USGS-OFR-94-156

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U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

ONSHORE-OFFSHORE WIDE-ANGLE SEISMIC RECORDINGS OF THE SAN FRANCISCO BAY AREA SEISMIC IMAGING EXPERIMENT (BASIX): DATA FROM THE NORTHERN CALIFORNIA SEISMIC NETWORK

By

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Open-File Report 94-156

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Menlo Park, California
1994

ABSTRACT

The report presents wide-angle seismic reflection and refraction data obtained in the vicinity of the San Andreas, Hayward, and Calaveras faults during the Bay Area Seismic Imaging eXperiment (BASIX). BASIX's goal was to define the crustal structure in the San Francisco Bay Area of California. In September, 1991, the U.S. Geological Survey's (USGS's) R/V **S.P. Lee**'s airgun array, totaling 96 liters (5824 cu. in.), was used during BASIX as a seismic source for a marine reflection survey of the lower Sacramento River delta, San Francisco Bay, and the continental margin. The Northern California Seismic Network (NCSN), stretching from Pacific coast to the Sierras, continuously recorded the airgun signals on analog tape. In this report, we describe the BASIX experiment, present in detail the scheme followed to digitize and reduce the NCSN data to seismic sections, and illustrate the wide-angle seismic data obtained by NCSN.

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INTRODUCTION

The Loma Prieta magnitude 7.1 earthquake of October 17, 1989 served as a catalyst for studies aimed at better understanding the crustal structure in the San Francisco Bay Area (U.S. Geological Survey Staff, 1990). Results from seismicity and trenching studies indicate that the San Andreas fault is not the only major earthquake hazard in the Bay Area. Seismicity compilations show that the Hayward, Calaveras, and Greenville faults are seismically active (e.g., Hill and others, 1990); historical records indicate that these faults are capable of generating large-magnitude earthquakes (Ellsworth, 1990).

We describe and present the wide-angle seismic data recorded by the Northern California Seismic Network (NCSN) during the Bay Area Seismic Imaging eXperiment (BASIX), an onshore-offshore seismic reflection/refraction investigation of the crustal structure in the San Francisco Bay Area. BASIX's deep seismic reflection profiling was conducted in September, 1991, using a marine airgun array and a telemetered hydrophone array (Furlong and others, 1991; McCarthy and Hart, 1993). A companion Open-file Report presented the wide-angle data obtained during BASIX using USGS 5-day recorders and discussed the rationale for this wide-angle recording (Brocher and Moses, 1993).

DATA ACQUISITION

Operations on the **S. P. Lee**

BASIX acquired deep-crustal seismic reflection profiles stretching along the Sacramento River from Rio Vista in the western Great Valley through the Carquinez Strait to the San Francisco Bay and seaward to the Golden Gate (McCarthy and Hart, 1993). The seismic profiles were acquired in 12 separate, overlapping, segments (lines), each about 27 km long (Table 1). The sound source used for BASIX consisted of a 12-element airgun array totaling 96 liters (5858 cu. in.) towed at a depth of 7.6 meters (25 feet) by the R/V **S.P. Lee** (McCarthy and Hart, 1993).

The nominal shot interval along lines progressively increased from the 50 m used for lines 105 to 113, to 75 m for lines 201 and 202, and 100 m for lines TR1 and OBS2. More than 11,600 separate airgun shots were fired during BASIX.

Lines 105 through 202 were recorded by moored hydrophones to obtain vertical incidence seismic reflection profiles (McCarthy and Hart, 1993). Lines 105 to 109 form a continuous E-W profile across the Hayward-Rodgers Creek and Concord-Green Valley faults (fig. 2). Lines 110 to 113 were acquired along a NW-SE trend in San Francisco bay proper (fig. 3). Lines 201 and 202 constitute a short ENE-WSW transect from Alcatraz Island through the Golden Gate past the San Andreas and San Gregorio faults (figs. 1 and 3).

TABLE 1. R/V **S.P. Lee** Airgun Firing Times and Locations

Line	UCT Begin Day HRMIN	Lat. (N) Deg. Min.	Long. (W) Deg. Min.	UCT End Day HRMIN	Lat. (N) Deg. Min.	Long. (W) Deg. Min.
105	252 0213	38 03.46	122 17.39	252 1227*	38 03.89	122 02.11
107	254 0250	38 00.15	122 22.00	254 1017*	38 02.76	122 10.57
108	255 0350	37 57.04	122 25.52	255 1048*	38 03.67	122 14.66
109	256 0330	37 53.29	122 25.77	256 1100*	38 03.24	122 18.63
110	257 0500	37 52.78	122 24.66	257 1152*	38 01.34	122 23.13
111	258 0609	37 45.54	122 21.64	258 1230*	37 36.46	122 17.04
112/ OBS-1#	259 0346	37 36.47	122 17.02	259 1053	37 57.58	122 26.69
113	260 0518	37 47.14	122 20.40	260 1217*	37 57.10	122 26.40
201	261 0512	37 47.55	122 31.92	261 1030*	37 50.79	122 24.83
202	262 0330	37 49.04	122 23.39	262 1115*	37 45.83	122 48.19
TR1#	262 1311	37 46.08	122 32.52	262 1417	37 40.80	122 32.80
OBS2#	262 1417	37 40.80	122 32.80	263 0430	37 12.52	123 31.22

#These lines were intended solely for recording by wide-angle recorders, no reflection profiles were obtained along these lines.
*The **S. P. Lee** reversed course along these lines and stopped approximately where it began; thus, the end time indicates when the **S.P. Lee** ceased firing the airgun array, and the end latitude and longitude indicate the location of the **S. P. Lee** at the farthest distance it reached from the beginning of the line.

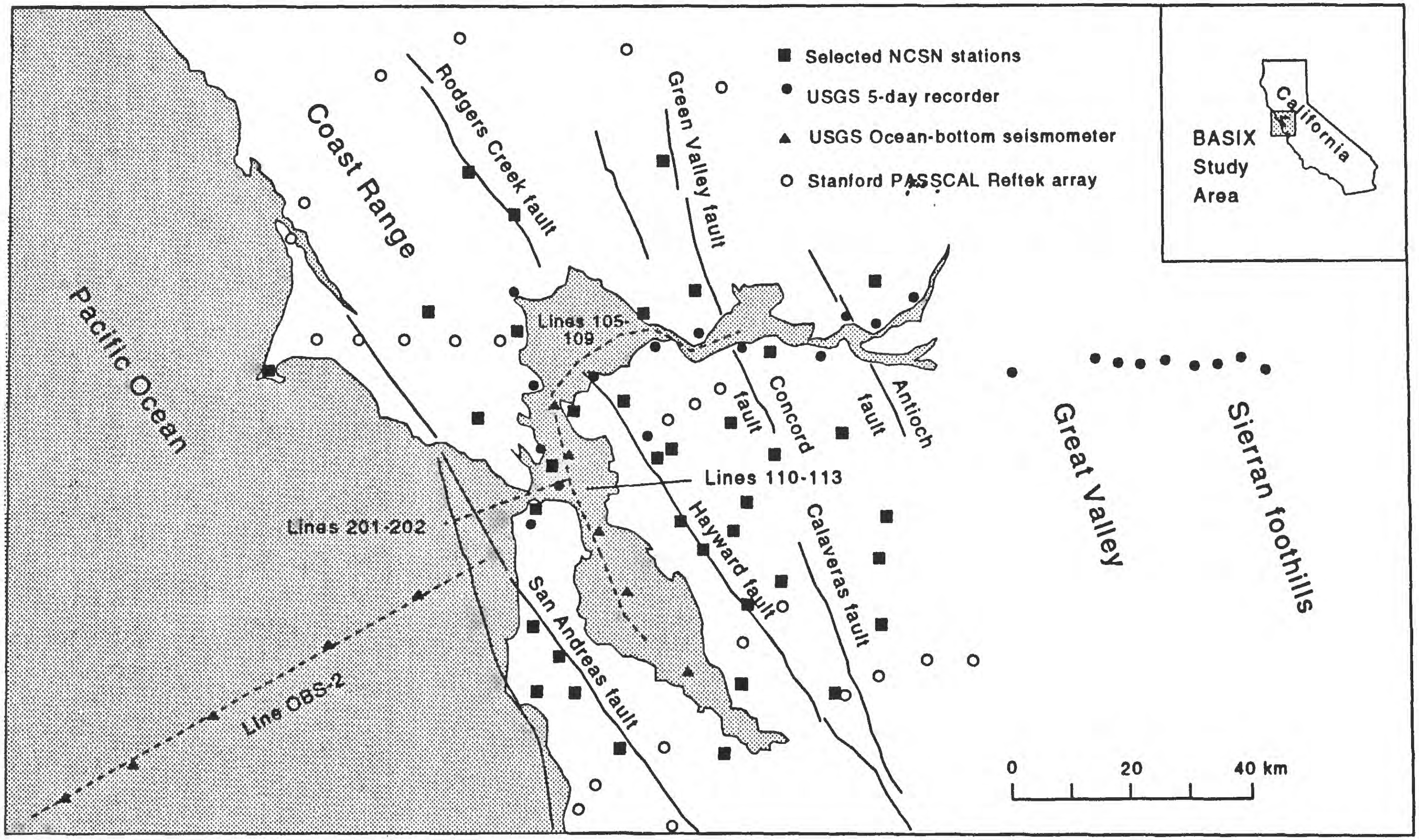

Figure 1. Map of California (Inset) showing the location of the study area in the San Francisco Bay Area. Index map showing location of BASIX seismic reflection lines (dashed lines) and wide-angle recorders (various symbols defined on figure) used to record these lines. Only selected NCSN stations are shown.

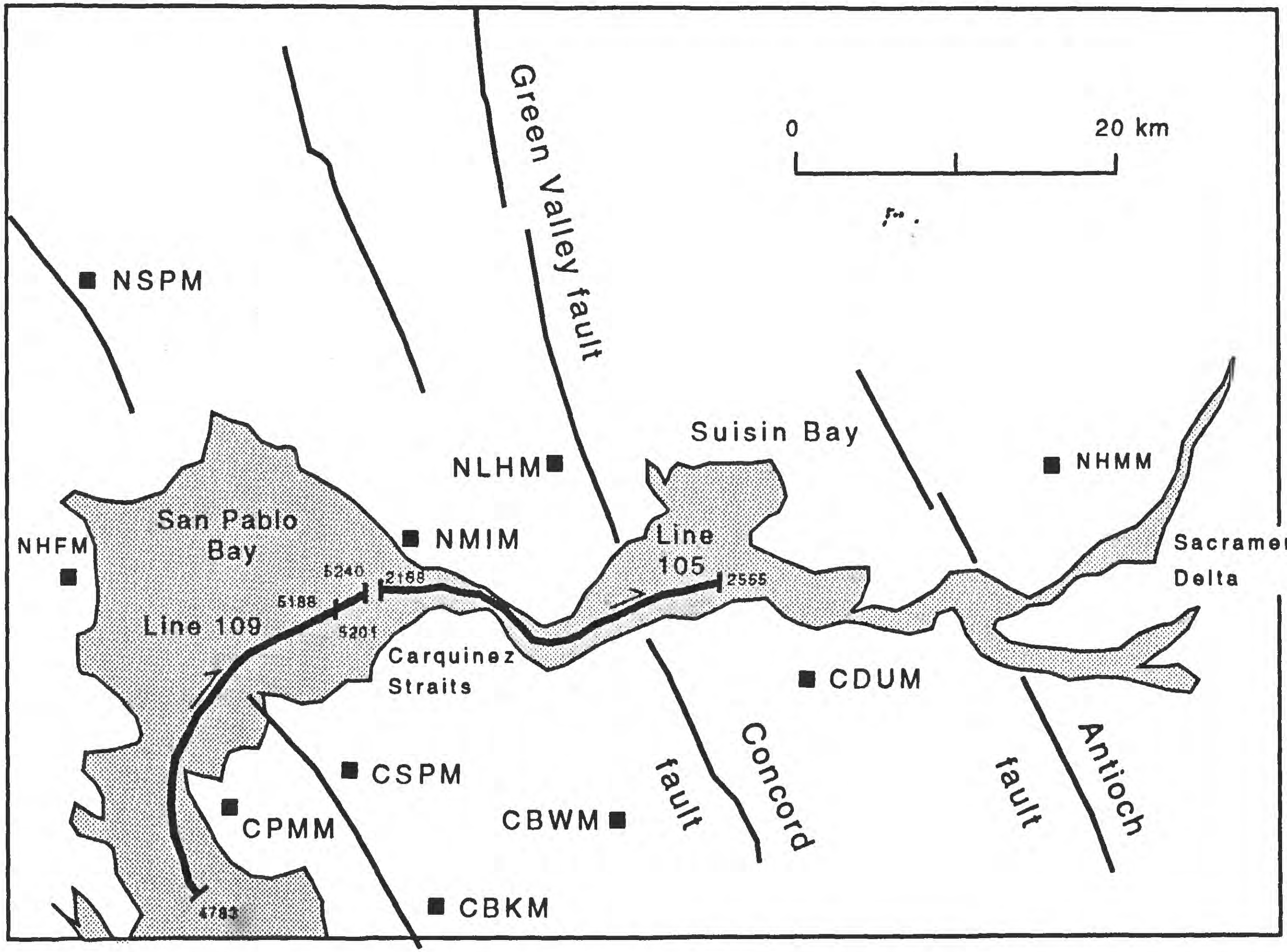

FIGURE 2. Expanded view of San Pablo Bay and Sacramento Delta showing locations of BASIX reflection lines 105 and 109 (bold solid lines) relative to locations of NCSN stations (filled squares) and mapped faults. Numbers along seismic lines provide shot numbers cited in text as trace numbers, and arrows show direction ship transited the line for plots shown in this report. Abbreviations of NCSN station names are defined in Table 2.

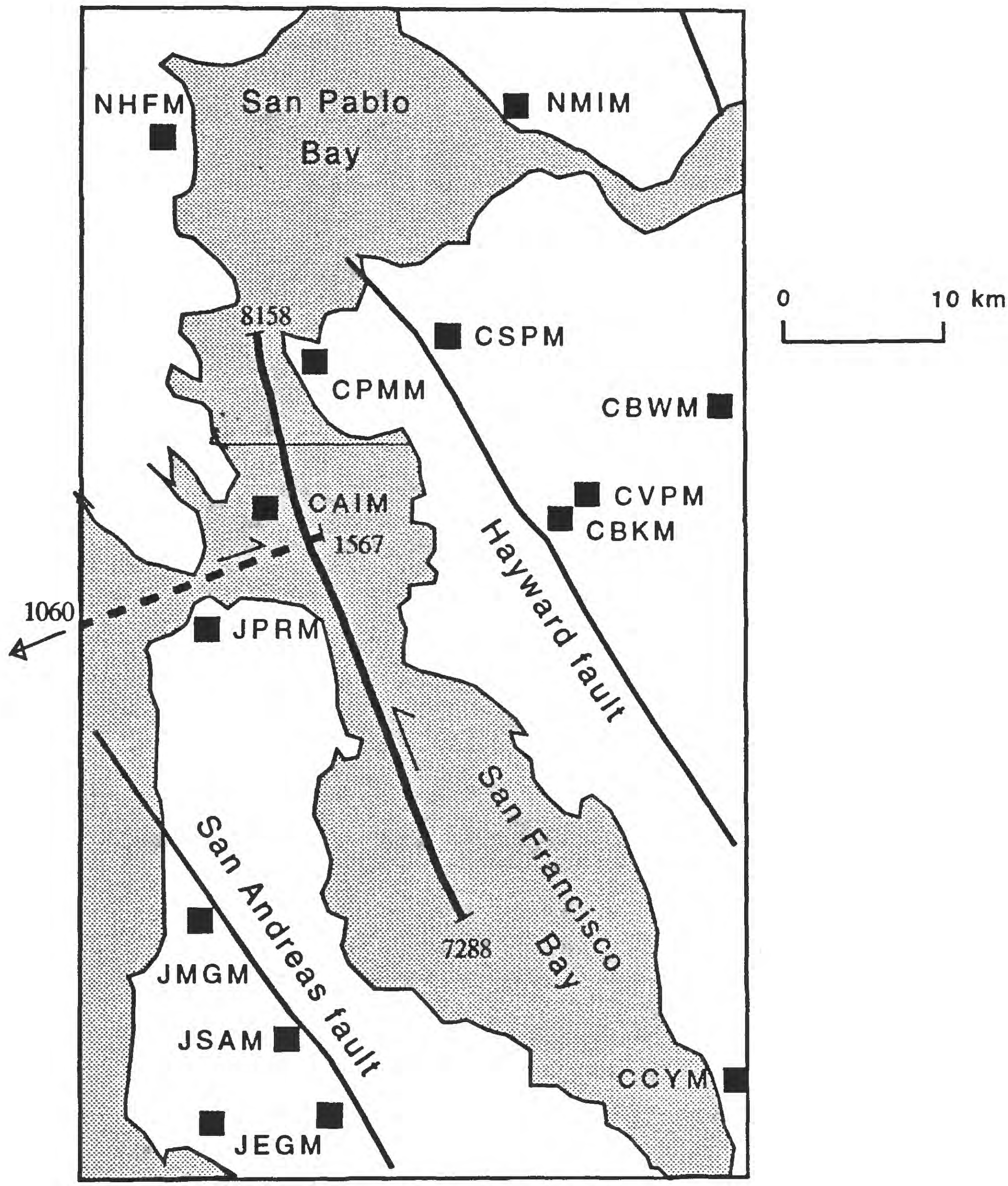

FIGURE 3. Expanded view of San Francisco and San Pablo Bays showing locations of BASIX reflection line 112 (bold solid line), line 202 (bold dashed line), NCSN stations (filled squares), and mapped faults. Numbers along seismic lines provide shot numbers cited in text as trace numbers, and arrows show direction ship transited the line for plots shown in this report. Abbreviations of NCSN station names are defined in Table 2.

In addition to the BASIX vertical-incidence seismic reflection lines 105-202, the airgun array on the **S.P. Lee** was used as a seismic source for wide-angle profiles along three other lines: these include the (1) NNW-SSE trending Line 112 (this line is also called line OBS1, due to the deployment of Ocean Bottom Seismometers along it (Brocher and Moses, 1993)); (2) Line TR-1; and (3) the E-W trending Line OBS-2 on the continental margin (fig. 1; Table 1). The 50-m shot interval used for Line OBS-1 was doubled for Lines TR-1 and OBS-2.

Shot locations for the wide-angle profiling within the bay were determined using a Global Positioning System (GPS) receiver, yielding source location accuracy of a few tens of meters. Shot locations for Lines 202, TR1, and OBS-2 seaward of the San Andreas fault were determined using a combination of GPS operated in a selected availability mode and rho-rho Loran-C, and is considered accurate to within 150 to 200 m. Airgun shot times, accurate to a millisecond, were obtained as described by Brocher and Moses (1993).

The Northern California Seismic Network (NCSN)

The NCSN array is used primarily for recording earthquake and aftershock sequences in Northern California. The permanent array of NCSN stations, consisting mostly of telemetered vertical-component seismometers, recorded BASIX lines 105-111, OBS1, 113, 201-202, TR1 and OBS2 (analog tapes used to record NCSN data for BASIX lines 101-104 were subsequently lost). The frequency response and characteristics of the analog NCSN seismic recorders are described by Eaton (1993) and Oppenheimer and others (1993). The combined frequency response of the 1 Hz geophones and internal NCSN recorder electronics is heavily weighted to frequencies less than 15 Hz. In Table 2 we provide the locations and elevations of the NCSN stations which provided useful wide-angle data from the BASIX experiment. Data from other NCSN stations, such as those in the Sierras, near Oroville, Auburn, and Long Valley, were examined, but did not appear to provide useable data from BASIX.

The airgun shots represent a relatively small energy source for NCSN, and of the more than 11,600 airgun shots fired during BASIX, only 41 were located by the NCSN array as earthquakes. These 41 events were located by the Real Time Processor (RTP) as occuring in the vicinity of the San Francisco airport, with focal depths of about 3 km, and magnitudes between 0.3-0.4 (David Oppenheimer, personal communication, 1993). Nonetheless, 40 NCSN stations provided useful data from at least one of the BASIX lines (Table 2, Figure 4).

TABLE 2. Selected NCSN Station Locations and Elevations

Station Abbrev.	Station Name	Latitude (N) Deg. Min.	Longitude (W) Deg. Min.	Elevation (m)
CAIM	Angel Island	37 51.68	122 25.77	223
CALM	Calaveras Res.	37 27.07	121 47.95	265
CBRM	Bollinger Cyn. Rd.	37 48.97	122 03.72	610
CBWM	Brookwood Res.	37 55.45	122 06.40	221
CCYM	Coyote Hills	37 33.10	122 05.45	67
CDUM	Duarte Ranch N.	38 01.78	122 00.05	168
CLCM	Lake Chabot	37 44.28	122 03.83	312
CMCM	Mills College	37 46.88	122 10.55	90
CMJM	Mission San Jose	37 31.25	121 52.23	498
CMOM	Morgan Terr. Rd.	37 48.68	121 48.15	792
CPLM	Palomares Road	37 38.25	121 57.64	317
CPMM	Point Molate	37 56.94	122 24.46	116
CSPM	San Pablo Ridge	37 57.45	122 18.65	216
CSVM	Stone Valley	37 51.88	122 00.16	238
CVPM	Vollmer Peak N	37 53.04	122 13.32	568
JBCM	Bear Creek Road	37 09.62	122 01.57	660
JBGM	Bear Gulch Road	37 20.52	122 20.34	158
JBMM	Black Mountain	37 19.09	122 09.16	820
JEGM	El Granada	37 30.84	122 27.74	202
JHPM	Huddart Park	37 26.65	122 18.09	347
JJRM	Joaquin Road	37 20.68	122 12.09	430
JMGM	Milagra Ridge	37 38.22	122 28.43	201
JPPM	Portola State Park	37 15.81	122 12.78	186
JPRM	Presidio S.F.	37 47.70	122 28.43	107
JSAM	San Andreas Cr.	37 34.95	122 25.03	207
JSFM	Stanford Telescope	37 24.31	122 10.55	143
JSJM	St. Joseph Seminar	37 20.03	122 05.48	122
JSMM	Sawmill Road	37 12.74	122 10.06	262
JSSM	Soda Springs Road	37 10.17	121 55.84	946
JUCM	U.C. Santa Cruz	37 00.07	122 02.91	177
NBRM	Beebe Ranch	38 15.65	122 32.99	137
NGVM	Green Valley Rd.	38 16.84	122 12.89	257
NHFM	Hamilton Field E.	38 02.98	122 31.34	61
NLHM	Lake Herman	38 07.19	122 08.87	177
NLNM	Lincoln School	38 09.15	122 42.75	120
NMIM	Mare Island	38 04.69	122 15.44	70
NOLM	Olema CA.	38 02.50	122 47.64	37
NSPM	Sears Point	38 12.02	122 27.82	221
NTAM	Tamalpais Peak	37 55.43	122 35.70	768
NTYM	Taylor Mountain	38 23.37	122 39.70	372

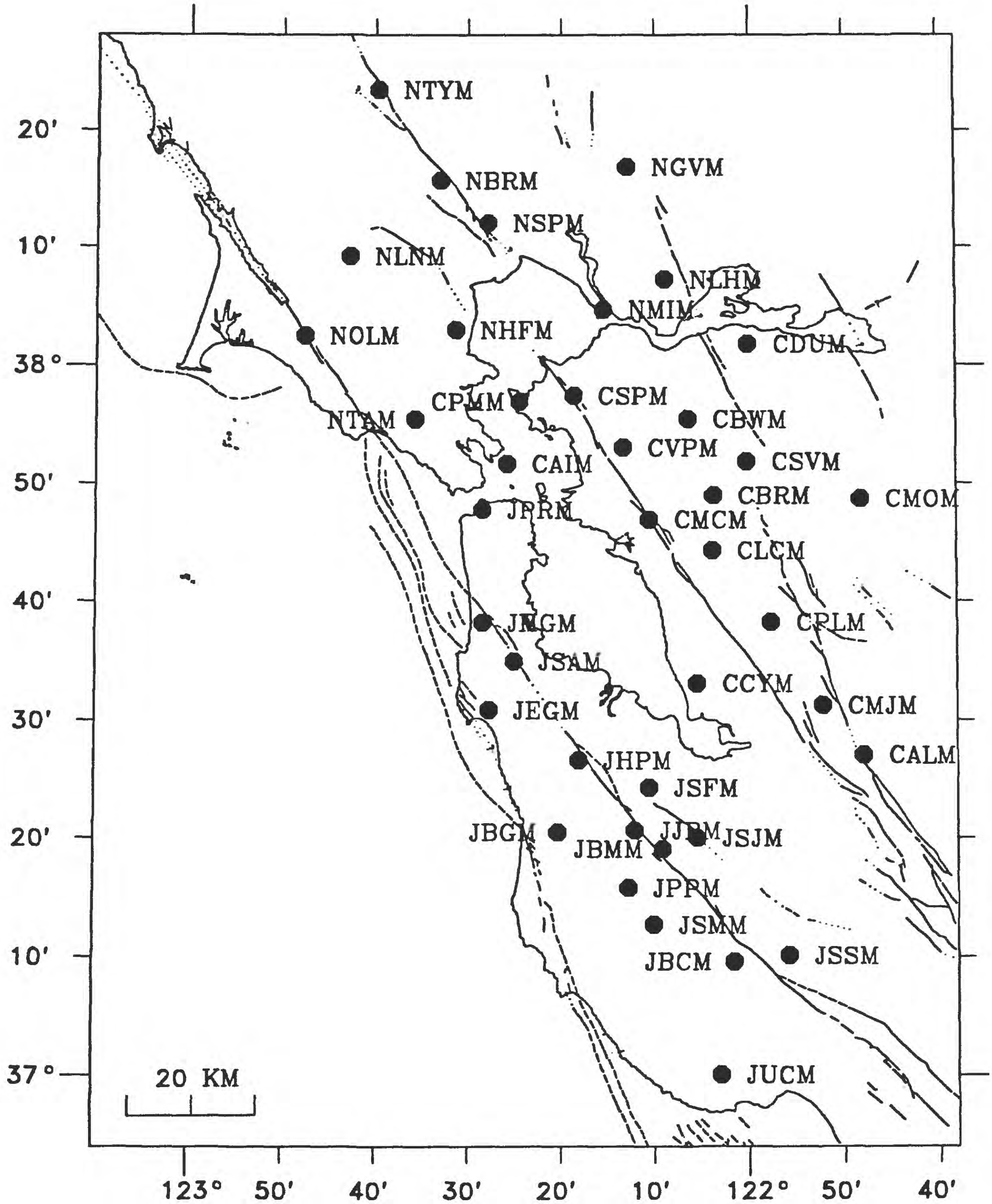

Figure 4. Map of San Francisco Bay Area showing locations of NCSN stations which provided data shown in this report. The station names and elevations are provided in Table 2.

DATA REDUCTION

Analog Data Recording and Digitization

During BASIX, the data produced by the entire NCSN was continuously recorded on analog backup tapes (e.g., Eaton, 1989). These analog backup tapes were changed daily: five different analog tapes were required to record the daily data for the entire NCSN array. These tapes (usually referred to as the A tape, B tape, C tape, D tape, and E tape) cover the different geographic areas encompassed by the NCSN. Of most concern here are the B and C tapes, which recorded stations in the immediate San Francisco Bay Area. The B tape records data for stations surrounding the northern Bay Area, whereas the C tape records data for stations south of San Jose. Each analog backup tape is further divided into four passes (bands), and each pass contains the data from about 20-30 NCSN stations. These passes are referred to as pass 1, pass 2, pass 3, or pass 4 of the tape being analysed. Thus, to locate data for a given station, it is necessary to know the tape letter and pass number for the station. The data presented here represent data recorded on all four passes of the B tapes and on the first pass of the C tapes.

To retrieve data recorded by the NCSN from the 12 nights of BASIX airgun profiling, a total of 82 passes were digitized, including all four passes of the B tapes and pass 1 of the C tapes for all BASIX lines (the playback and digitization of the analog NCSN tapes at the USGS, Menlo Park, are described in Appendix A). Twenty-two other passes were digitized, including passes 2 through 4 on E tapes (recordings of the Long Valley and central Sierra arrays) for lines 105-109 and 201-202, and passes 3-4 on tape A (recordings of the Oroville and Auburn arrays) for lines TR1 and OBS2. Only data from the B and C tapes, however, provided useful record sections. Conversion of the digitized data into SEGY-formated, reduced record sections is described in Appendix B. These record sections represent common receiver gathers since we store all the shots recorded by a single receiver in a separate SEG-Y file. To monitor data quality the common receiver gathers were plotted using the plotting program RSEC90 (Luetgert, 1988).

SEG-Y Tape Format

The common receiver gathers generated from the analog NCSN tapes are stored in a reduced travel time format. The reduced travel time for each source-receiver pair was calculated from a list of shot times and locations, the receiver location, and a reduction velocity of 8 km/s. Twenty-three seconds of data were saved for each trace in the common receiver gather. The gathers obtained for all the stations which recorded a BASIX line were then written in SEG-Y format to a DAT tape (see Appendix B). Only data from the vertical geophone component was converted to SEG-Y format. The location of each value in the SEG-Y trace header as described by Barry and others (1975) was slightly modified as described by Luetgert and others (1990). The number of traces in each common receiver gather varies from line to line, from a minimum of 101 for line TR1 to a maximum of 1021 for line OBS2, although for most of the lines the number is about 850.

DESCRIPTION OF THE DATA

Plots of the common receiver gathers recorded during BASIX using the NCSN are presented in Figures 5 to 96. These figures all have a similar format. The travel times are all linearly reduced to 8 km/s, and the traces are plotted as a function of offset in km. Small numbers along the top of the traces show the trace location numbers, to help identify the traces used to make the plots. Ranges are shown as positive if the airgun shot was located to the north or east of the NCSN station, and are shown as negative if the airgun shot was located to the south or west of the station. In all the figures, the data were bandpass filtered between 2 and 20 Hz, and the amplitudes of the traces were not corrected for geometrical spreading. Six seconds of data are shown in all cases but the horizontal range scale is variable, to best display the data quality. In cases where the station was in a fan geometry relative to the BASIX line, we have plotted only positive or negative ranges, in order to better display the data. Only plots with useful data are presented.

The plots of the NCSN data are arranged by BASIX line in the order in which the lines were collected. For the purposes of this discussion we group the lines into five major sets of lines:

(1) 105-109, (2) 110-113, (3) 201-202, (4) TR1, and (5) OBS2. Plots for any given BASIX line are alphabetically ordered by station name.

Although highly variable, in general the quality of the recorded data is highest for those stations nearest the airgun source and decreases as the distance of the NCSN station to the airgun line increases. Station location is also a very important factor in determining the data quality. As a rule, the quality of data acquired by stations in the Coast Range (e.g., CAIM, JEGM, JHPM, JMGM, JSAM, NHFM, NLNM, NTAM) and East Bay Hills (CBRM, CBWM, CSVM, CVPM) are superior to those acquired east of Concord. A peat layer underlying the Sacramento Delta east of Concord (Vuillermoz and others, 1987) is thought to account for the lower signal levels and thus poorer quality data for the stations there.

NCSN recordings of BASIX lines 105-109, which have a combined length of 40 km (Figure 2), provided useful data from source-receiver offsets ranging from as little as 1.9 km to as large as 60 km. We display plots of common-receiver gathers for BASIX lines 105 and 109 in figs. 5-32. These lines overlap slightly, and together provide an overview of the data obtained from BASIX lines 105 to 109. For the plots of BASIX line 105 we masked trace locations 2556 to 2972 and for the plots of line 109 we masked locations 5189 to 5200 and 5240 to 5639.

NCSN recordings of BASIX lines 110-113 (including line OBS1), span a length of 49 km. We present in Figures 33 to 60 plots of recordings of BASIX line 112, which is over 40 km long and provides a useful overview of all these lines. The NCSN recordings provide useful data from source-receiver offsets between 1.8 and 100 km.

NCSN recordings of BASIX lines 201-202 span a length of about 25 km (Figure 3). Inline recordings of these lines were made at stations JPRM, CAIM, CVPM, and CBWM. To illustrate the quality of these data we present plots of recordings made for line 202. In these plots we have masked trace locations 656 to 1060. Useful NCSN recordings of these lines were made at offsets as small as 2 km to as large as 68 km (Figures 67-84).

BASIX Lines TR1 and OBS2 transit the continental shelf and slope (fig. 1). Line TR1 was run subparallel to the coast. The quality of the recordings obtained during lines TR1 and OBS2 are generally inferior to those for other BASIX lines, perhaps because they were shot during daylight hours when cultural noise levels are higher. Useful data for BASIX line TR1 were obtained at seven NCSN stations (figs. 85-87). Nine NCSN stations recorded useful data for BASIX line OBS2, to source-receiver offsets of as much as 100 km (figs. 88-96).

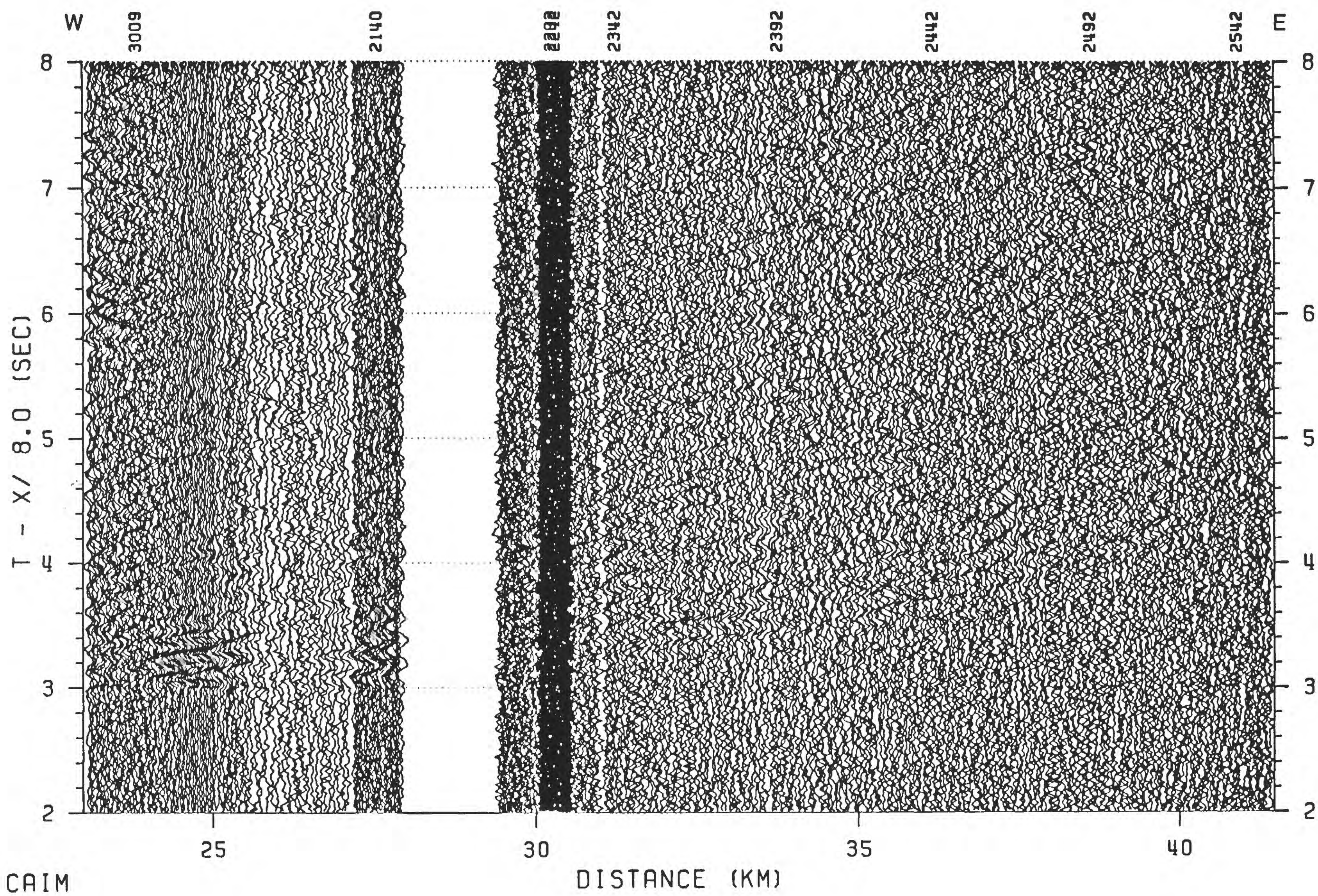

Figure 5. Receiver gather from station CAIM for BASIX line 105. Plot parameters are described in the text.

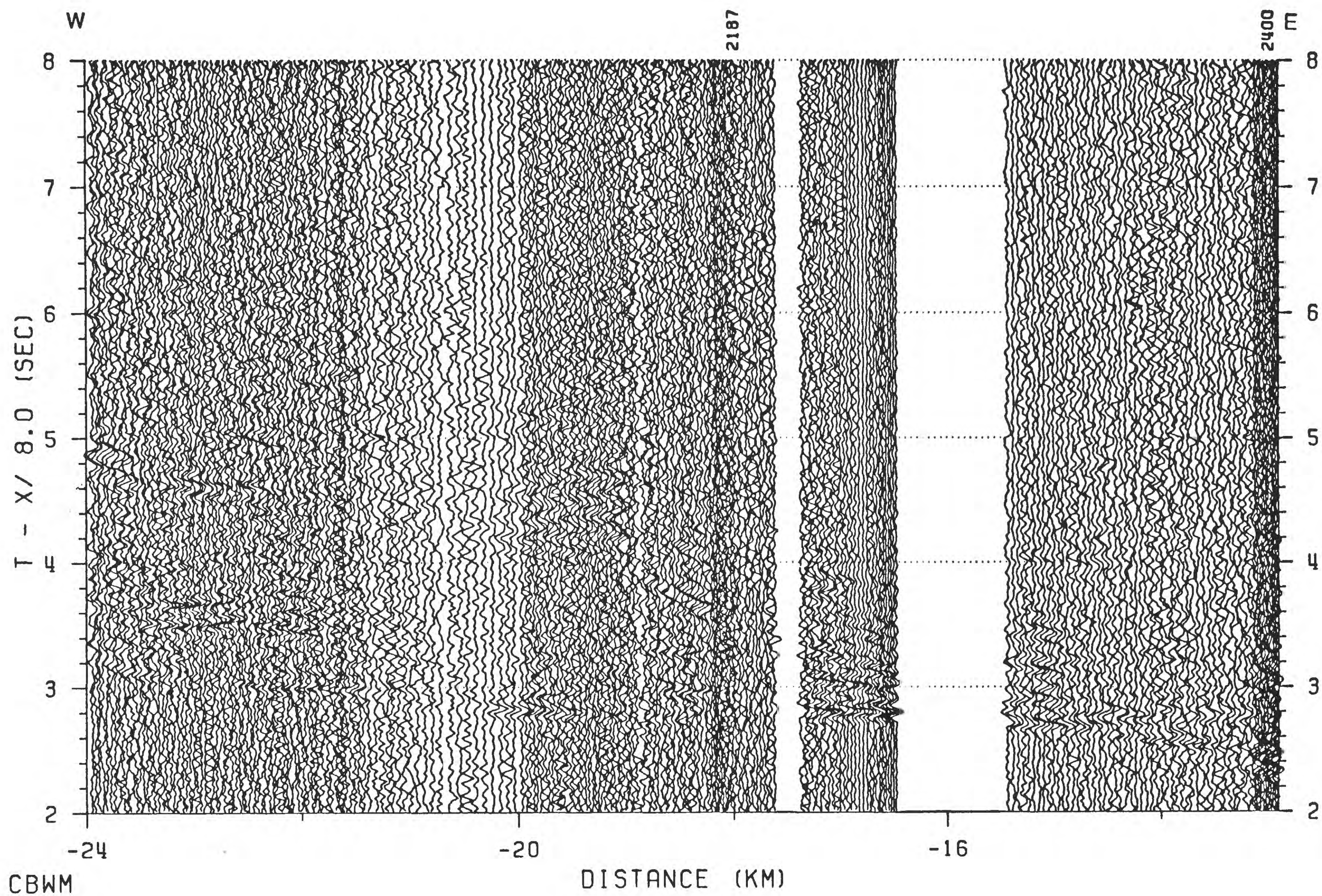

Figure 6. Receiver gather from station CBWM for BASIX line 105. Plot parameters are described in the text.

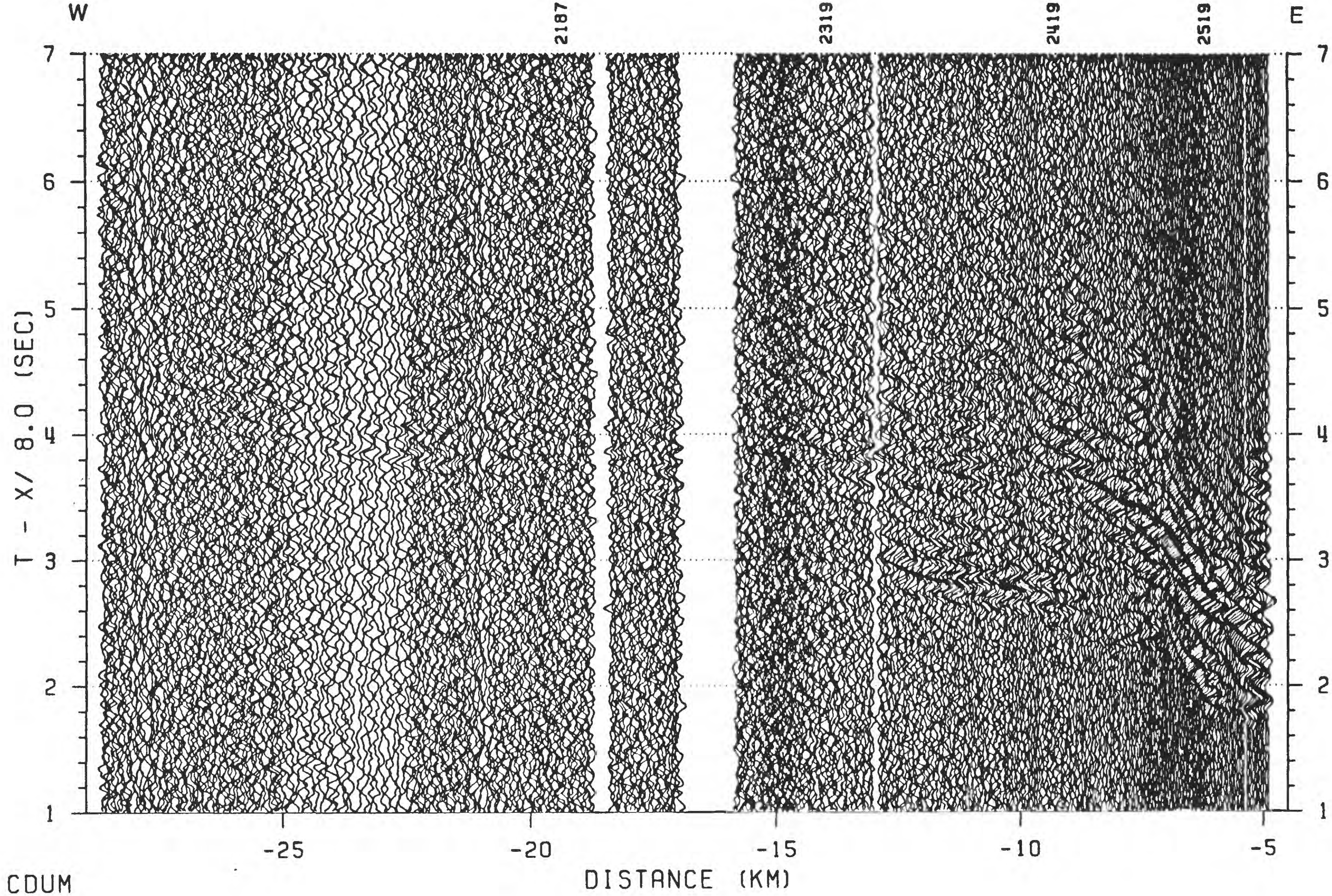

Figure 7. Receiver gather from station CDUM for BASIX line 105. Plot parameters are described in the text.

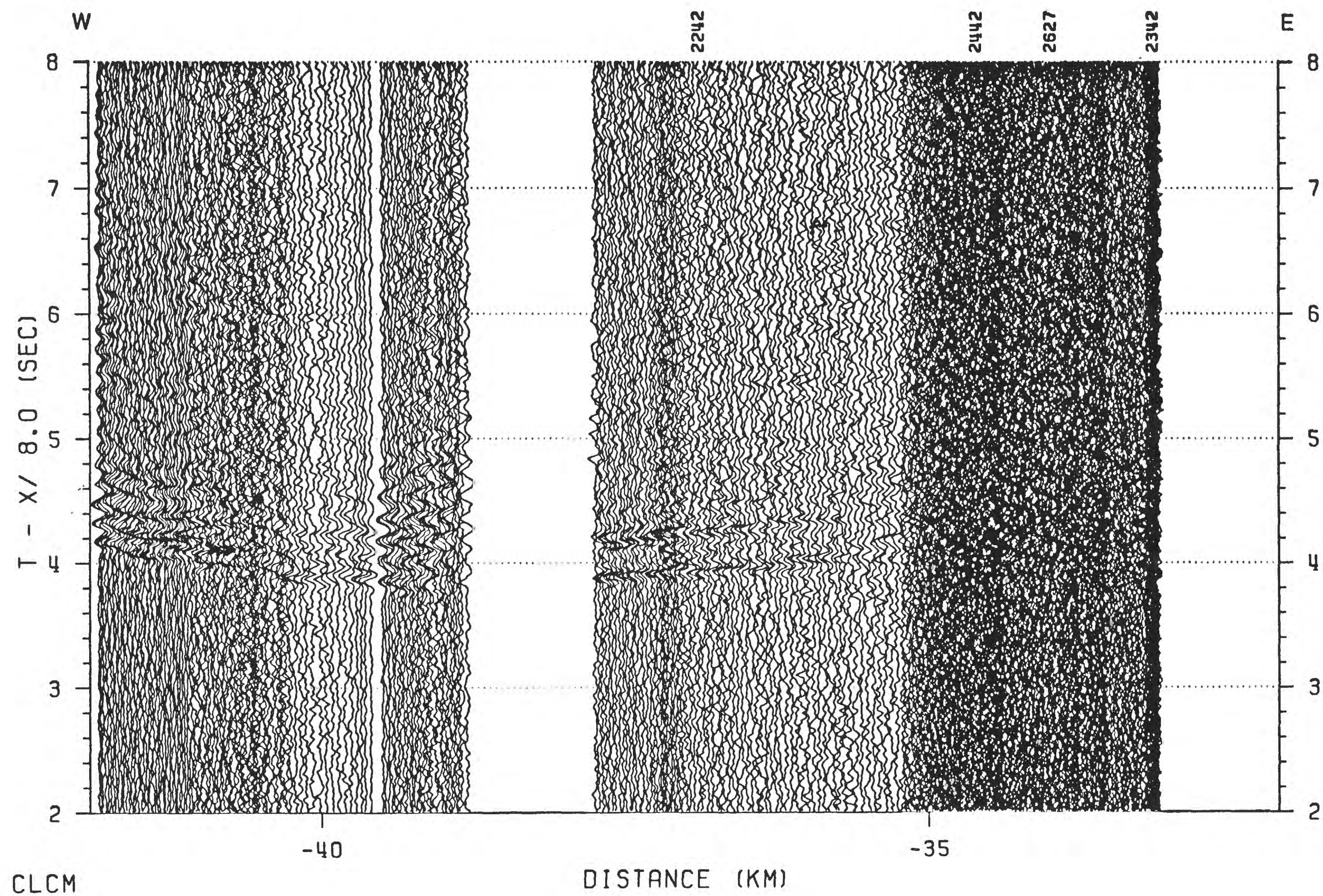

Figure 8. Receiver gather from station CLCM for BASIX line 105. Plot parameters are described in the text.

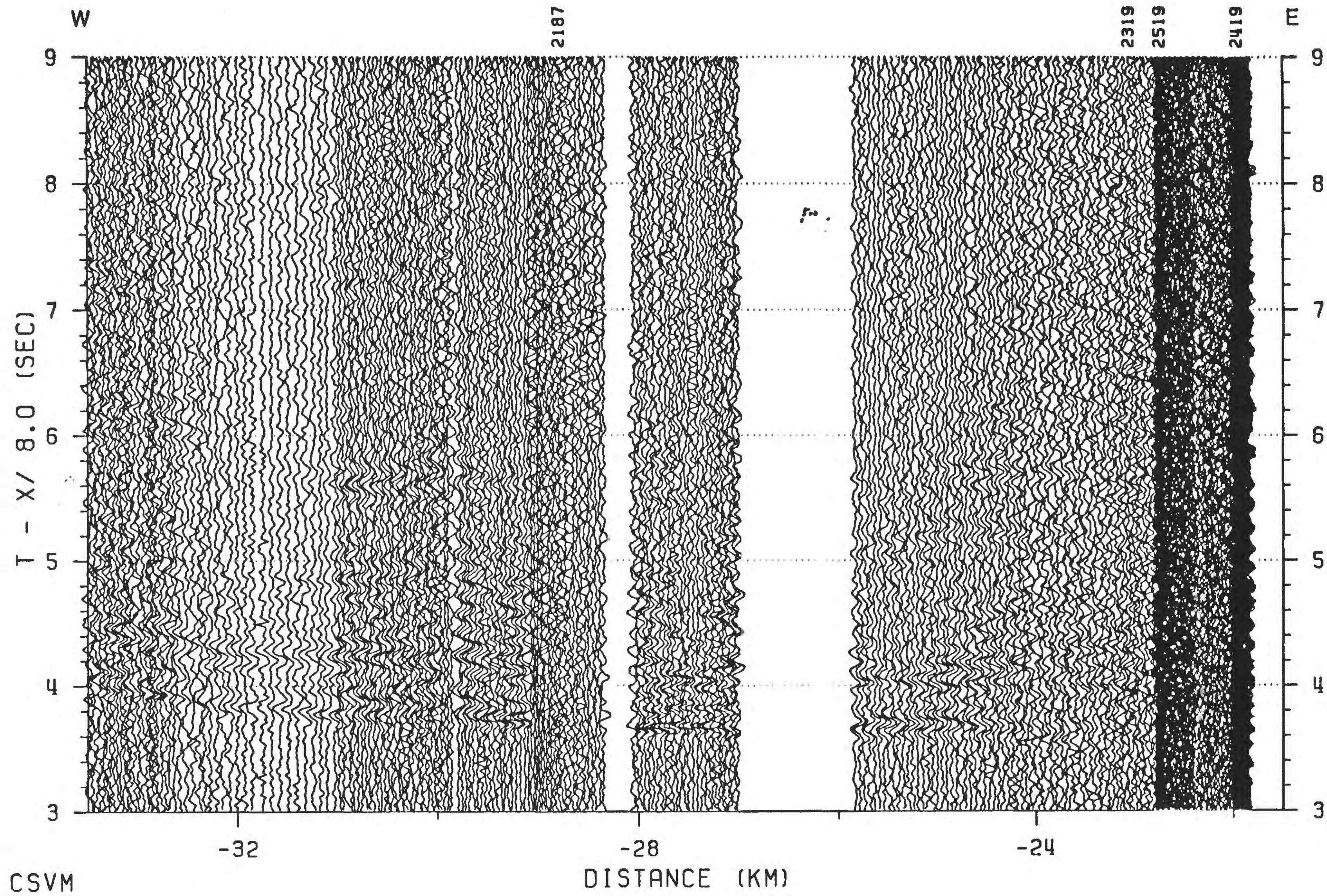

Figure 9. Receiver gather from station CSVM for BASIX line 105. Plot parameters are described in the text.

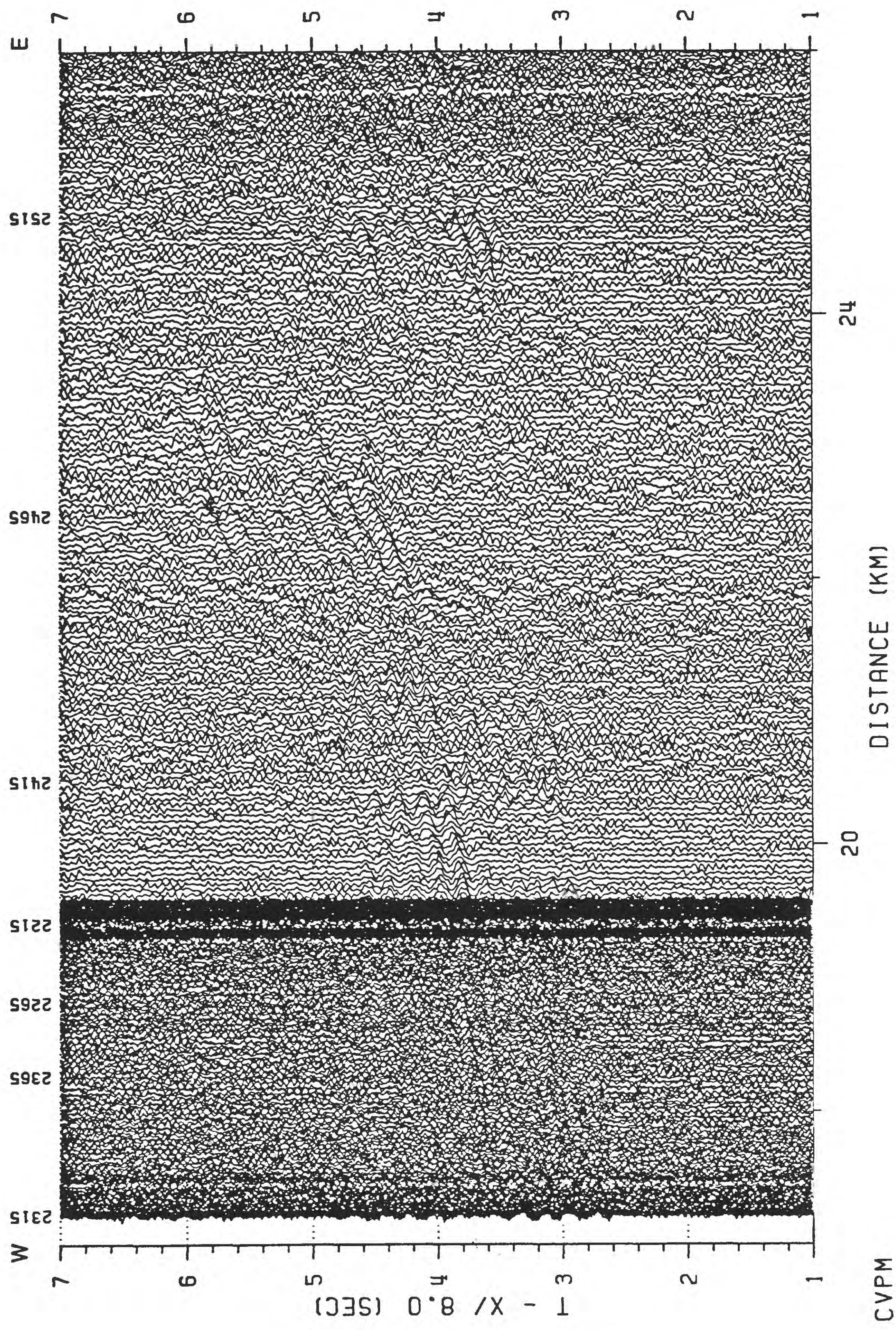

Figure 10. Receiver gather from station CVPM for BASIX line 105. Plot parameters are described in the text.

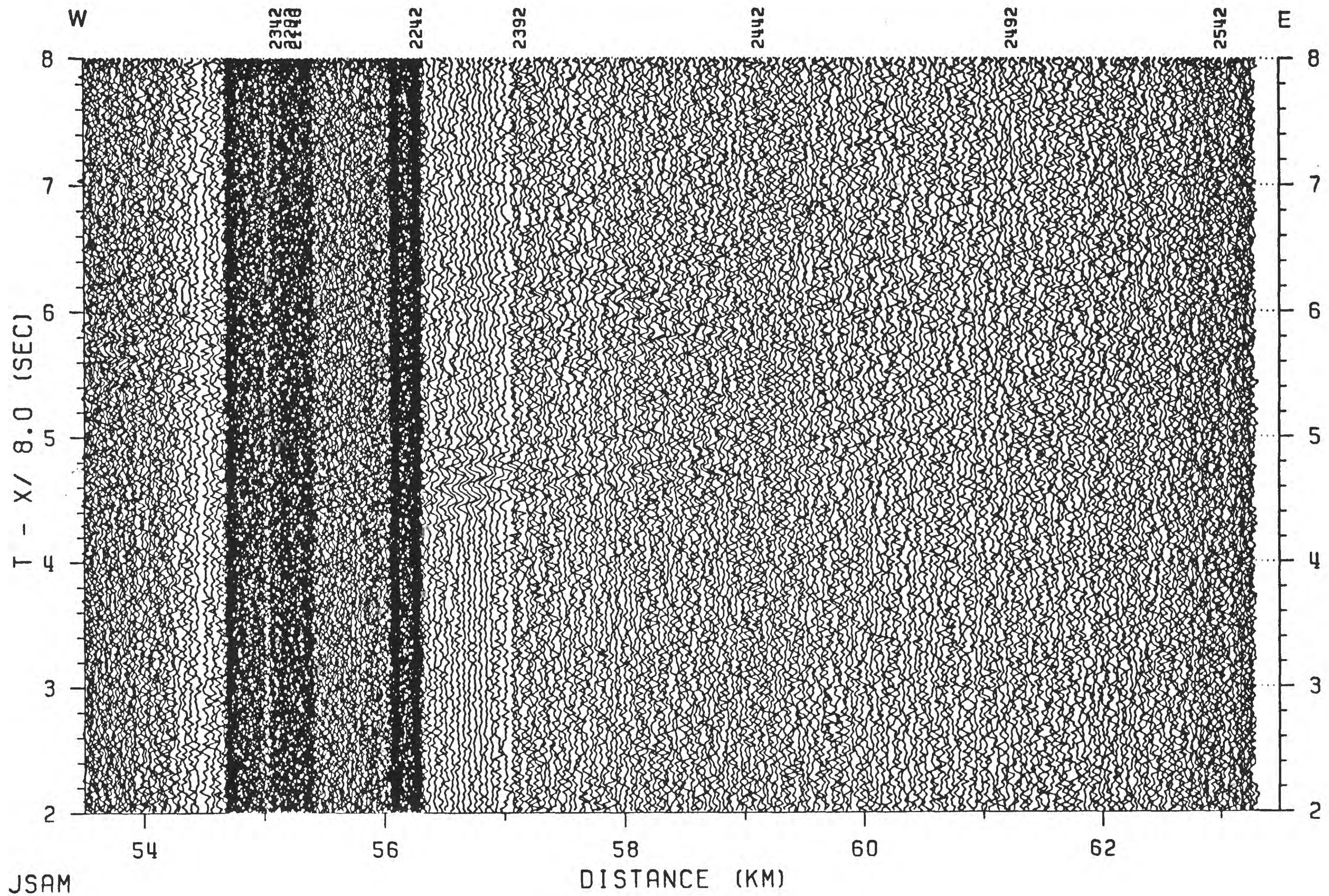

Figure 11. Receiver gather from station JSAM for BASIX line 105. Plot parameters are described in the text.

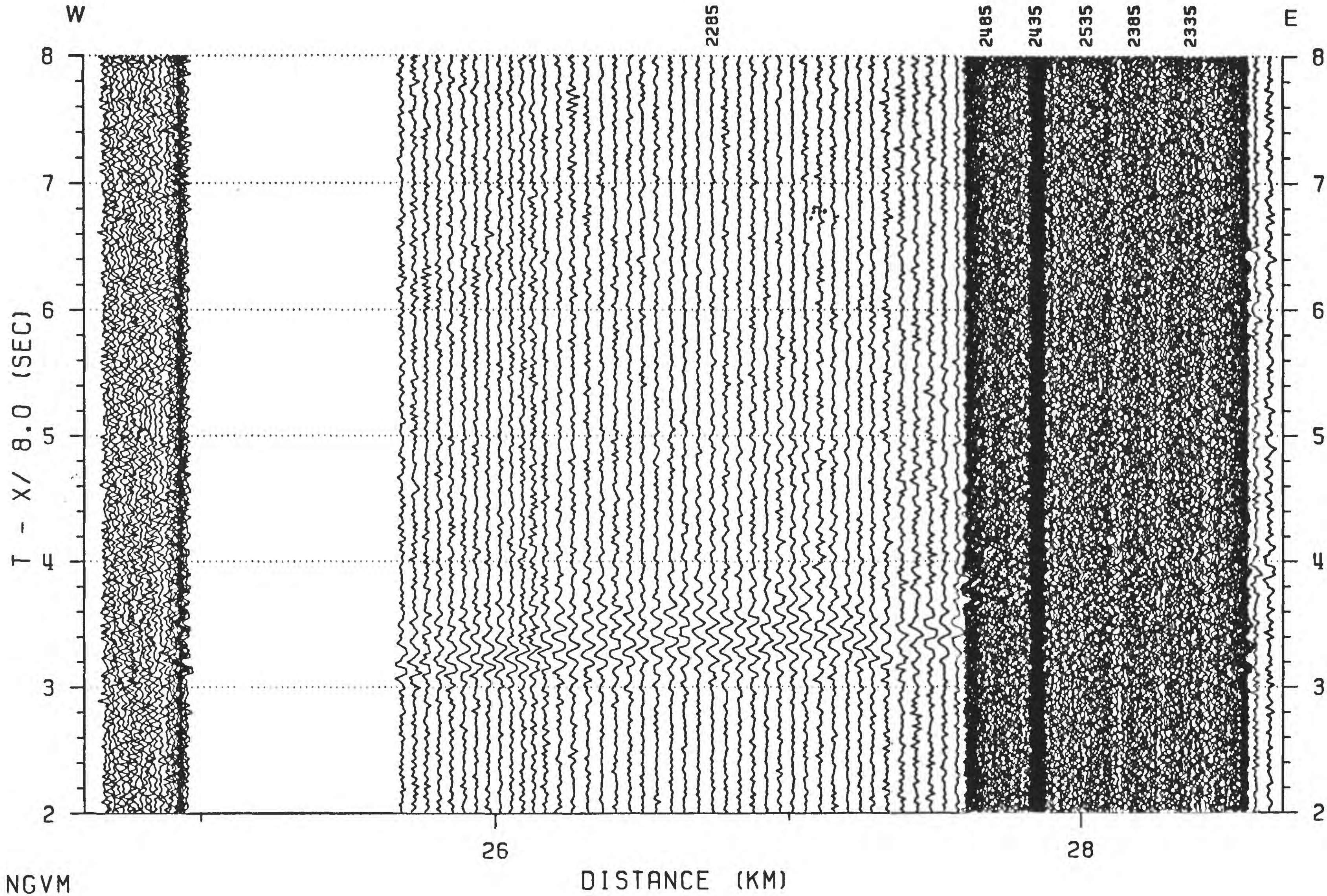

Figure 12. Receiver gather from station NGVM for BASIX line 105. Plot parameters are described in the text.

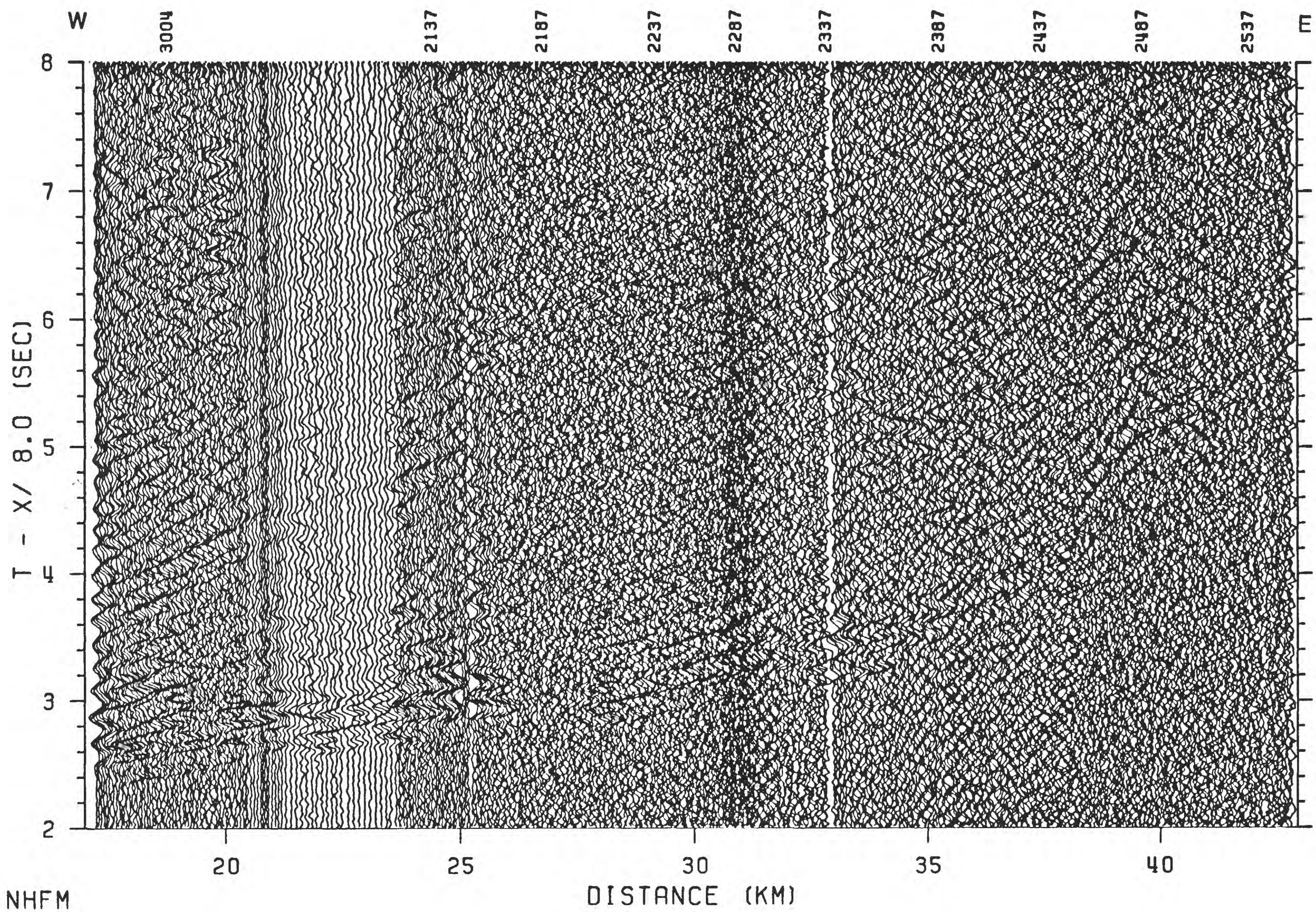

Figure 13. Receiver gather from station NHFM for BASIX line 105. Plot parameters are described in the text.

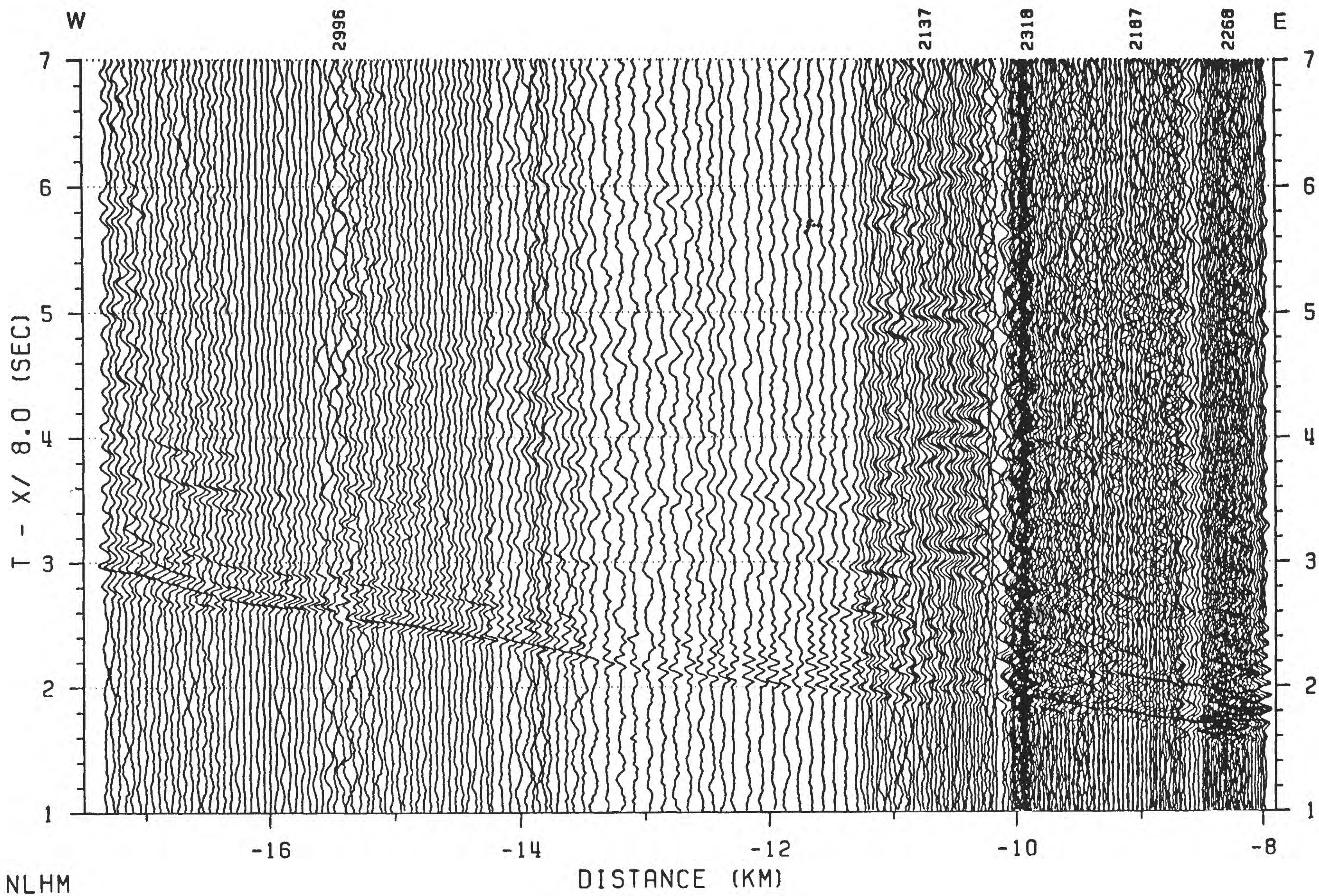

Figure 14. Receiver gather from station NLHM for BASIX line 105. Plot parameters are described in the text.

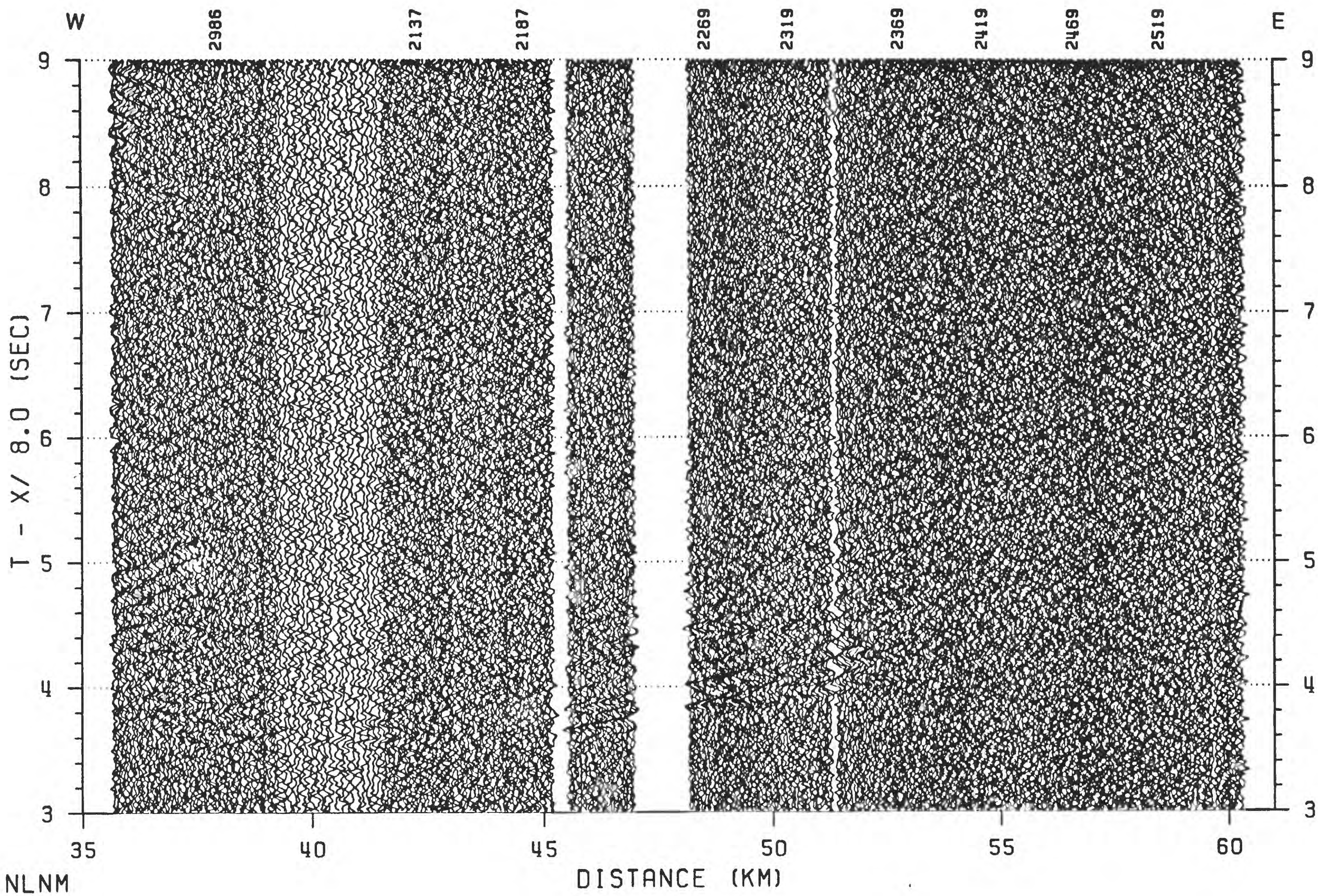

Figure 15. Receiver gather from station NLNM for BASIX line 105. Plot parameters are described in the text.

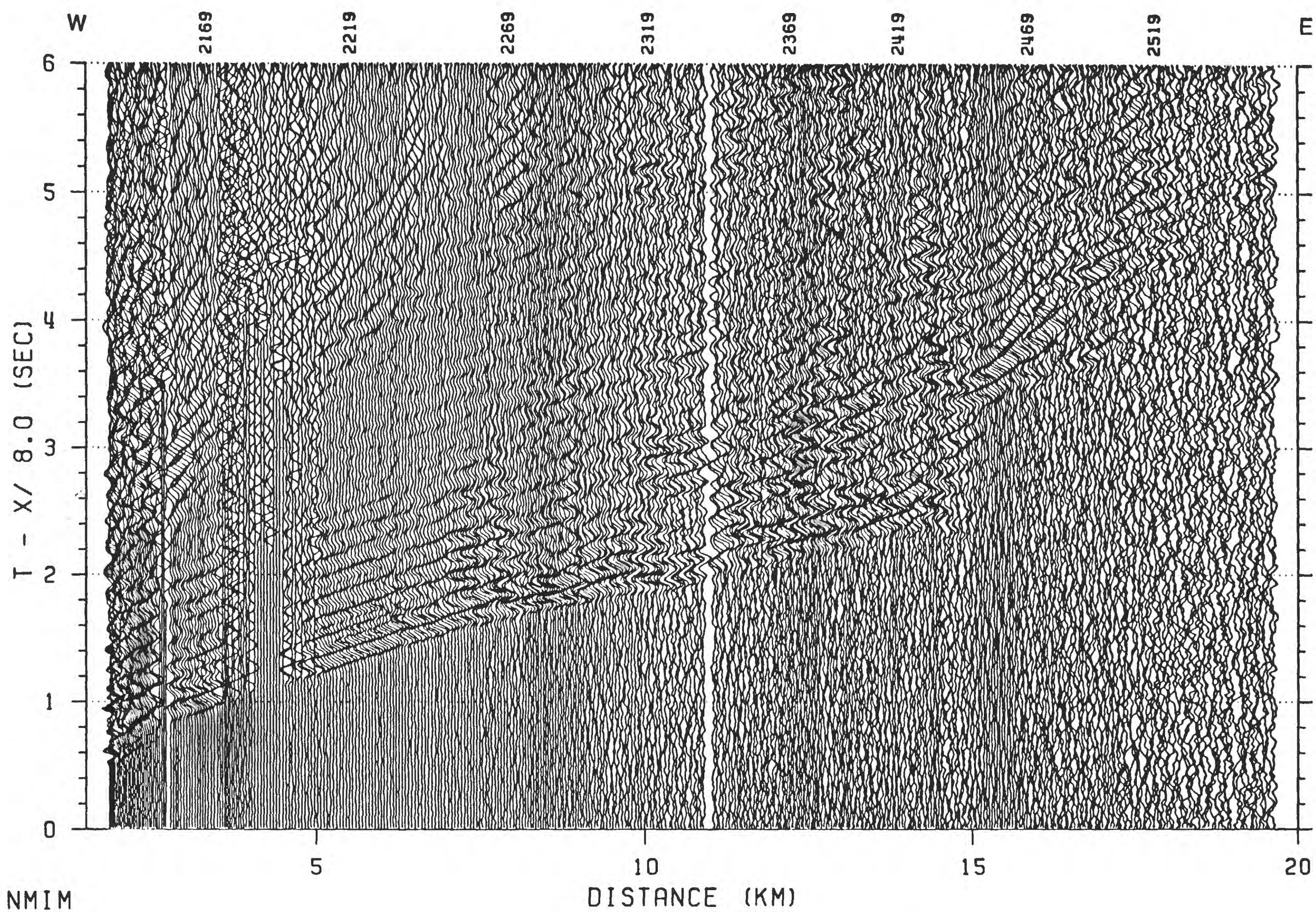

Figure 16. Receiver gather from station NMIM for BASIX line 105. Plot parameters are described in the text.

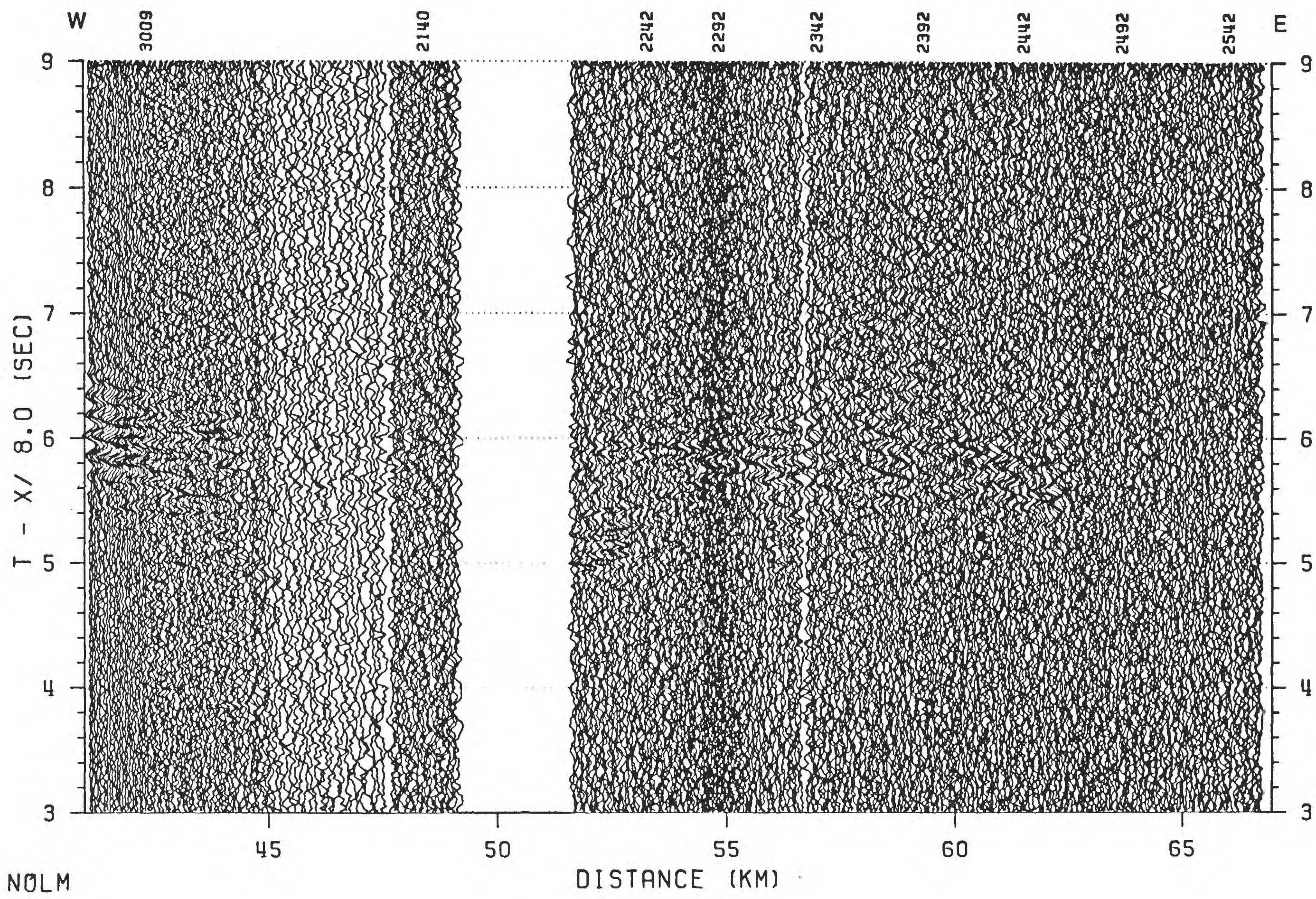

Figure 17. Receiver gather from station NOLM for BASIX line 105. Plot parameters are described in the text.

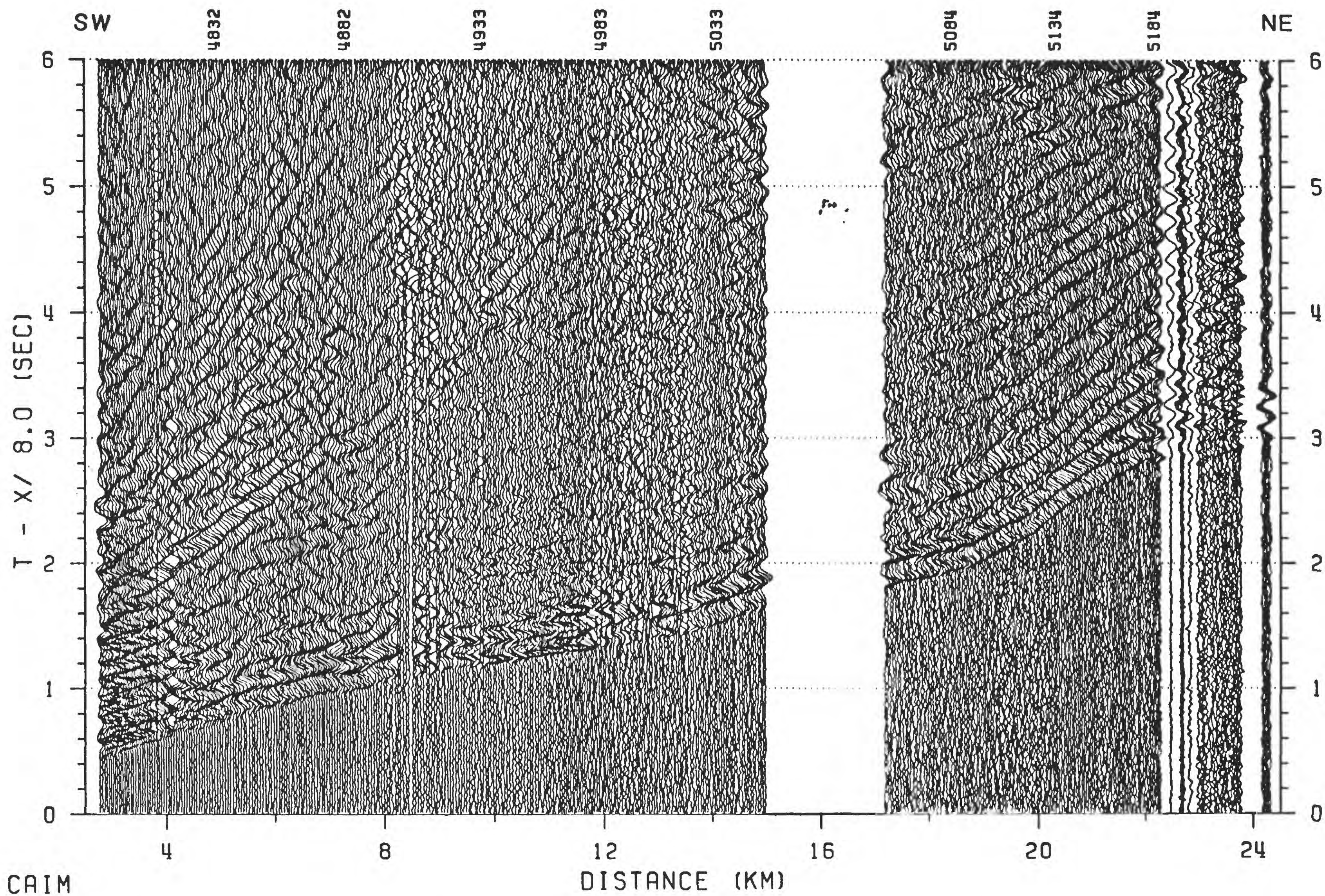

Figure 18. Receiver gather from station CAIM for BASIX line 109. Plot parameters are described in the text.

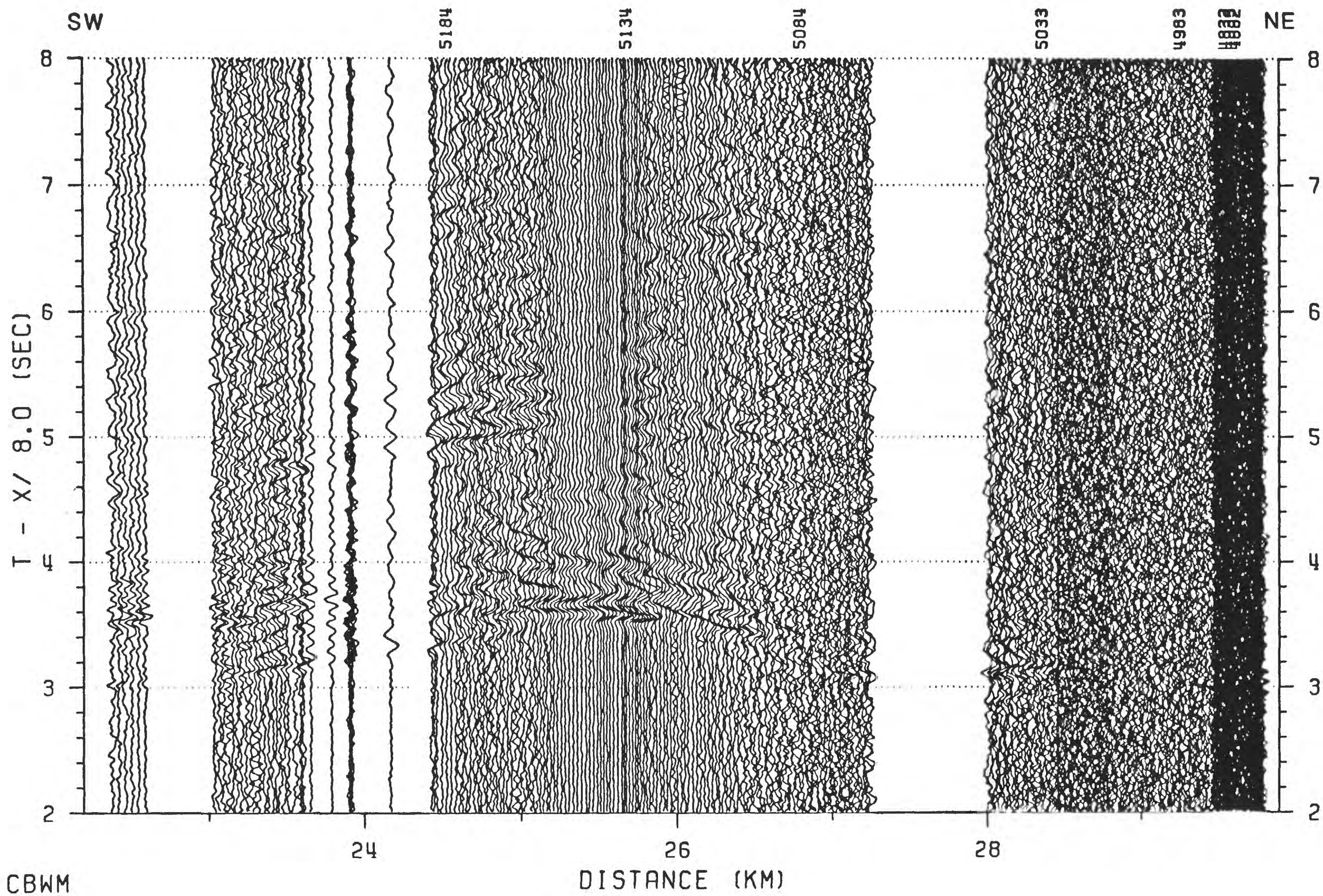

Figure 19. Receiver gather from station CBWM for BASIX line 109. Plot parameters are described in the text.

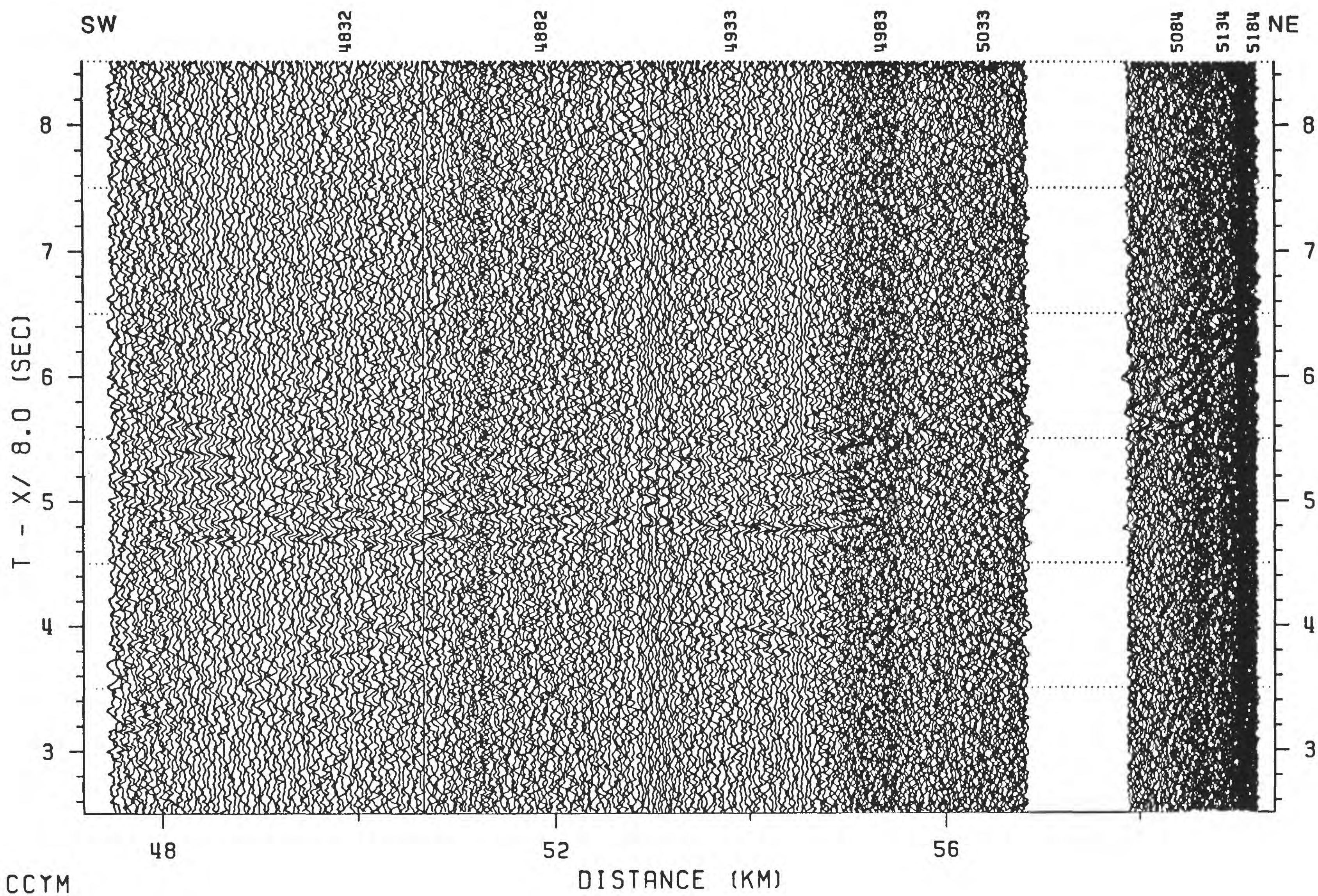

Figure 20. Receiver gather from station CCYM for BASIX line 109. Plot parameters are described in the text.

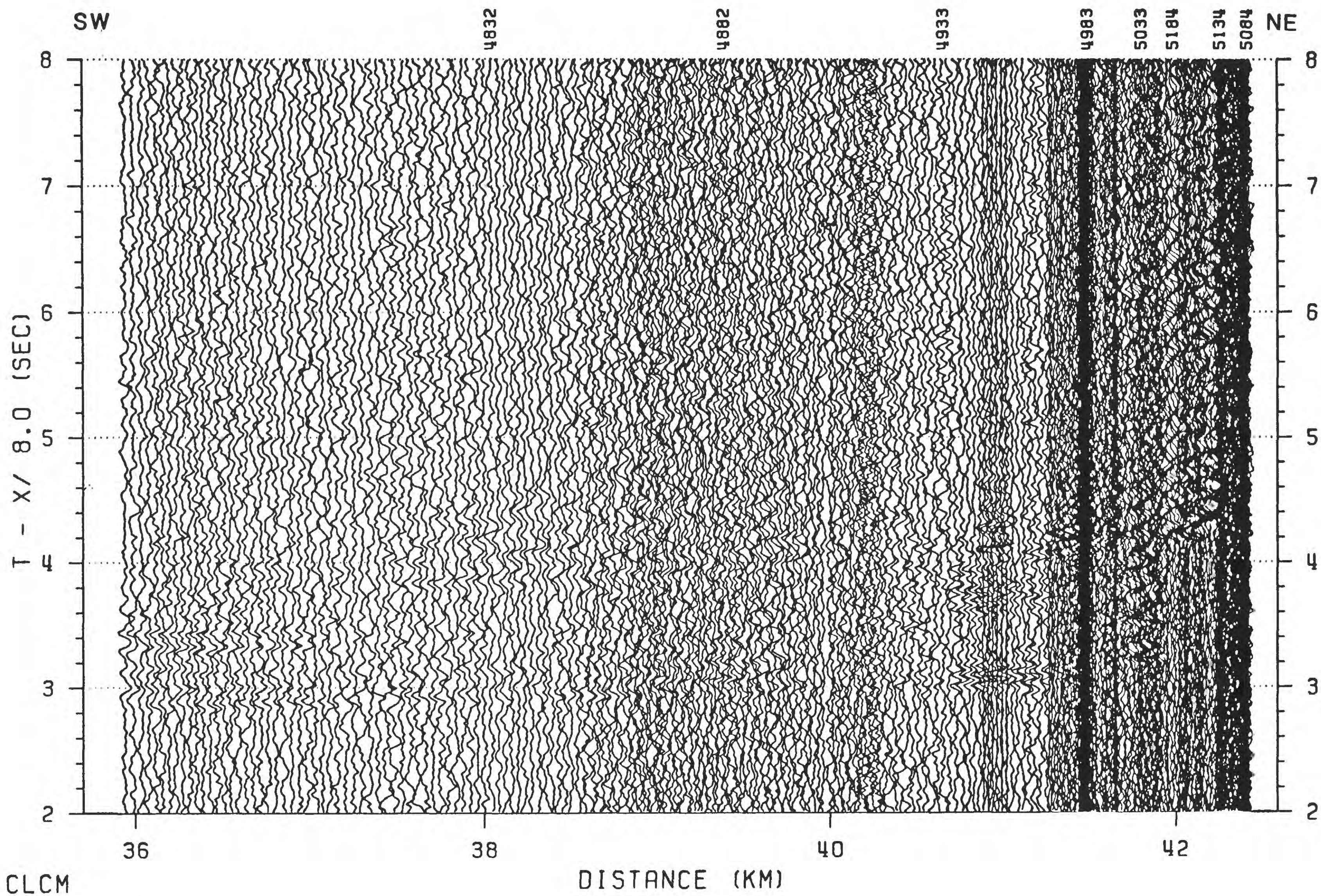

Figure 21. Receiver gather from station CLCM for BASIX line 109. Plot parameters are described in the text.

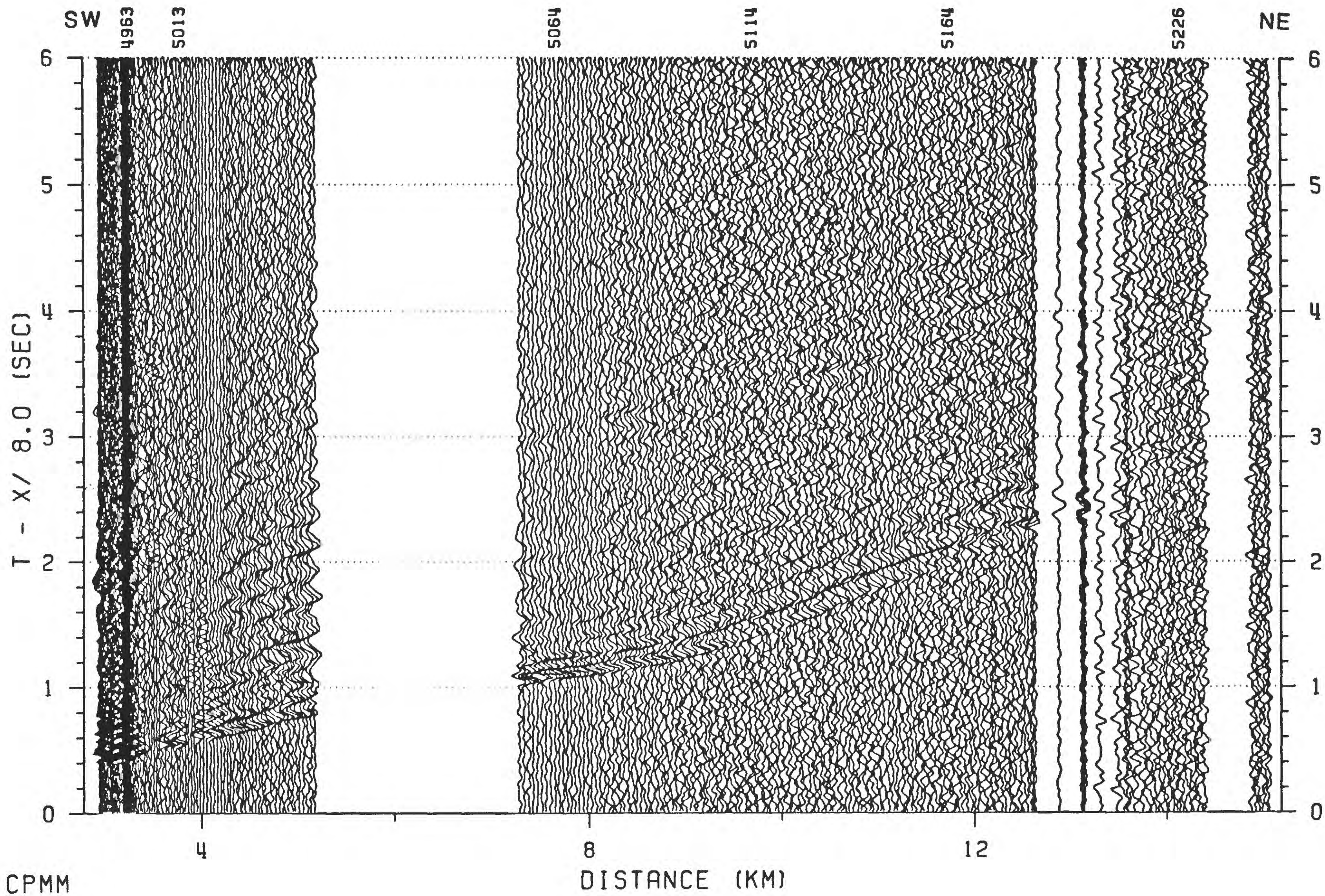

Figure 22. Receiver gather from station CPMM for BASIX line 109. Plot parameters are described in the text.

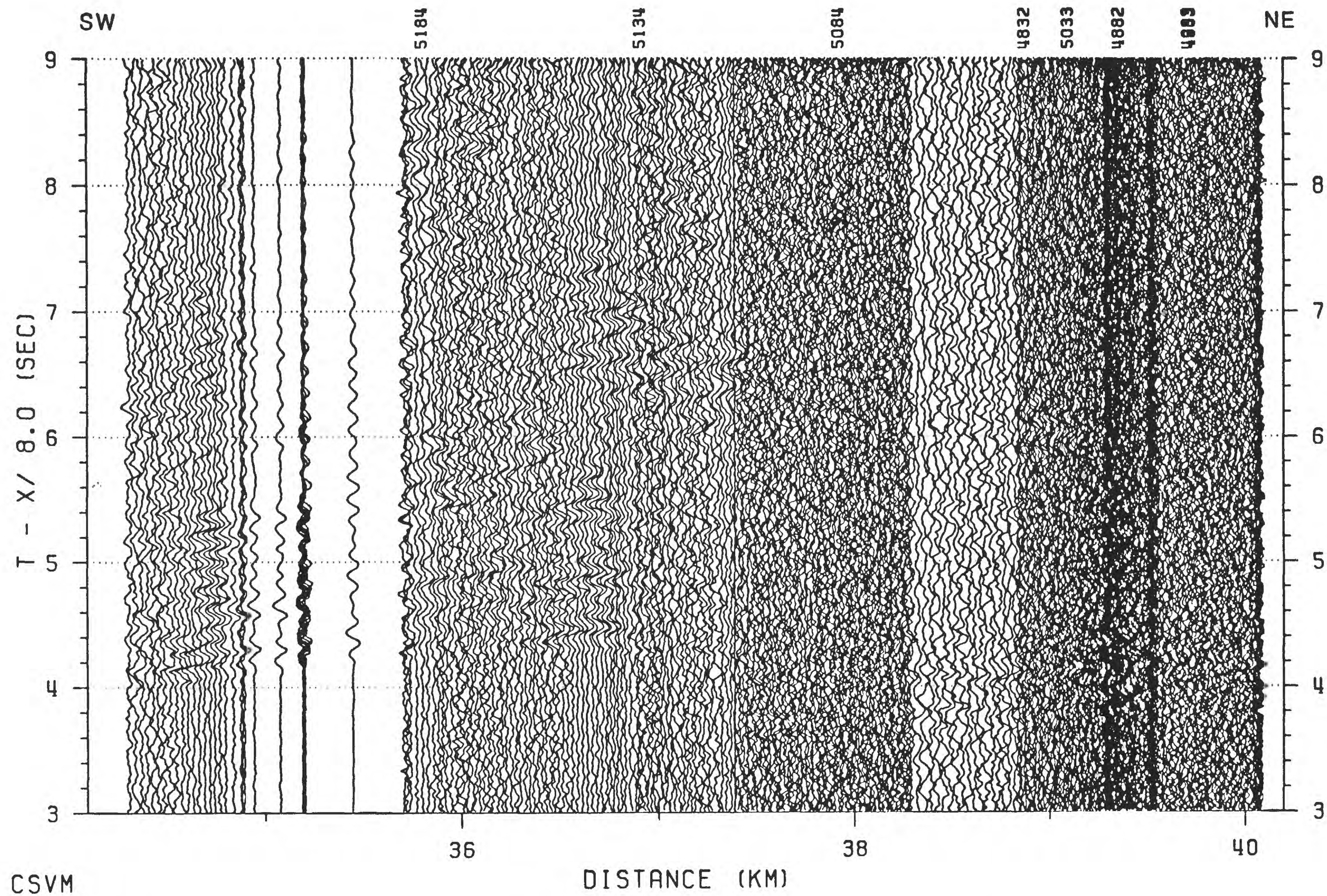

Figure 23. Receiver gather from station CSVM for BASIX line 109. Plot parameters are described in the text.

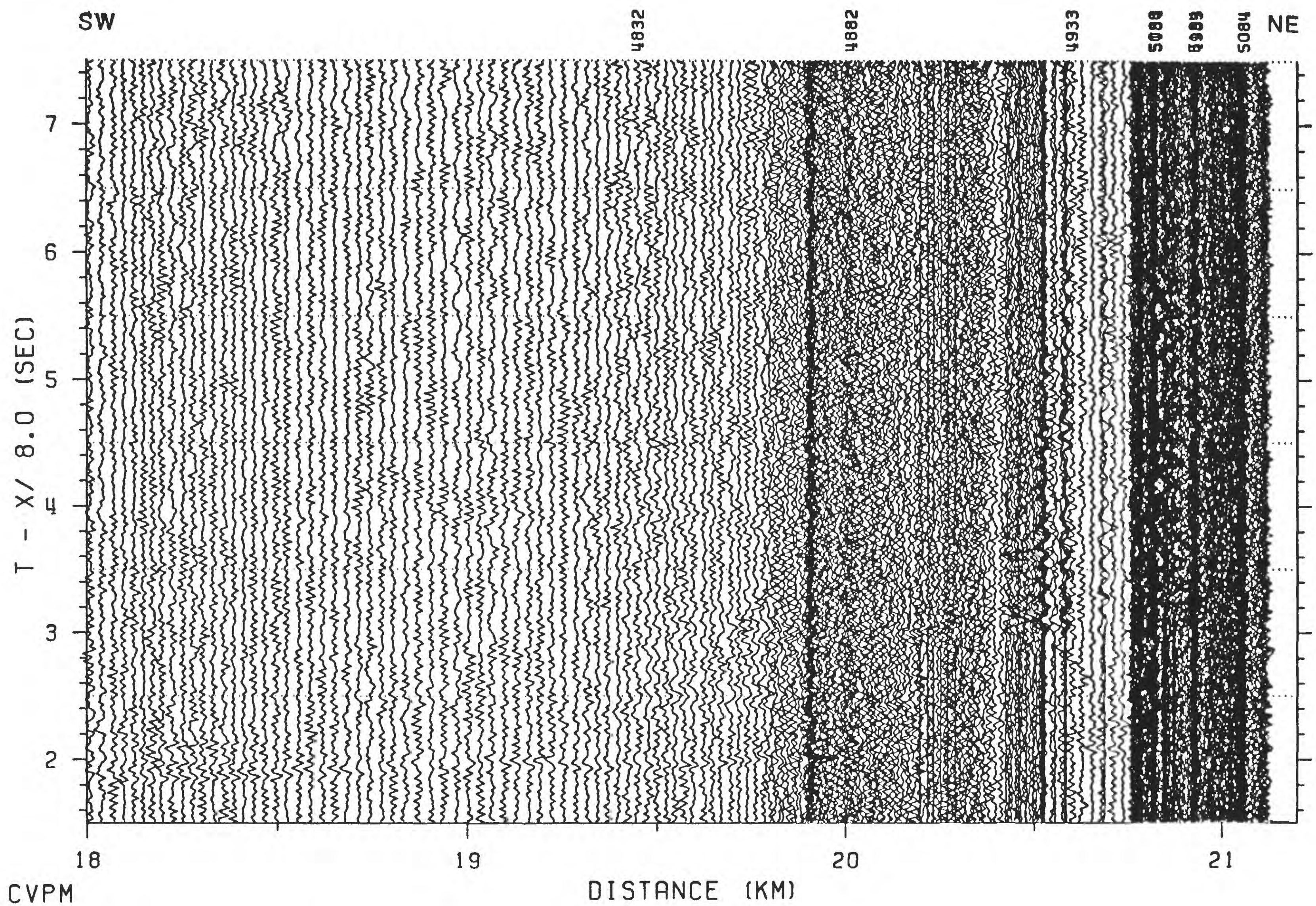

Figure 24. Receiver gather from station CVPM for BASIX line 109. Plot parameters are described in the text.

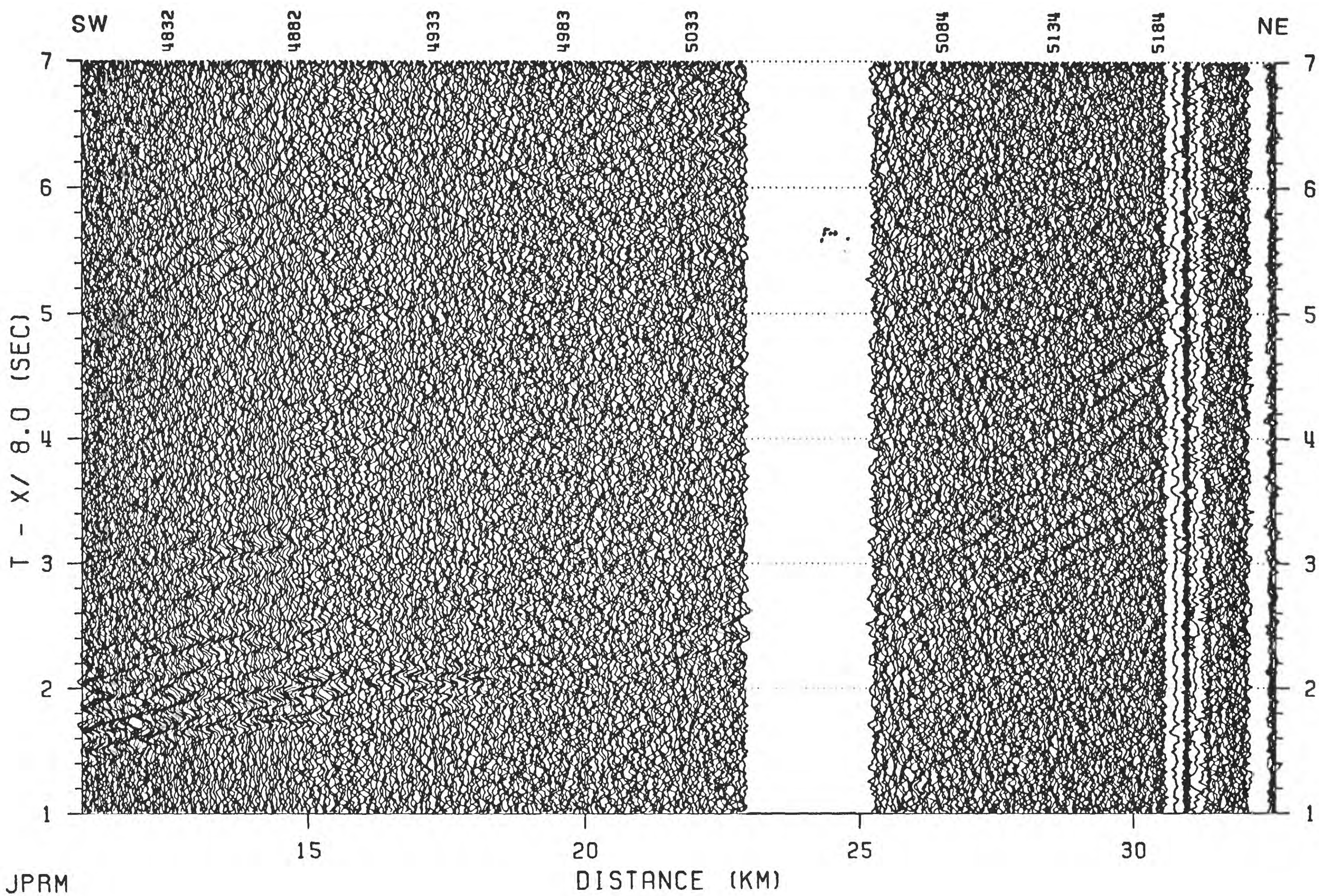

Figure 25. Receiver gather from station JPRM for BASIX line 109. Plot parameters are described in the text.

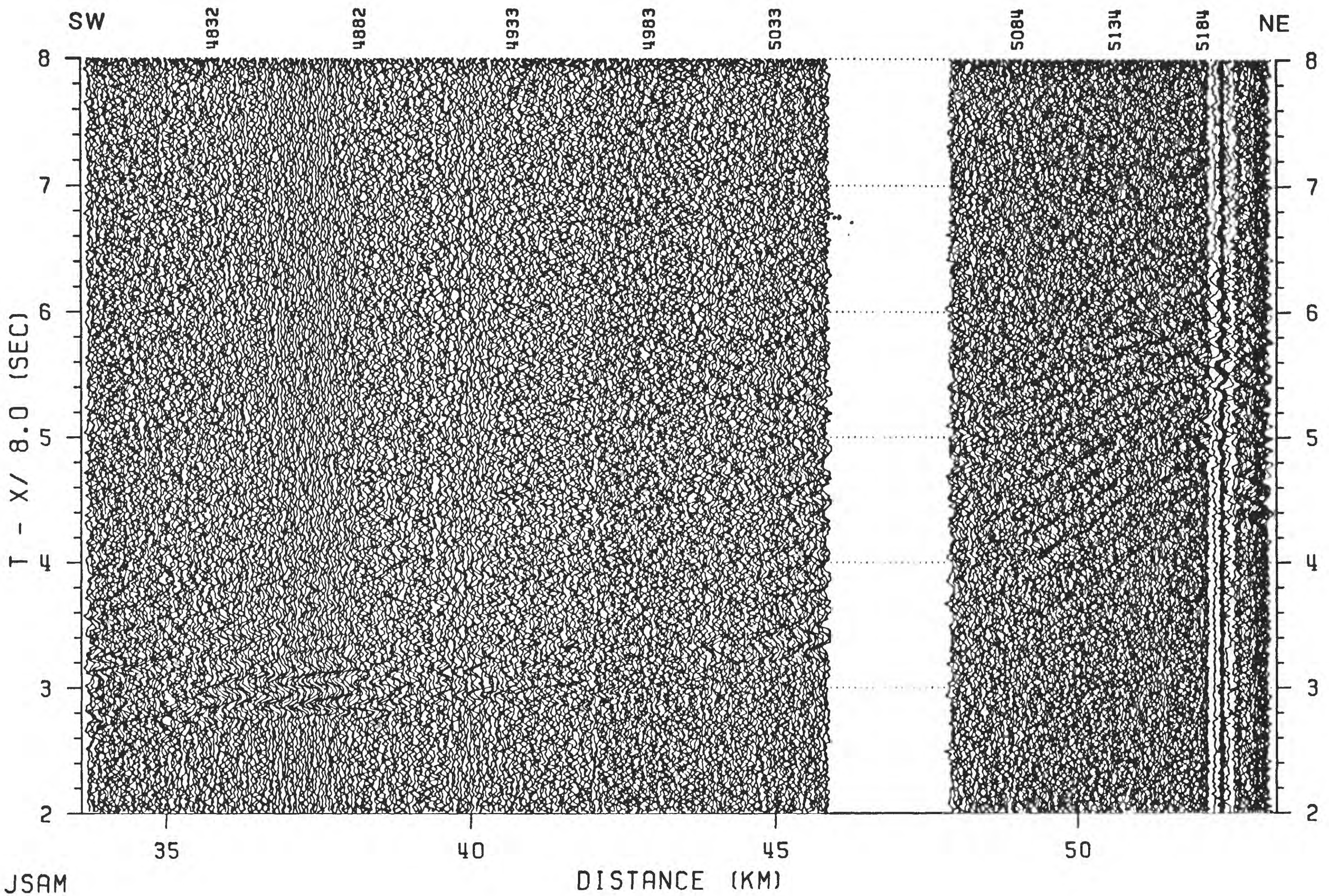

Figure 26. Receiver gather from station JSAM for BASIX line 109. Plot parameters are described in the text.

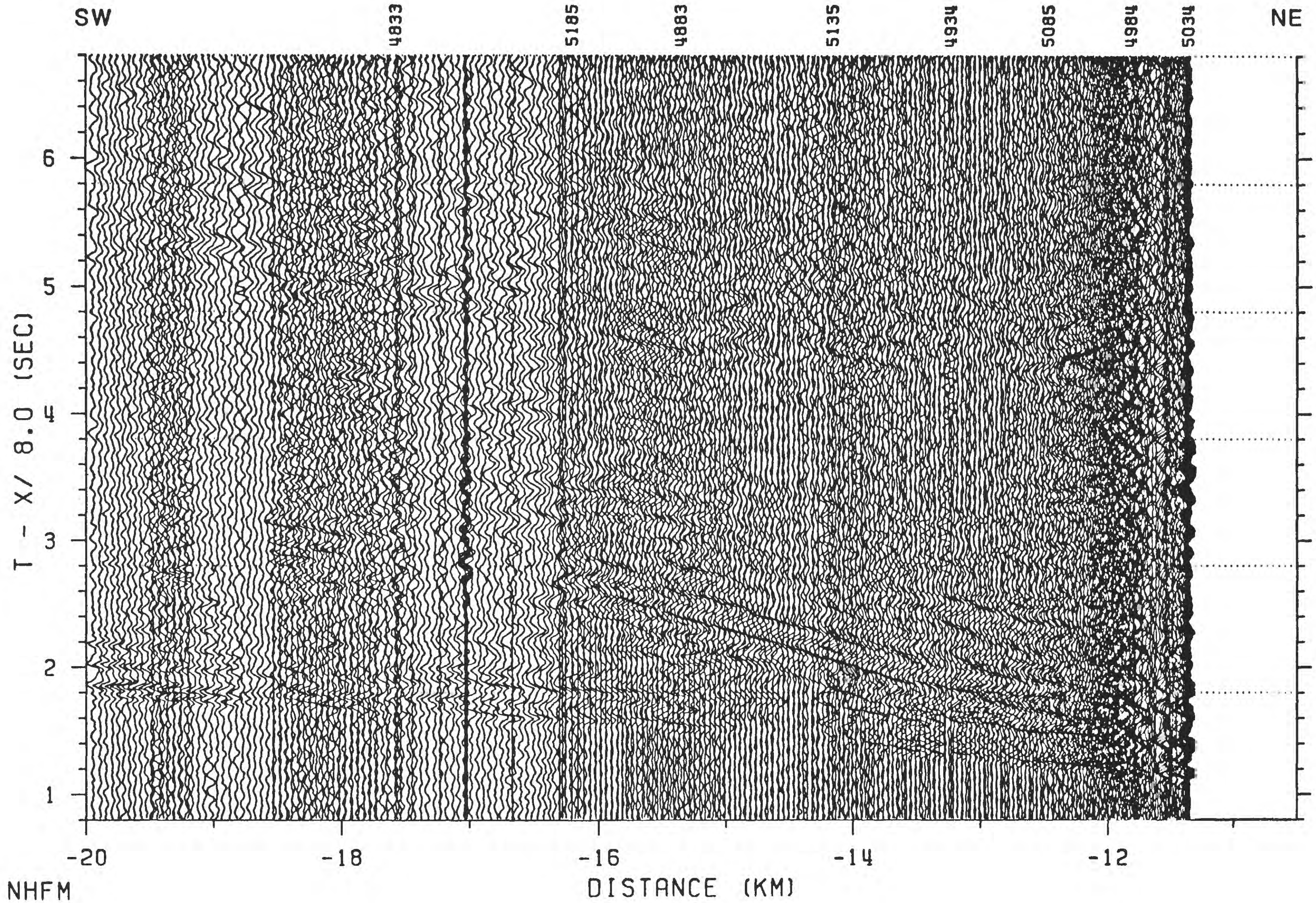

Figure 27. Receiver gather from station NHFM for BASIX line 109. Plot parameters are described in the text.

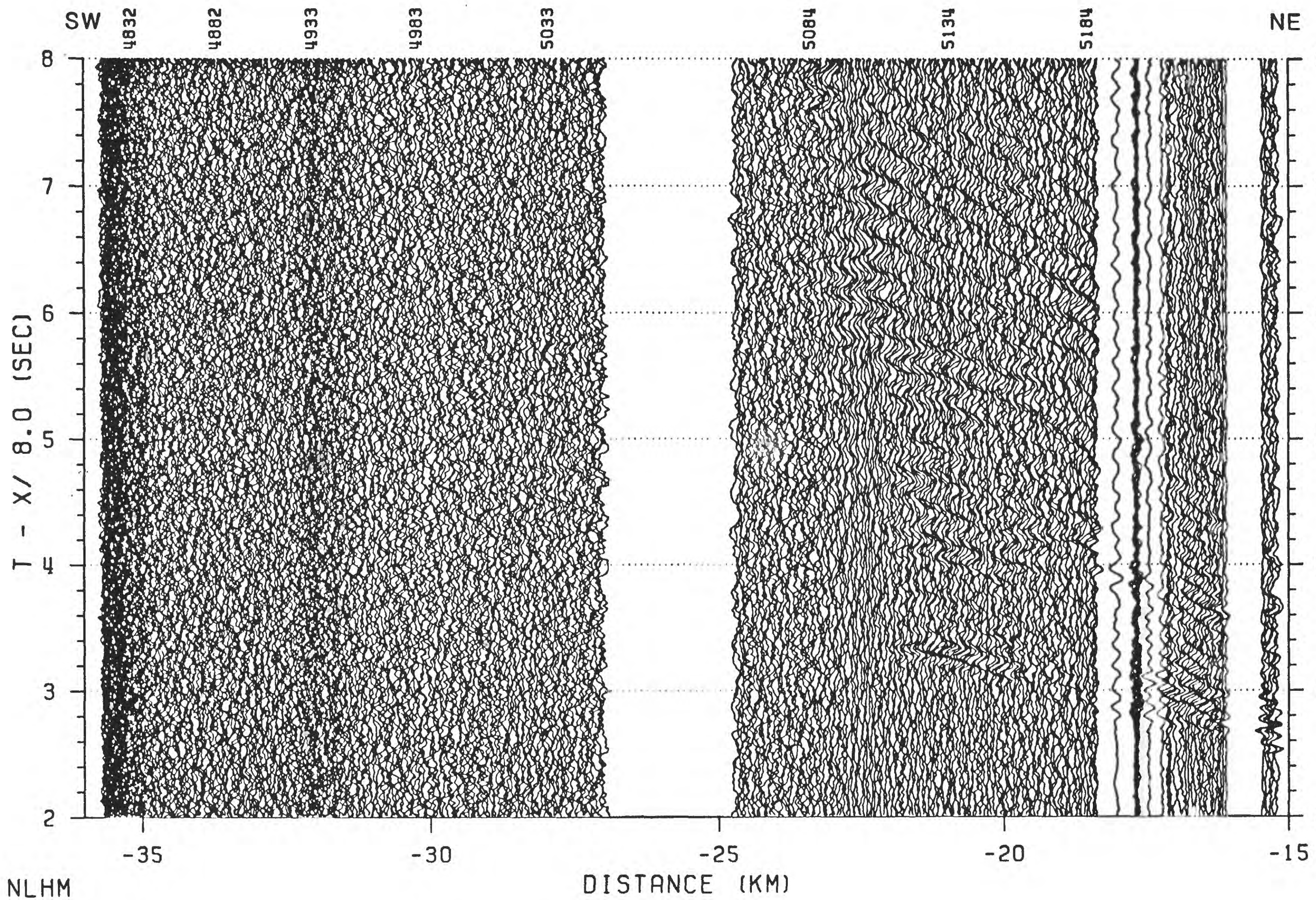

Figure 28. Receiver gather from station NLHM for BASIX line 109. Plot parameters are described in the text.

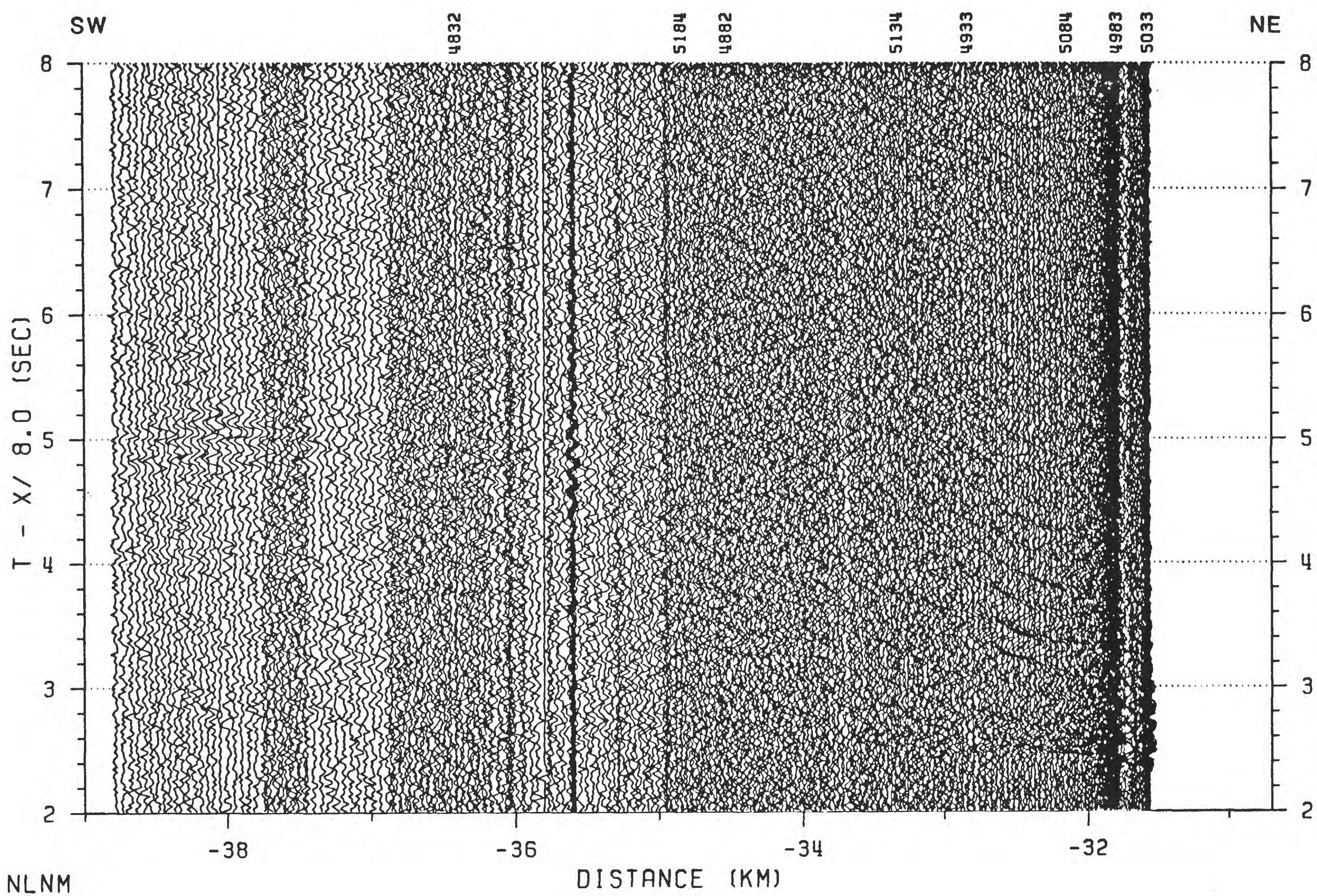

Figure 29. Receiver gather from station NLNM for BASIX line 109. Plot parameters are described in the text.

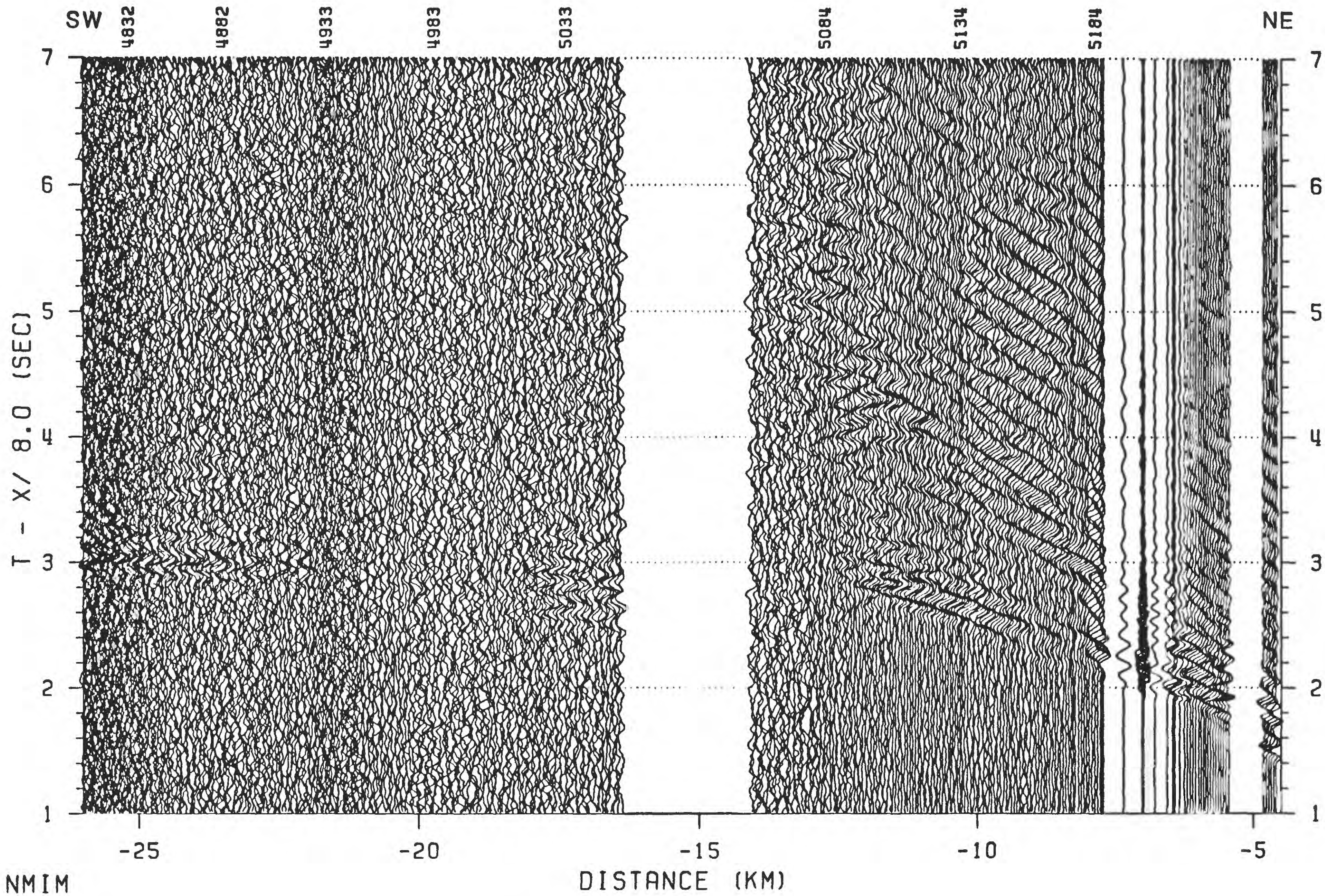

Figure 30. Receiver gather from station NMIM for BASIX line 109. Plot parameters are described in the text.

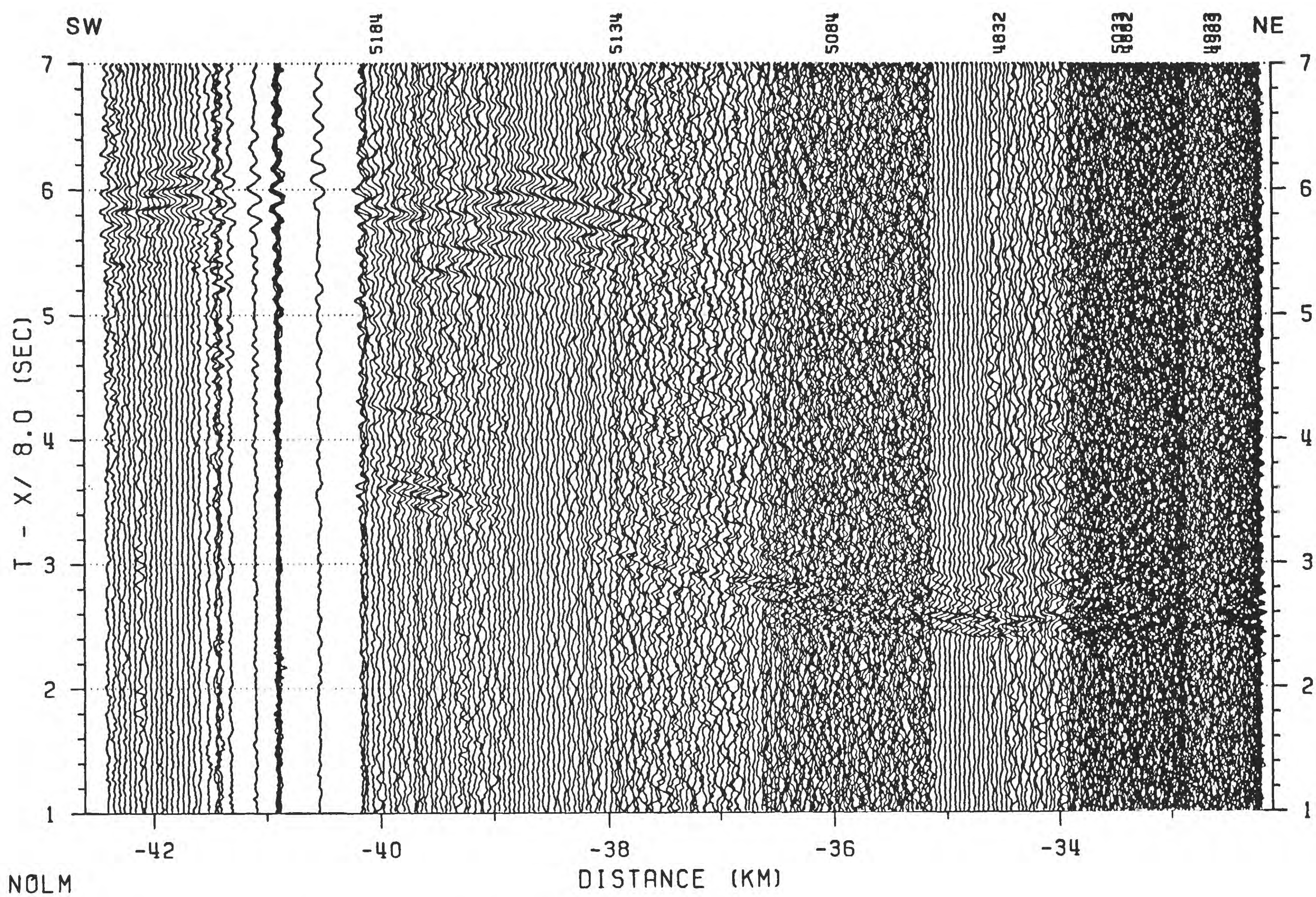

Figure 31. Receiver gather from station NOLM for BASIX line 109.

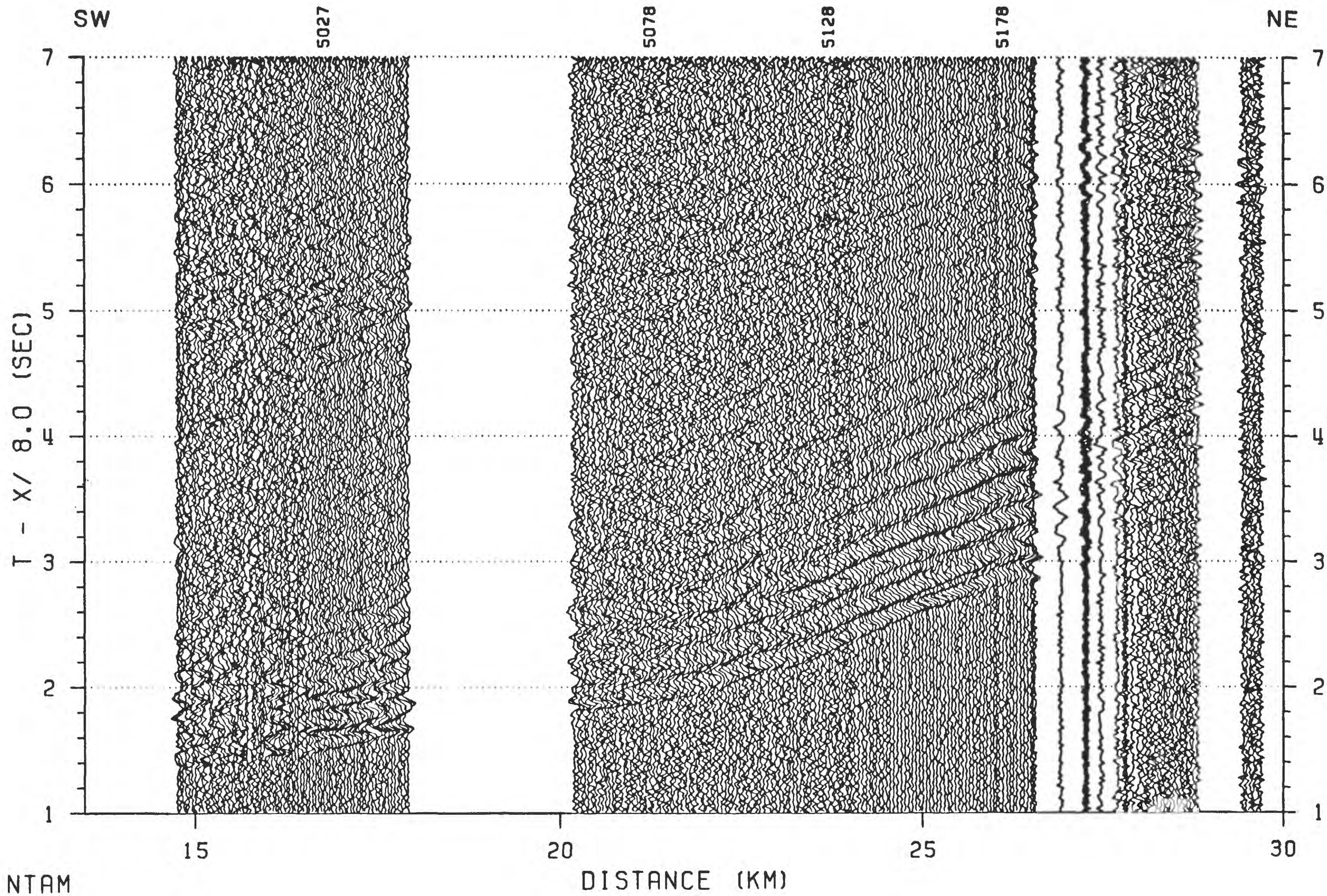

Figure 32. Receiver gather from station NTAM for BASIX line 109. Plot parameters are described in the text.

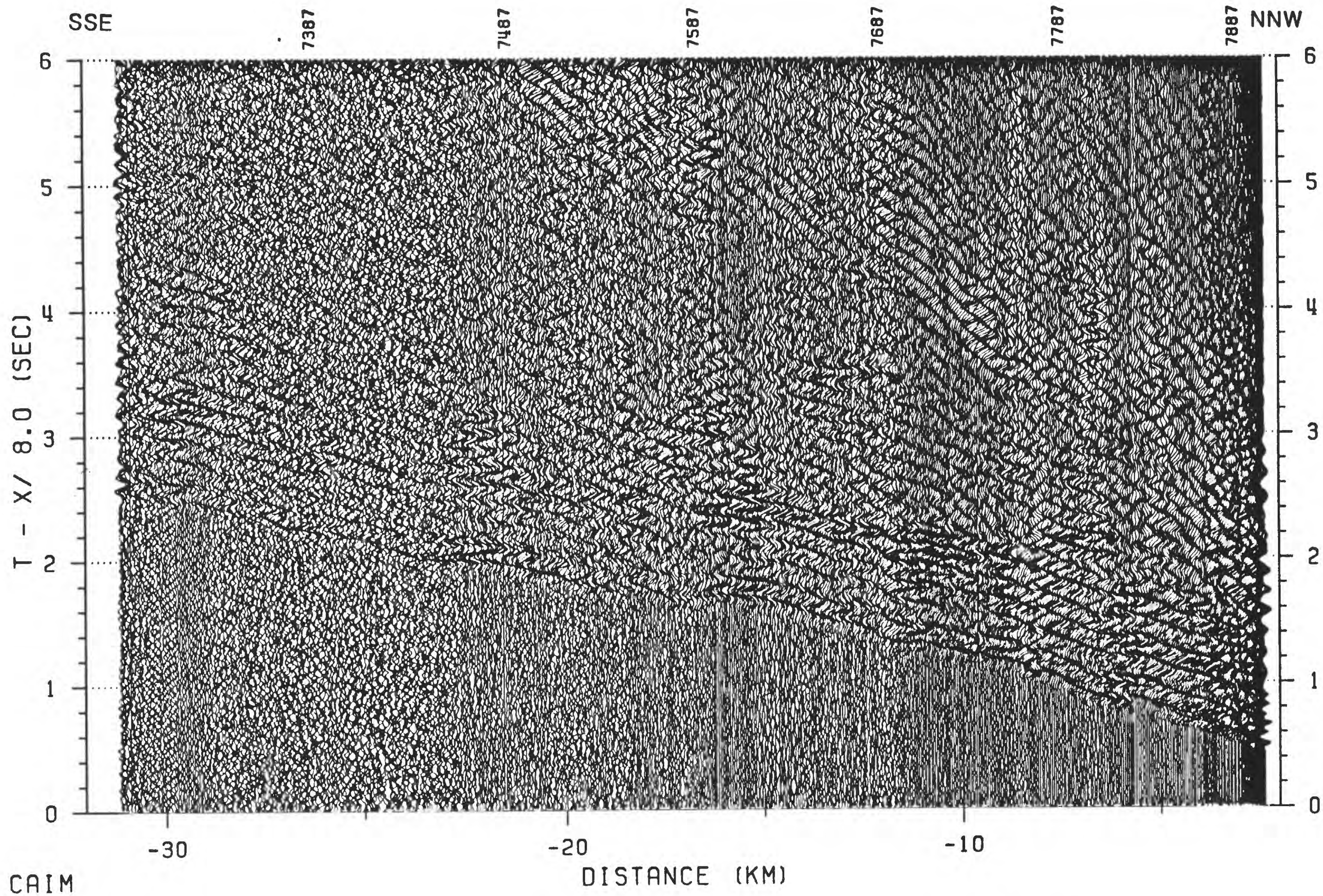

Figure 33. Receiver gather from station CAIM for BASIX line 112. Plot parameters are described in the text.

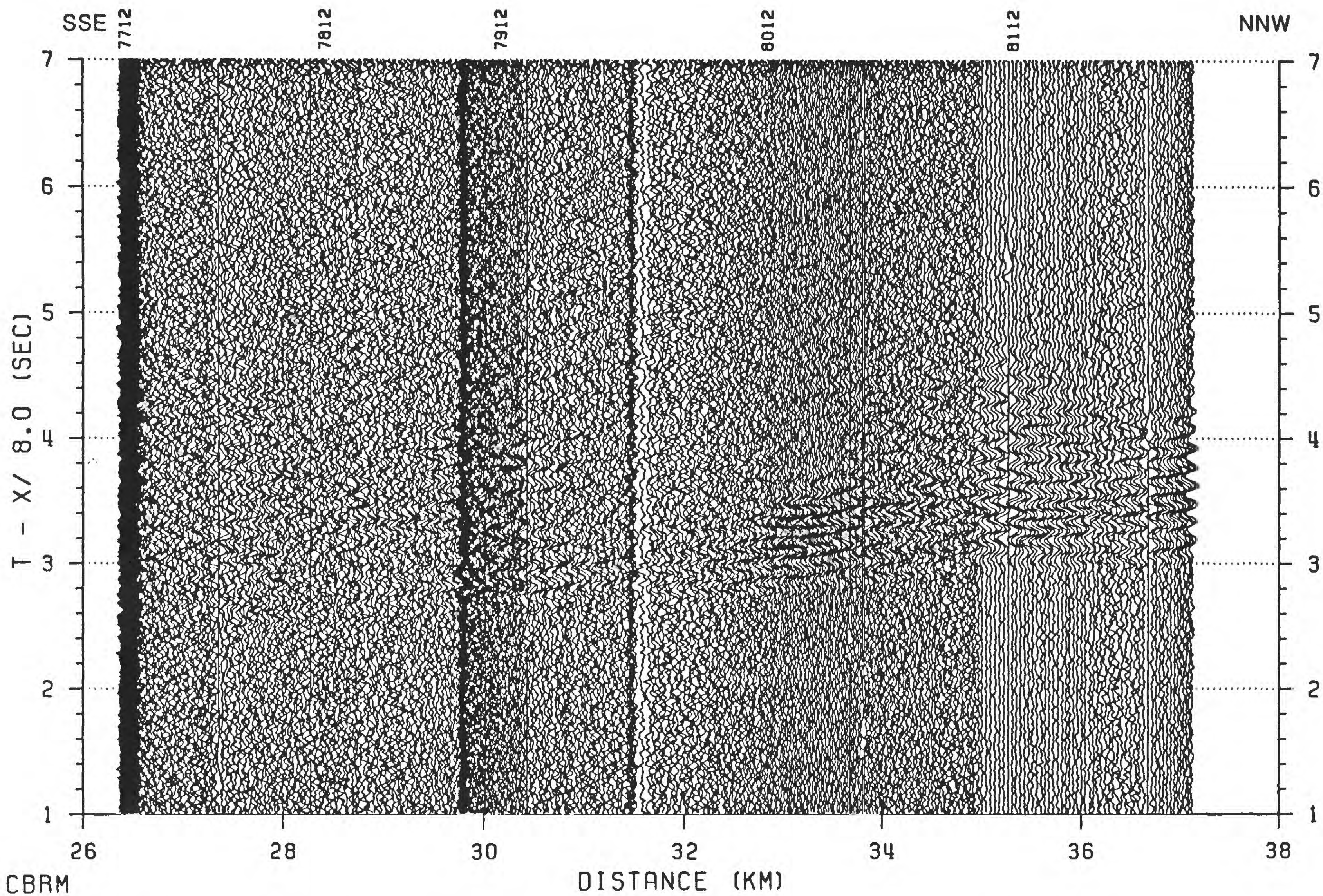

Figure 34. Receiver gather from station CBRM for BASIX line 112. Plot parameters are described in the text.

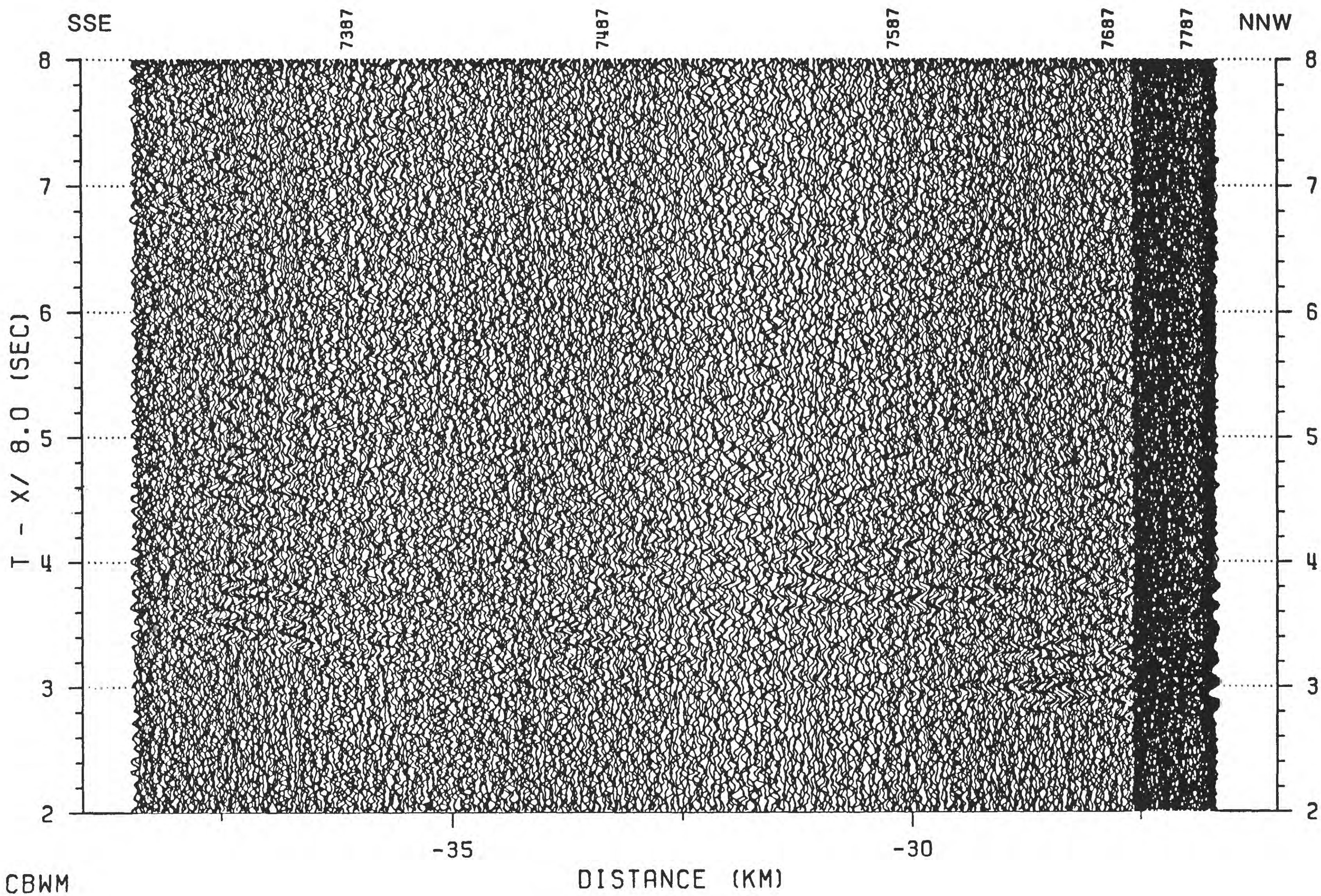

Figure 35. Receiver gather from station CBWM for BASIX line 112. Plot parameters are described in the text.

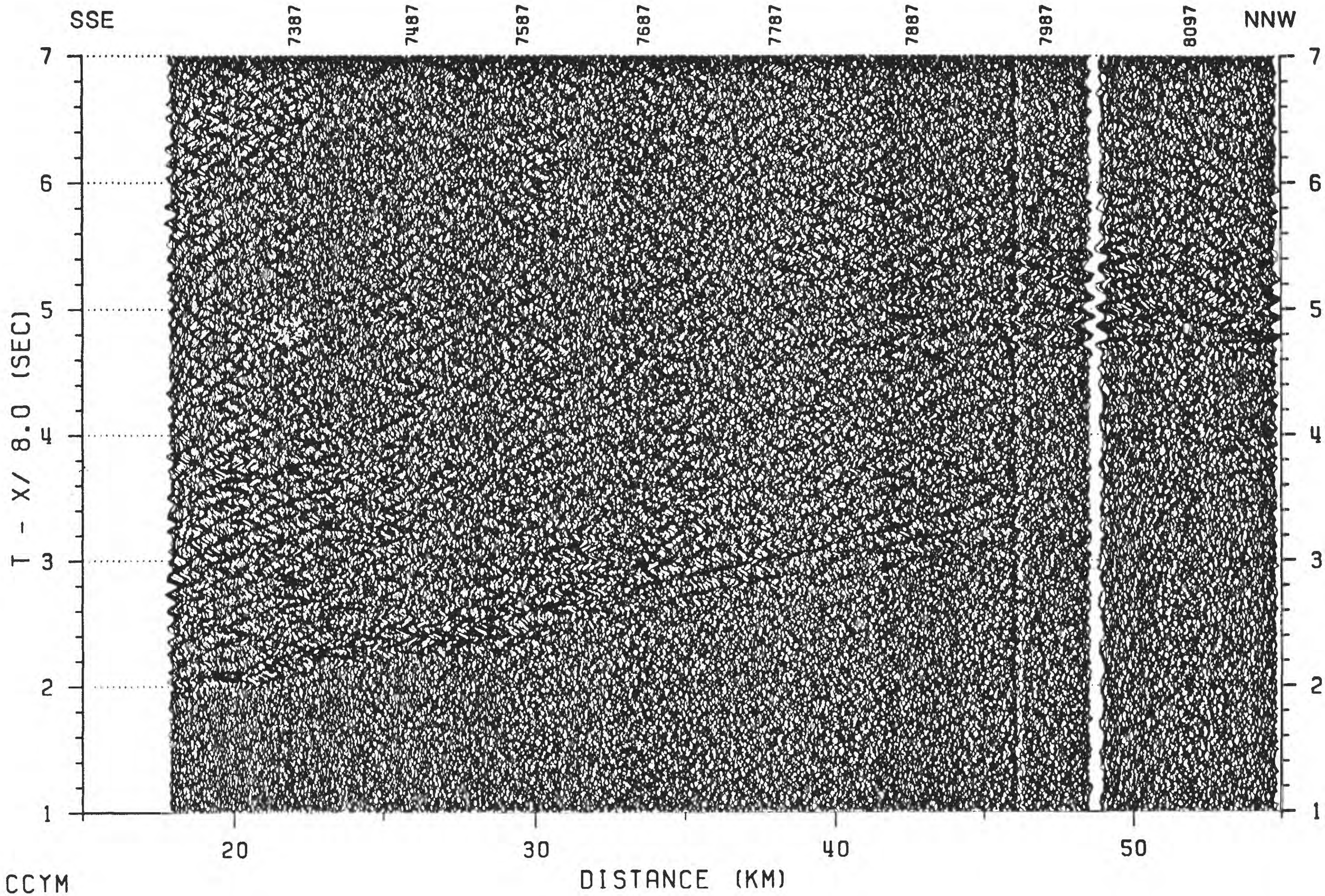

Figure 36. Receiver gather from station CCYM for BASIX line 112. Plot parameters are described in the text.

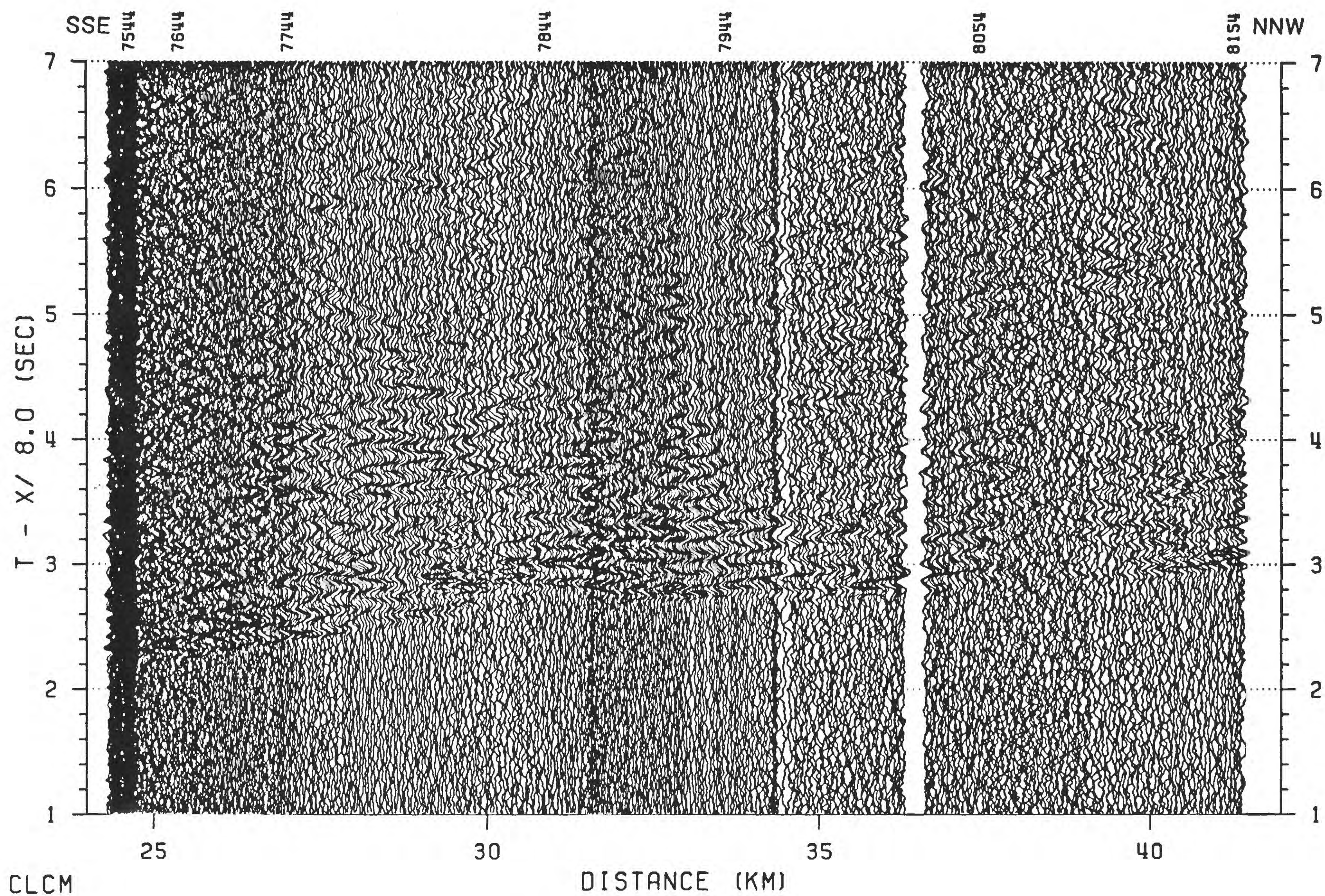

Figure 37. Receiver gather from station CLCM for BASIX line 112. Plot parameters are described in the text.

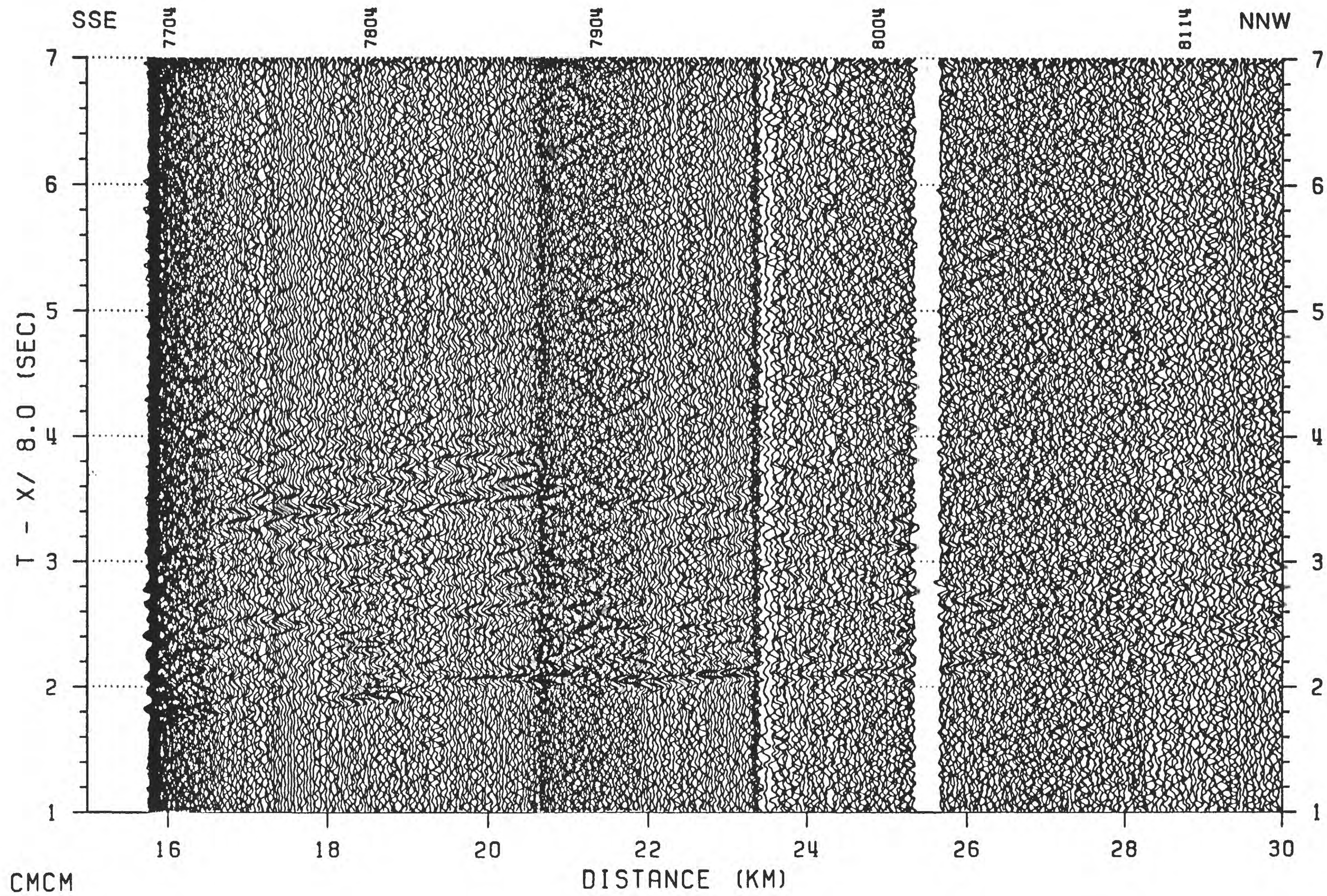

Figure 38. Receiver gather from station CMCM for BASIX line 112. Plot parameters are described in the text.

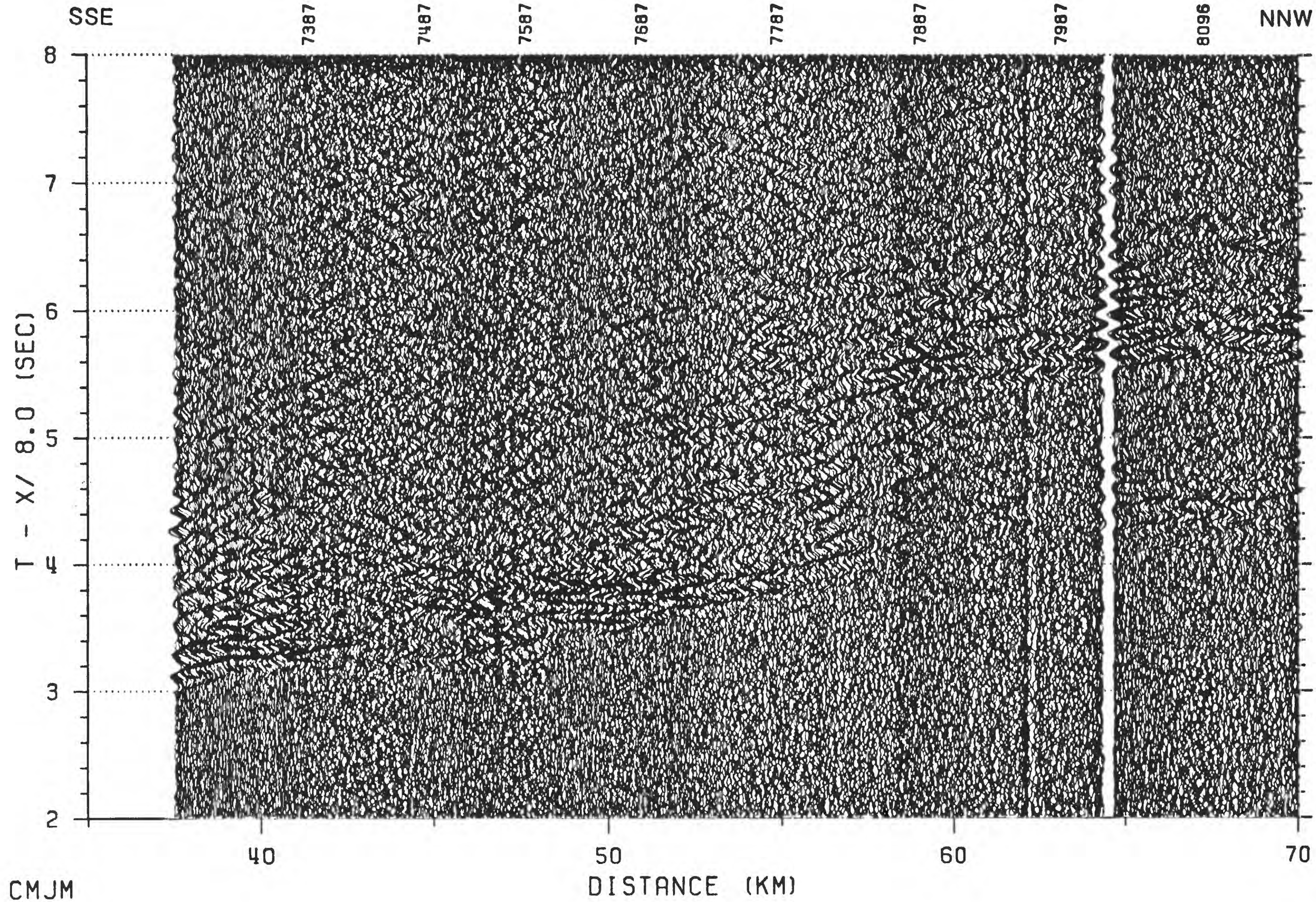

Figure 39. Receiver gather from station CMJM for BASIX line 112. Plot parameters are described in the text.

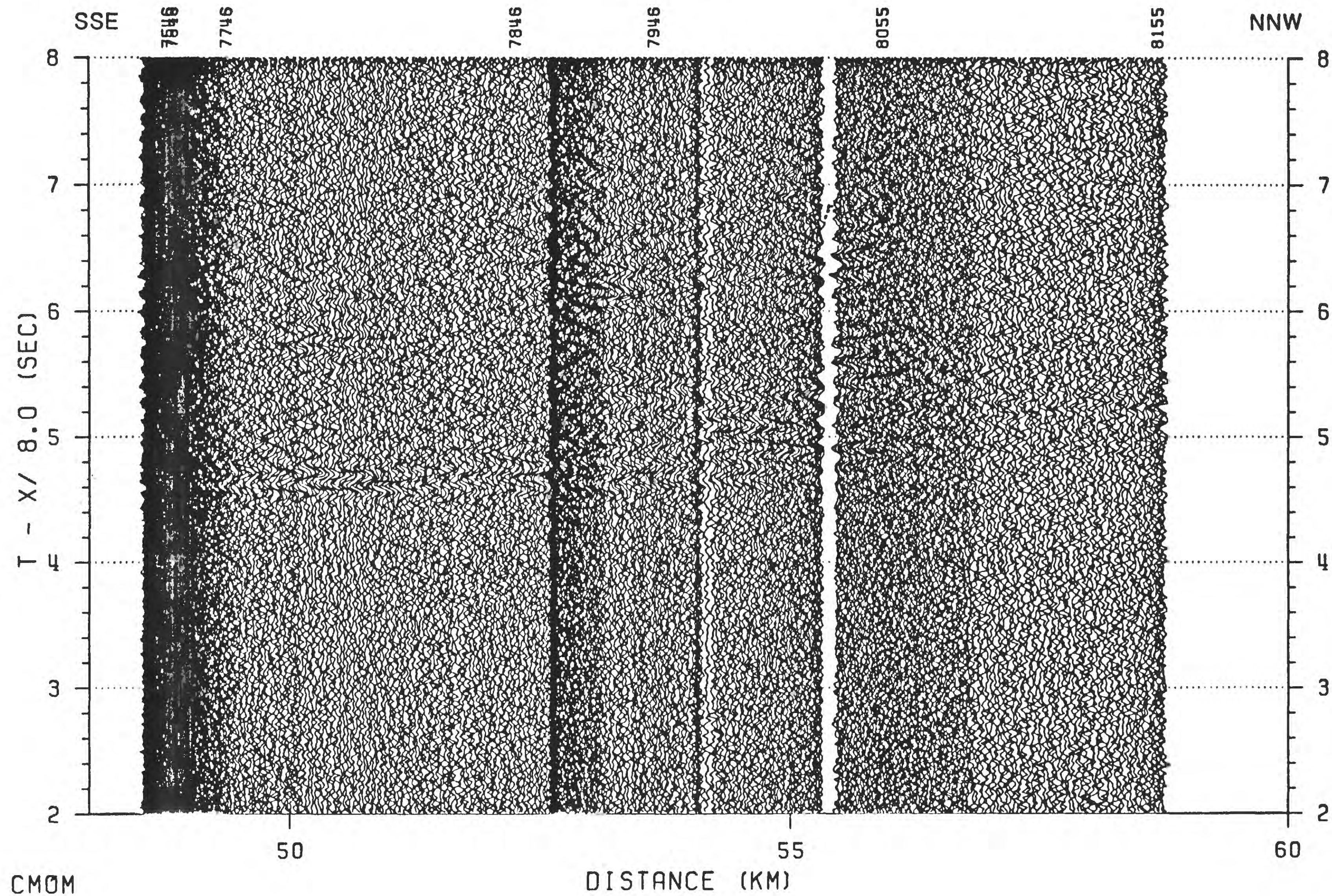

Figure 40. Receiver gather from station CMOM for BASIX line 112. Plot parameters are described in the text.

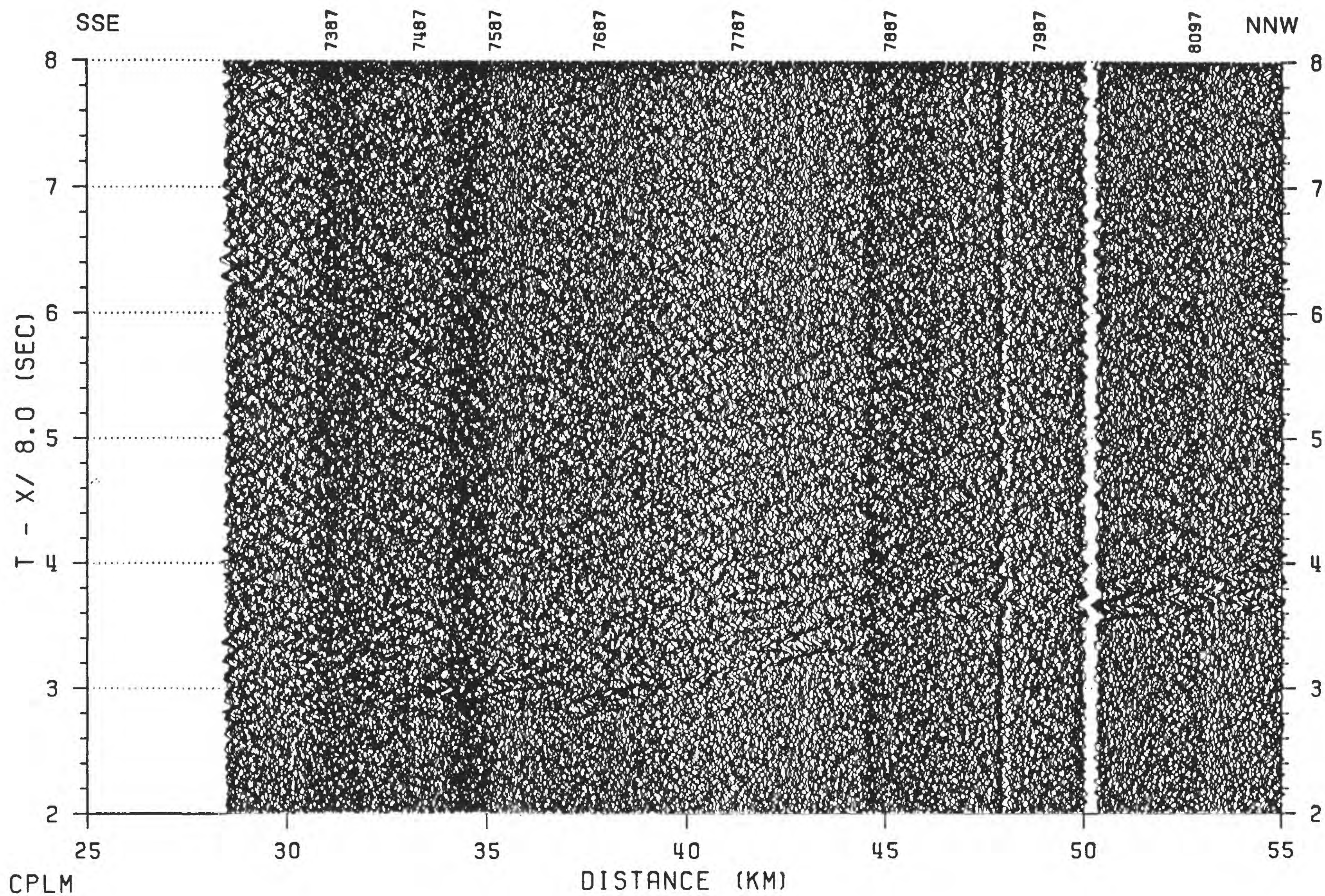

Figure 41. Receiver gather from station CPLM for BASIX line 112. Plot parameters are described in the text.

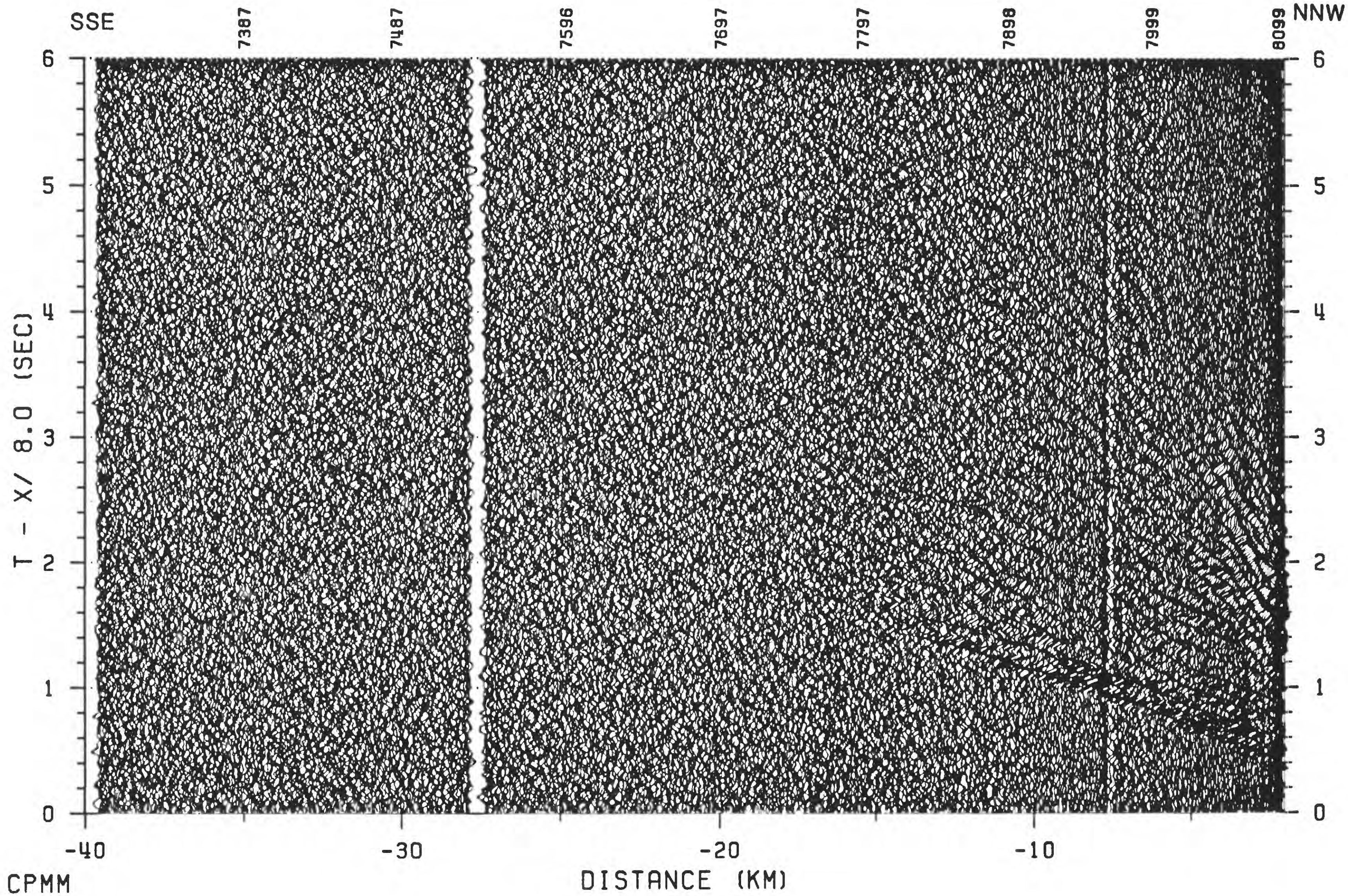

Figure 42. Receiver gather from station CPMM for BASIX line 112. Plot parameters are described in the text.

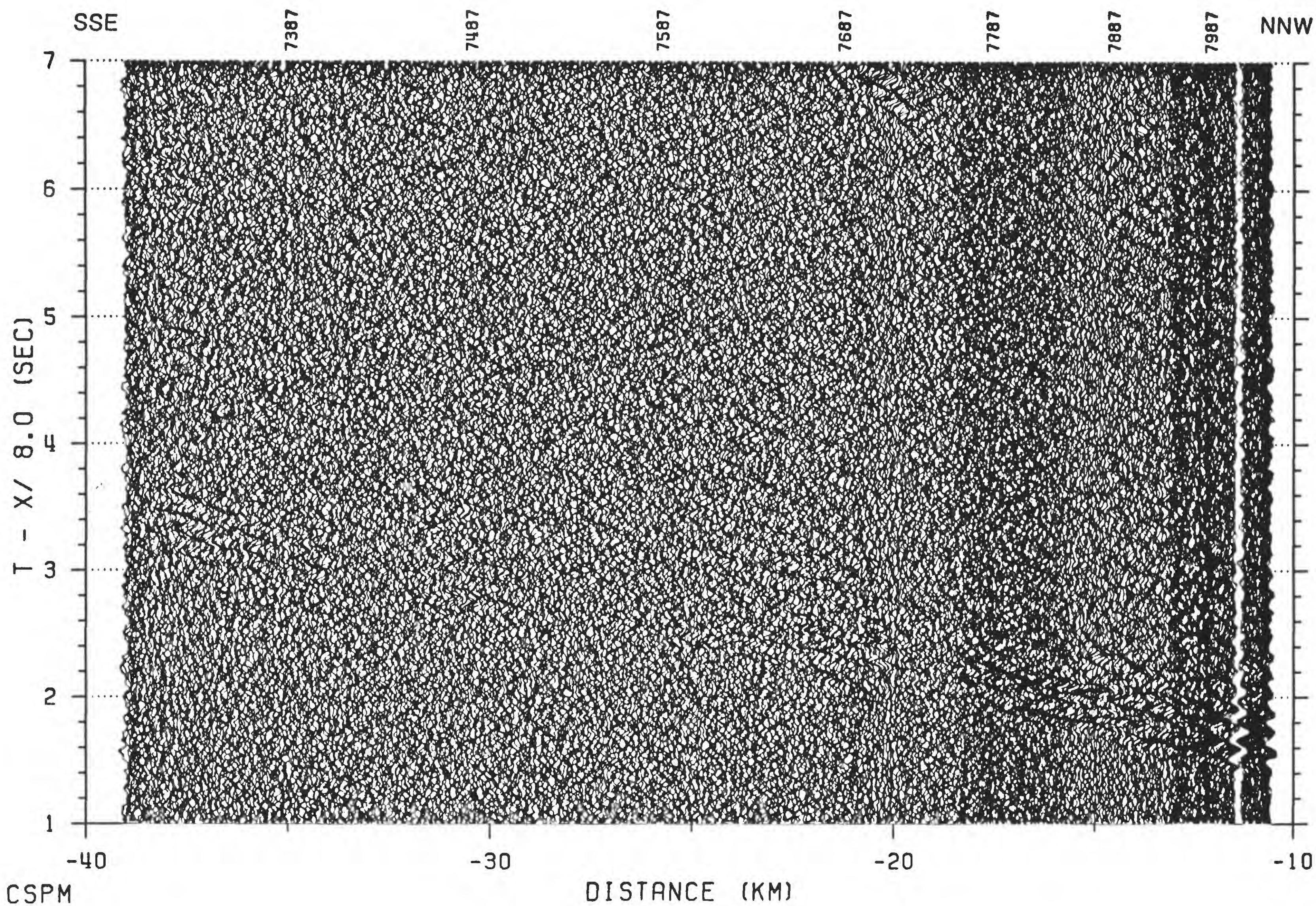

Figure 43. Receiver gather from station CSPM for BASIX line 112. Plot parameters are described in the text.

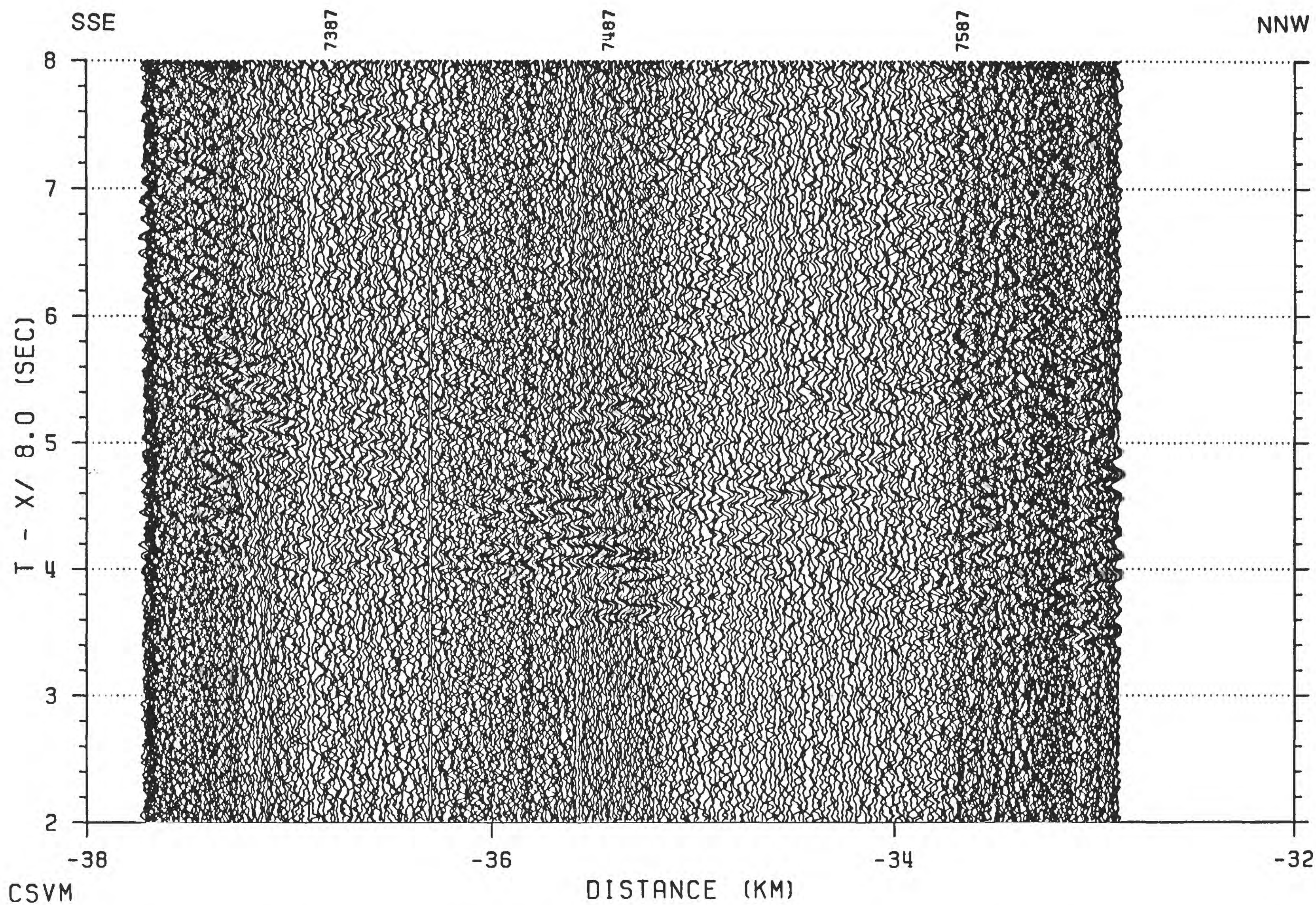

Figure 44. Receiver gather from station CSVM for BASIX line 112. Plot parameters are described in the text.

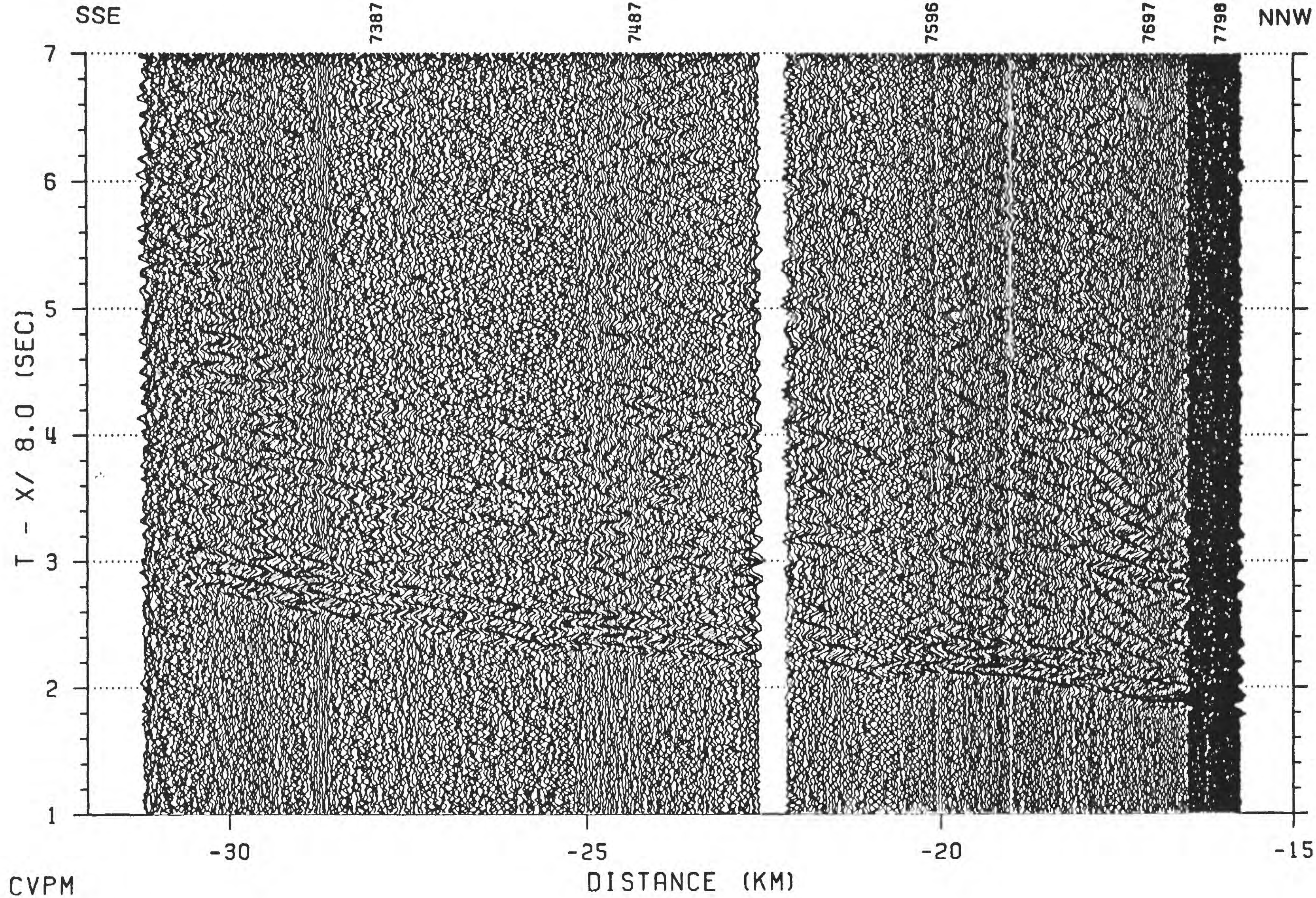

Figure 45. Receiver gather from station CVPM for BASIX line 112. Plot parameters are described in the text.

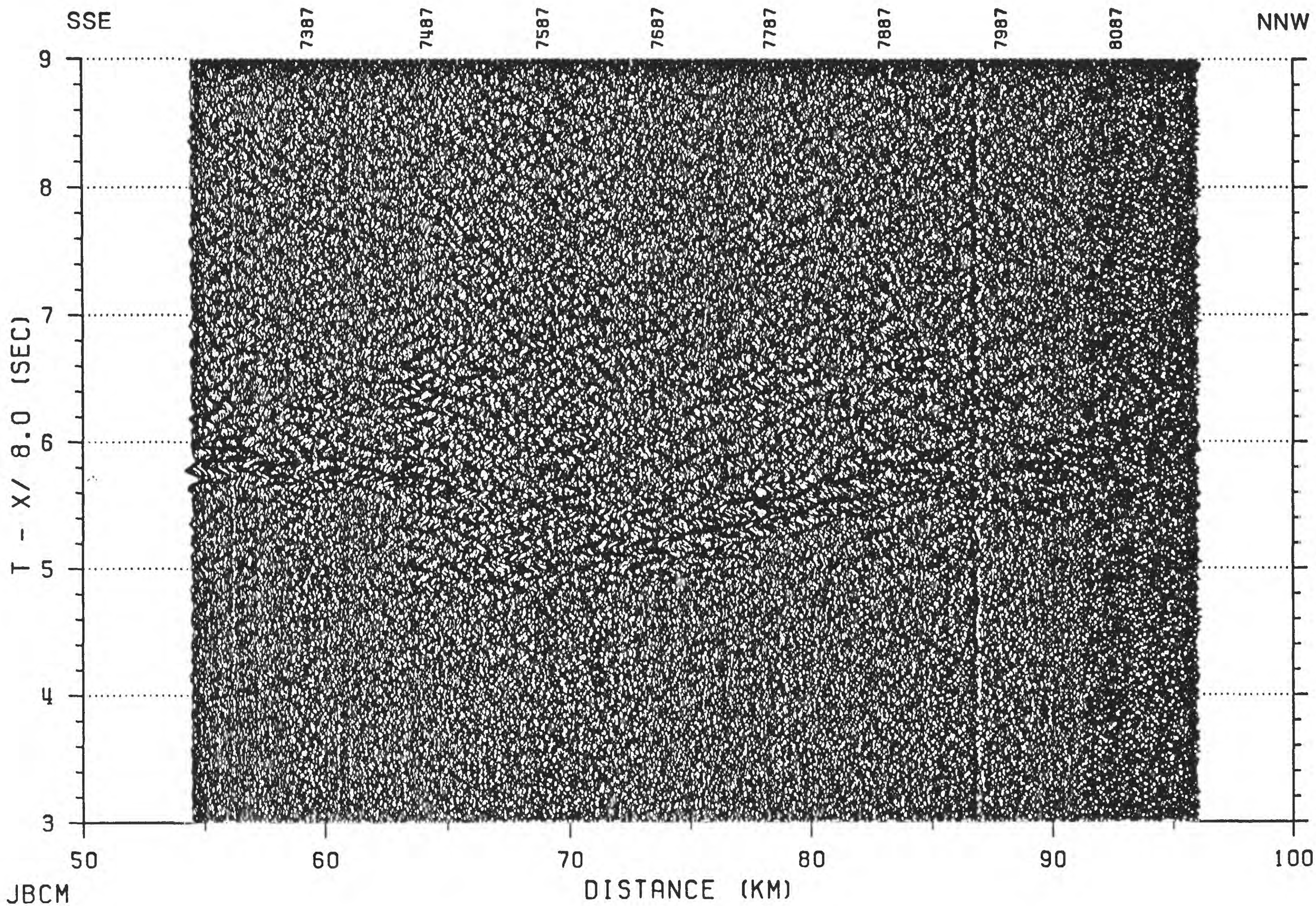

Figure 46. Receiver gather from station JBCM for BASIX line 112. Plot parameters are described in the text.

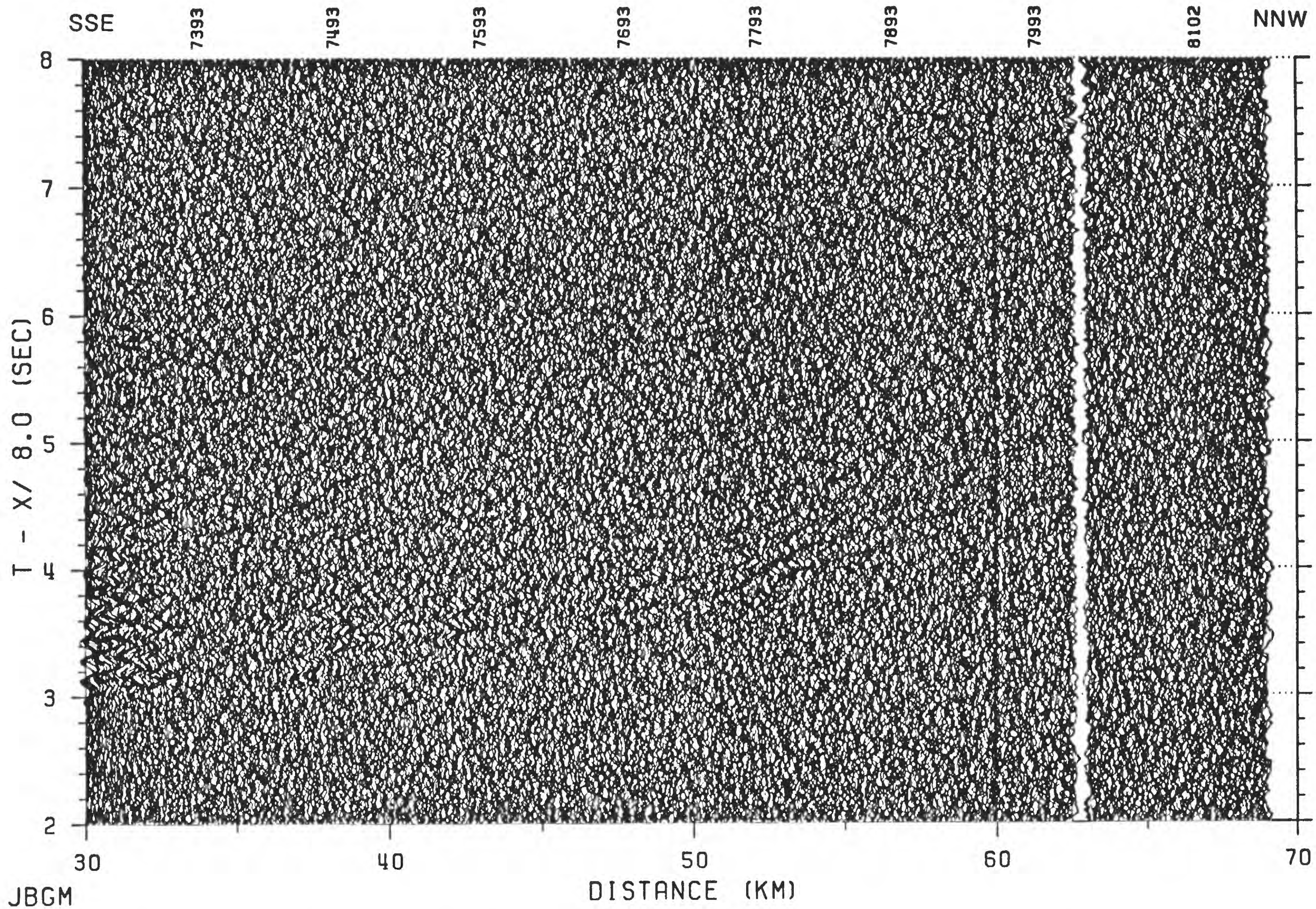

Figure 47. Receiver gather from station JBGM for BASIX line 112. Plot parameters are described in the text.

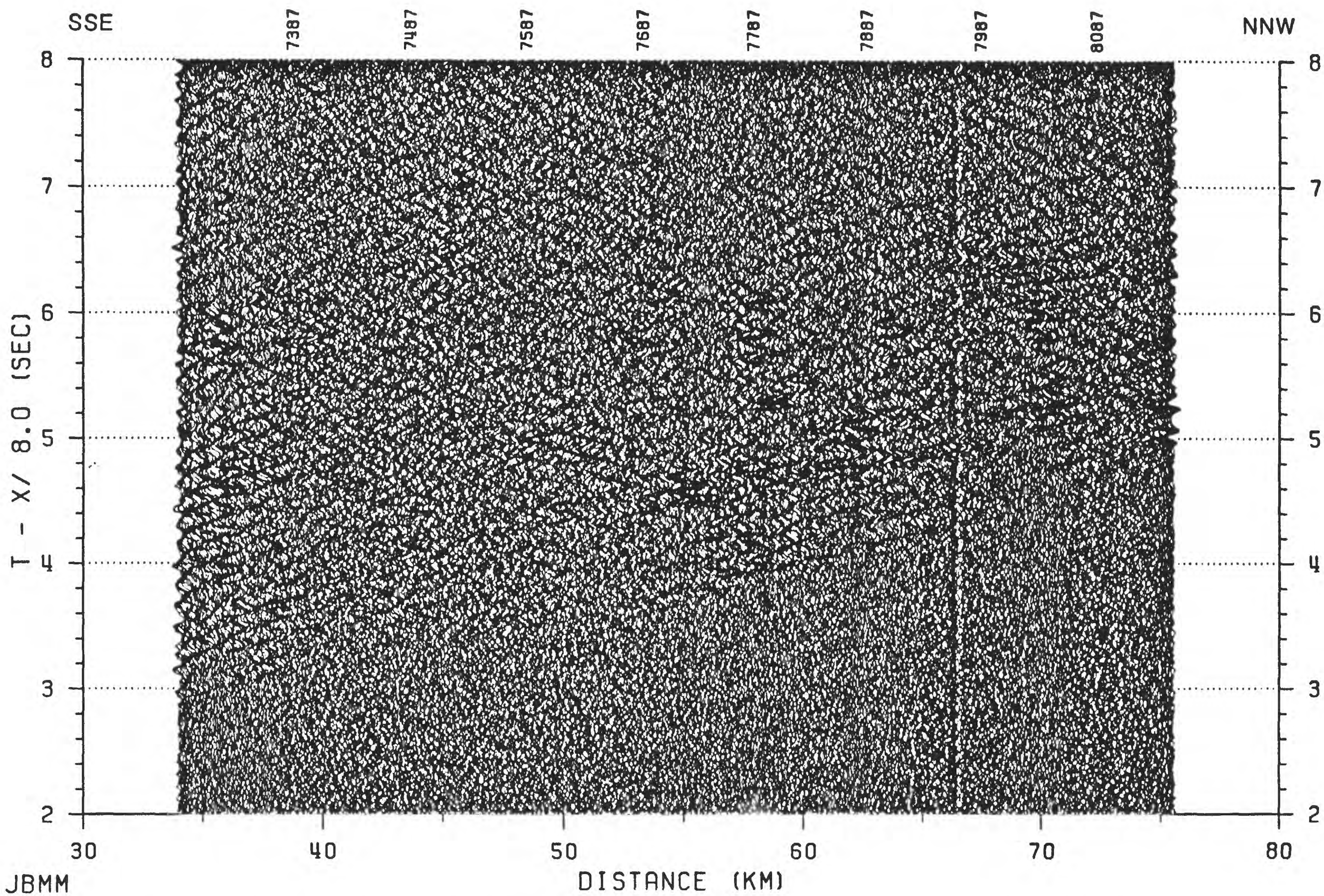

Figure 48. Receiver gather from station JBMM for BASIX line 112. Plot parameters are described in the text.

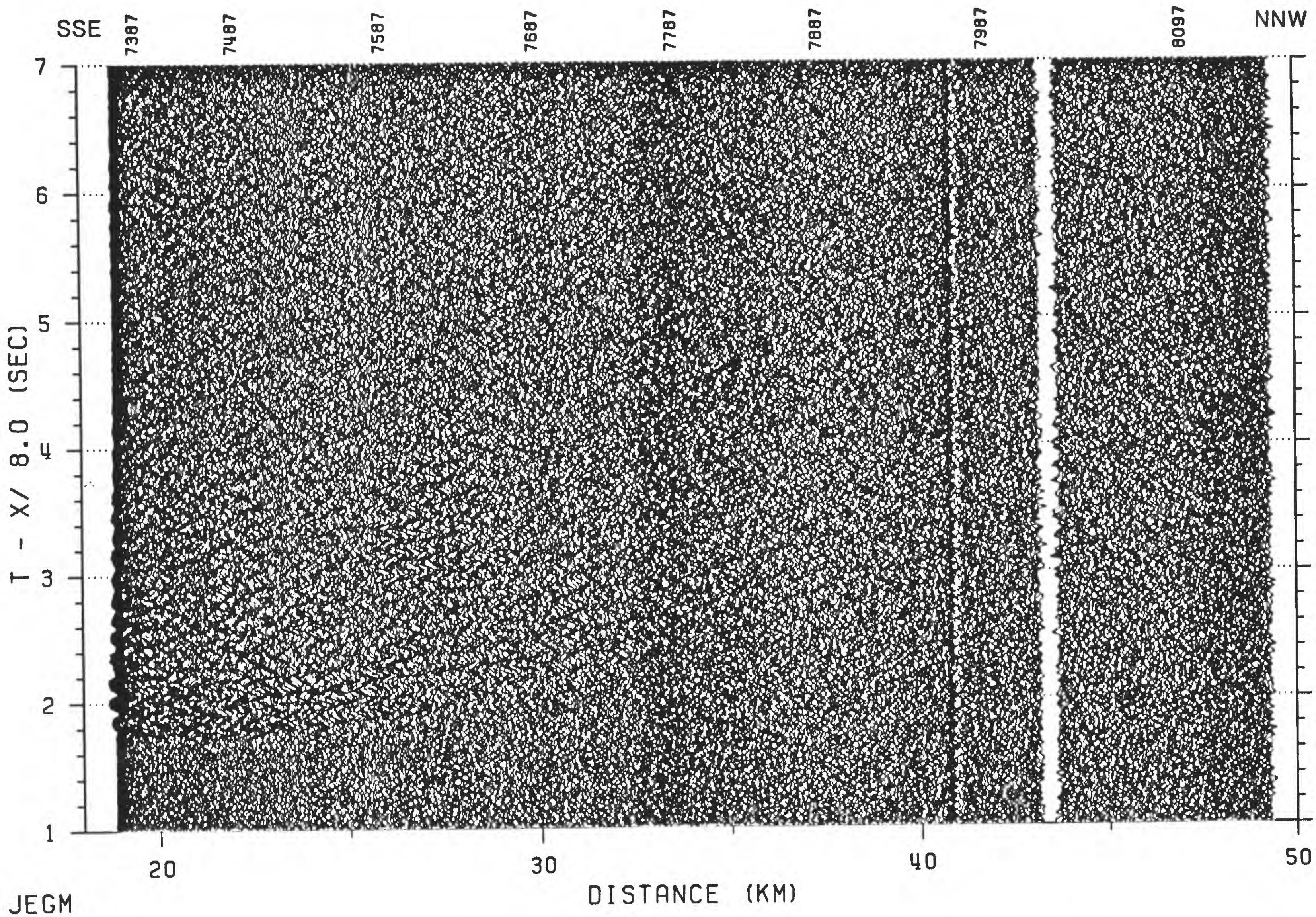

Figure 49. Receiver gather from station JEGM for BASIX line 112. Plot parameters are described in the text.

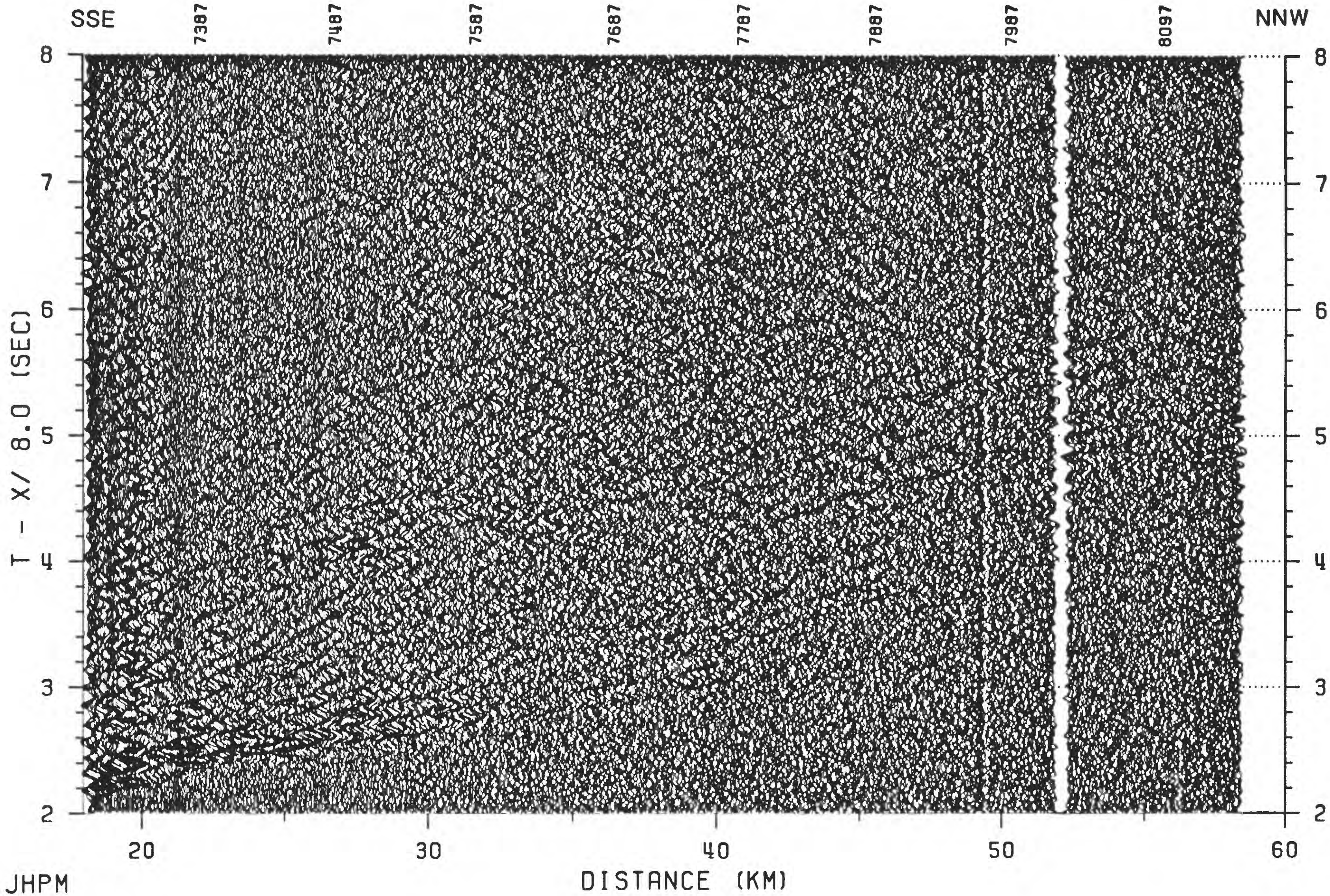

Figure 50. Receiver gather from station JHPM for BASIX line 112. Plot parameters are described in the text.

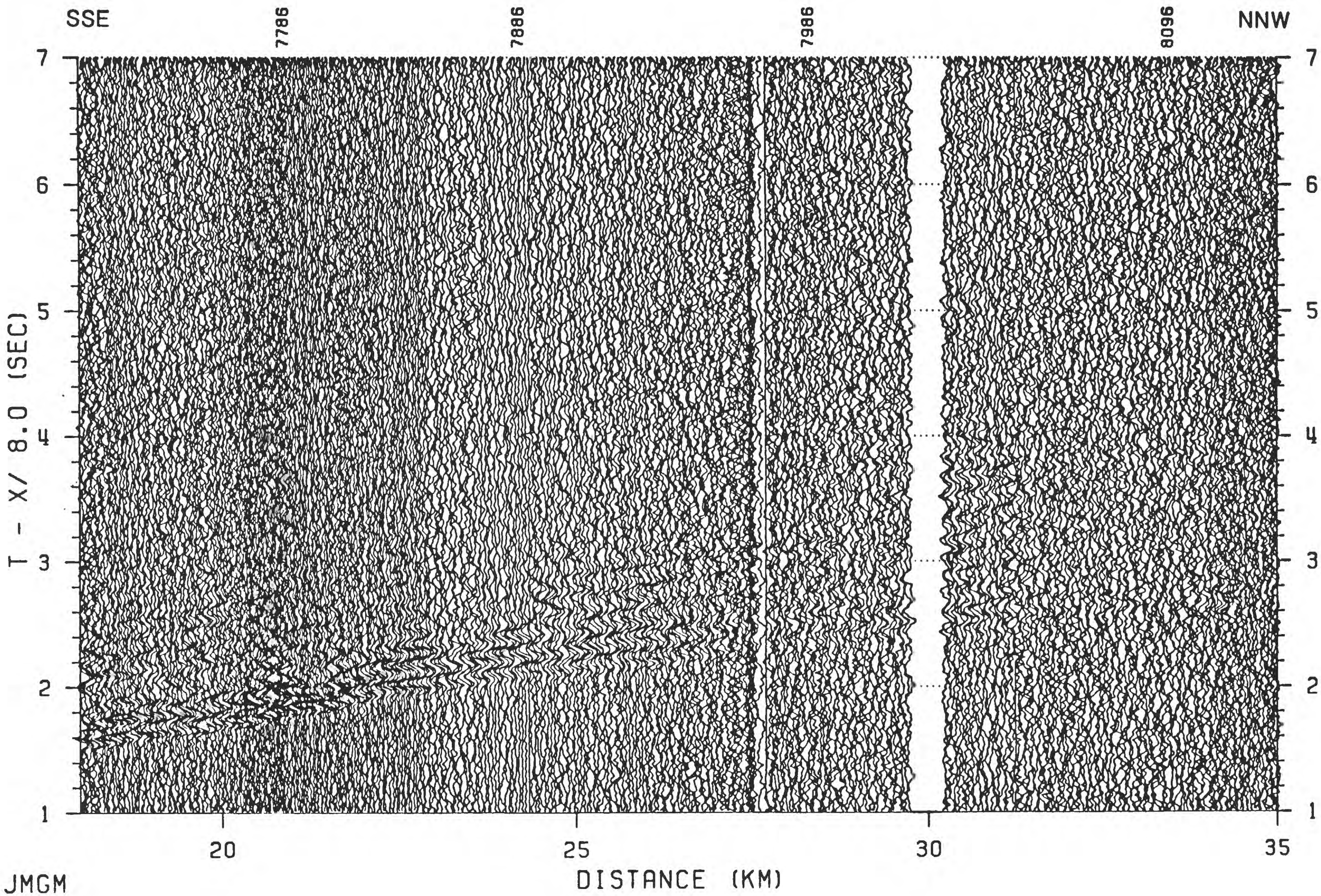

Figure 51. Receiver gather from station JMGM for BASIX line 112. Plot parameters are described in the text.

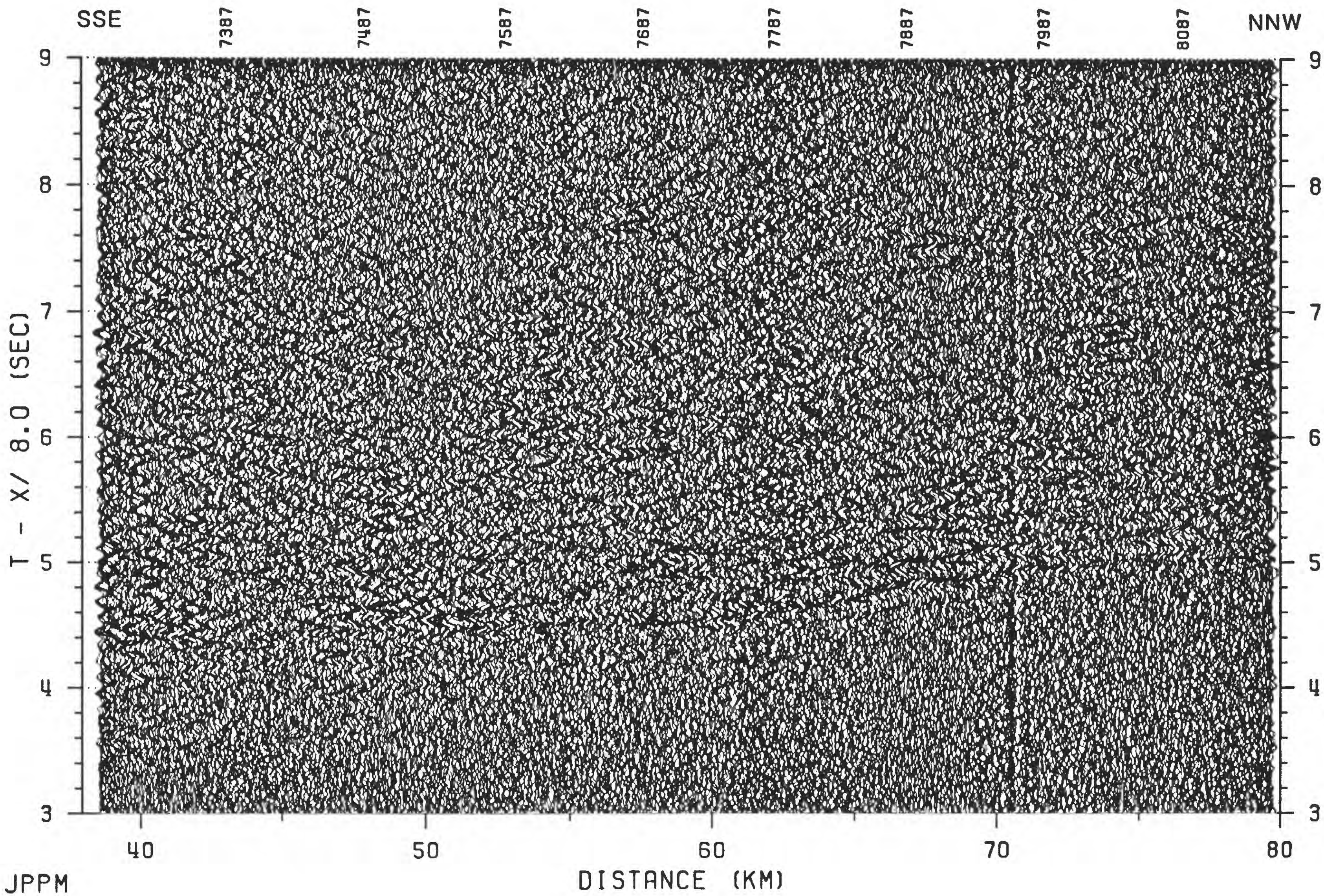

Figure 52. Receiver gather from station JPPM for BASIX line 112. Plot parameters are described in the text.

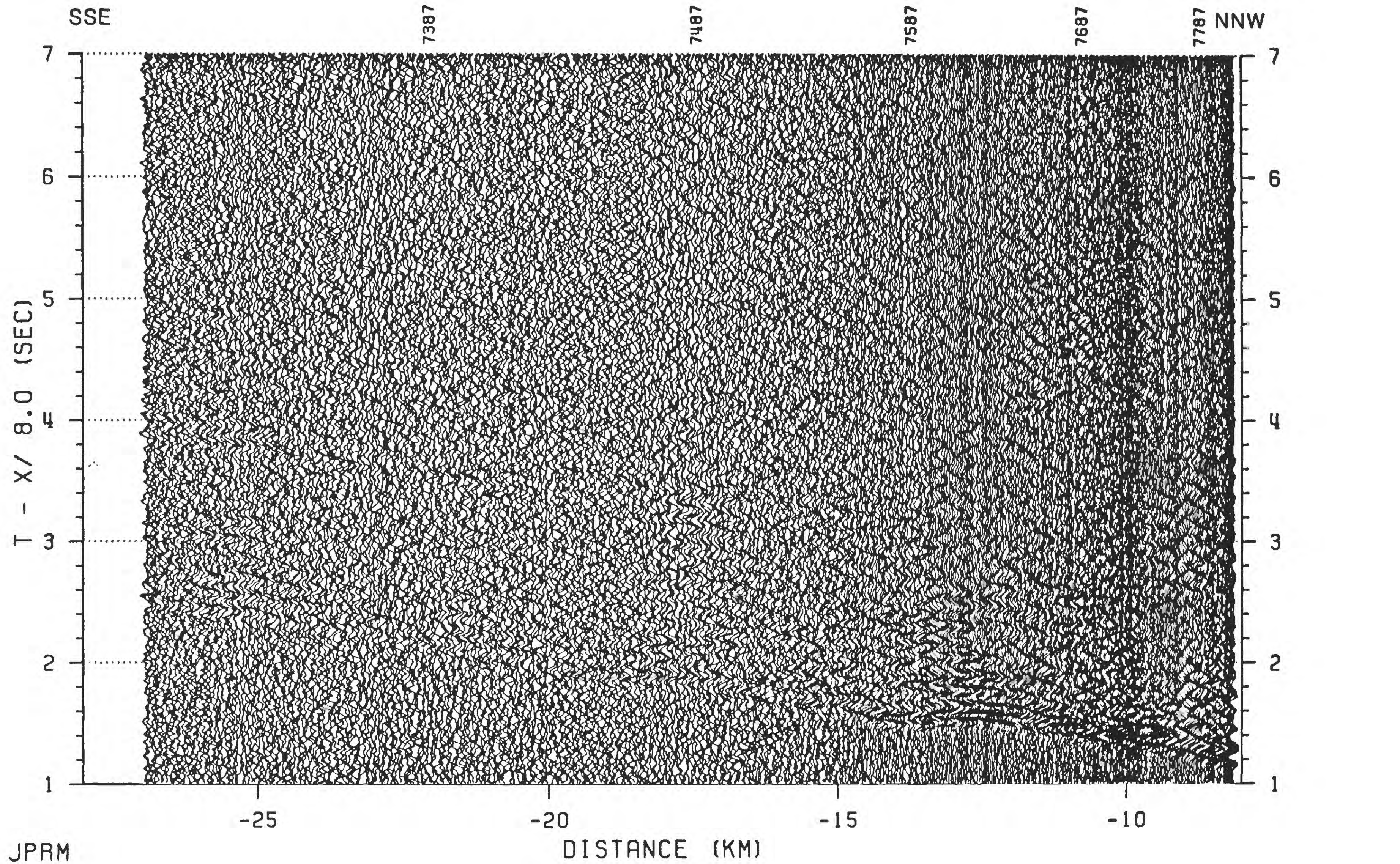

Figure 53. Receiver gather from station JPRM for BASIX line 112. Plot parameters are described in the text.

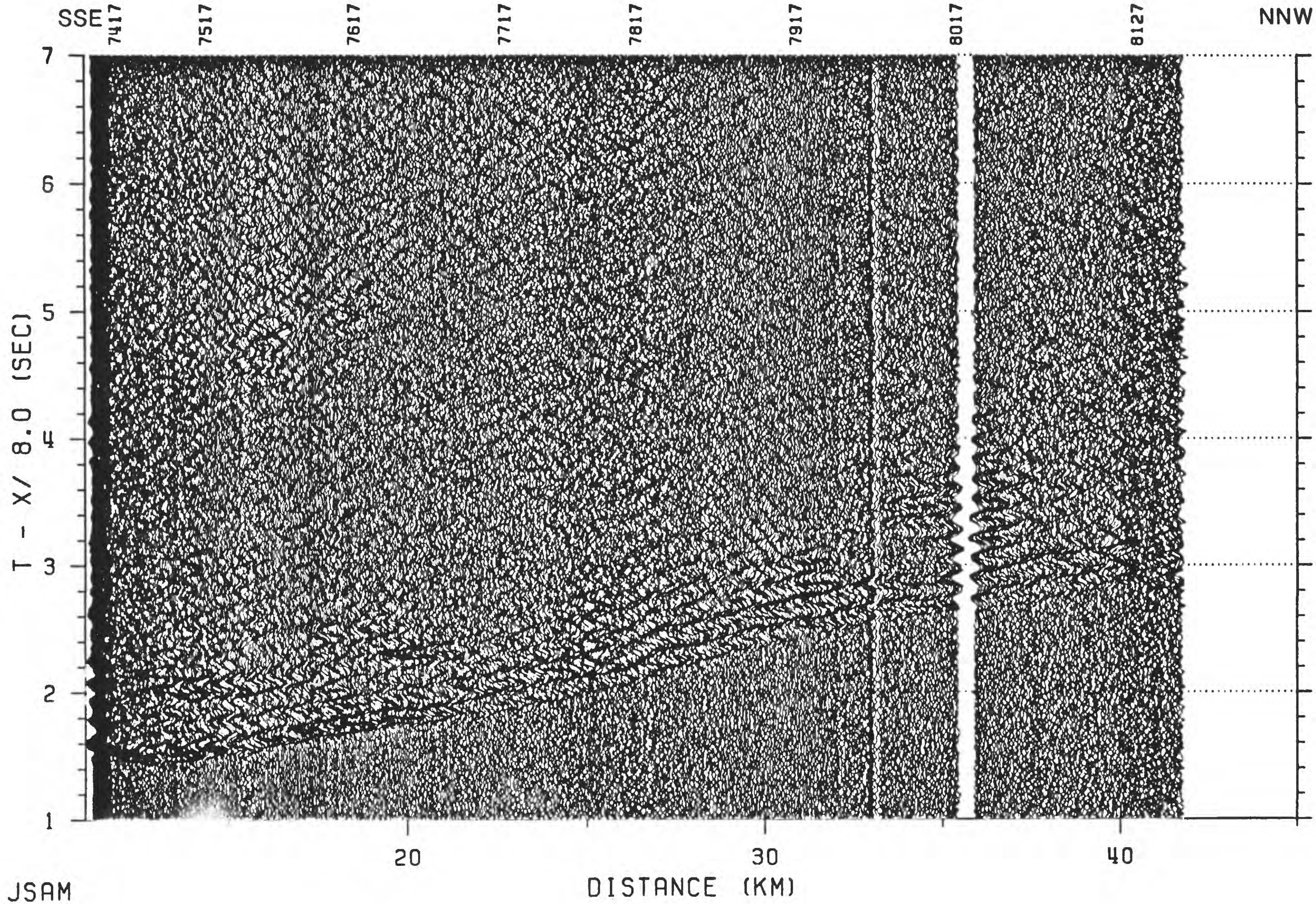

Figure 54. Receiver gather from station JSAM for BASIX line 112. Plot parameters are described in the text.

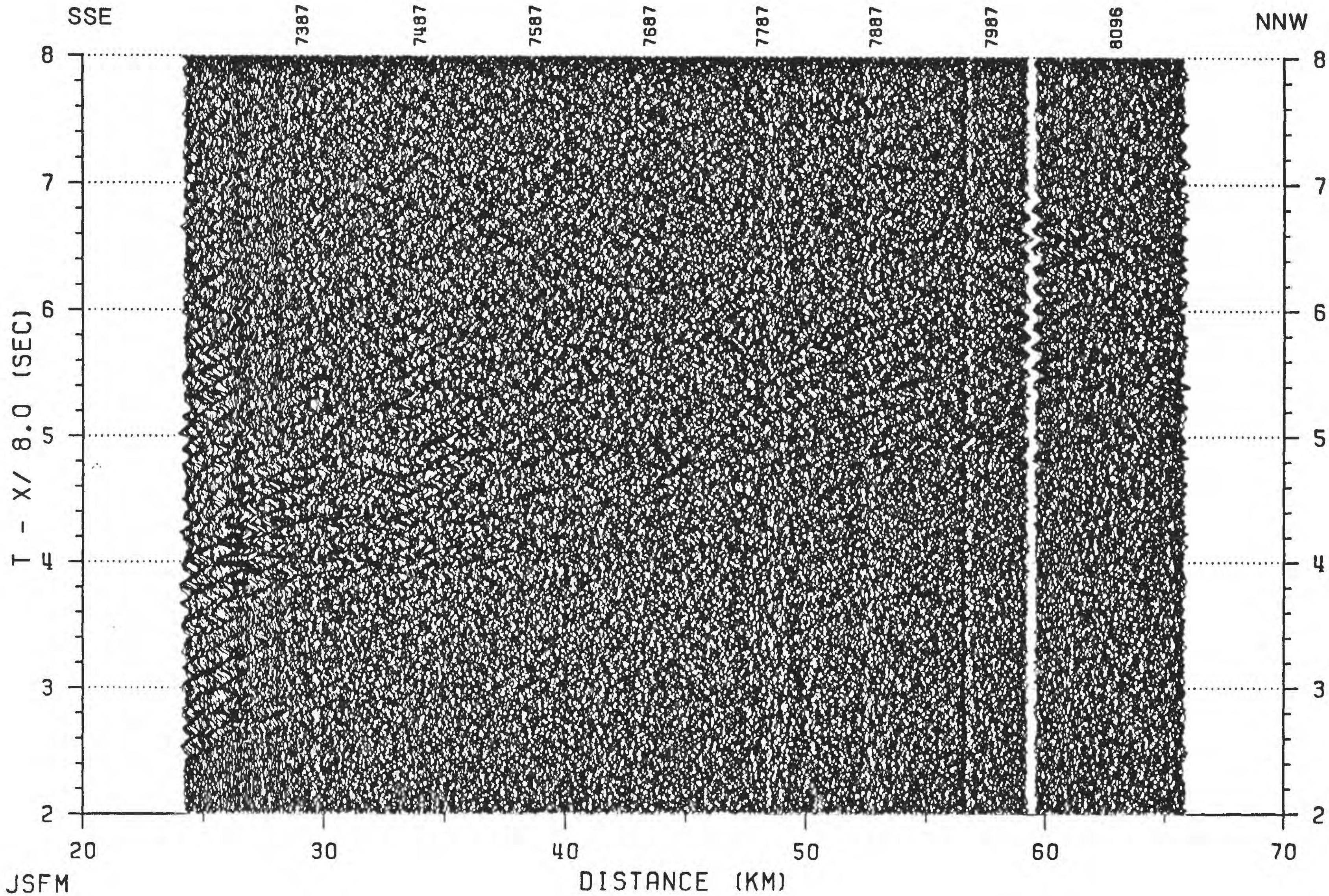

Figure 55. Receiver gather from station JSFM for BASIX line 112. Plot parameters are described in the text.

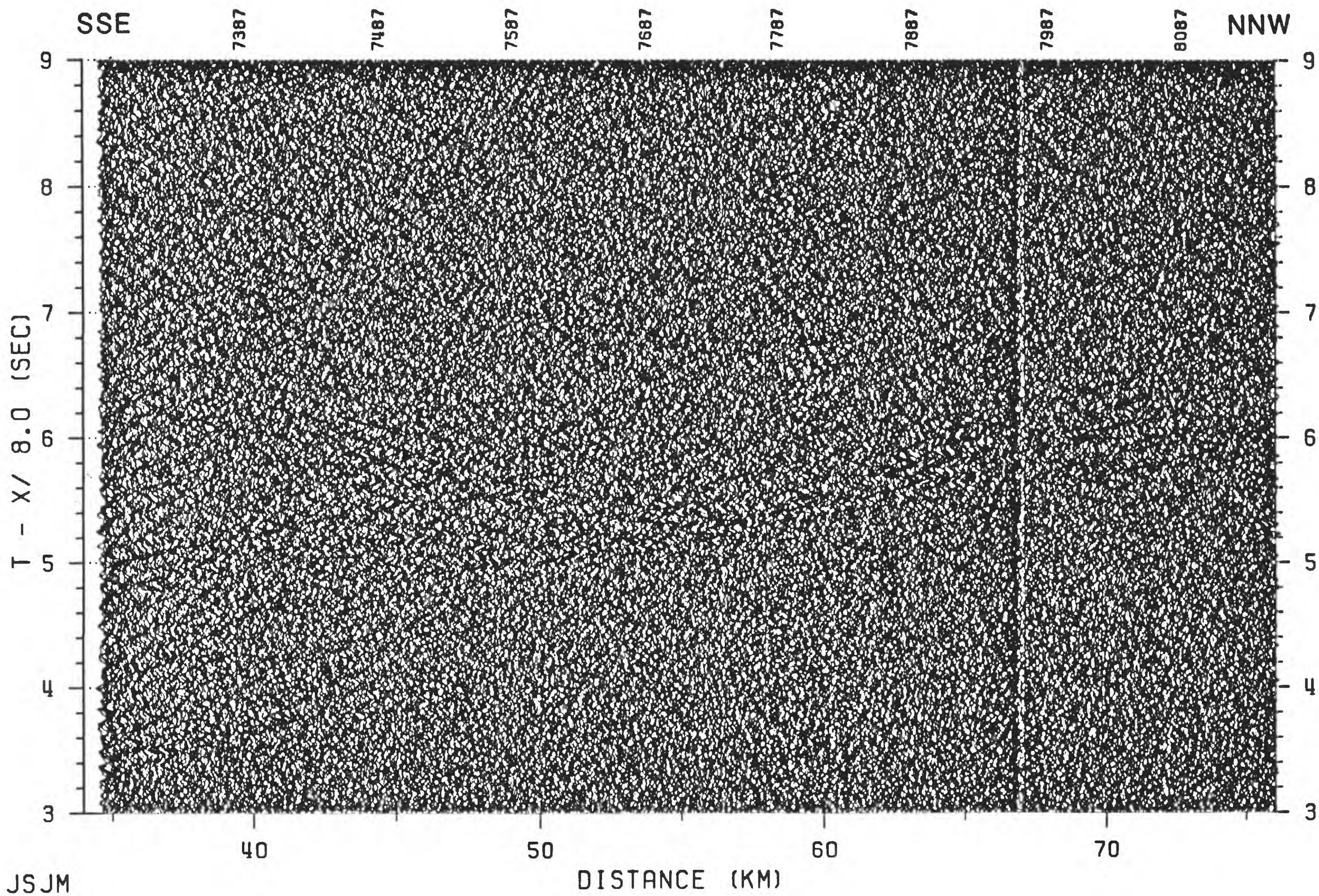

Figure 56. Receiver gather from station JSJM for BASIX line 112. Plot parameters are described in the text.

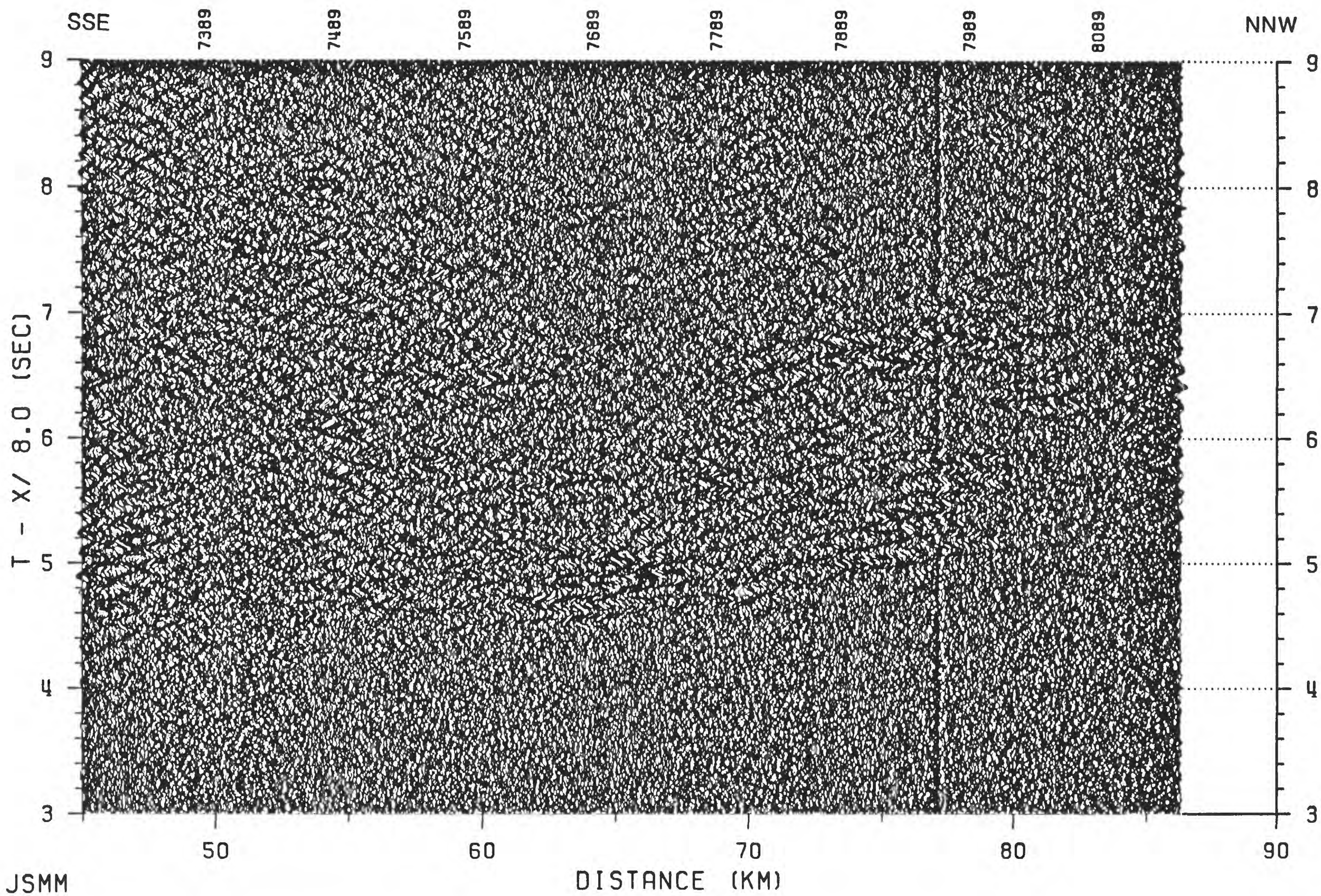

Figure 57. Receiver gather from station JSMM for BASIX line 112. Plot parameters are described in the text.

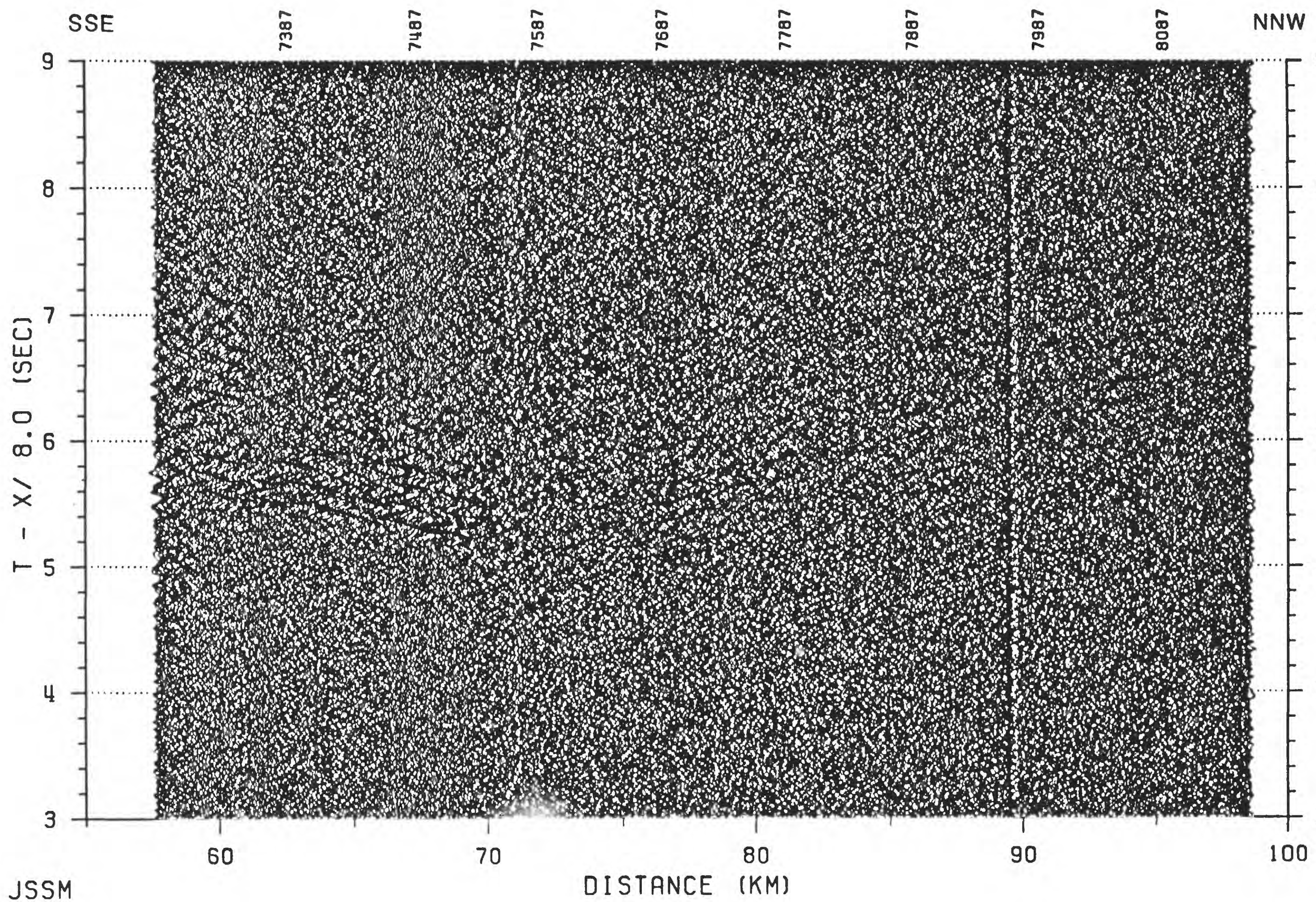

Figure 58. Receiver gather from station JSSM for BASIX line 112. Plot parameters are described in the text.

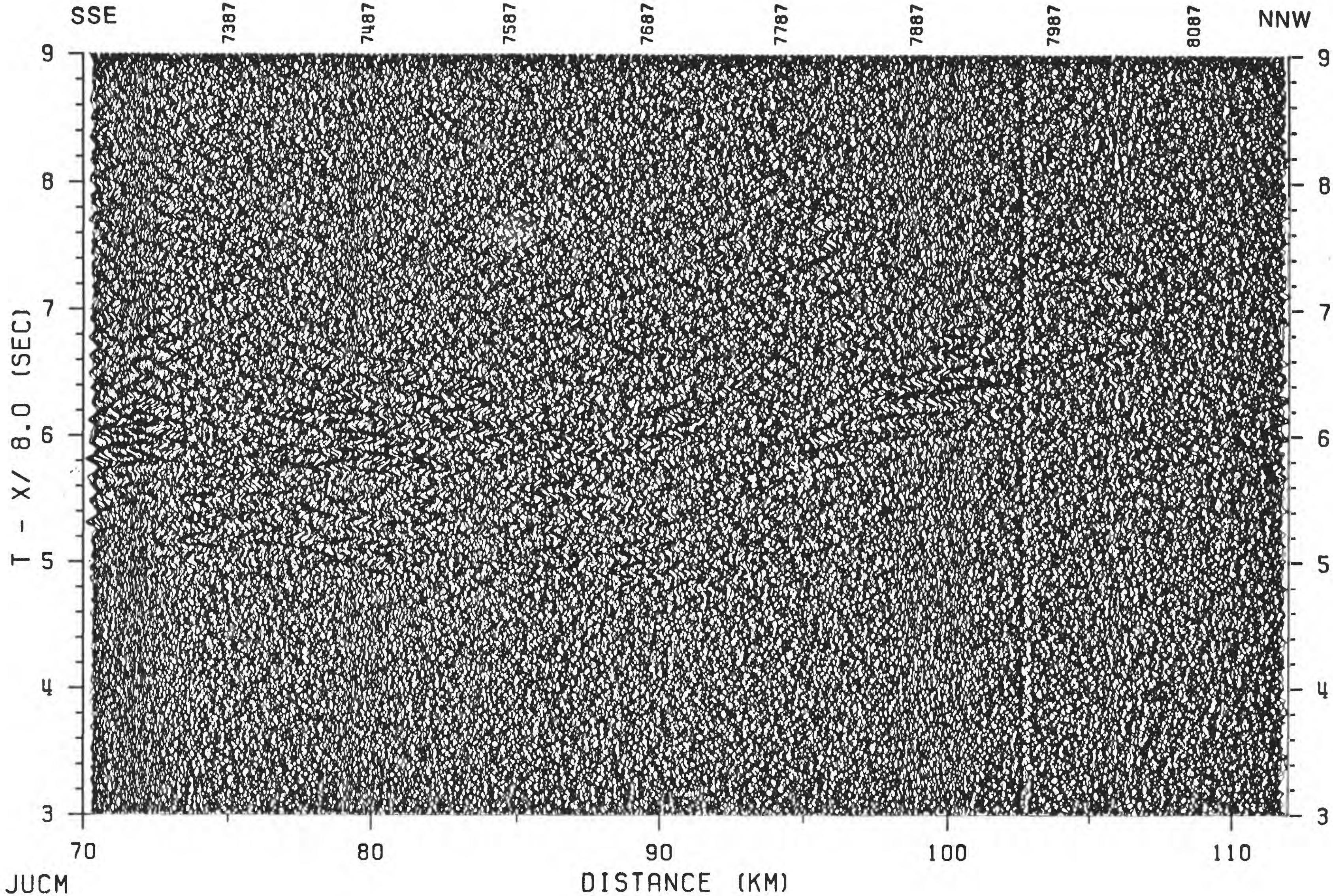

Figure 59. Receiver gather from station JUCM for BASIX line 112. Plot parameters are described in the text.

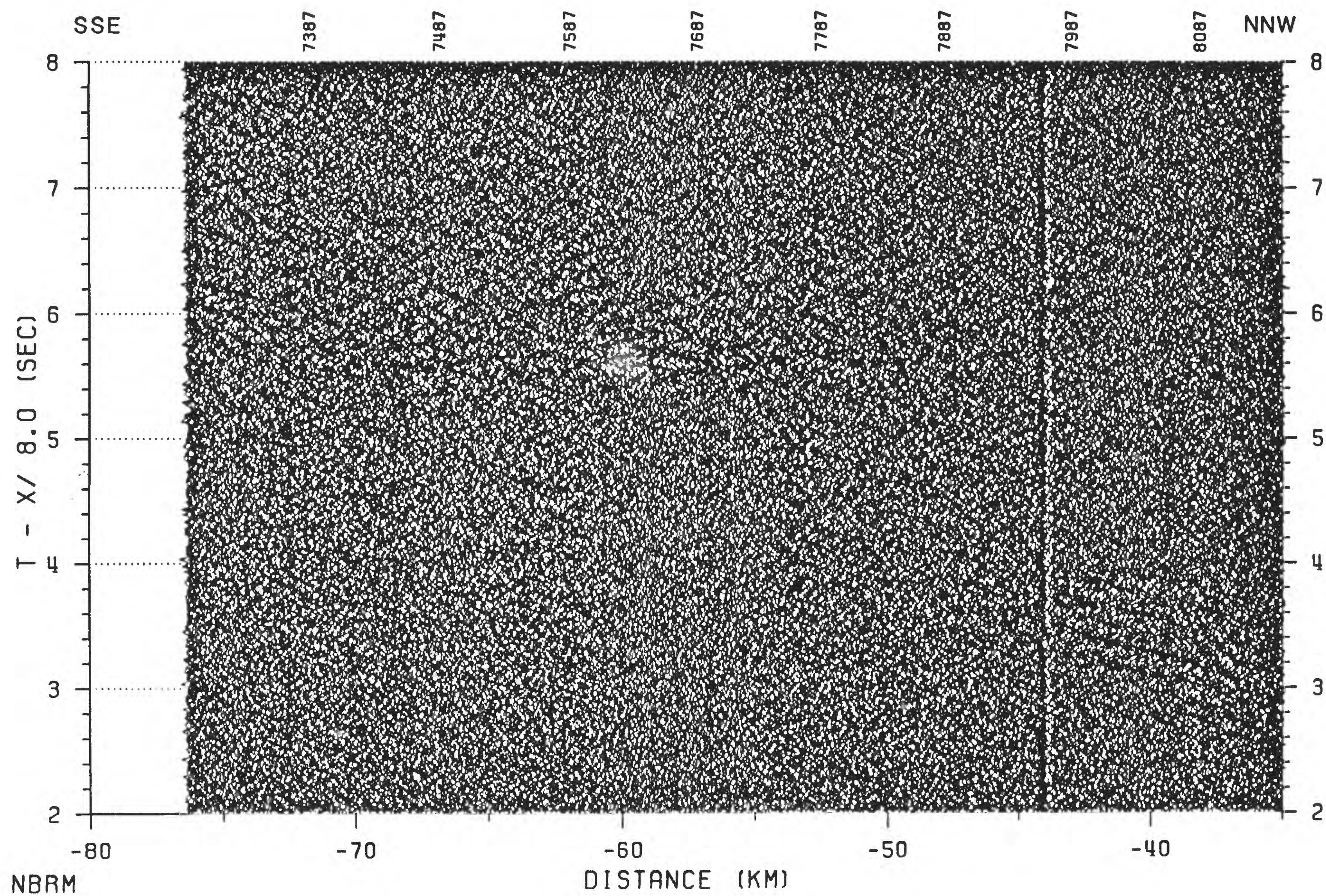

Figure 60. Receiver gather from station NBRM for BASIX line 112. Plot parameters are described in the text.

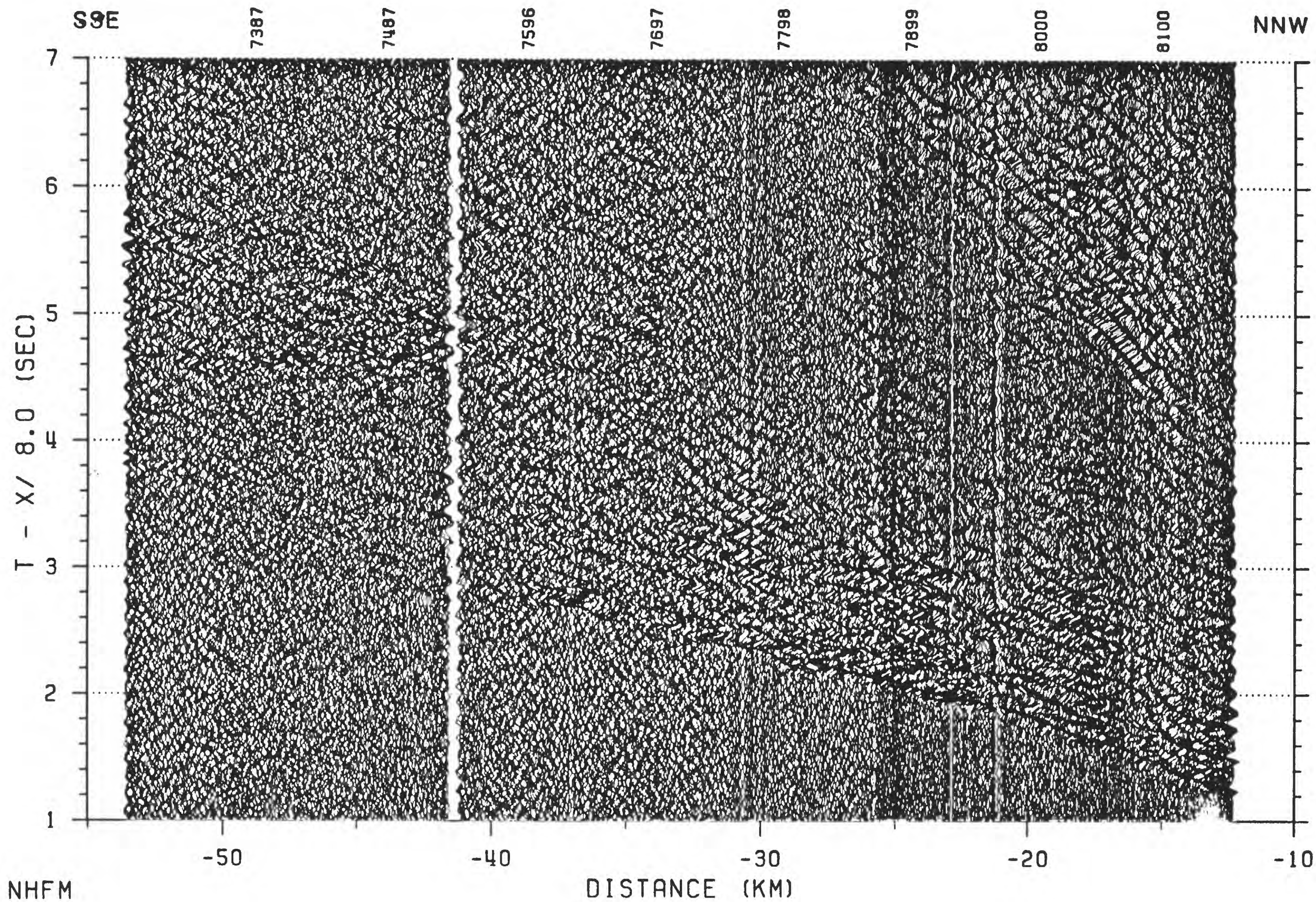

Figure 61. Receiver gather from station NHFM for BASIX line 112. Plot parameters are described in the text.

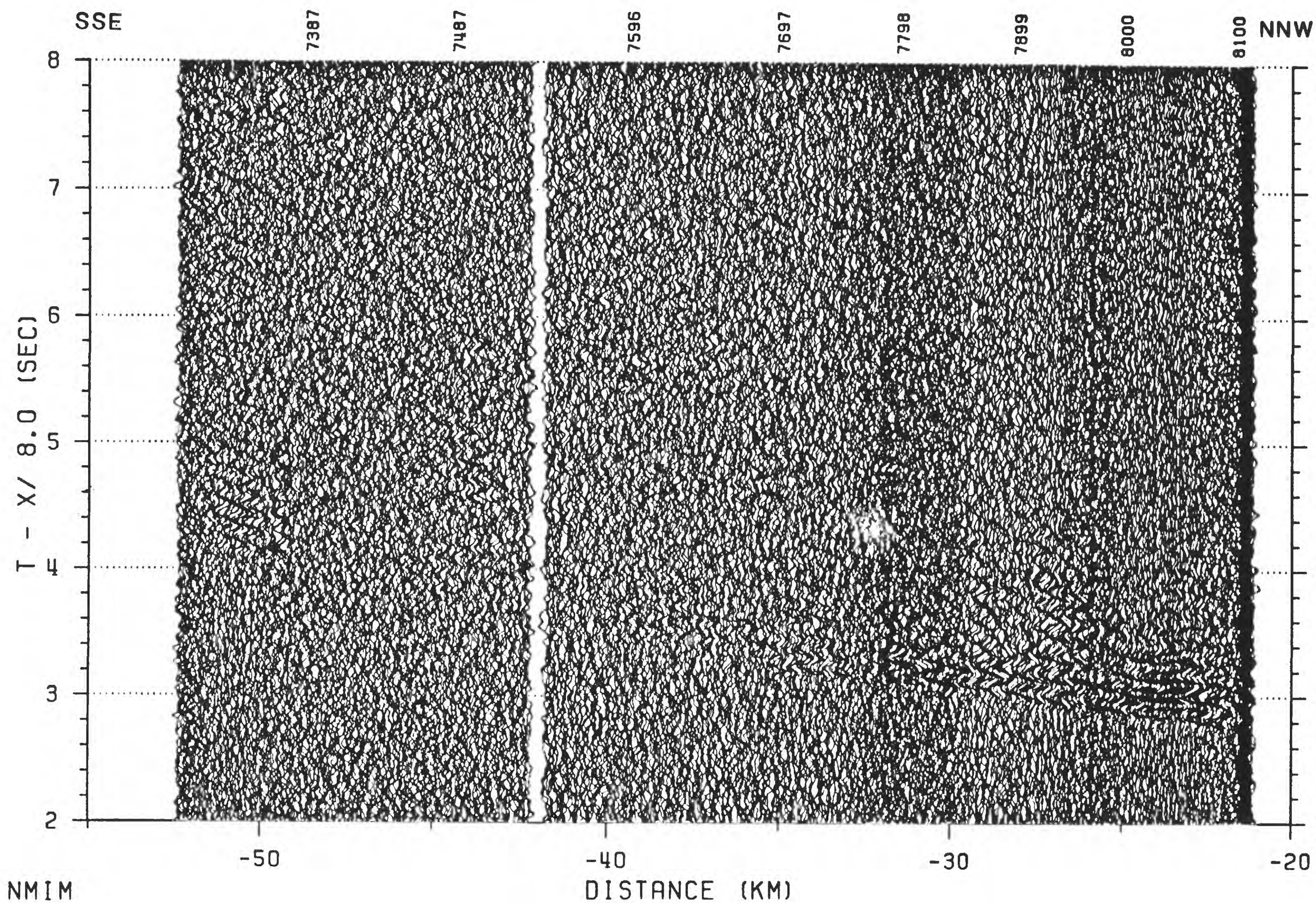

Figure 62. Receiver gather from station NMIM for BASIX line 112. Plot parameters are described in the text.

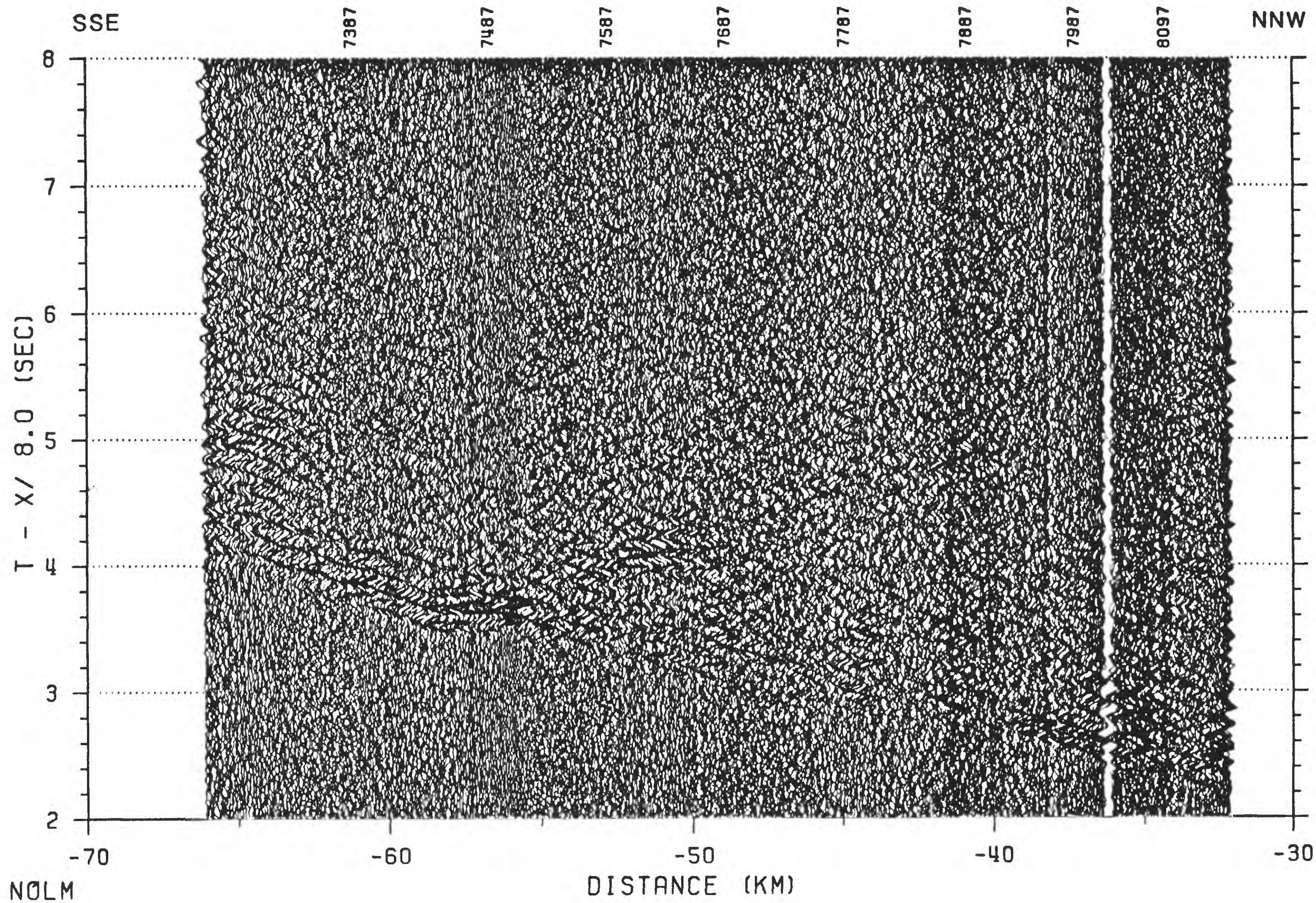

Figure 63. Receiver gather from station NOLM for BASIX line 112. Plot parameters are described in the text.

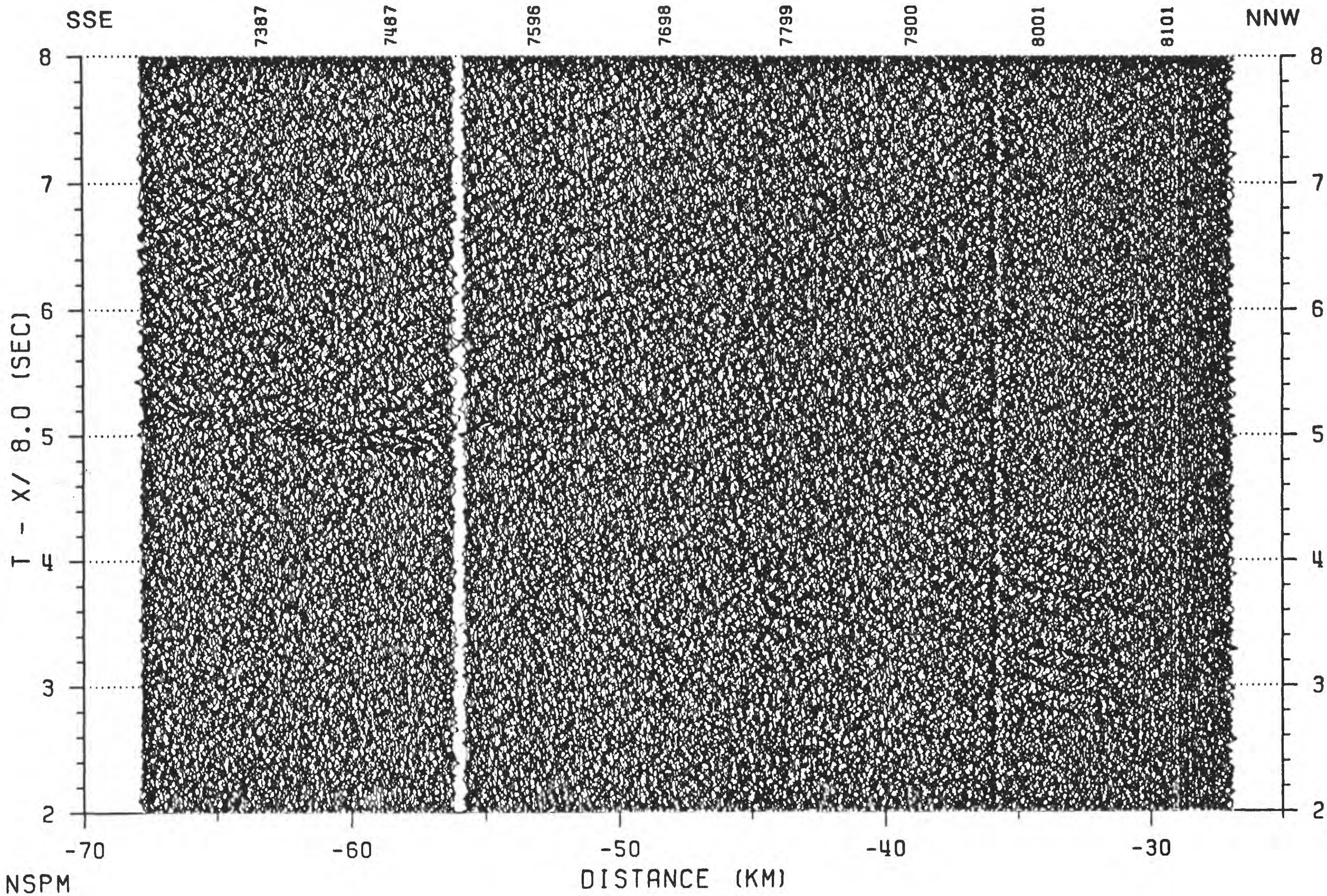

Figure 64. Receiver gather from station NSPM for BASIX line 112. Plot parameters are described in the text.

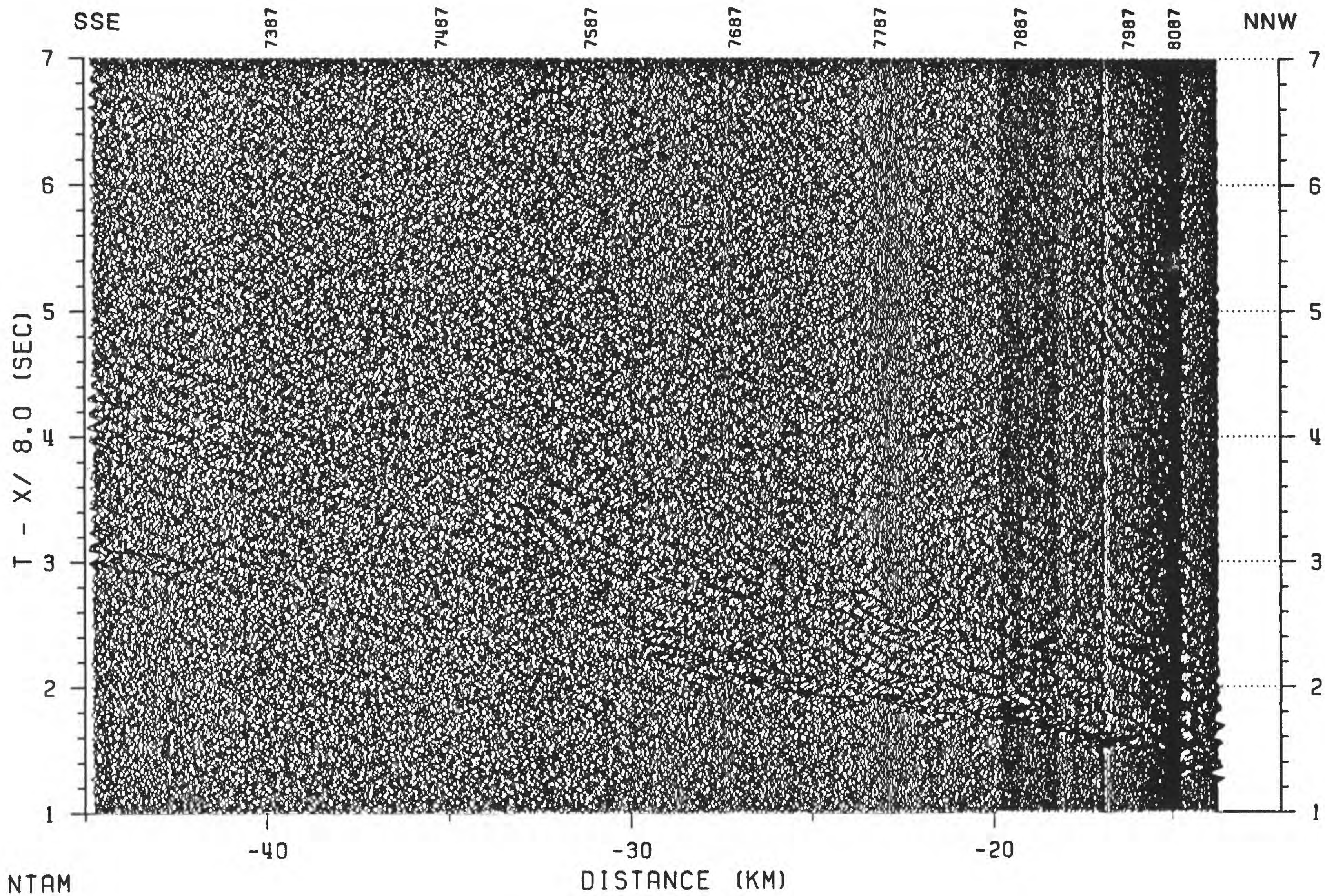

Figure 65. Receiver gather from station NTAM for BASIX line 112. Plot parameters are described in the text.

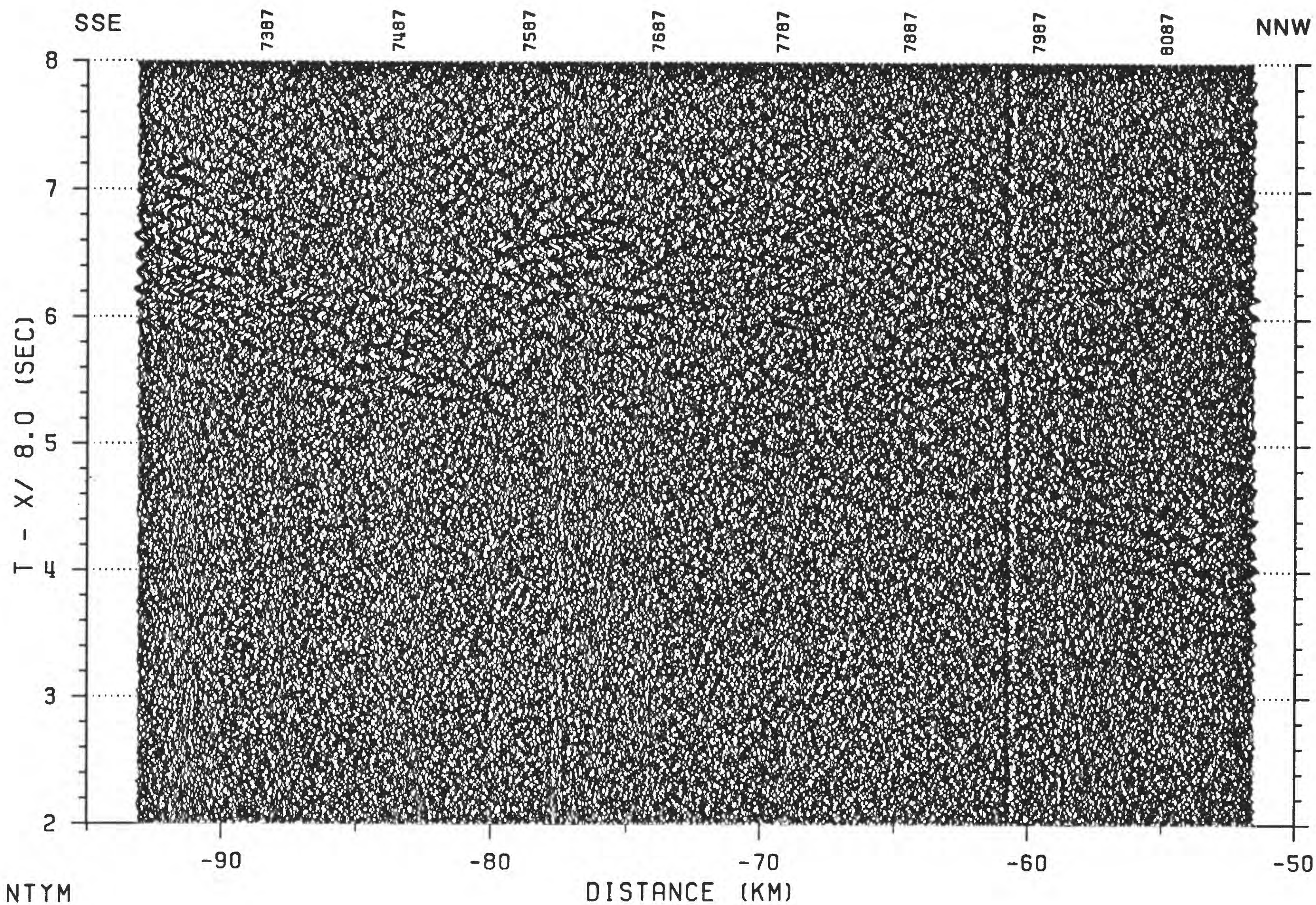

Figure 66. Receiver gather from station NTYM for BASIX line 112. Plot parameters are described in the text.

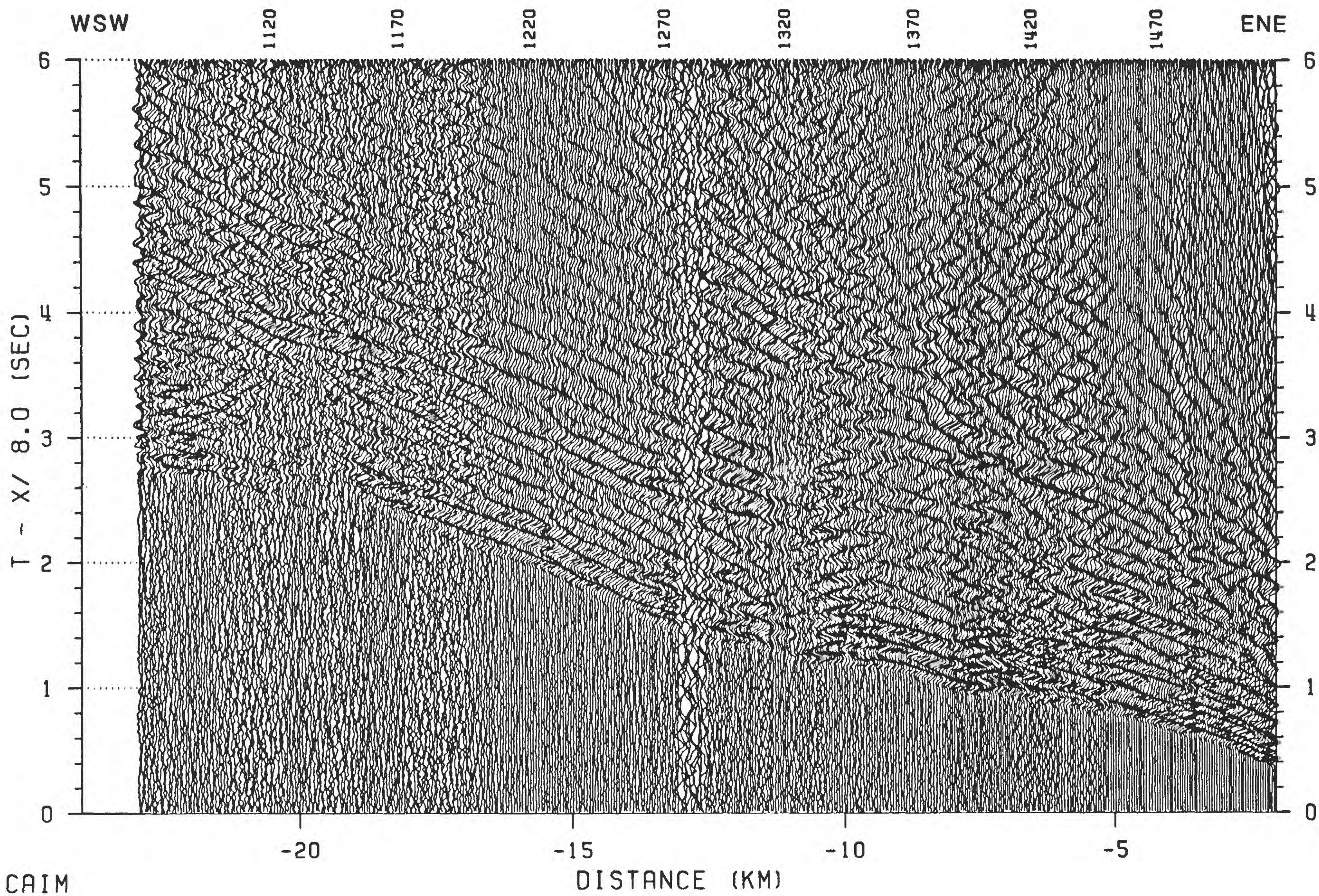

Figure 67. Receiver gather from station CAIM for BASIX line 202. Plot parameters are described in the text.

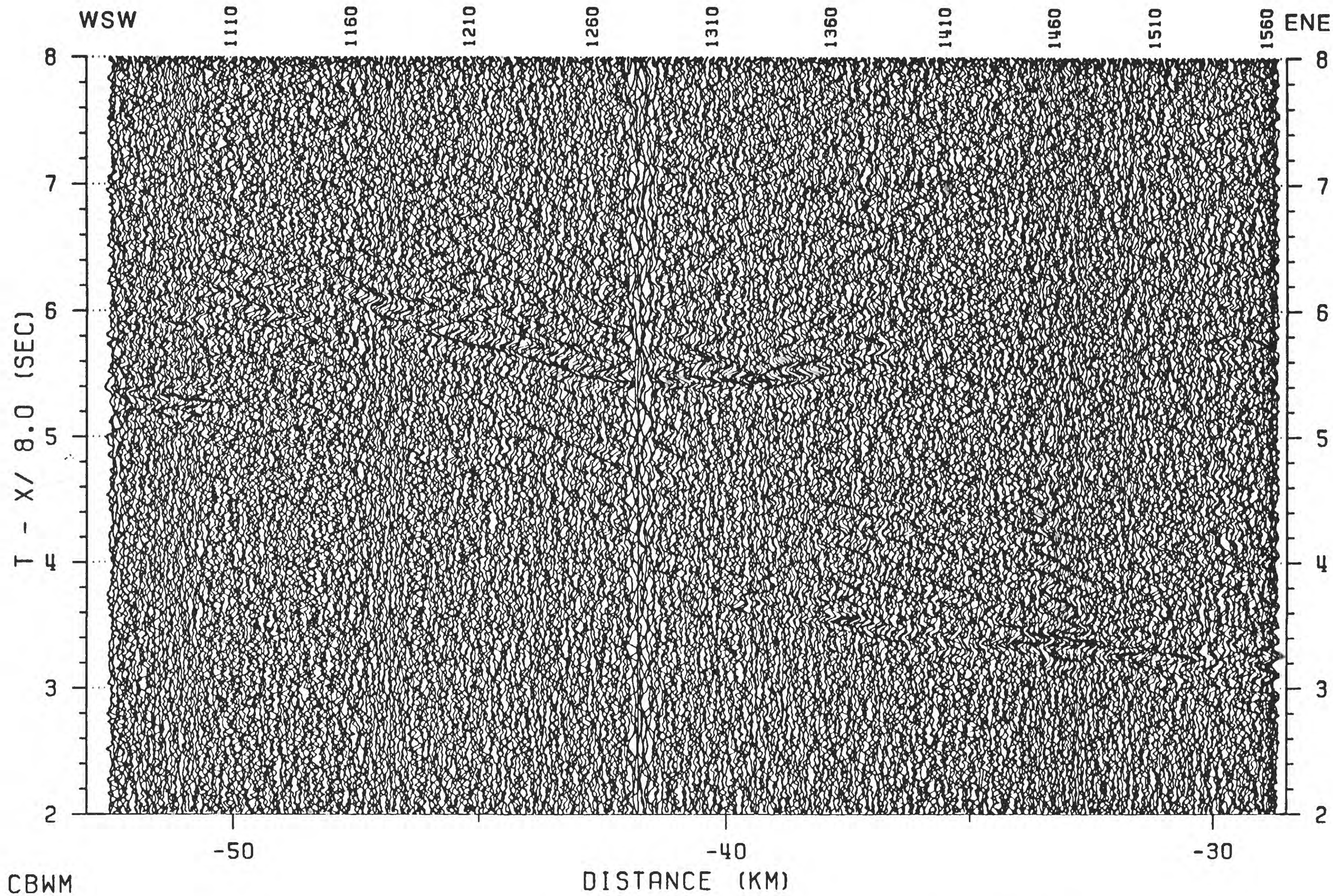

Figure 68. Receiver gather from station CBWM for BASIX line 202. Plot parameters are described in the text.

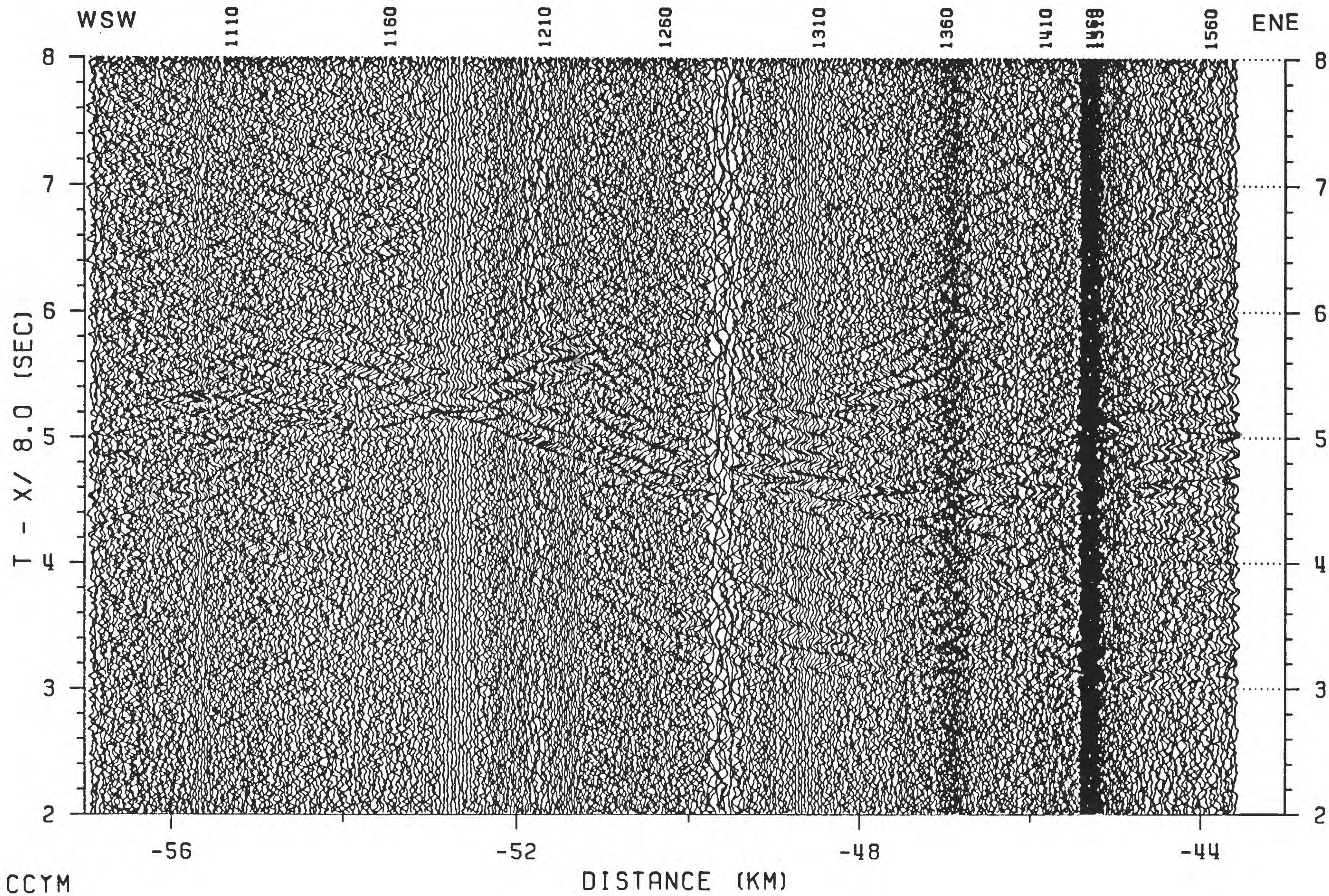

Figure 69. Receiver gather from station CCYM for BASIX line 202. Plot parameters are described in the text.

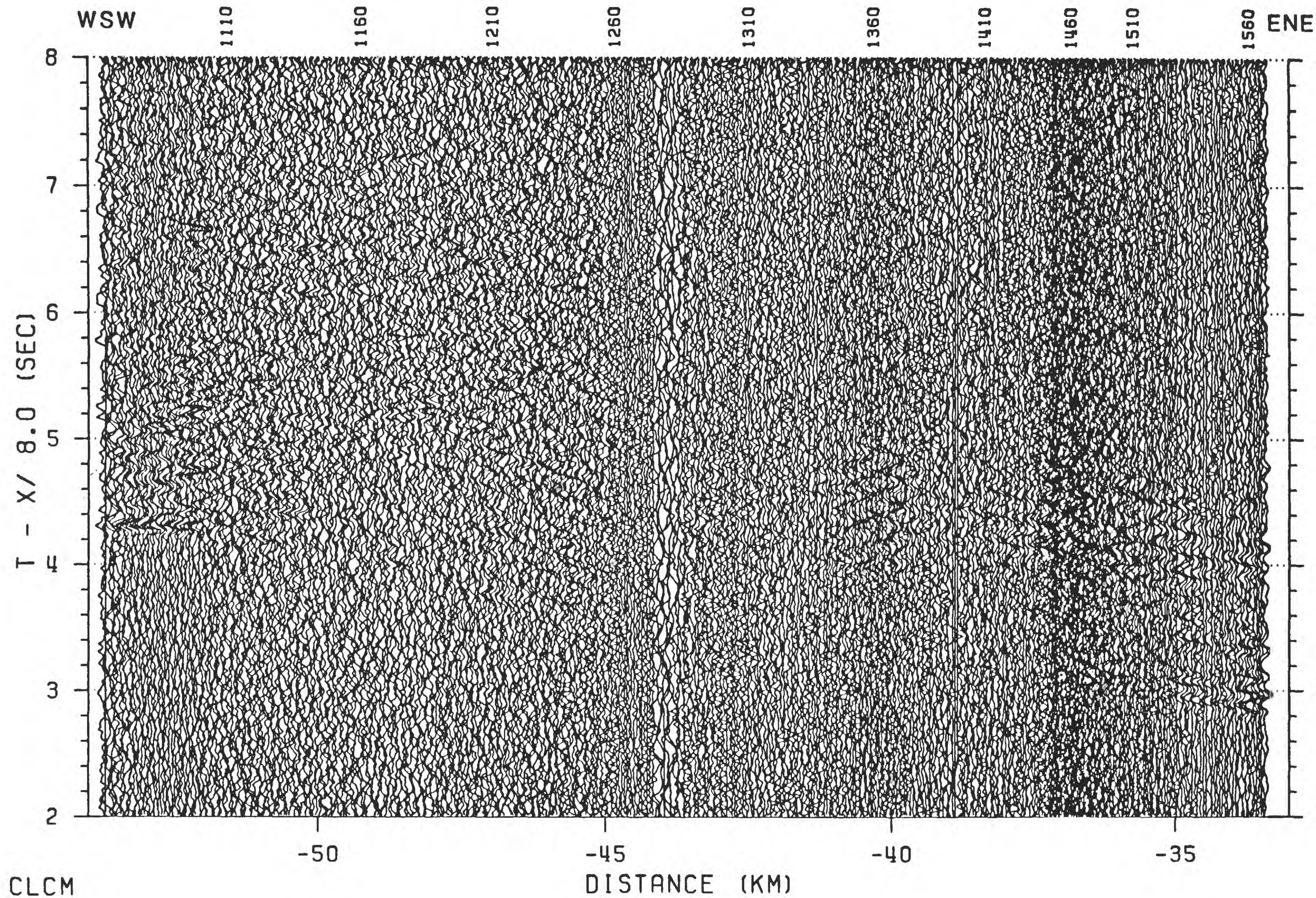

Figure 70. Receiver gather from station CLCM for BASIX line 202. Plot parameters are described in the text.

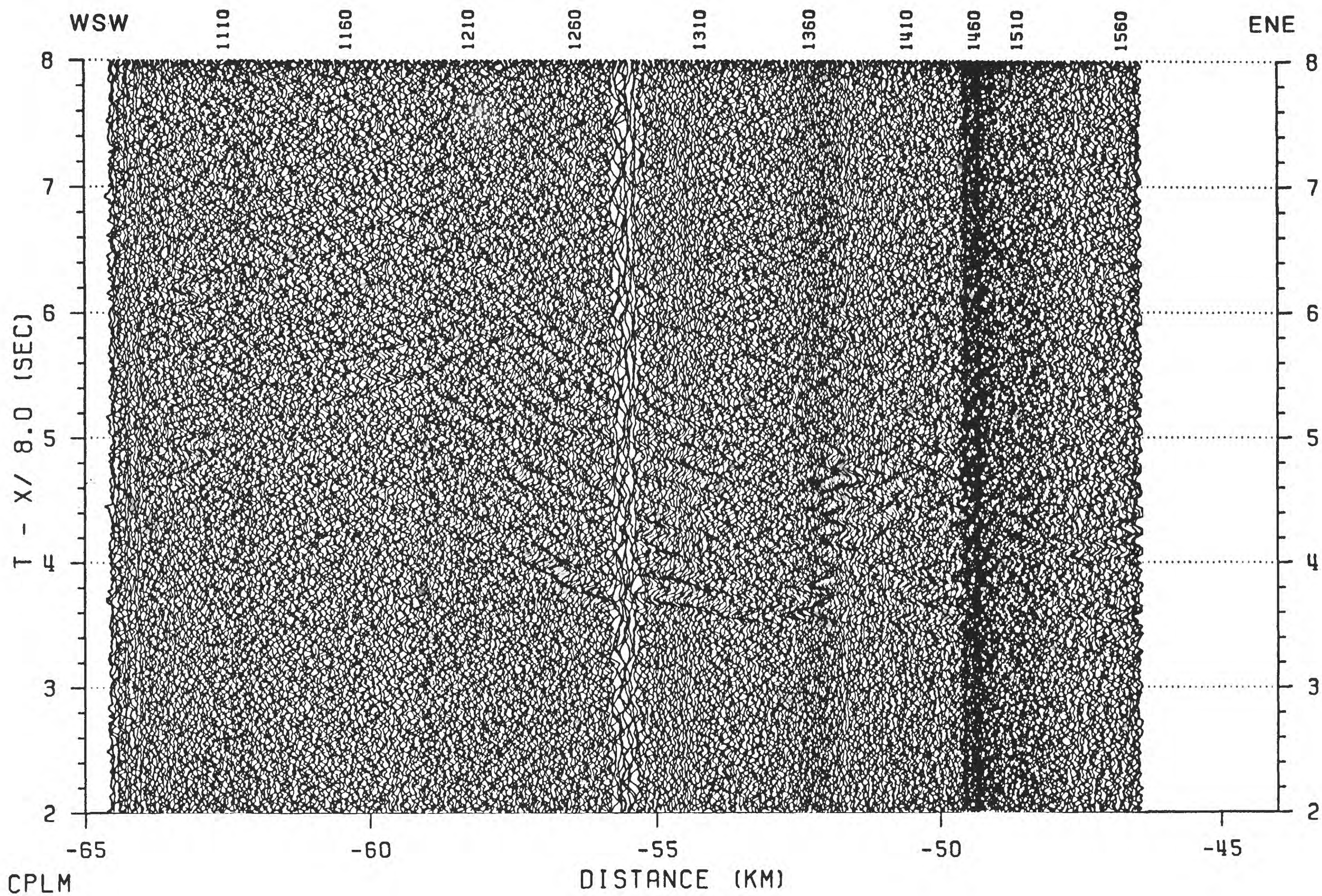

Figure 71. Receiver gather from station CPLM for BASIX line 202. Plot parameters are described in the text.

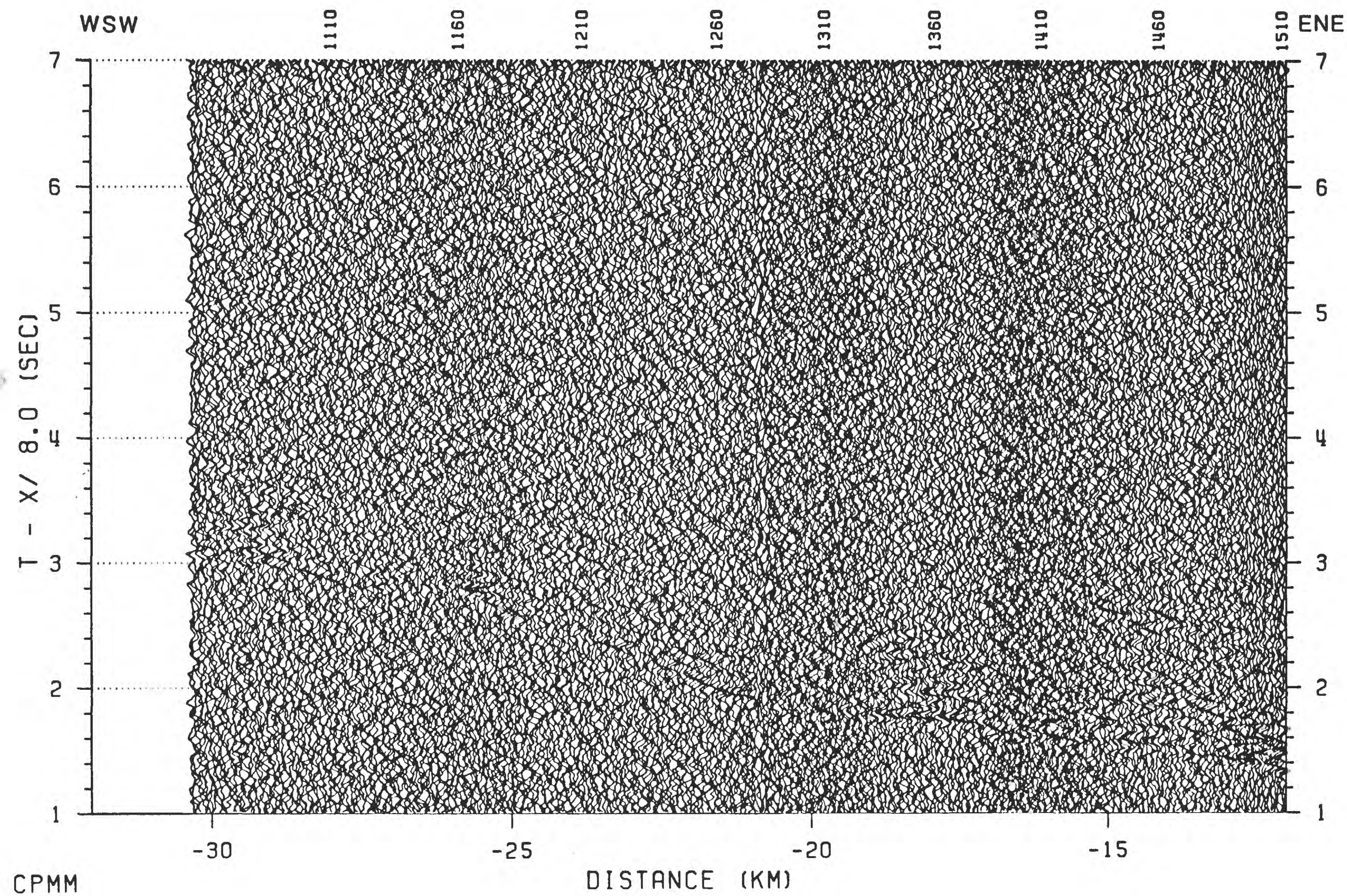

Figure 72. Receiver gather from station CPMM for BASIX line 202. Plot parameters are described in the text.

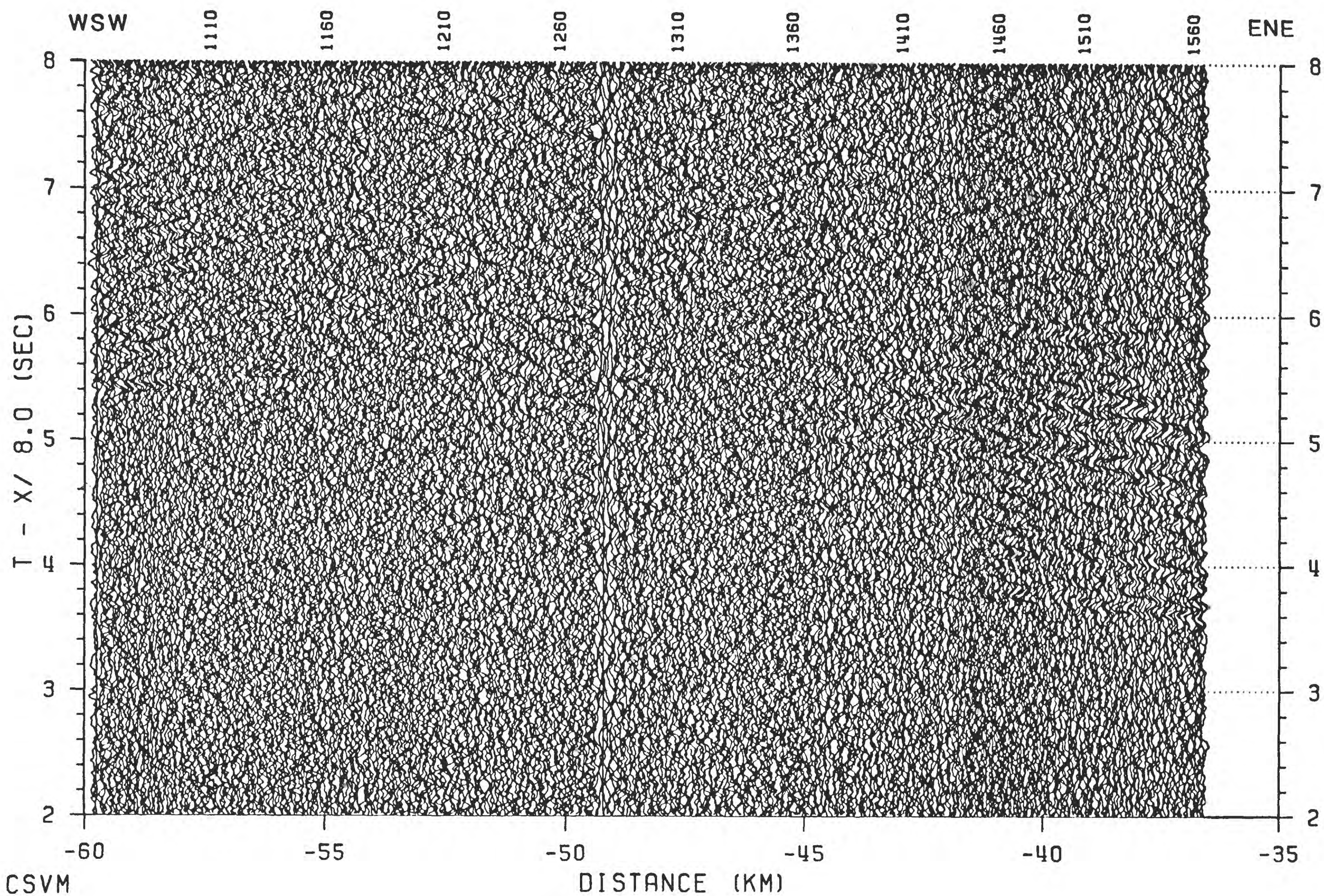

Figure 73. Receiver gather from station CSVM for BASIX line 202. Plot parameters are described in the text.

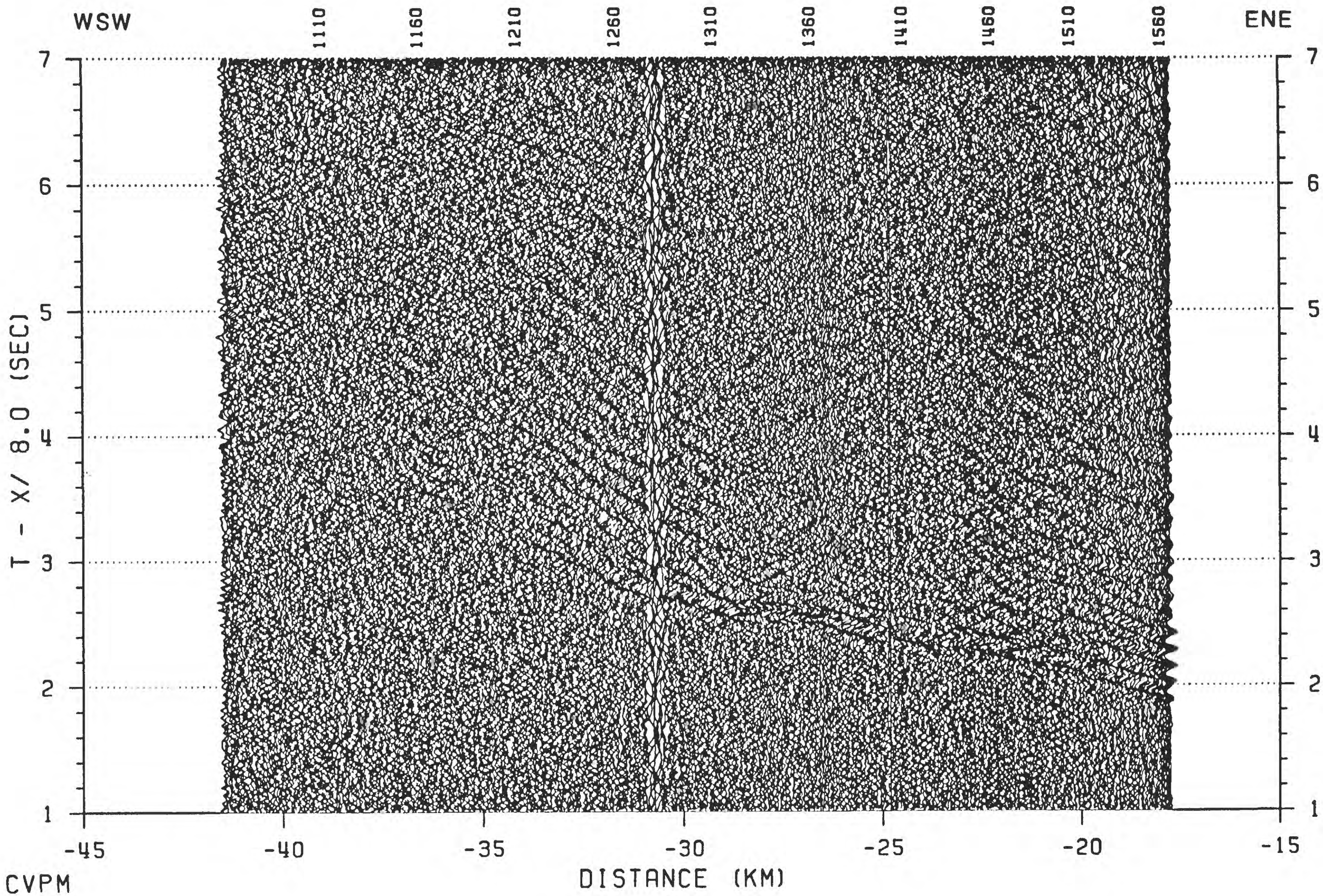

Figure 74. Receiver gather from station CVPM for BASIX line 202. Plot parameters are described in the text.

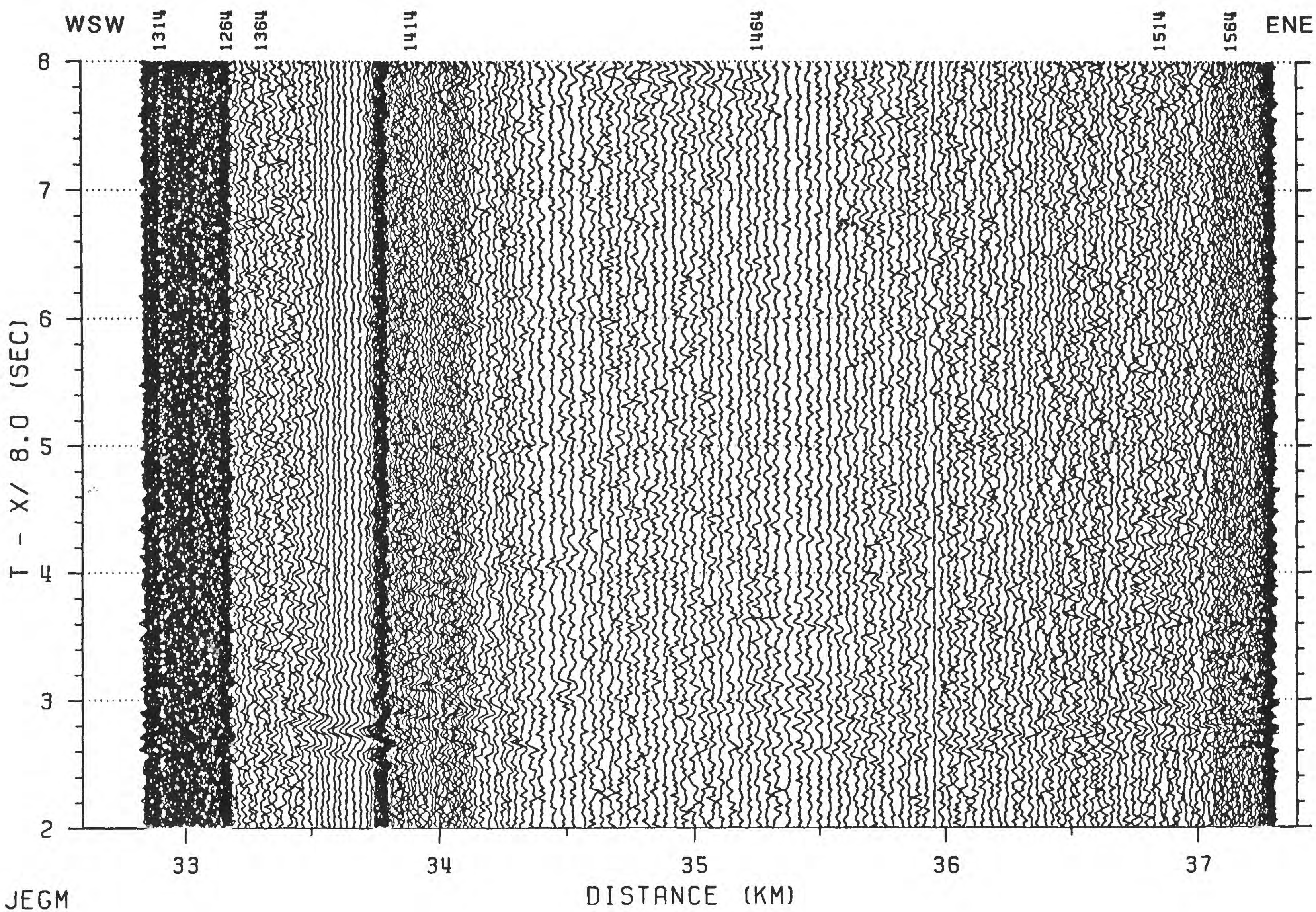

Figure 75. Receiver gather from station JEGM for BASIX line 202. Plot parameters are described in the text.

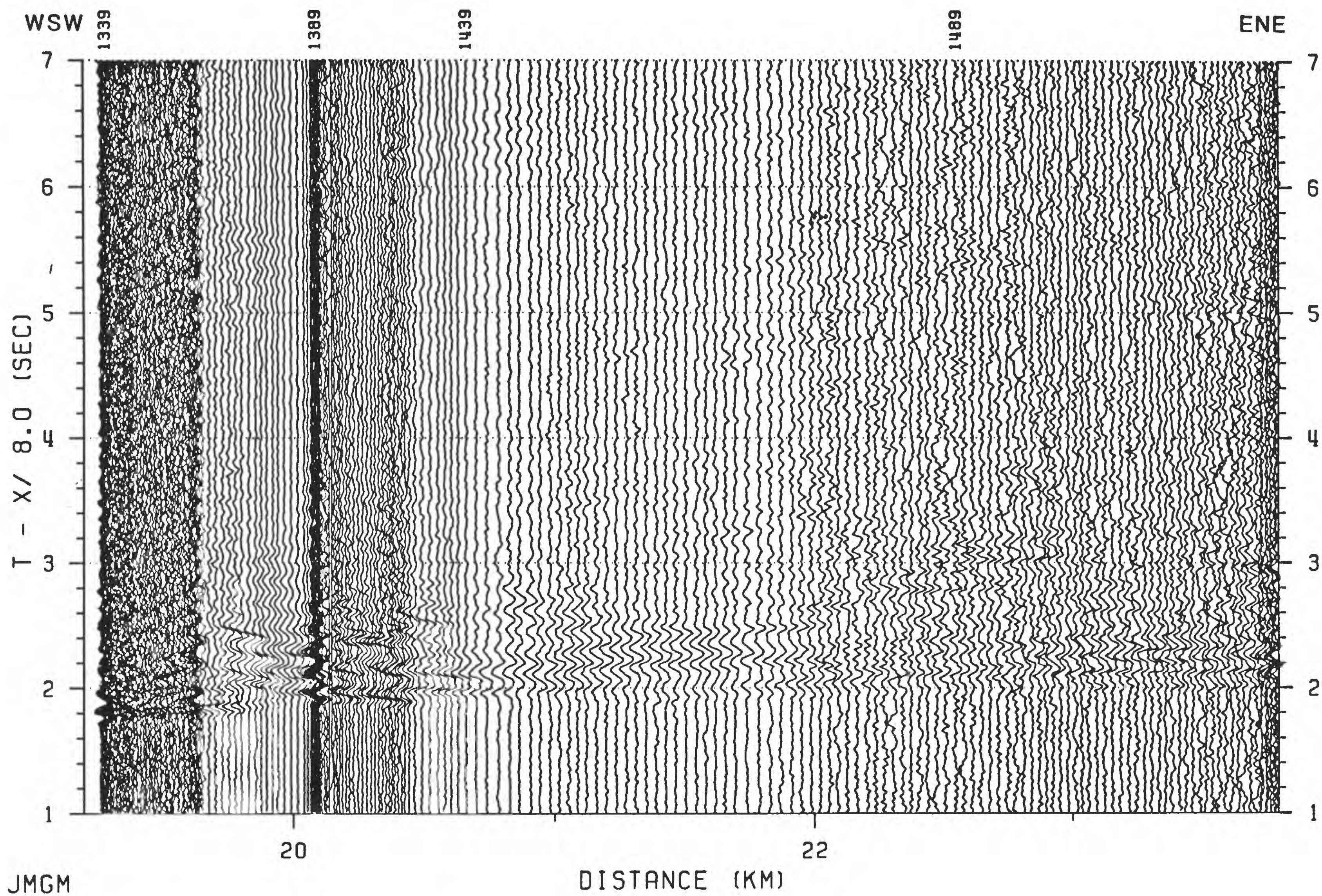

Figure 76. Receiver gather from station JMGM for BASIX line 202. Plot parameters are described in the text.

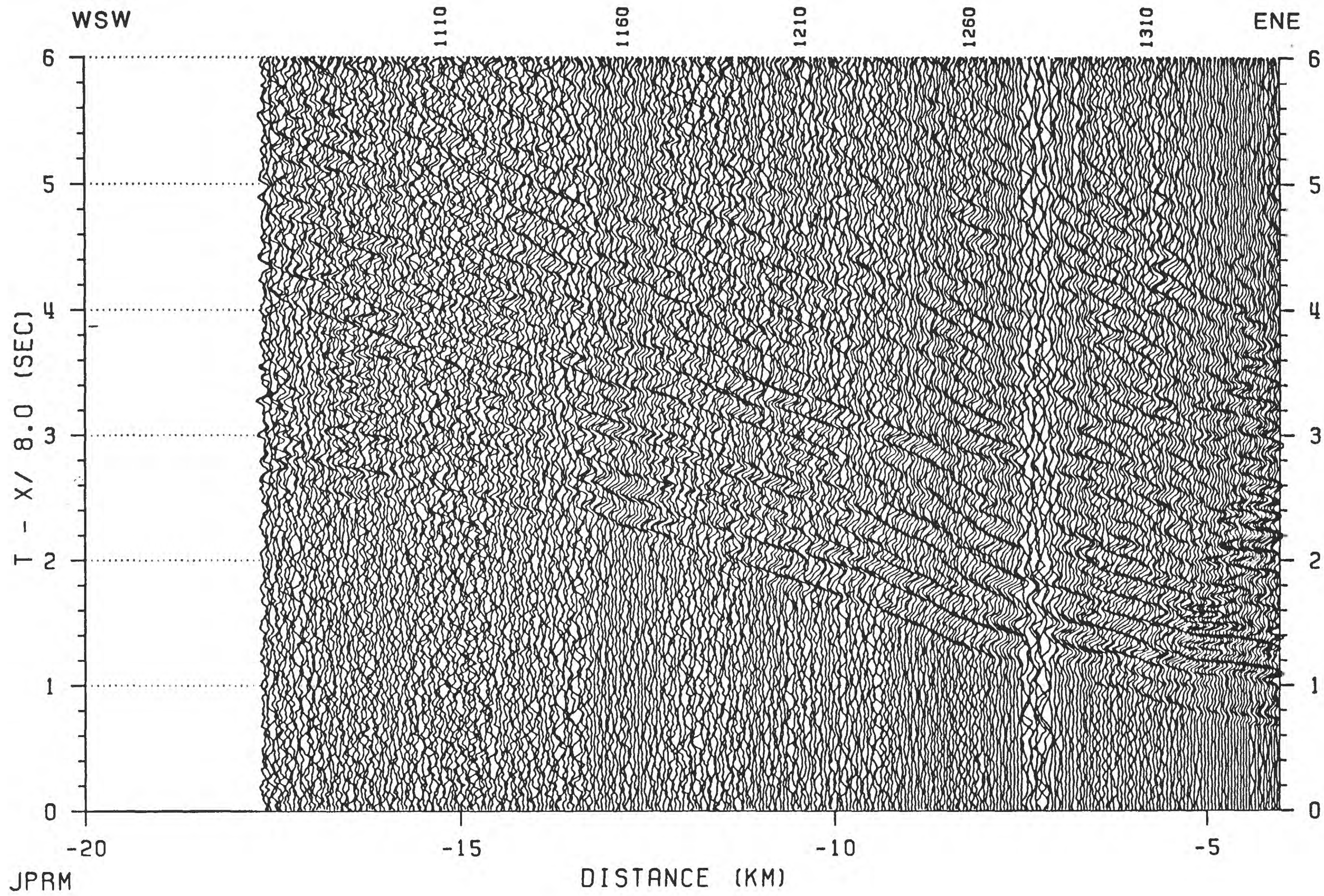

Figure 77. Receiver gather from station JPRM for BASIX line 202. Plot parameters are described in the text.

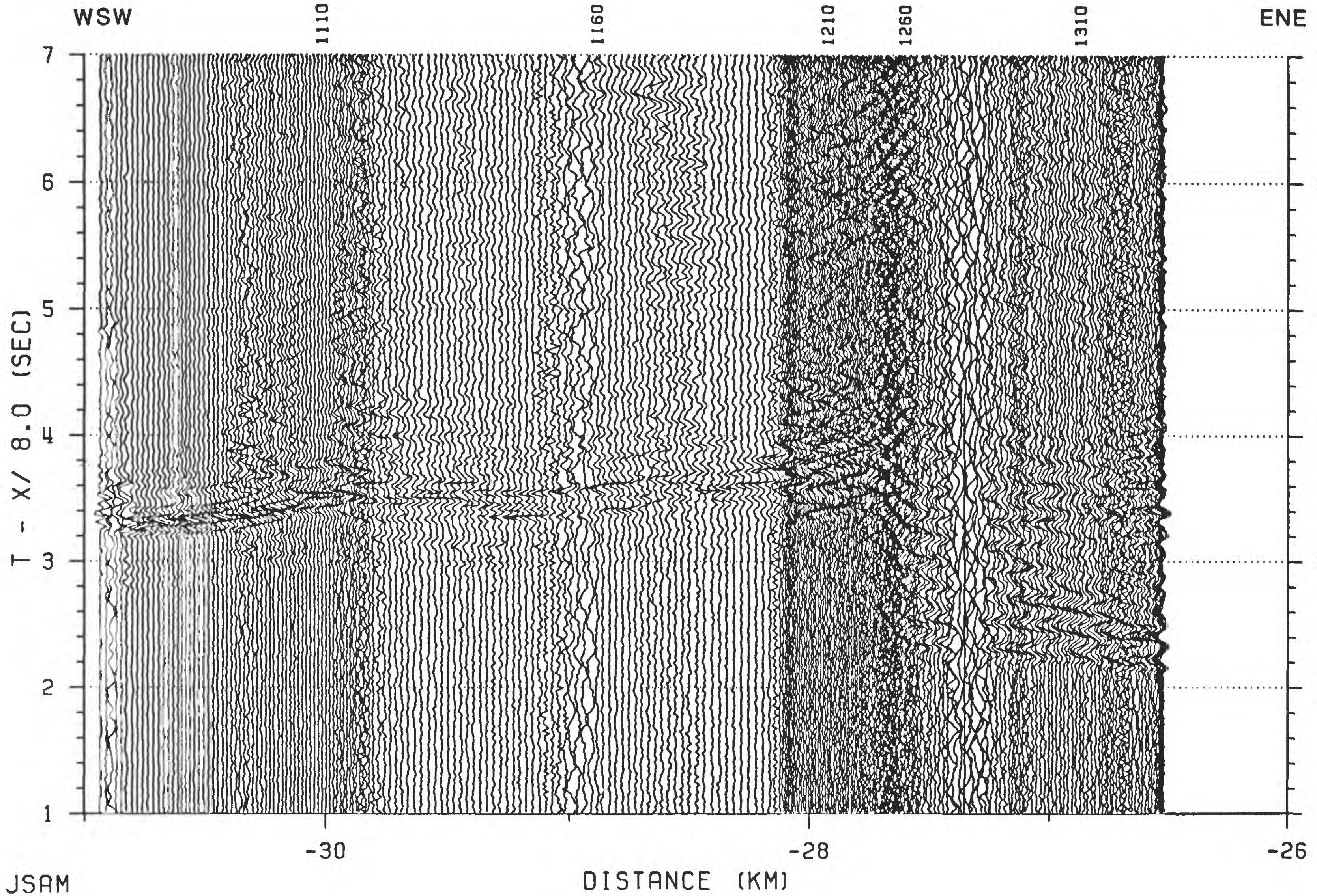

Figure 78. Receiver gather from station JSAM for BASIX line 202. Plot parameters are described in the text.

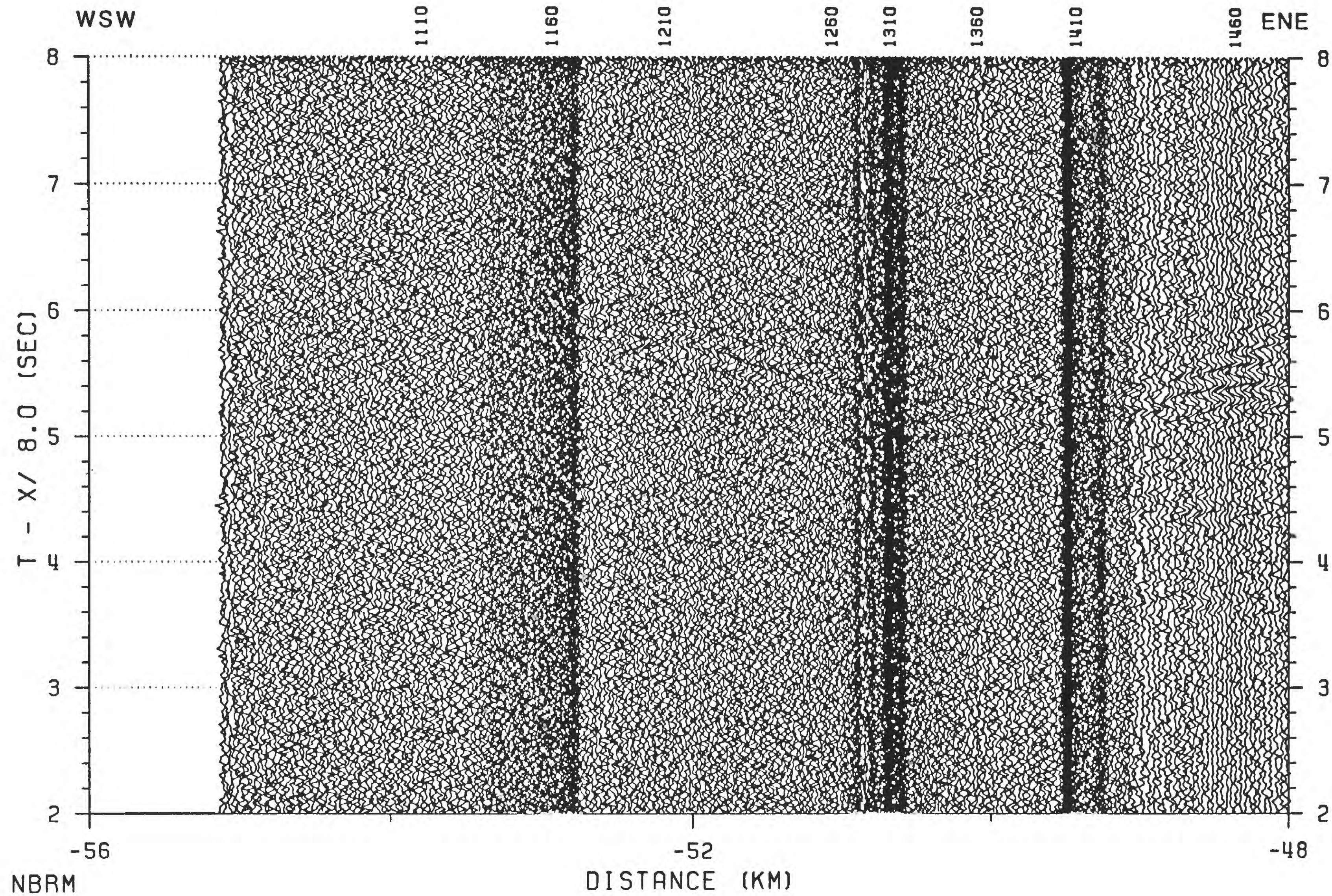

Figure 79. Receiver gather from station NBRM for BASIX line 202. Plot parameters are described in the text.

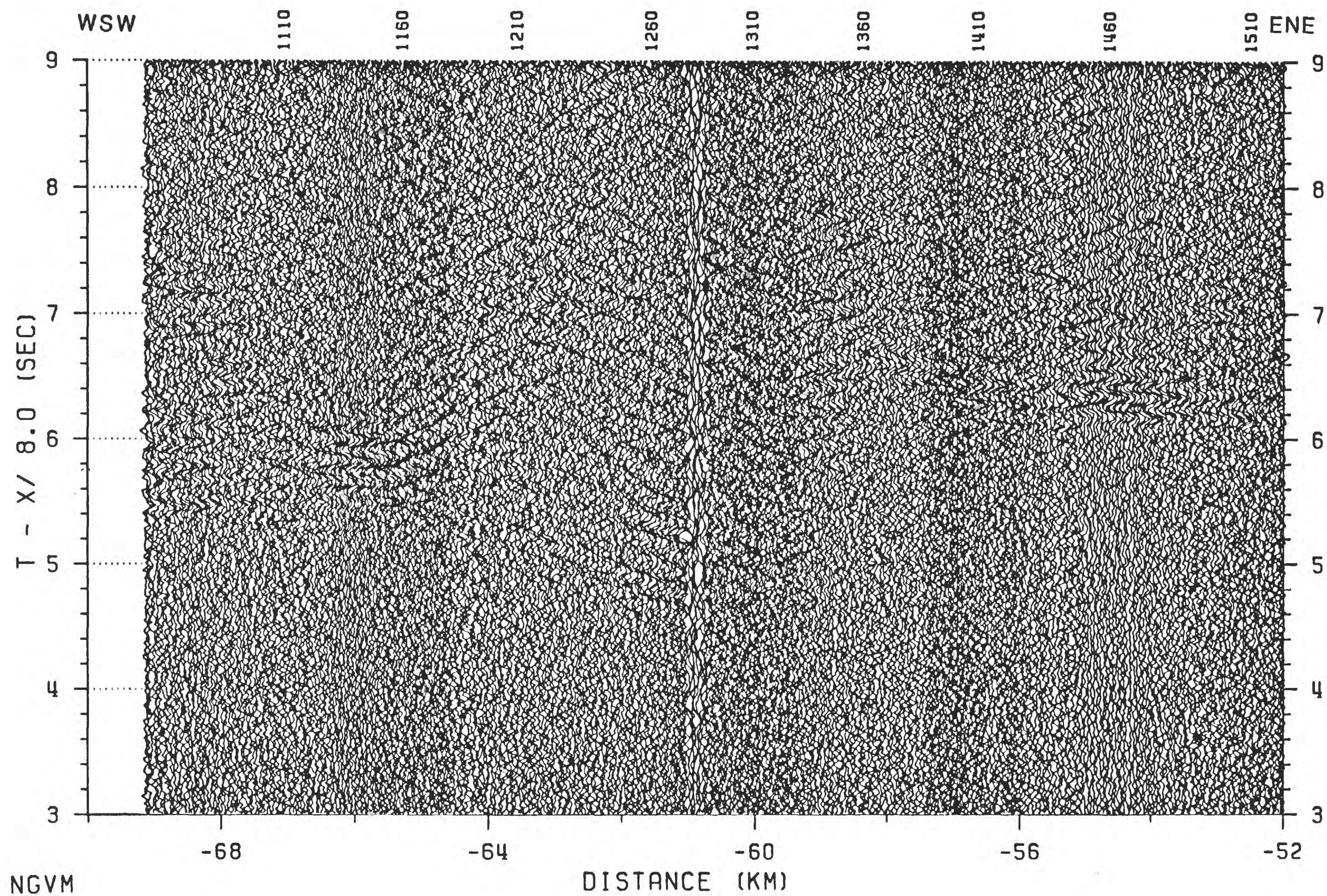

Figure 80. Receiver gather from station NGVM for BASIX line 202. Plot parameters are described in the text.

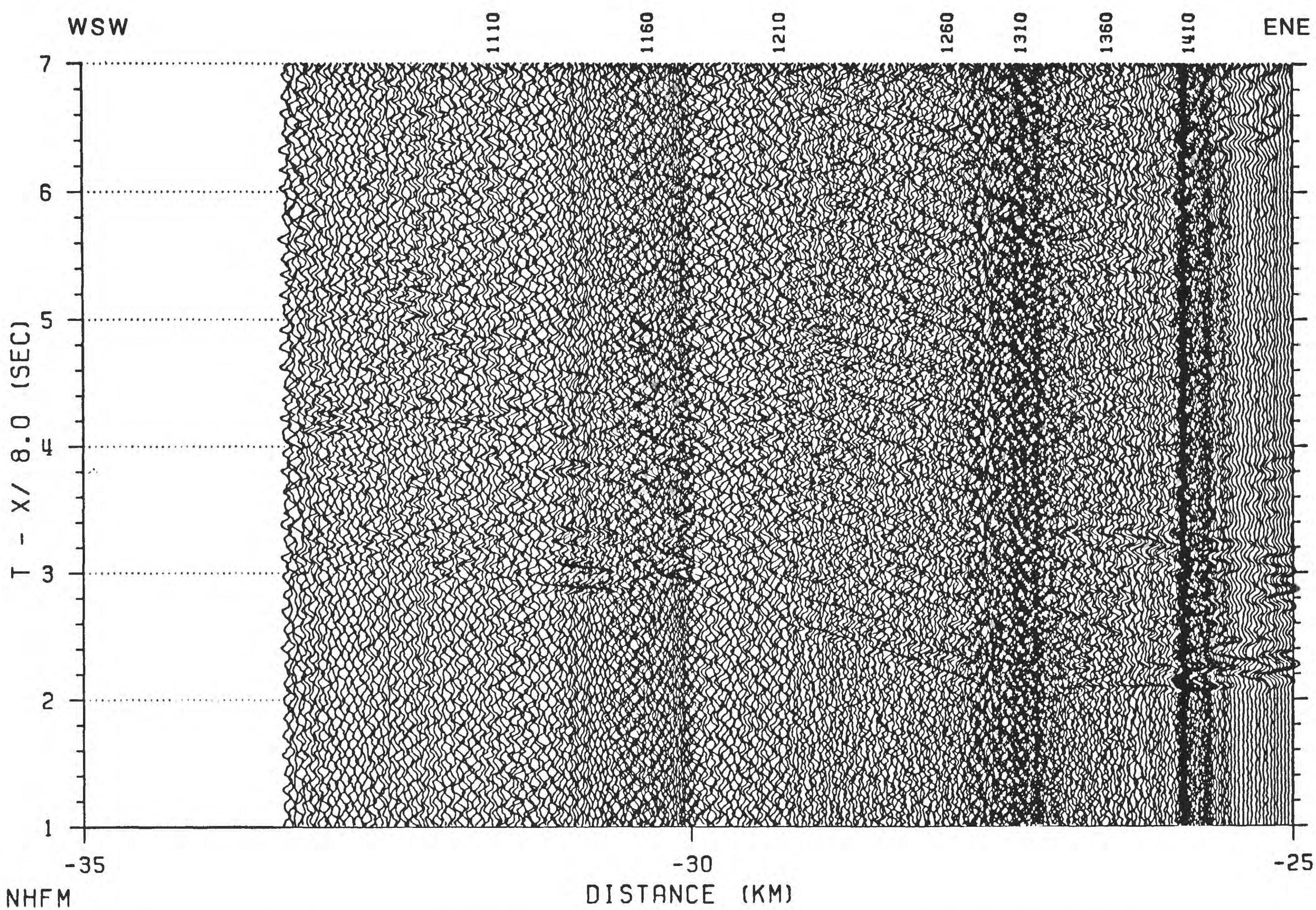

Figure 81. Receiver gather from station NHFM for BASIX line 202. Plot parameters are described in the text.

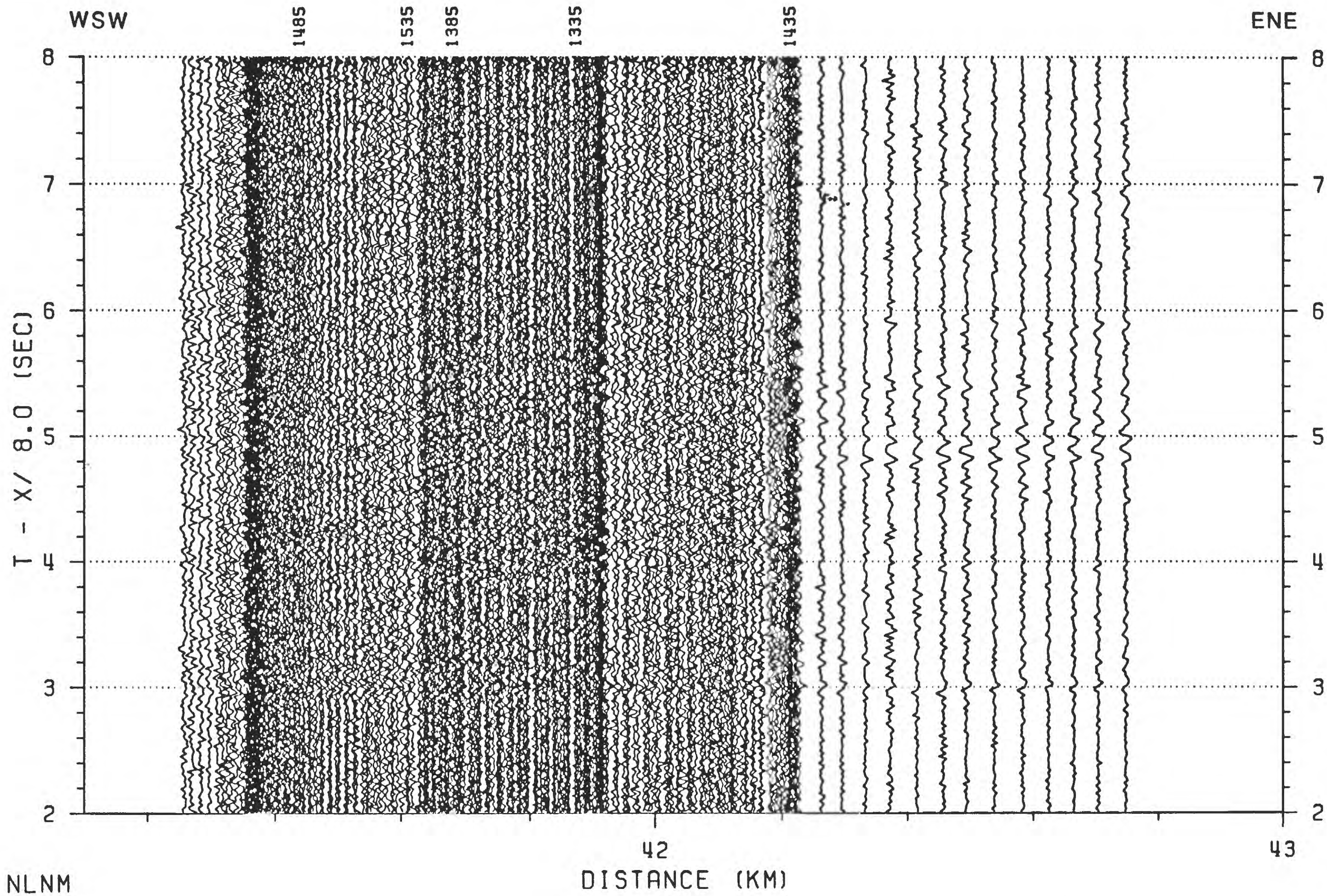

Figure 82. Receiver gather from station NLNM for BASIX line 202. Plot parameters are described in the text.

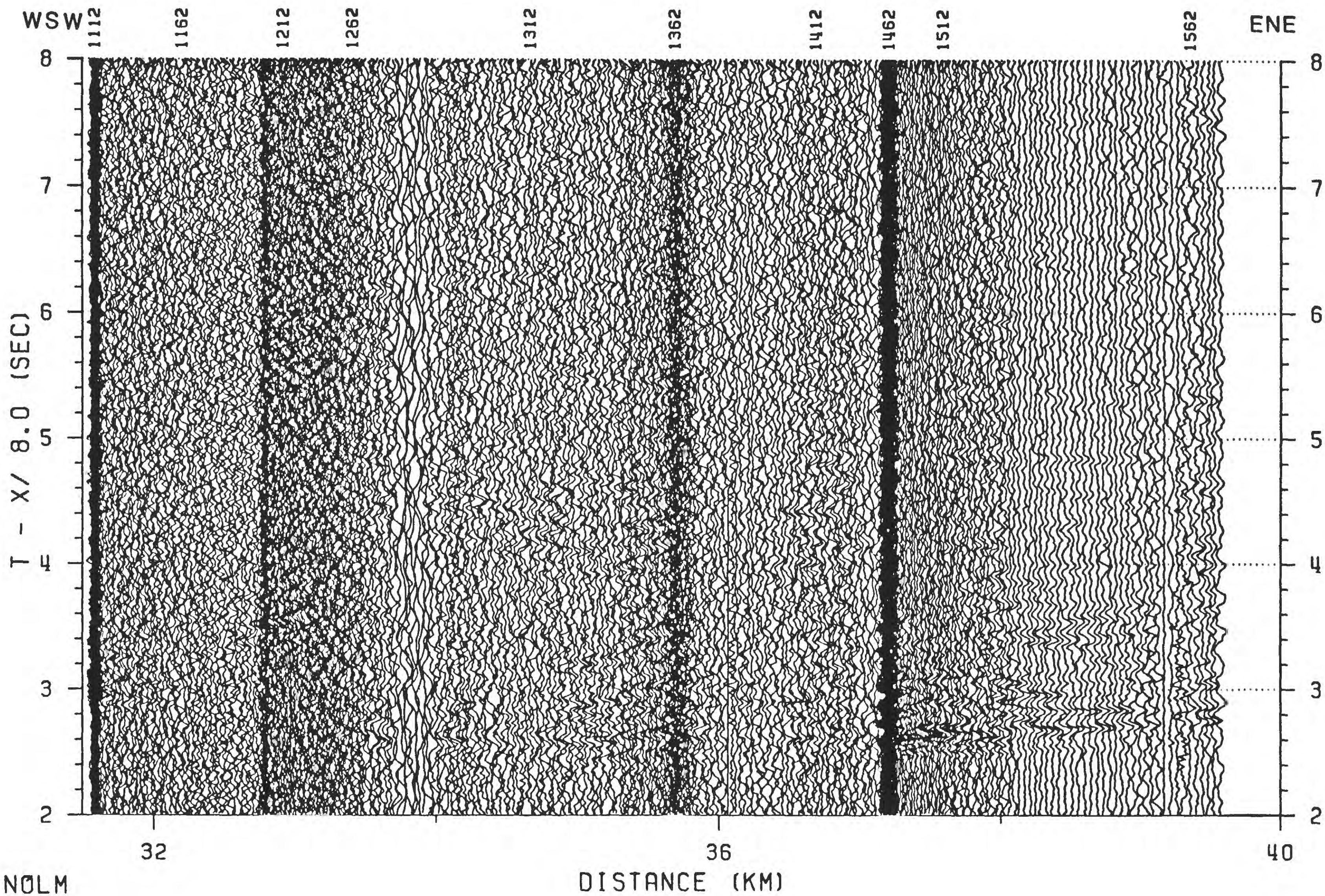

Figure 83. Receiver gather from station NOLM for BASIX line 202. Plot parameters are described in the text.

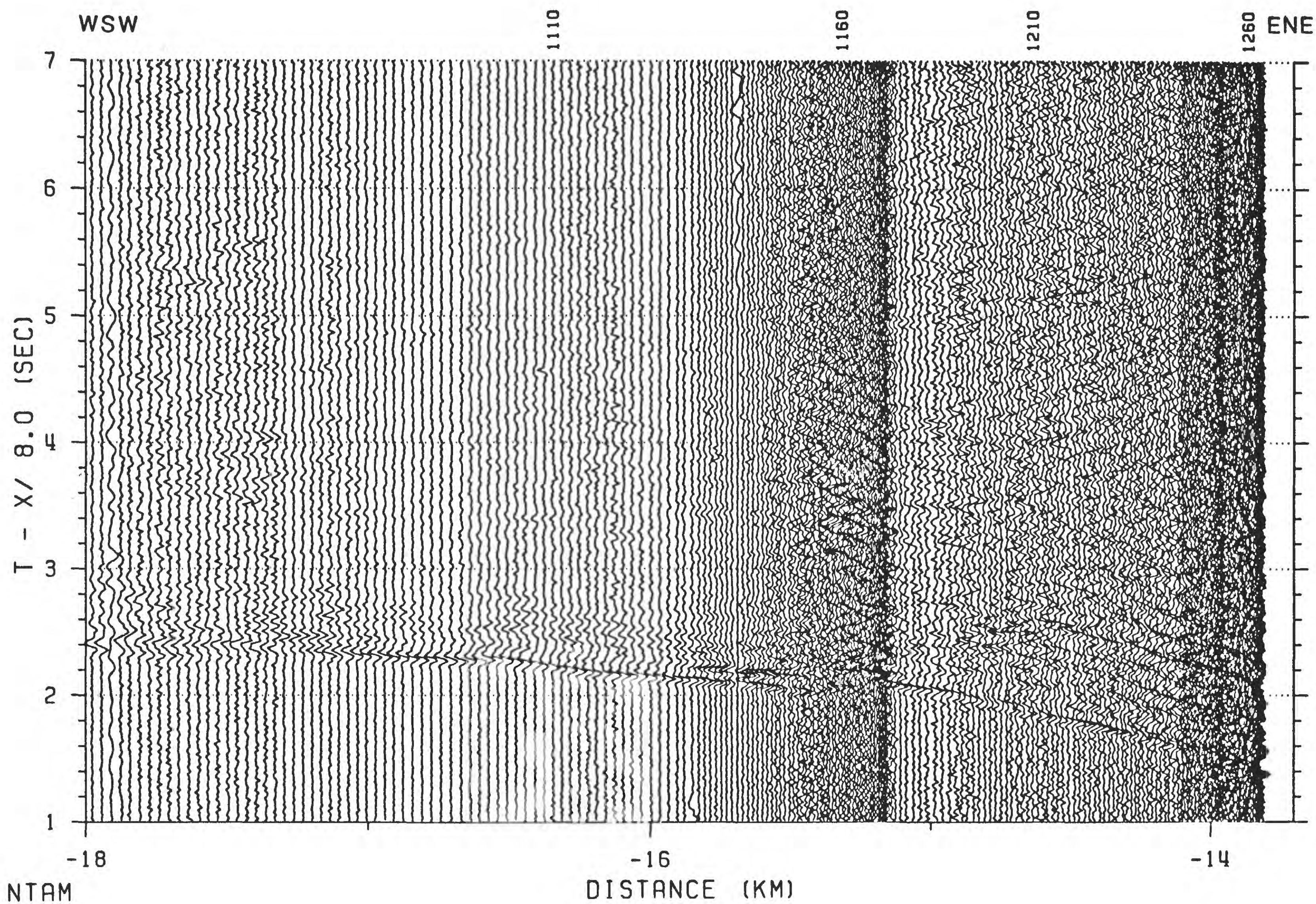

Figure 84. Receiver gather from station NTAM for BASIX line 202. Plot parameters are described in the text.

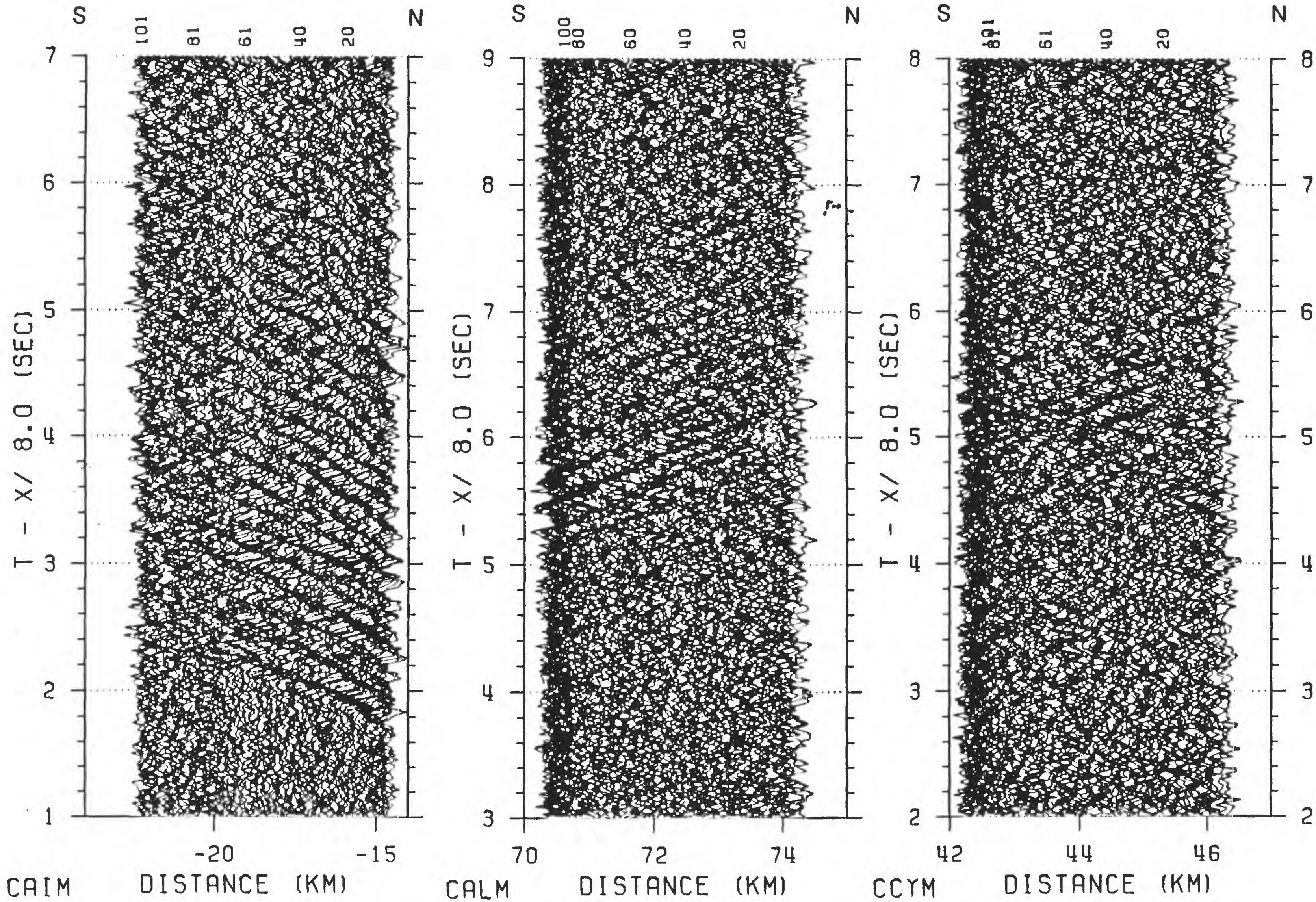

Figure 85. Receiver gather from station CAIM, CALM, and CCYM for BASIX line TR1. Plot parameters are described in the text.

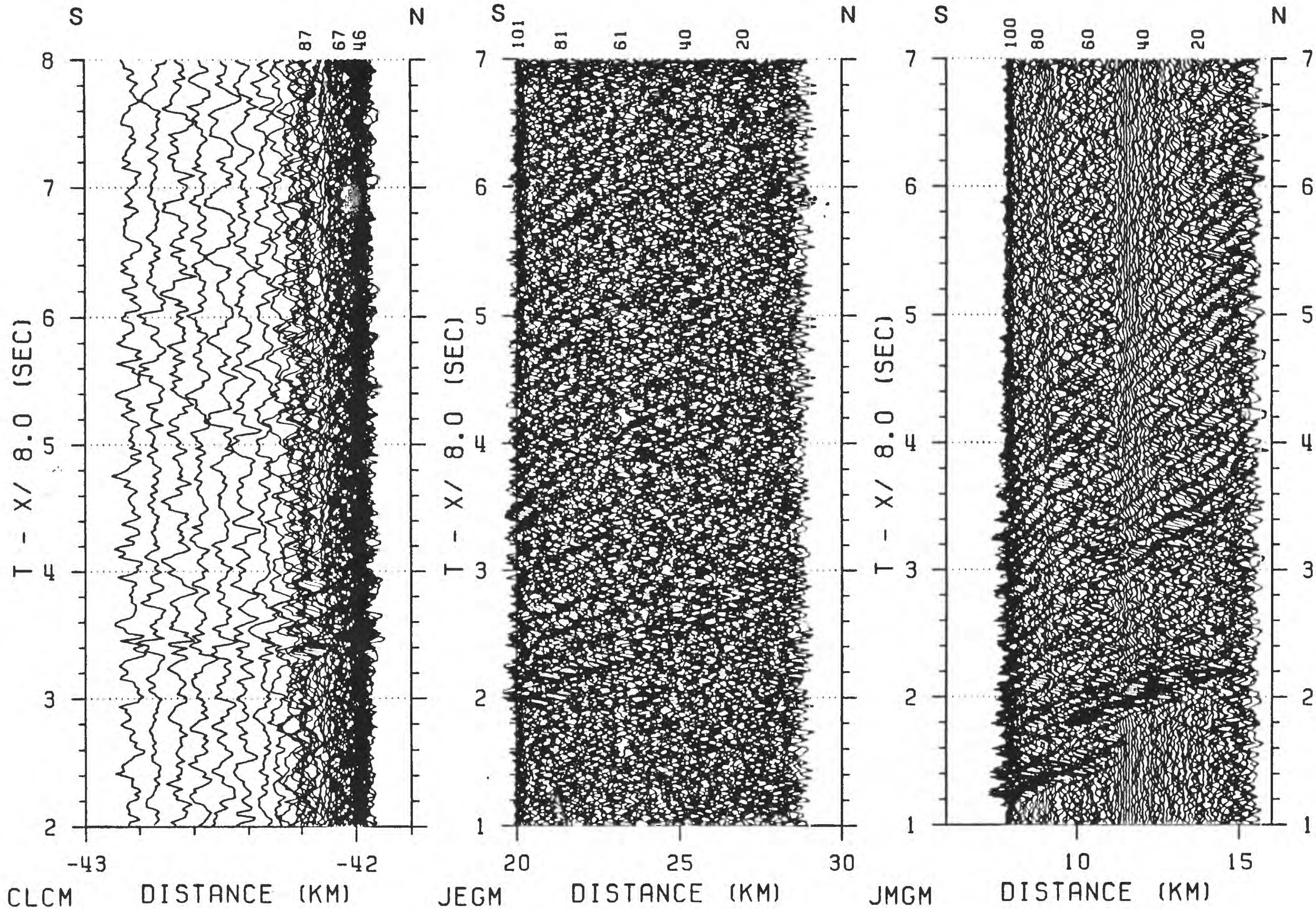

Figure 86. Receiver gather from station CLCM, JEGM, and JMGM for BASIX line TR1. Plot parameters are described in the text.

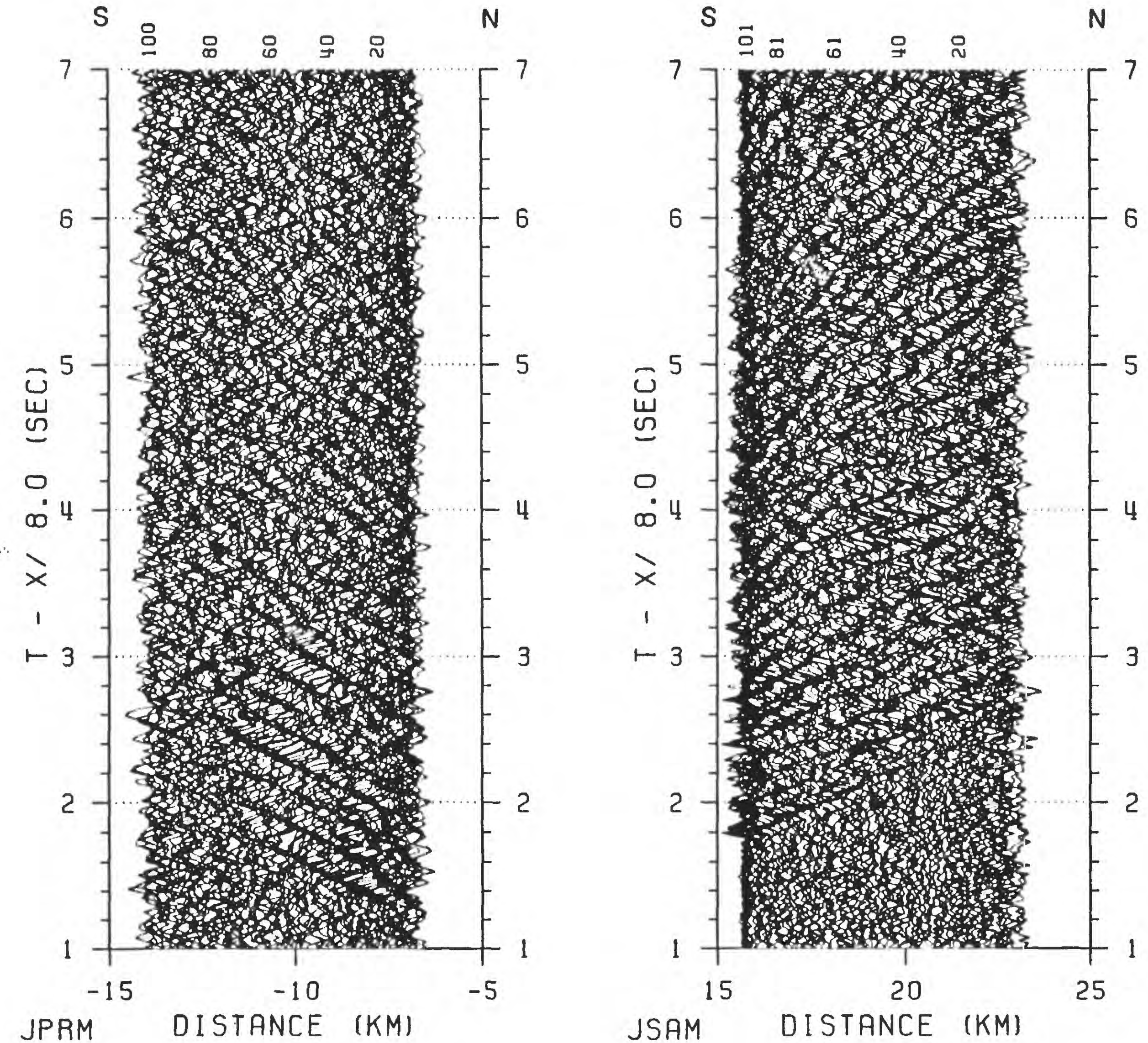

Figure 87. Receiver gather from station JPRM and JSAM for BASIX line TR1. Plot parameters are described in the text.

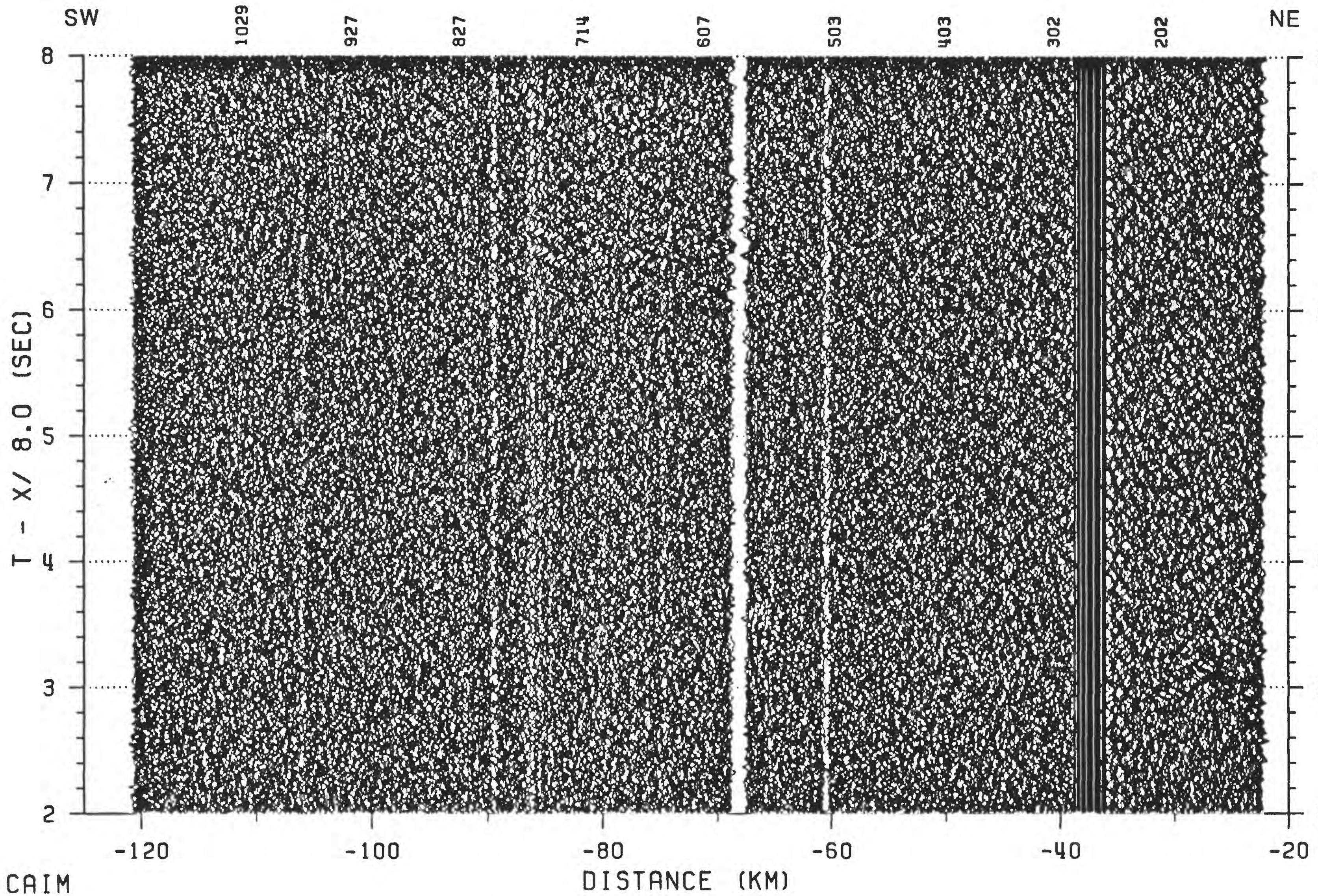

Figure 88. Receiver gather from station CAIM for BASIX line OBS2. Plot parameters are described in the text.

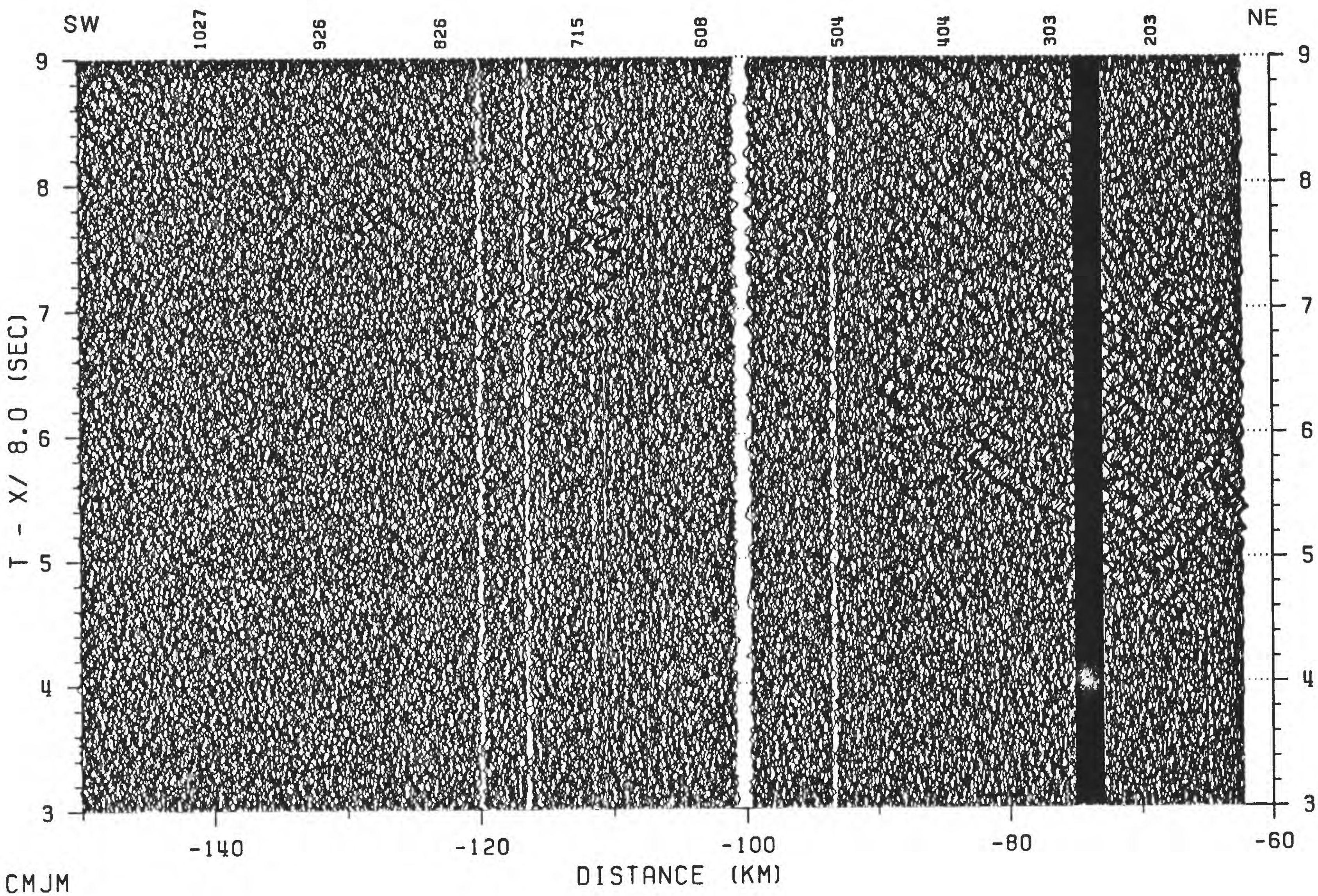

Figure 89. Receiver gather from station CMJM for BASIX line OBS2. Plot parameters are described in the text.

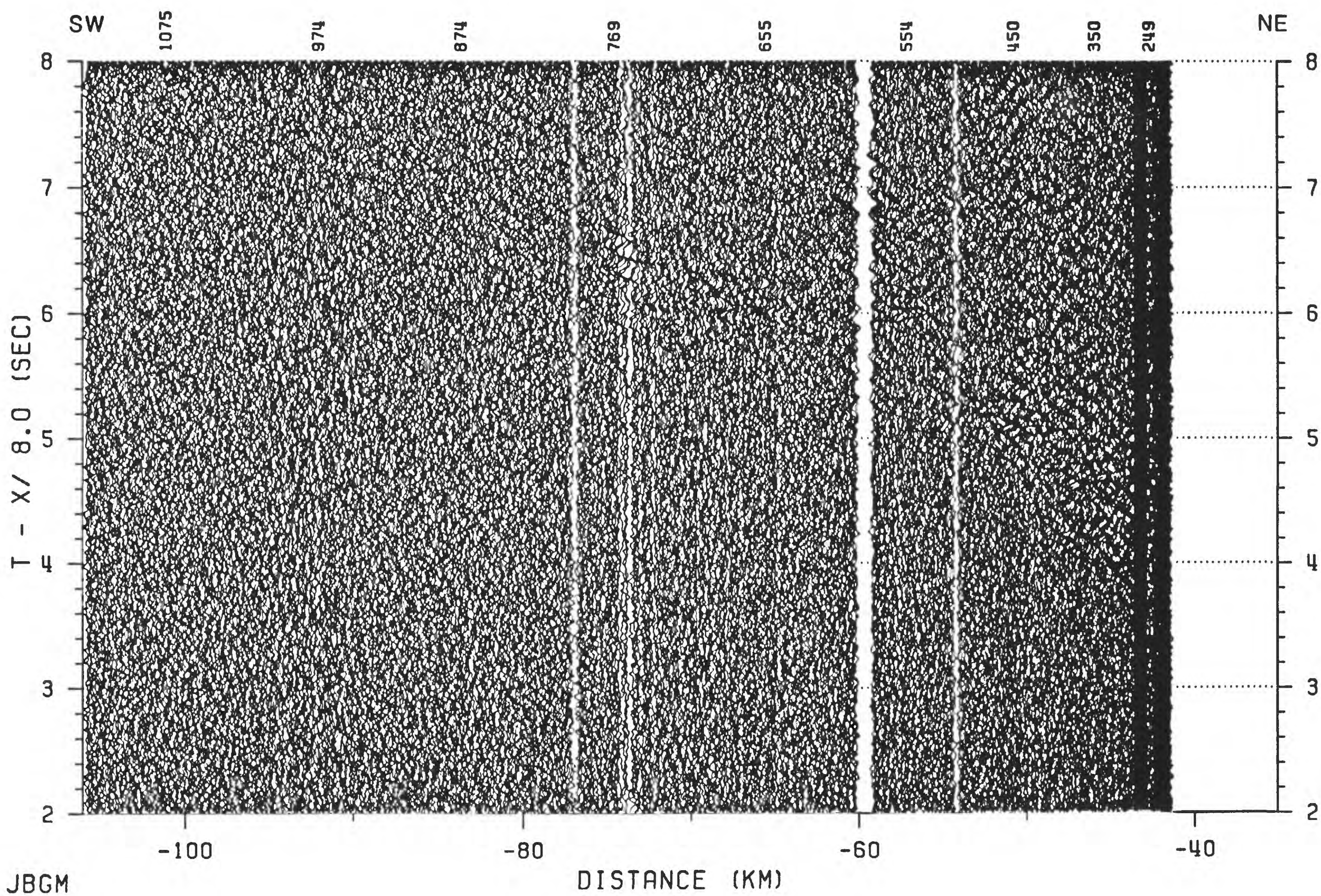

Figure 90. Receiver gather from station JBGM for BASIX line OBS2. Plot parameters are described in the text.

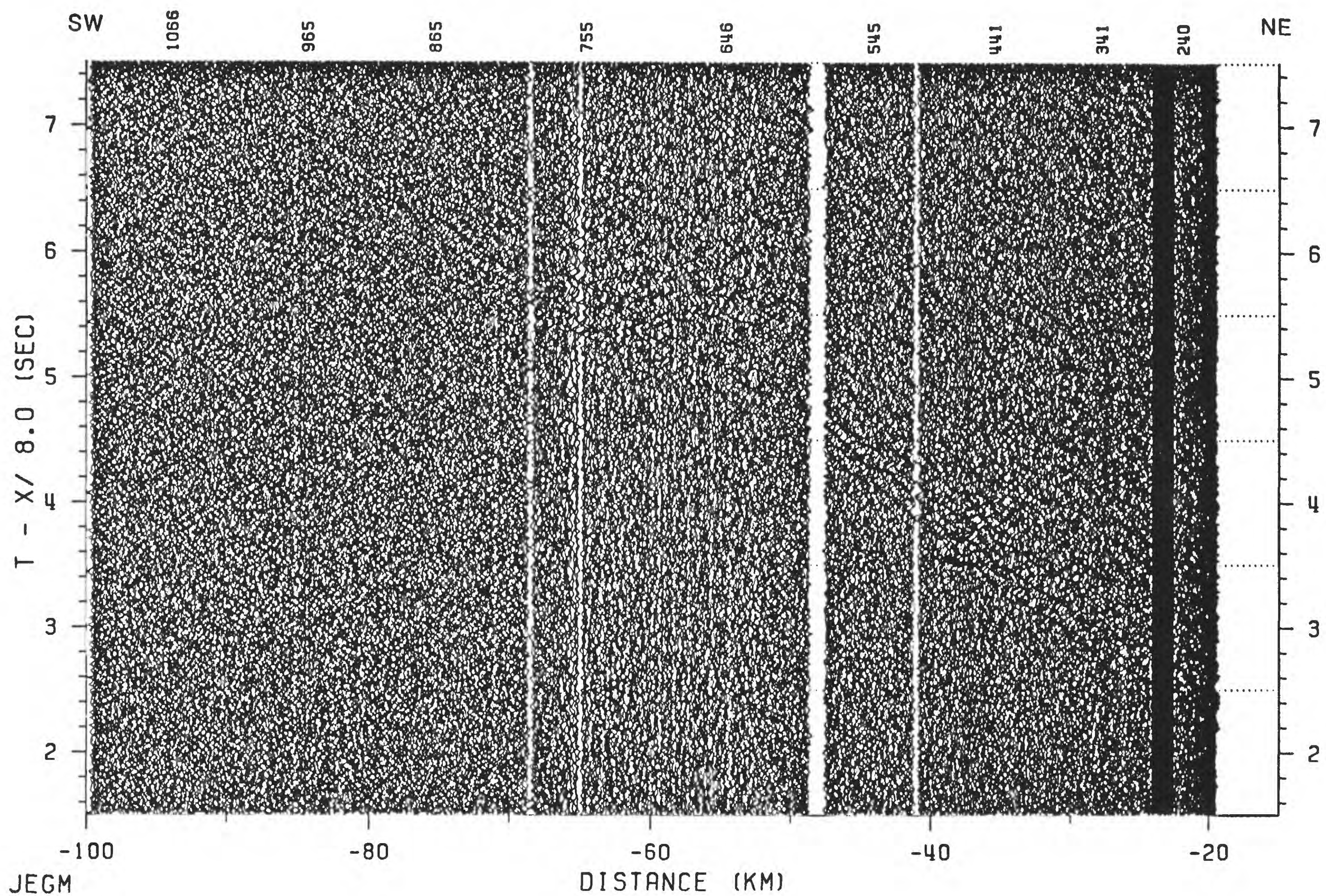

Figure 91. Receiver gather from station JEGM for BASIX line OBS2. Plot parameters are described in the text.

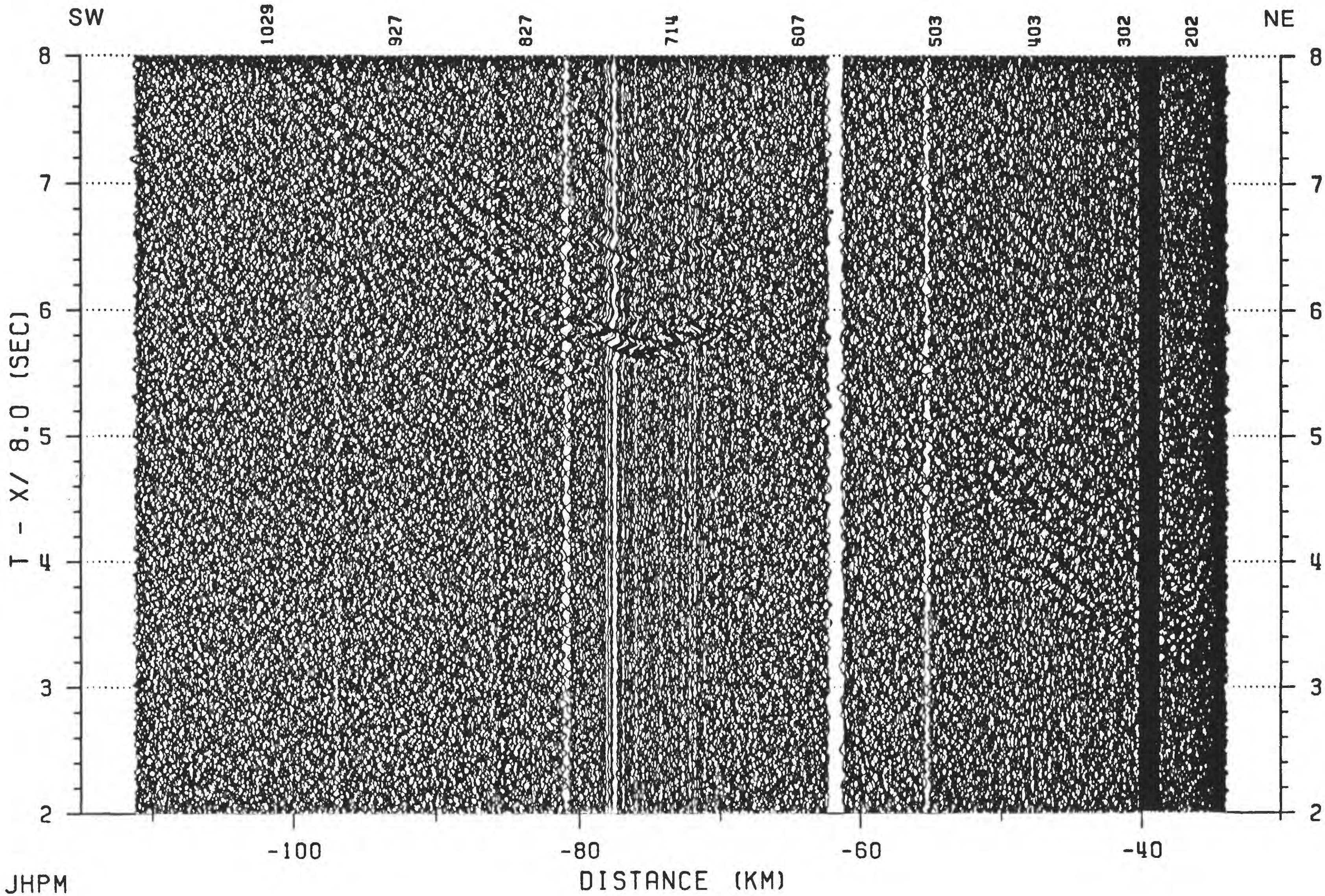

Figure 92. Receiver gather from station JHPM for BASIX line OBS2. Plot parameters are described in the text.

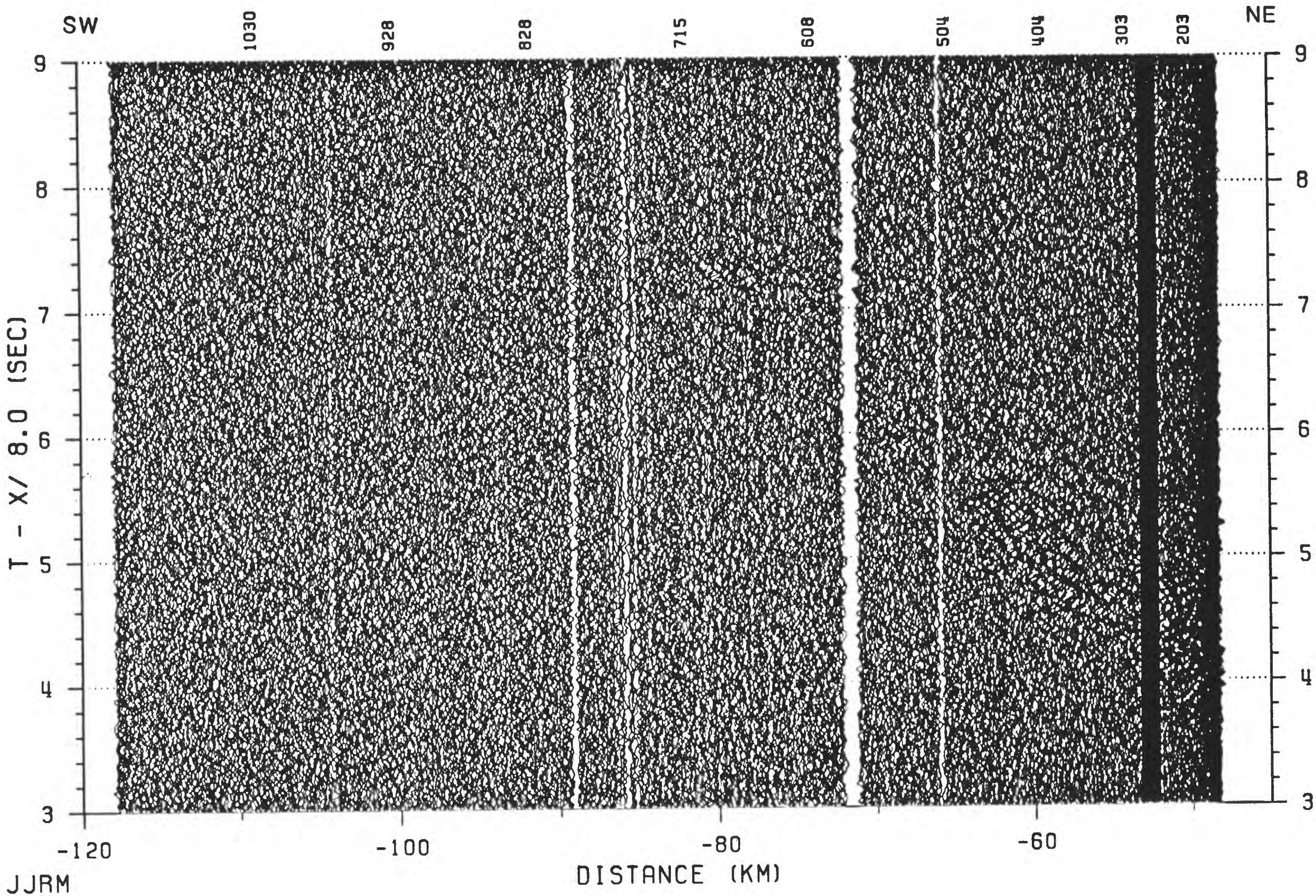

Figure 93. Receiver gather from station JJRM for BASIX line OBS2. Plot parameters are described in the text.

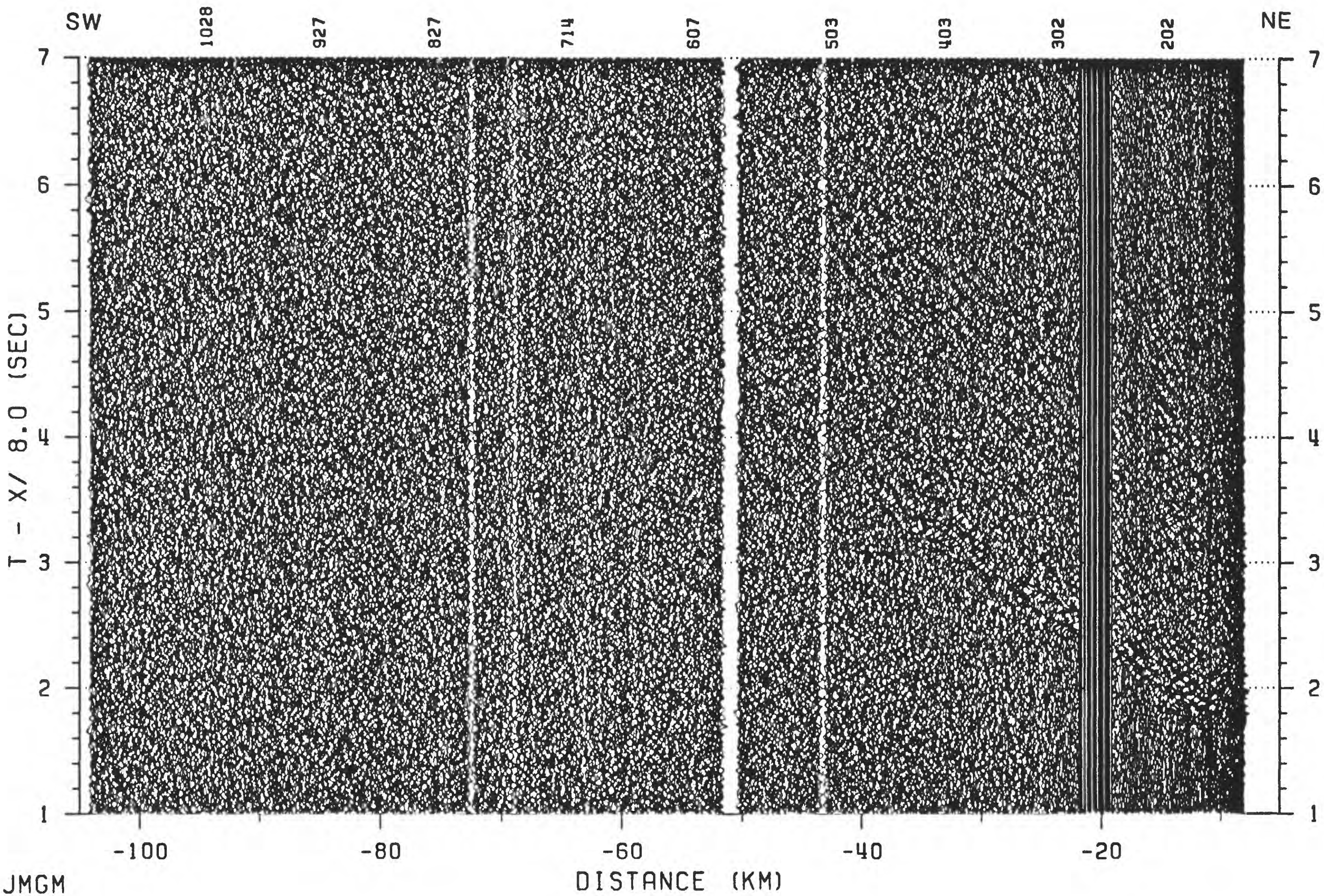

Figure 94. Receiver gather from station JMGM for BASIX line OBS2. Plot parameters are described in the text.

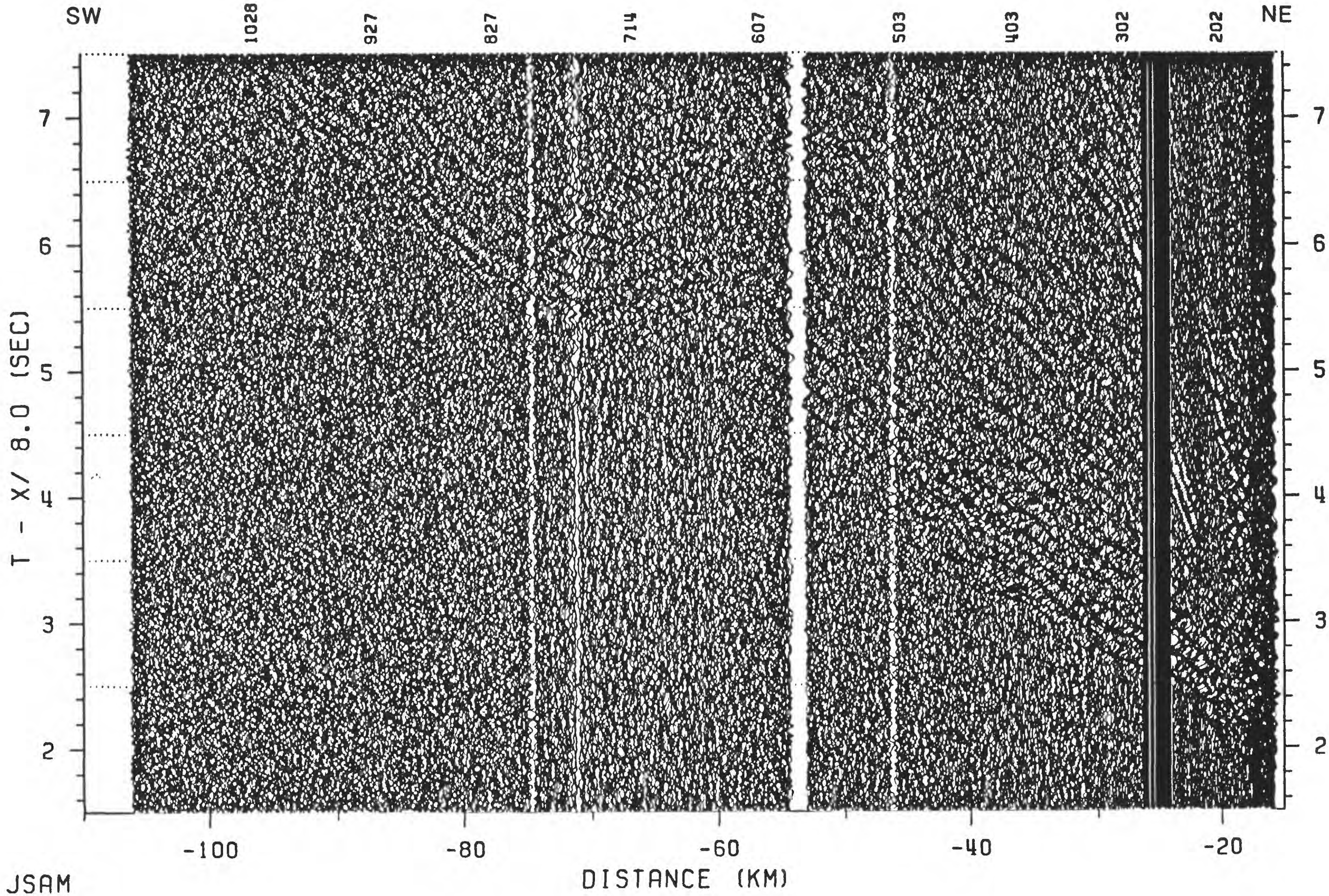

Figure 95. Receiver gather from station JSAM for BASIX line OBS2. Plot parameters are described in the text.

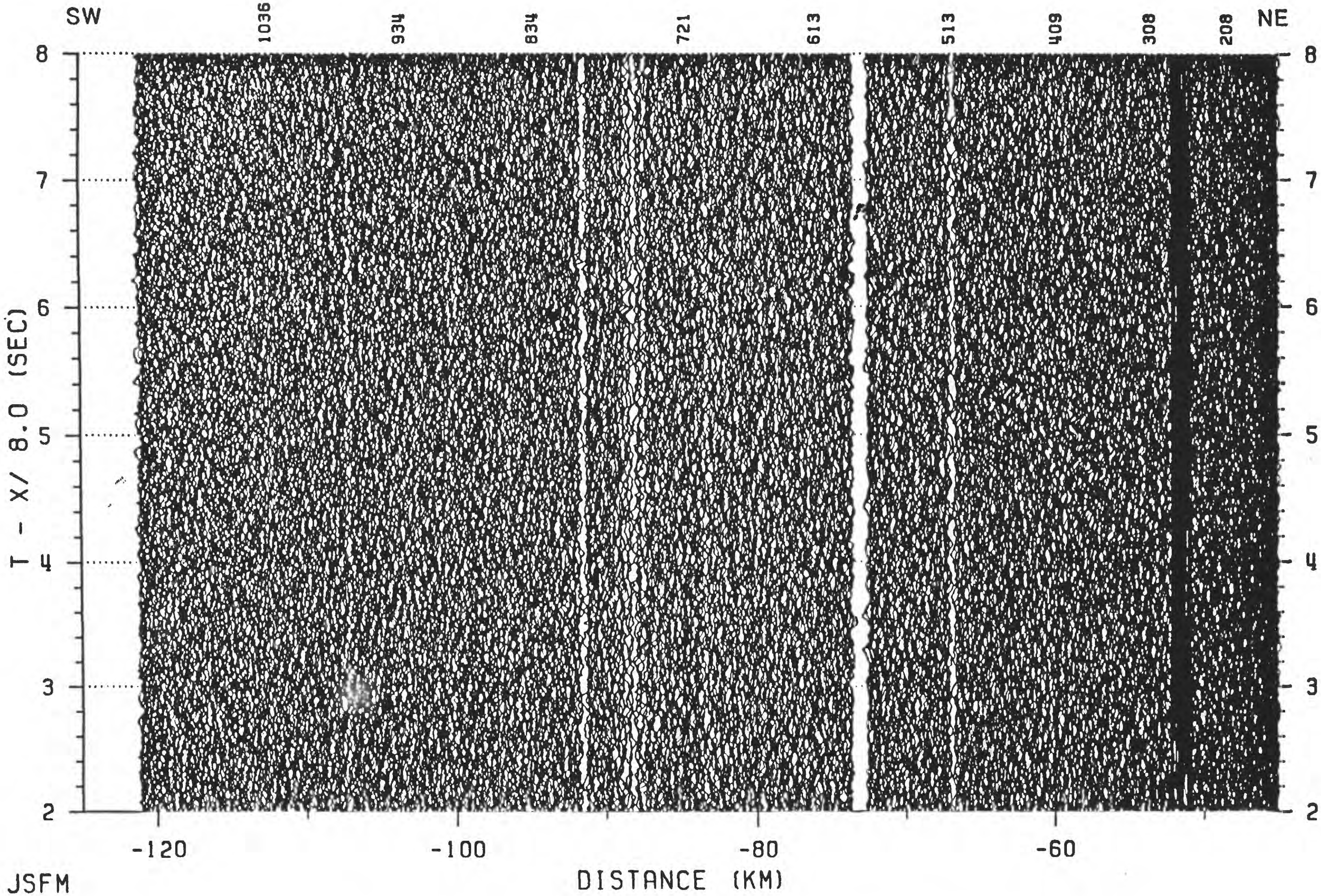

Figure 96. Receiver gather from station JSFM for BASIX line OBS2. Plot parameters are described in the text.

Appendix A. Digitizing NCSN Analog Tapes

This appendix presents a step-by-step description of the method followed for digitizing NCSN analog tapes at the USGS, Menlo Park. Several steps were required to prepare the data for digitizing, reformating, and backing up the digitized data on DAT tapes.

Throughout this appendix *italics* represent computer responses, **bold** characters to indicate the users responses and normal type for general actions or explanations. ***Bold italics*** indicates a generic users response. A carriage return is always assumed following each command. When a capital **R** follows the command it signifies two returns. **N** equals no and the converse is true, **Y** symbolizes yes.

Preparation:

Before digitizing two files are made that dictate the digitizing process. The first of these is a digitizing control file (DCF) which is in turn used to construct the second, an event scheduling file for tape digitizing (a KIN file).

First a window is created, to provide a working environment, by pressing the far left button on the mouse to open a menu. Highlight and then press the mouse button again on the line that says, *Create New VT200 Window*. Input one's login and password to complete the process.

CUSP defines the necessary computing environment.
CD HOT moves the environment to the correct directory.

DIGDCF this program prompts interactively for the user data needed to create the DCF file.

Accept Job-specific variables? **R.**
Input the date of the required data then **R** in the same format as the computer shows as an example.
Input an appropriate filename R (e.g. **L110_B2**). This filename is the name given to the .KIN file (e.g., L110_B2.KIN).
Next Tape is Daily[dai] or Dub[dub]? **DAI R.**
Enter next event [1] **R.**
Enter Digtime yyyy mm dd hh mm ss
Input the same digitizing(dig.) date as above as well the hr. and min. for the beginning of the digitizing pass. Allow a margin of 5 minutes at the beginning as well as overlap between events.

e.g. **1991 09 19 14 17 00 R**

A similar display to the dig. date is posted for the tape mount time.
Mount time is the time when the tape was turned on to record data and the time should be written on the outside of the tape box. Most likely the time the computer provides will be incorrect so, enter **N**. Now input the correct mount time in the same format as with the dig. time. If correct, press **Y**.
Enter Duration [60.00] Input length of each digitizing piece (the unit is seconds and a decimal point is necessary) **R** (we normally used **1800.)**
Enter Tape-ID and Passes as one string (e.g. **B3** would be a B tape on pass 3) R.
In order to end that query type **X** or correct any error.

Note that we kept each pass separate, for example, doing pass 1 for the entire length of digitizing line. For the next pass create different DCF and KIN files.
The program then provides a summary of one's commands for approval.

To proceed to the next dig. event type **ACC**. However, if there is a mistake there are appropriate options explained by the prompt.
Typing **R R R R** keeps the initial options the same and returns one back to the digtime for the next event.
Repeat the previous commands until the full sweep of digitizing is finished for that tape and pass. After the last event has been accepted the program asks, *More Input?* Respond **N**. The program concludes and returns the prompt.

DIGCLI program uses the DCF file created by DIGDCF to make the event scheduling file needed for digitizing (e.g., L110_B2.KIN).

File: enter, ***@filename*** of the dcf file (e.g. **@L110_B2**). The program automatically makes the .KIN file.

These steps complete the preliminary work needed for digitizing.

Digitizing:

Open and login to a digitizing window by pressing the far left button on the mouse, a menu appears as a result. Of the choices, highlight *Create New VT200 Window* with the mouse and press the button again. The new window prompts for a login; respond **DIGITIZER** and follow with the password. The system soon asks for the users initials and then the setup procedure continues for several minutes.

When the system has finished setup it displays, *Do you want to run manual digitizing?* Reply **Y**.
File: Making sure the "caps lock" is on, type in the appropriate file name of the KIN file (e.g. **L110_B2**) and then **R**.
When tape is at 15ips, type [G]o, or [S]top Cue the tape to about 10 min (on the irige counter) before the first dig. time which is posted a few lines above on the screen. <u>Make sure that the pass dial located below the irige counter is set to the right pass number (e.g. pass 1,2,3, or 4).</u> The current pass is also displayed above. Allow the tape to run at normal speed (15 ips) for at least 3 minutes of irige time and then type **G**. The "address/data" lights begin flickering.
Enter [T]rigger, [R]etry, or [S]top Default = T When the irige counter reaches 20 seconds before the dig. time press return.

The digitizing routine has now been invoked and the "address/data" lights below the screen continue to flash along with the C36_SYS disk below the desk until the duration assigned in the dcf file has passed.

After completion, the program posts the next event. Repeat the previous steps making sure to rewind the tape to the appropriate place.

After the last event, *No Dig Tuples For Tape*
Continue? [Y/N] (Default=Y),
is displayed. Respond, **N**.

File: **QUIT**

Now make a logfile to display what has just been digitized (steps 7-9).

Is There More To Do? (Y/N) **Y**.

Do you need to edit a commandfile? (Y/N) **Y**.

File: **REA *filename*** (e.g. **REA L110_B2**).

These commands cause the last event digitized to be displayed; to make a logfile save the file.

Newline: **FILE *filename.done*** (e.g. **FILE L110_B2.DONE**).

Newline: **EXIT**

Run Manual Digitizing is displayed meaning that digitization of the file is completed. Either digitize another pass or exit the digitizing window (generally one has to move those recently created files, for several reasons, before continuing with the digitization).

Problems With Digitizing:

Occasionally there are digitizing errors. Three primary errors can occur.

1) The drive never starts and the program says on completion that *Digitization incomplete* and then displays*File:*.

In this case first enter **CLOSE**.
Type **OPEN** and the .KIN file name (e.g. **OPEN L110_B2**).
Rewind the tape to the posted event, which should be the one that just failed, and start the event over.

2) The program is not correctly set up in which case it fails to trigger properly and states that *Digitization is Incomplete* and *Timer Error: Irige Not Decoded.*

If this happens, type **CLOSE** and then move to the other login window by clicking the mouse button while the arrow is on it and then enter, **CD HOT** followed by **SPINIT**.
When a prompt appears again type, **IRIGE**. After this is complete, return to the digitizing window and open the file and redigitize the event as previously explained.

3) Digitization appears to be correct but, on completion, the computer only moves down a line instead of moving on to the next event. The computer has created an incomplete file.

In this case press **S**.
The computer replies that the event is incomplete (take note of the event number of the incomplete file, i.e. if it was the second event the number would be 2).
At this point, type **CLOSE** followed by **QUIT** at the *File:* prompt.
The computer asks, *Is There More To Do? (Y/N)*, respond **Y**.
Reply **Y** to the question, *Do you need to edit a commandfile? (Y/N)* .
At the *File:* prompt type, **APP** and the file name (e.g. **APP L110_B2**).
Since the program created a file it thinks it has finished the event; fix this problem by typing, **CHA** and then the event number followed by **1** (e.g. if it was the second event one would type, **CHA 2 1**).
The program should post a listing of the event on the screen and under the heading RID it should say DUN.

Change this DUN to DIG by entering **RID DIG.**
To finish this editing type, **END.**
EXIT at which point it states, *Run Manual Digitizing.*
Move to the "Hot" window and enter, **DIRS *.EVT** to get a list of digitized files. The last event should be a different size then the others and must be deleted by typing, **DEL** and the file name (e.g. **DEL X366592.EVT;1**).
Return to the digitizing window and start again (the first event posted should be the one that had a problem).

Format Change & Transport:

Several programs must now be run before the files are completed and can be moved to a staging area to be backed up. Return to the "HOT" window where the DCF and KIN files were created.

Type **LW** ***FILENAME*.DONE** in order to print out the logfile (e.g. **LW L110_B2.DONE**).
Type **DIR *.EVT** to confirm that all the files are the same size and that there are the right number of them.
Type **QSTAT** to display the files posted to "BIGEVT" and "READY"
Type **RECYCLE BIGEVT 0 JUMP 100** to post the files to "JUMP" for the next step.
Type **JUMP** to run a program that transfers the files from the C36_sys disc to JANUS:[DIGIT.DIGITCUSP.HOT] (or more simply HOT_JANUS).

A series of four questions are posed by "JUMP". Respond in turn,

1) Press return,
2) **REFORM,**
3) **EVT,**
4) **JANUS:[].**

The program JUMP takes a little more then a minute to transfer each event.

Once the program has finished type **CD HOT_JANUS** to move to the directory where the files have been relocated; confirm the transfer by typing **QSTAT**. The files should now be posted to "REFORM".
Now move the files to the WARM_JANUS directory by typing **REFORM REFORM.DCK REFORM.**

Note that this program runs continually until told to stop. Type **QSTAT** in the HOT_JANUS directory to determine when it has finished. When Qstat is done the program says, *Nothing scheduled in Cusp.kin.*

After completion it must be halted before running JUMP again. To do this type, **SET HOST EUREKA** and then enter the appropriate login and password.
To confirm that the program running is under your login type, **CUSP** and then **QUE EUR$L3** (this displays the batch jobs running in EUR$L3).
If REFORM is running under your login, respond, **PAR SET REFORM STOP.**

The computer replies in a minute or two that REFORM has completed.
Meanwhile logout of Eureka and return to the previous window by typing, **LO.**
This same termination sequence can be used to end other batch jobs with just minor adjustments.

The events should now have been transferred to WARM_JANUS as GRM and MEM files posted to "SYNCH". To confirm this type, **CD WARM_JANUS** and then **QSTAT**.

Run the program "SYNCH" by entering, **SYNCH SYNCH.DAT SYNCH**. This program should only take a minute or so to complete.

After completion type, **CD NAMES** and then run a program by typing **TUSPINS** and then the date of the data collection (e.g. **TUSPINS 910915**, 91 being the year, 09 the month, and 15 the day).

TUSPINS runs interactively and should take a few minutes. After it has finished and the $ prompt returns type **SET HOST WARM_JANUS** then type **QSTAT** to confirm that the events are now posted to "NEWNAM" and not "SYNCH".

Type **NEWNAME.**

To verify that the programs worked type, **TUPLES** and a file id# (e.g. **TUPLES 366592**). In order to find out the file id# one may either look at the log sheet under the header, "LID/HEXON" or type **DIR *.MEM** to get a list of the files (For example, the following file, X366592.MEM, is the file for the above id#). The TUPLES command prints out several columns of numbers and letters. About half way through it should display a column four letters wide in the middle of the array of characters as seen in the example below with the pertinent section in bold.

Pin	1 0	*:	* *	WWVB	T	0
	1 1	*:	* *	IRG1	T	0
	1 2	*:	* *	IRG2	T	0
	1 3	*:	* *	PIN3	X	0
	1 4	*:	* *	**B010 X**	0	
	1 5	*:	* *	**CVPM**	E	0
	1 6	*:	* *	**B030 X**	0	
	1 7	*:	* *	**B040 X**	0	
	1 8	*:	* *	**NSPM**	V	0
	1 9	*:	* *	**NPVM**	V	0

Many of the sequences in this column should resemble seismograph station names and not a series of letters followed by ascending numbers (an exception is the end of the list on the fourth pass).

Moving to Staging Area and Backup:

The digitized files are now ready to transfer to a staging area to be backed up on to tape. We moved them to REFLECT:[BASIX.CALNET.(and a specialized directory for each tape and pass, e.g. L110_B2)]. We used DAT tapes for our backup on a DAT drive located on CUSP36.

It is necessary to open up another window (as explained above) and then, **SET HOST** (to the system for the appropriate drive to backup e.g. **CUSP36** for DAT tapes)

Now to get in the appropriate directory by saying for example, **SET DEF REFLECT:[BASIX.CALNET.L110_B2]** (the L110_B2 signifies the line, tape and pass digitized). A simple **DIRS** displays the size and contents of the directory. To create a directory one must be in the directory below the proposed directory and type, **CREATE/DIR** *[.(DIRECTORY NAME)]* (e.g. to create the directory 110_B2 one would type **SET DEF REFLECT:[BASIX.CALNET]** and then enter, **CREATE/DIR [.L110_B2]**).

COPY JANUS:[DIGITNET.WARM]*.GRM,*.MEM */LOG copies the files from WARM_JANUS to the present directory. This should take about a minute or two for each GRM file.

Even though the files are now in the new directory they are still present in the old one as well, so after confirming the copying delete the old files in the other window (**DEL *.GRM;1** and **DEL *.MEM;1**). Now the files are ready to be backed up.

Making sure one is in the correct directory allocate the backup drive by typing, **ALLOC MUA1** (The name of the DAT drive on CUSP36).

Assuming the drive is allocated type, **INIT MUA1** (and an appropriate 6 character label for the tape for example, **INIT MUA1 110_B2**).

Once the prompt returns type, **MOUNT/FOR MUA1**.

The computer should respond after a brief pause that it is mounted, if so enter **BACKUP/LOG/VERIFY *.* MUA1:**(a label such as **BASIX110_B2.BCK**) **/BLOCK=32256/IGNORE=LABEL**.

The computer now begins to back up the files in that directory taking approximately 2 to 3 minutes for each GRM file.

When the computer has finished and the $ prompt appears again type, **DISMOUNT MUA1** in order to eject the tape.

Type **DEALLOC MUA1** to deallocate the drive.

Make sure to type **LO** twice as well, to account for both CUSP36 and the initial window.

This section concludes the entire digitizing and backup procedure, however, some advanced procedures are next discussed. They include: 1) How to take the data back off the tapes, and 2) time saving tips.-

Data Recovery from Backup Tapes:

Before the digitized NCSN data can be further processed, they must be removed from the backup tapes. We used the DAT drive mual located on CUSP36.

Log-in to CUSP36.

Type **SET DEF** to the directory one wants the files backed-up to.

Type, **ALLOC MUA1**. The computer responds shortly that either the drive has been allocated or that it is already in use.

Insert the desired tape in the drive and enter, **MOUNT/FOR/NOWRITE MUA1** to which the computer answers that the tape is mounted (if it responds otherwise it could have been because the command was entered before it had finished loading the tape).

Type, **BACKUP/LOG MUA1:/SEL=*.*;* *.*** to initiate the retrieval of the files.

After completion tell the computer to first, **DISMOUNT MUA1** in order to eject the tape.

Type, **DEALLOC MUA1** to release the drive.

The files should now be restored to the desired directory.

Time Saving Tips:

After developing a basic understanding of the digitizing process one can try and run several of the different steps concurrently. However, there are several do's and don'ts:

1) Do not digitize at the same time one runs the programs "JUMP" or "NEWNAME" because the digitizing event in progress is disrupted by the activity on the C36_SYS drive.
2) Do not run the programs "JUMP" and "SYNCH" at the same time because they both use the same queue, EUR$L1. Run "SYNCH" before running "JUMP" since "SYNCH" runs in only a few minutes as opposed to the 20 to 30 minutes needed for "JUMP".
3) Due to the large number of files, it is important to be aware of the amount of space available on each disc. Type, **BR** and the drive name (e.g. **BR JANUS** tells the amount of space available on the janus disc).
4) It is important to keep each digitizing pass separate so one must be careful when running several programs at once. Remember that "REFORM" runs continuously unless stopped. As a result is is quite easy to run "JUMP" with "REFORM" still on and another pass waiting in WARM_JANUS and end up with a pileup of files.
5) If one does accidently run a program out-of-order stop it as described previously for stopping the program "REFORM". By taking note of what queue each program operates in one can move to the appropriate directory and get a listing of the operations by typing, **QUE** and the program queue (e.g. **QUE EUR$L1**). To halt the program enter either, **PAR SET** and the program name **STOP** (e.g. **PAR SET REFORM STOP)** or by saying, **DELETE/ENTRY=** and the number associated with the program displayed (e.g. **DELETE/ENTRY=336**).

Appendix B. Converting to Segy Format

This appendix presents a detailed, step-by-step guide for converting digitized NCSN files into SEGY files at the USGS, Menlo Park. These steps including checking the time code (using CHKTC), slicing out sections of files having bad time codes (using SLICE), converting the files to segy format (using TO_SEGY), and plotting the files (using RSEC90 and TRAN4).

Getting Set Up:

Call, Display, Modify is initially displayed when the computer is turned on. Respond **C GSVAX0.**
When the computer says that the call is complete press return and then login.
Type, **SET HOST EUREKA** to gain additional speed by moving to Eureka. Again, when prompted to, login.
Because several of the commands are defined in a cusp environment, enter **CUSP**.
Now move to the correct directory by typing, **SET DEF (or SD) REFLECT:[BASIX.CALNET.*(and the appropriate directory)*]**.
Make directories for each pass digitized. Generally the format of the directory name is, **L**(followed by the line number)_(followed by the Tape letter and the pass) (e.g. **L110_B2** is the second pass of line 110 on a B tape).

Recovering Data Off the DAT Backup Tape:

If the desired files are not present in the directory, restore them from the DAT tape on which they are backed up. We assume use of the DAT drive mua1 on CUSP36.

When in the correct directory type, **ALLOC MUA1.**
Assuming the drive is allocated, insert the appropriate tape into the drive and then enter, **MOUNT/FOR/NOWRITE MUA1.**
When the tape is mounted, type **BACKUP/LOG MUA1:/SEL=*.*;* *.***, to initiate the restoration of the files.
When the backup is finished, type **DISMOUNT MUA1** to eject the tape, followed by **DEALLOC MUA1.**

The files should now be restored to the appropriate directory.

Conversion to SEGY Format:

Now the files must be run through a series of programs to convert them into Segy format and to plot them using RSEC90 (Luetgert, 1988). In the process one needs several files in addition to the files retrieved from the disk. These files are SEGY.KOM, PASS*.SITES (where * is 1 to 4), SFB91COORD_***B.DAT (the *** represents a line number, such as 107), and OGLOBAL.JMP. Copy them to each desired directory by entering, **COPY [BASIX. CALNET.L105_B1]*(the file name)* *.*** (e.g. **COPY [BASIX.CALNET.L105_B1] SEGY.KOM *.***).

Enter **DIRS** to find the id#s of the files.

CHKTC

The first program, called "CHKTC", checks the time code of the files and produces a log file, chktc.lis, with the needed information. The program is post scheduled so type, **POSTM *(lowest id#) (highest id#)* CHKTC 100** (e.g. **POSTM 368808 369007 CHKTC 100**).

Type **STATUS CHKTC** to confirm that the files are posted correctly. There should be a list of id#s followed by a column of 100's and then a column of 0's (when a posted event is completed the 0's are replaced with 1's).

Once all the events are correctly posted enter, **CHKTC 1**.

The CHKTC program runs for several minutes.

After completion, when the $ prompt returns, enter, **TYPE CHKTC.LIS** to view the log file. It is often helpful to print out a hard copy by typing, **LW CHKTC.LIS**.

The file contains an entry for each of the files. Bad time code files have the heading "PULSE_CNTS" with a non multiple of 10 below, e.g.:

PULSE_CNTS	END_OFFSET	T	?TCORR(S)?
11	115028	1991 SEP 16 0356 36.89	-0.10 0.090

This section must be removed from the event because it contains a bad portion of time code. The END_OFFSET (115028) is the time in hundredths of a second to the error from the start time (or 1150.28 sec.). Following this is the actual time the error took place. To remove this error run a program called "SLICE", which takes an event and breaks it up into multiple events.

SLICE

Create a file with the same name as the flawed event except with the suffix, CUT (e.g. for the event X368808.GRM one creates the file X368808.CUT). To do this type, **EDT X368808.CUT**.

Edit the file by pressing **C**.

The file must contain the information directing the program to break the bad file into several events without the flaw. The program requires a start time for each piece as well as a duration, e.g.:

```
1991  09  16  03  40  26.62  1150.18
1991  09  16  03  59  36.99  666.52
[EOF]
```

The first line contains the year, month, day, hour, minute, and seconds for the beginning of the first new event. The last number, in the first line, is the desired duration of the new event file (It is necessary to shorten the duration 0.1 seconds of the duration on each side of the flaw in order to insure removal of the bad time code). The second line provides the same information as the first except it is for a second new event file. Therefore the start time of the second new event is 0.1 seconds after the flaw and then the duration is found by subtracting the time of the error from the time of the next error and subtracting 0.2 seconds from this number (to insure removal of the bad time code). Note that the total length of the file is given under "PULSES EXPECTED" (In our thirty minute files this number was either, 18171 or 18170. Both values are in tenths of seconds). So in the example the duration 666.52 is calculated from 1817.00 - 1150.28 - 0.2. Once these lines are created, the file can be exited (if there are several flaws in one event, at different areas, several lines are necessary to break it into several new event files).

Before running "SLICE", the flawed file or files are posted by entering, **POST *(id#)* SLICE 100** (e.g. **POST 68808 SLICE 100**).

Now run "SLICE" by simply typing, **SLICE**.

After completion, **TY SLICE.LOG** to view the log file. To make viewing easier and to keep records it is useful to print out a hard copy as well by entering, **LW SLICE.LOG**.

SYNCH

The events that were sliced should now be posted to "SYNCH" and to confirm this type **STATUS SYNCH**.

Assuming they are posted, run "SYNCH" to realign these events, **SYNCH**.

It is a useful to rerun "CHKTC" in order to be insure that the bad time sections have been removed.

To do this type, **DEL CHKTC.LIS** and then delete the bad event file as well.

Run "CHKTC" again.

TO_SEGY

Before running the program that converts the files into Segy format first edit both the "SEGY.KOM" file as well as the "PASS*.SITES" file, where the * represents the pass number. With the "SEGY.KOM" file be sure to change the azimuth to the strike of the seismic line and to confirm that the directory is the one needed. The "PASS*.SITES" file can include every station desired for this pass on a separate line. E.g.;

CVPM
CPMM
CPVM
etc,

When the conversion program, "TO_SEGY", is run it is important to post and run the files in the appropriate order in time. Therefore, it may have to be run several times depending on the number of out of place events created from files with bad time codes. An example is given below.

File Number	Time
1	1:30
2	2:00
4	3:00
5	3:30
6	4:00
7	2:30*
8	2:48*

*These files were created from the flawed and now deleted #3 file.
If these files were posted and run all at once, the output file would have the events out of order. Therefore, events #1 and #2 must be posted and run through "TO_SEGY" followed by events #7 an #8 and lastly events #4, #5, and #6.

Post these events as explained above by typing, **POST** *(id#)* **SEGY 100** (e.g. **POST 368808 SEGY 100**).

Once the first batch of files are posted enter, **TO_SEGY**.

TO_SEGY runs for several minutes or hours (depending on the number of events and stations) and creates output files with a prefix of the first three letters of the stations followed by a **_V** and then a suffix of **0** (zero) and the line number (e.g. for station CAIM on line 112 the output file would look like, **CAI_V.0112**). As each batch of files is added for that station the size of the output files grows.

To confirm that there is a transfer of shots, type, **SEGY_LIST**.

The computer asks, *Enter Name of Segy File:*; respond with the recently created file.

The computer counters with, *Enter Name of Output File [Sys$output]*; answer with a carriage return.

Finally the computer asks, *Swap Bytes?:(.True. .or. .False.)* Respond **.FALSE.**

The computer displays a file with a series of abbreviated words followed by numbers. Note the number of shots abbreviated as "NOTIF". This number should be similar but, not exactly the same as the number of shots.

To compare the two, edit the shot file (e.g. **EDT SFB91COORD_ OBS1B.DAT**) and then **QUIT**. The number of shots should be equal to the number of lines which is displayed when one quits.

Creating a Plot:

Type, **RSEC90** (see Luetgert, 1988 for documentation on RSEC90).

When the "?" prompt is displayed, enter, **OPEN SEGY**.

The computer asks what segy file. Answer with the appropriate filename (e.g. **CAI_V.0110)**

When the "?" prompt appears again enter, **LIST DATA**. A long list of data scrolls by with each line representing a different shot. The information includes, the shot number, the distance from the station, and the azimuth as well as other things. Upon completion the program displays the minimum and maximum distances from the station. Write these values down because they are needed to edit the command file. Type, **QUIT** to end this program.

Rename and edit the command file. To rename see explanation shortly after the heading of "Conversion".

Get into the editor and change the first line of the file to read the present directory.

Next edit the "Range" so it reads the two values one just obtained going from lowest to highest.

Also edit the line, *Set Plotid* ***** and *Open Segy* ***** so that the asterisks represent the segy file (e.g. CAI_V.0110). **EXIT**.

Type **SUBMIT/QUE=EUR$L3** ***(the .COM file)*** (e.g. **SUBMIT/QUE=EUR$L3 CAI_V.COM**). The files are now being prepared and sent off to the printer (the program runs on the queue, EUR$L3).

Masking Traces in a Segy File:

Several BASIX seismic lines double back on themselves muddling the plots of the record section. For this reason, it can be useful to plot out only part of the shots for a BASIX line at a time by masking unwanted traces using the program TRAN4 (J.H. Luetgert, User's Manual for TRAN4, Interactive seismic data editor for USGS refraction data in direct access disc SEGY format, 29 pp., unpublished document, 23 Oct. 1990).

Before performing the masking operation make another copy of the segy file because the segy file is altered by the masking procedure.

To do this type, for example, **COPY CAI_V.0202 CAI2_V.0202**.

First list the shots in the segy file to enable the masking of traces. To do this use **RSEC90** as described previously.

Note the locations of the shots to be masked.

Exit from RSEC90.

To mask traces run the program TRAN4 by typing, **TRAN4**.

At the prompt *Open Segy*, enter the appropriate filename, e.g. **CAI2_V.0202**.

After the prompt *Enter Task*: type, **EDIT**. A menu is then displayed with numbers corresponding to different options.
Select the number which says, Mask Traces, **10.**
The computer asks, *Mask by Location Number (1) or Record Number (2)* with a matching number by each option. Select, *by Loc#.*
Now enter the range of shot numbers to be masked. Repeat as many times as necessary.
Exit from TRAN4 by entering a return, a 0 return, and then exit.

The Segy file, e.g. **CAI2_V.0202**, is now ready to be plotted using RSEC90.

ACKNOWLEDGEMENTS

We thank Jill McCarthy of the USGS for organizing and heading the BASIX project. Andy Michael helped us save the NCSN tapes. Bob Somera taught us how to digitize NCSN tapes. Vicki Goetcheus helped to digitize the NCSN tapes. Allan Walter wrote the to_segy program and instructed us how to convert the digitized NCSN tapes to SEGY formatted files. Will Kohler, Jim Luetgert, and Peter Ward provided programming assistance. Barbara Bogaert coordinated the NCSN digitizing. Rick Lester patiently waited for us to digitize the NCSN tapes. Allan Walter and H.M. Iyer provided useful comments on an earlier draft of this report. Dave Oppenheimer plotted Figure 4.

This work was supported by the National Earthquake Hazards Reduction Program.

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