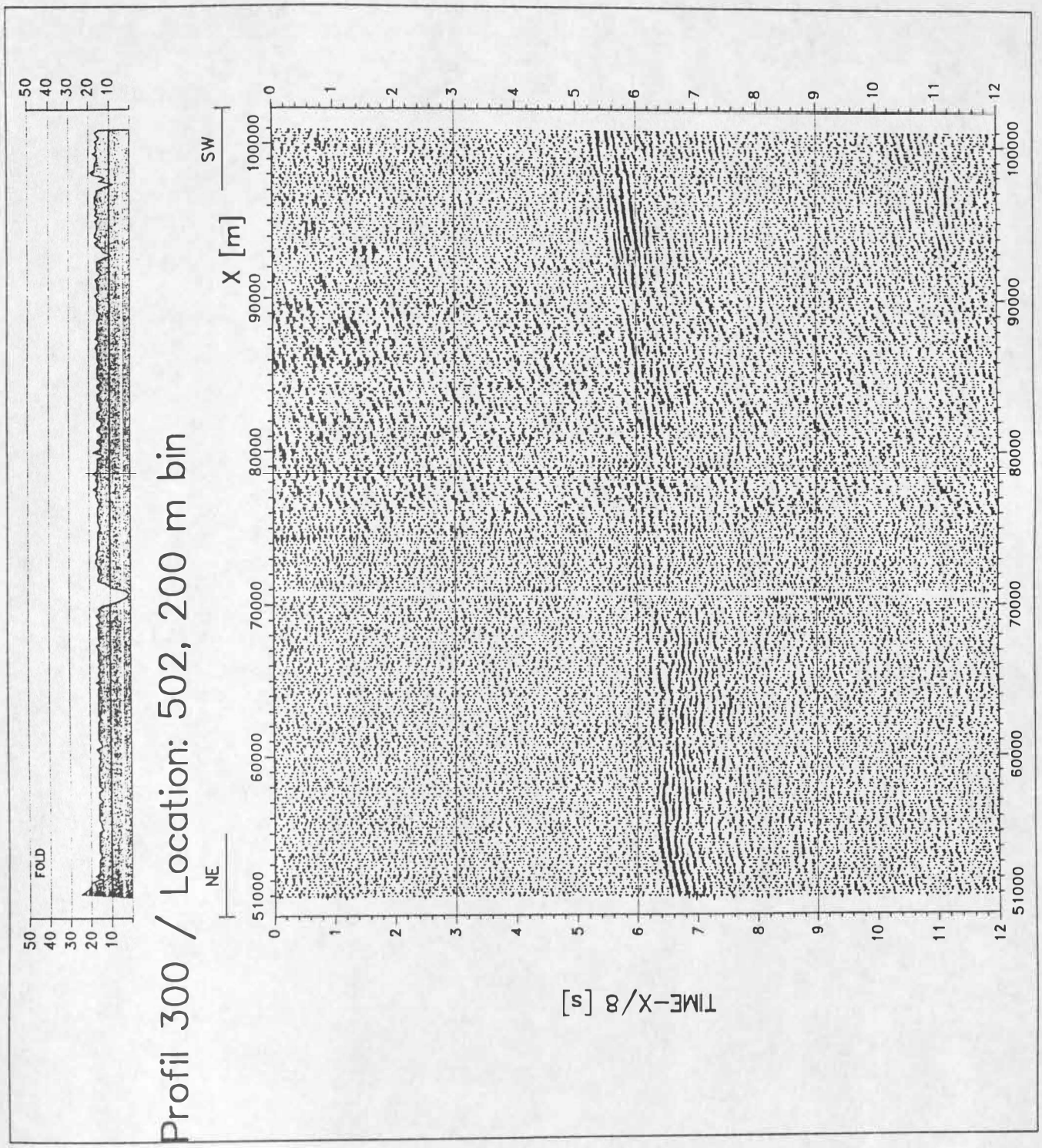

Figure 28: Record section of Landstation 502, Profile SO81-300