IV-C. Comparison of Network and Portable Arrival Times (Common Site).

In February of 1993 a Reftek instrument was installed at the top of Little Skull Mountain directly adjacent to (within 20 meters of) one of the permanent stations of the UNR Southern Great Basin Network. The station operated for several weeks during which time a number of triggered events were recorded coincidentally with the permanent net. Timing control for permanent network stations is provided by IRIG which is received at the University of Nevada Seismological Laboratory in Reno. IRIG is transmitted by satellite and its time accuracy is maintained by the U.S. Bureau of Standards. Trace data is time marked in Reno as it arrives via microwave from southern Nevada. Both the portable and network data are sampled at 100 samples per second.

The following set of pairs of plots show arrival time picks and traces for five coincidentally recorded events at the station LTSR of the permanent network and the portable Reftek station. The plots of P-wave arrival time picks for station LTSR are screen dumps from the VMS system which runs the CUSP processing software and program "PICKEM". Plots and P-wave arrival picks for the Reftek arrivals are from program PQL acquired from the IRIS/PASSCAL data center. Unfortunately there are problems with the seismometer response at the Reftek site which do not allow us to directly compare waveform data, although first arrival times compare to within +/- 2 samples (.02 seconds). Also, a non-causal anti-aliasing filter within the Reftek data acquisition system tends to introduce a high-frequency precursory signal for very impulsive arrivals, which sometimes obscures the precise P-wave arrival. (This problem is accentuated by the faulty seismometer response at this site.)

P-wave arrival times from the permanent network are referenced to the minute during which the system actually triggered and may appear to be off by 60 seconds. The P-wave arrival time for the CUSP triggered data is written at the top left of the plot and the Reftek picks are found at the top center of each plots. Each pick time is referenced as a vertical bar and as an "x" for the network data and the Reftek data, respectively. All events included in the comparison are aftershocks of the Little Skull Mountain earthquake.

<d0 74.88
S

19687

.TSR

-19687

1993 Mar 08 1326 46.82 CINCO$DKA500:UNRNET.93.93JUN.KENNYS X225867.GRM;1

18631.
LTSR
-19687.

2021.
LMTR
-19569.

19276.
LSMS
-20713.

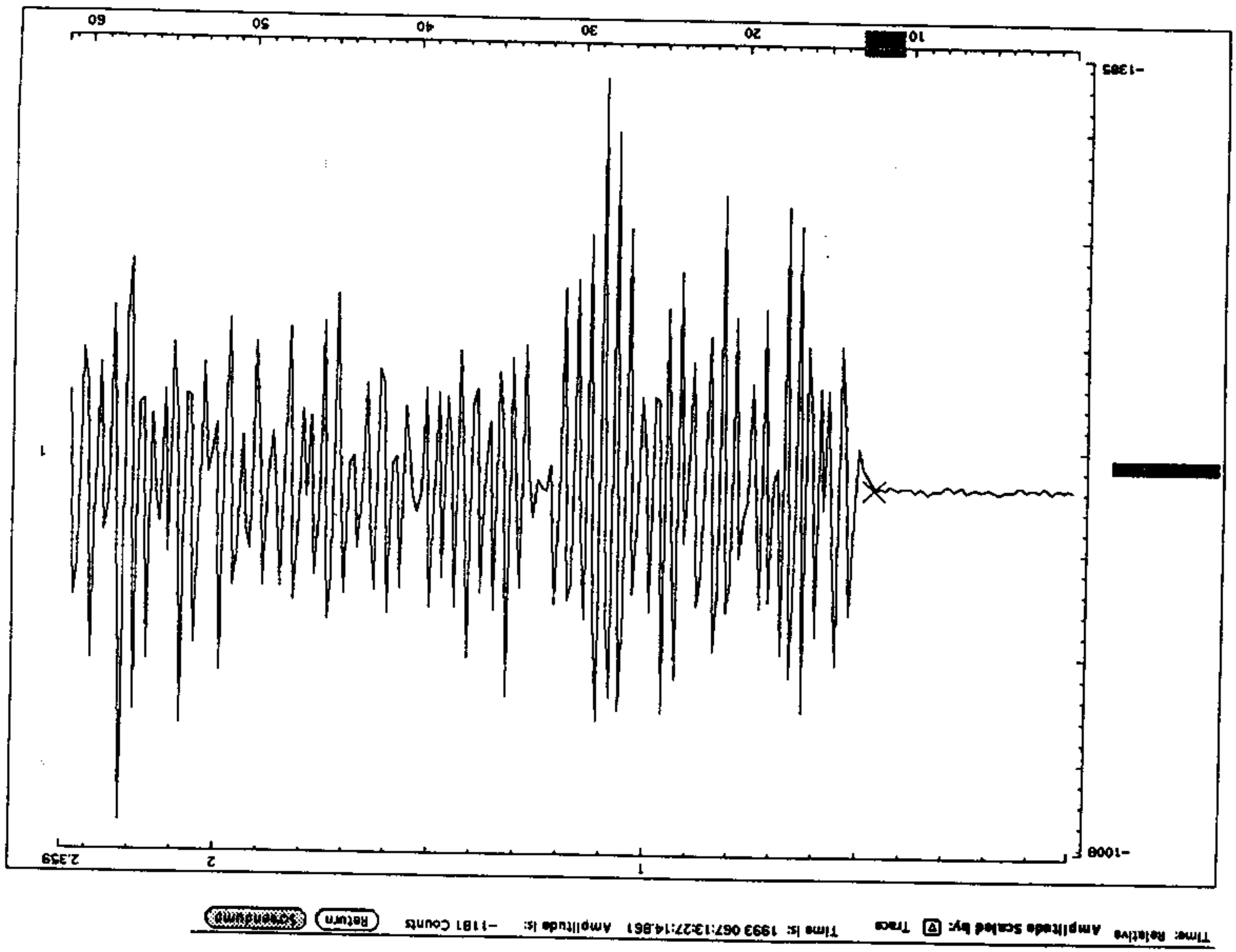
2694.
LSMS
-1247.

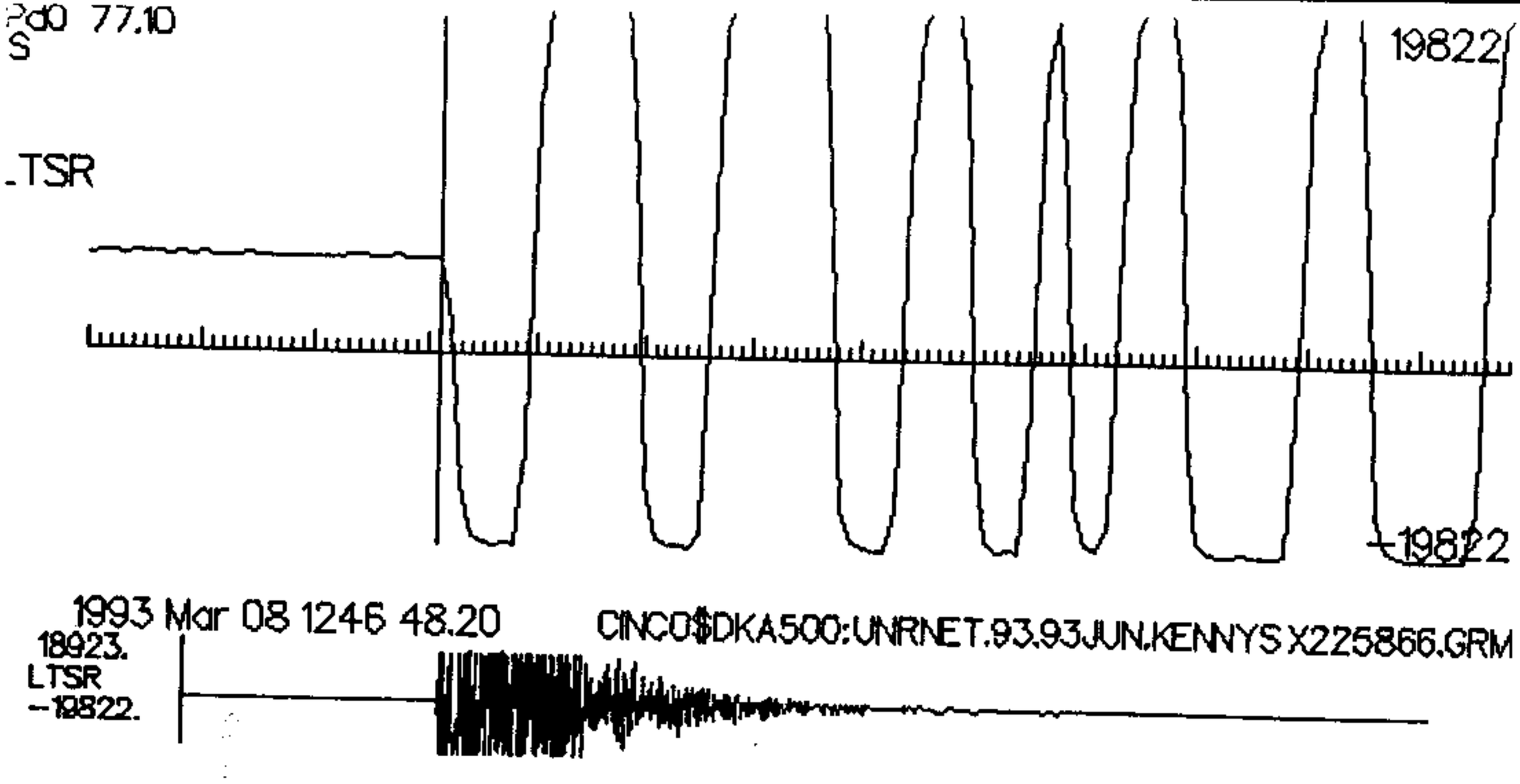
2209.
LSMS
-2440.

2474.
KRVR
-2495.

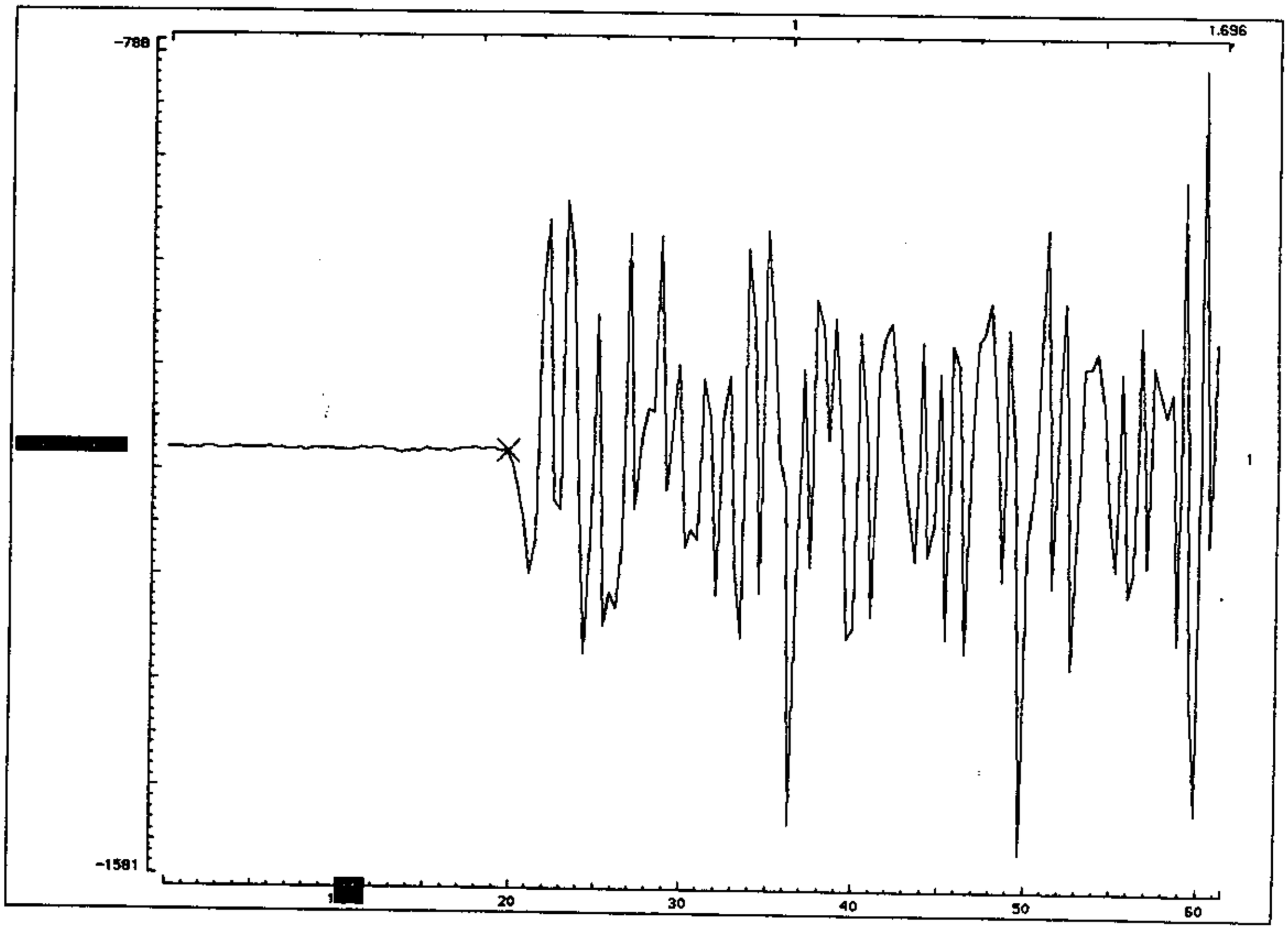
17777.
TWRR
-19432.

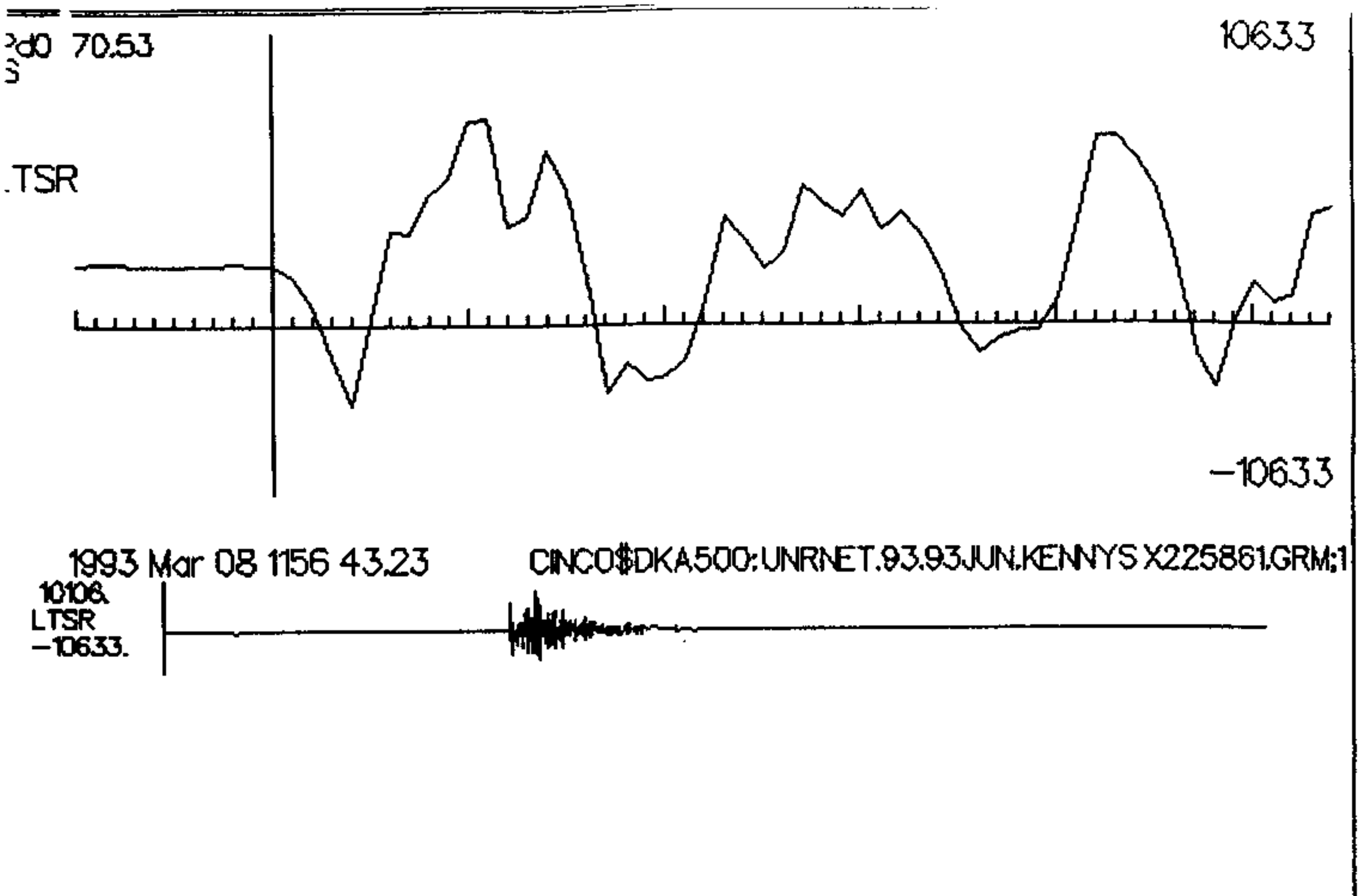
2461.
NSPR
-2477.

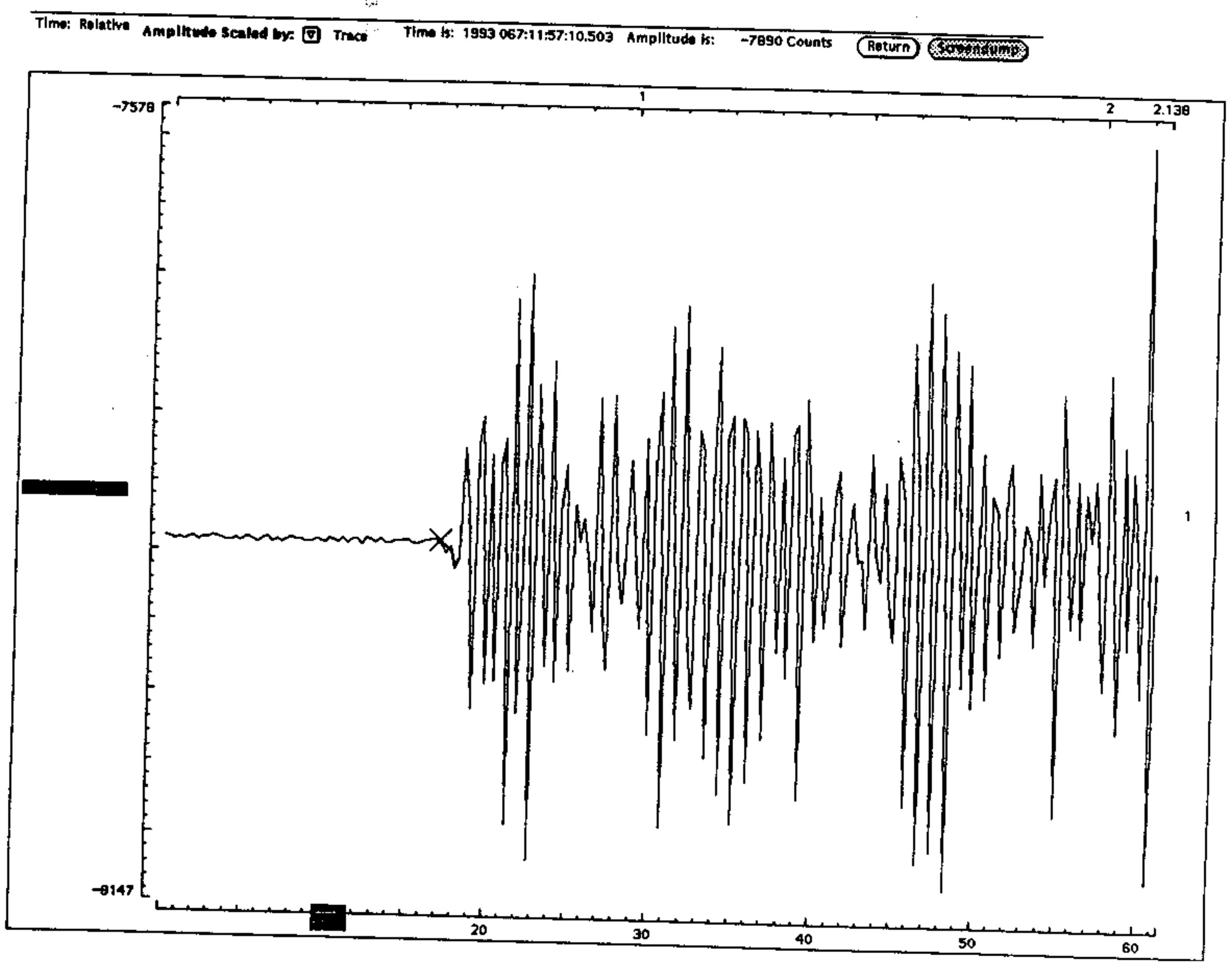

60
50
40
30
20
10
-1385
-1008
1
2
2.359
Time: Relative Amplitude Scaled by: Trace Time is: 1993:067:13:27:14.861 Amplitude is: -1181 Counts Return Expand/Jump


Pd0 77.10
S
19822
.TSR
-19822
1993 Mar 08 1246 48.20
CINCO$DKA500:UNRNET.93.93JUN.KENNYS X225866.GRM
18923.
LTSR
-19822.

Time: Relative **Amplitude Scaled by:** Trace Time is: 1993 067:12:47:17.089 Amplitude is: −1180 Counts Return Screendump




10633
TSR
-10633
1993 Mar 08 1156 43.23
CINCO$DKA500:UNRNET.93.93JUN.KENNYS X225861.GRM;1
10106.
LTSR
-10633.


Time: Relative
Amplitude Scaled by: Trace
Time is: 1993 067:11:57:10.503
Amplitude is: -7890 Counts
Return
Screendump
-7578
1
2
2.138
1
-8147
20
30
40
50
60

V. EDA/PRS4 Portable Data (Deployment off the Test Site).

V-A. Processing of EDA/PRS4 Data

In addition to the Reftek Instruments that were deployed on the Test Site, three EDA/PRS4 portable stations configured with three component Teledyne Geotech S-13 velocity seismometers were deployed off the Test Site in the Specter Range and south of Crater Flat. These stations were installed early in the aftershock sequence and were operated through mid-July 1992. This type of recording system (PRS4) requires almost daily attention since the units are only capable of storing 1 Megabyte of data in their static memory as compared to local storage of 175 Megabytes at Reftek sites. From middle of July through the end of the year PRS4 sites were reoccupied with Reftek instruments.

Time is set on a master clock from a WWVB radio signal. The master clock synchronizes with the radio signal for correct absolute time. The station deployment code and trigger parameters are established on an IBM PC compatible computer which is downloaded to each instrument prior to field deployment. At this time the internal clock of the PRS4 instruments is synchronized with absolute time. When the instruments are recovered from the field, a time differential is calculated at the time of uploading of the field data from the portable instrument to a PC. A linear time drift of the internal clock is assumed and timing correction are generated for each deployment period per instrument for timing corrections of individual phase picks.

Below is a summary of the field deployment for the EDA/PRS4 instruments. Listed is the field station name, the PRS4 serial number, the local time for set of time, the time of deployment, the calculated drift in seconds for that time period, the station location and the number of triggers that were recorded on that instrument for that particular deployment. Also listed are the serial number of the S-13 seismometers deployed at each site.

V-B. Deployment Information

EDA Little Skull Mountain Deployment - Field Notes

STA	EDA	LOCAL TIME		TIME SET	TIME DEPLOYED	DRIFT	STA LOCATIONS	#trig
YUC1	40 6/29 4:30PM			181:21:17:24	182:07:23:52	+0.003	36N39.1141 116W12.4549	
				182:03:46:07	183:06:32:37	+0.956	(leap second)	
YUC1'	66 6/30 11:00AM	7/1	11:30AM	182:14:39:46	183:22:41:45	+0.815	36N38.8630 116W12.4581	67
LSM	56 6/30 5:30PM			182:23:31:22	185:16:58:15	+0.940	(leap second)	9
	strong motion setup							
YUC	39 6/29 5:30PM			181:21:19:41	182:07:15:54	+0.035	36N37.2184 116W12.8394	4
	57 6/29 10:00PM			182:03:51:41	183:06:21:17	+0.984	(leap second)	
	39 6/30 11:50PM			low battery data lost				
	57 7/1 11:50PM			183:15:08:25	184:15:21:46	+0.008		14
	66 7/1 10:10PM			lost data				
	57 7/2 11:40AM	7/4	5:50PM	185:17:18:00	184:02:38:55	-0.015		38
	57 7/4 5:50PM	7/5	5:10PM	186:15:42:52	186:04:46:18	+0.029		33
	56 7/5 5:10PM	7/6		187:21:25:15	189:05:02:25	-0.055		42
	57 7/6 7:32PM	7/7	4:50PM	188:20:58:05	190:02:42:12	+0.019		76
	56 7/7 4:50PM			no data power failure				
	57 7/8 3:40PM	7/9	2:10PM	190:19:57:50	192:00:06:50	+0.011		33
	56 7/9 2:10PM	7/10	7:05PM	191:17:18:43	193:04:30:35	-0.026		4
	57 7/10 7:05PM	7/11	5:40PM	192:17:07:19	194:15:24:46	+0.029		34
	56 7/11 5:40PM	7/12	2:40PM	193:21:06:53	195:01:47:04	-0.008		13
	57 7/12 2:40PM	7/13	1:15PM	194:17:02:25	196:00:51:38	+0.067		23
	56 7/13 7:15PM	7/13	2:30PM	195:17:05:02	197:00:11:12	-0.058		31
	57 7/14 2:30PM	7/15	9:00AM	196:17:46:30	197:19:10:37	+0.005		25
BND	40 6/30 11:00AM			182:41:28:19	183:23:47:10	+0.978	36N39.87 116W12.29	48
	36 6/30	7/1	9:20PM	183:15:06:23	184:15:35:24		(leap second error)	
	39 7/1 9:20PM			184:02:43:51	185:16:00:30	-0.194		15
	36 7/2 11:00AM	7/3	12:50PM	184:16:12:39	186:04:55:02	-0.064		25
	66 7/3 12:50PM	7/4	5:10PM	185:17:14:56	187:02:55:06	-0.200		35
	36 7/4 5:10	7/5	4:15	186:15:49:03	188:04:37:06	-0.055		26
				get error message:error:Lithosis crashed?				6
	66 7/5 4:15	7/6	6:45	187:21:22:51	189:04:42:42	-0.225?	-0.025?	
	36 7/6 6:45	7/7	4:12	188:20:58:05	190:01:54:46	0.000		10
	66 7/7 4:15	7/8	2:50	189:19:58:58	191:01:47:03	-0.167		95
	36 7/8 2:50	7/9	1:15PM	190:20:00:23	192:00:24:02	-0.014		79
	66 7/9 1:25PM	7/10	4:40PM	191:17:23:07	193:04:38:35	-0.205		36
	36 7/10 4:40PM	7/11	4:10PM	192:17:05:12	194:05:11:30	-0.017		60
	66 7/11 4:10PM	7/12	1:55PM	193:21:09:17	195:01:58:46	-0.150		41
	36 7/12 1:55PM	7/13	12:30PM	194:17:04:45	195:21:54:58	+0.040		30
	66 7/13 12:30PM	7/14	1:45	195:17:09:31	196:23:15:02	-0.217		31
	36 7/14 1:45PM	7/15	7:40PM	196:17:48:52	197:19:25:03	-0.019		42
	8-13 seismometers			#1418 Z				29
				#1404 N				
				#1416 E				
DUN	43 7/1 2:00PM	7/3	11:29AM	183:16:09:58	186:04:34:57	-0.043	36N41.13 116W32.25	45
	39 7/3 11:29AM	7/4	6:40PM	185:17:21:27	187:02:23:20	-0.177		27
	43 7/4 6:40PM	7/5	6:00PM	186:15:45:01	188:05:02:24	-0.023		38
	39 7/5 6:00PM	7/6	8:30PM	187:21:27:58	189:05:27:10	-0.206		15
	43 7/6 8:30PM	7/7	3:25	data lost due to power failure				
	39 7/7 3:25PM	7/8	4:40PM	189:19:54:05	191:02:23:17	-0.136		
	43 7/8 4:40	7/9	12:20PM	190:19:54:58	191:22:22:06	-0.017		91
	39 7/9 12:20PM	7/9	8:50PM	191:17:20:53	193:06:22:56	-0.197		37
	43 7/10 8:50PM	7/10	6:30PM	192:17:09:22	194:05:28:12	-0.019		79
	39 7/11 6:30PM			193:21:04:50	195:03:06:59	-0.127		80
	43 7/12			194:17:06:52	195:21:38:03	+0.031		14
	39 7/13 2:00PM	7/14	3:30PM	195:17:07:10	197:03:30:05	-0.224		23
	40 7/14 3:30PM	7/15	6:20PM	196:17:44:19	197:18:27:48	-0.032		34
	8-13 seismometers			#1415 Z				72
				#1419 E				
				#1406 N				

EDA is EDA serial number.
Drift is in seconds.
#trg is the number of triggers during the deployment.

V-C. Calibration and Instrument Parameters

Waveforms from the EDA instruments included on the data tapes cover the first 2 weeks of the aftershock sequence from approximately 1 day after the mainshock. Many of the regional recordings that are also included in this data set are larger aftershocks from the Landers, California, area that triggered the portable stations. Also within the data set are a number of calibration pulses from calibration sequences that were periodically performed. These pulses were the result of a 5 volt boxcar impulse signal. In order to determine true ground motion the coil constants of the S-13 velocity seismometers must be considered. Specifications for all S-13 seismometers, both vertical and horizontal components, report a transfer function by the manufacturer of 629 V/m/s. Seismometers are configured at a 1 Hz free period. We have measured the output of the EDA digitizer as $2.35 \pm .06 \times 10^{-6}$ V/count.

VI. First Motion Database

VI-A. First Motion Determination from Portable Data

Reftek and PRS4 data were converted to SAC (Tapley and Tull, 1991) format and picked with SAC internal processing function "ppk" (Tapley and Tull, 1991). Programs to convert PRS4 and Reftek format data to SAC are included in this data submittal.

VI-B. Pick File Format

The first motion data base included on magnetic media was compiled from a number of sources. These include the network first motion data picked by the USGS in Boulder (prior to September 1, 1992), Colorado, portable first motion data from the USGS (smoked paper records and DR200 data), network first motion determined at UNR (after September 1, 1992), portable data from the UNRSL deployment (Reftek and PRS4 EDA instruments). Pickfiles are organized by month and file name is on a month-day-hour-minute format with an arbitrary file extension. File extensions may be different for events that occurred on the same minute and this is done to account for more than one event during that minute. The file naming convention was developed so that files could easily manipulated on a PC.

An event association scheme was developed to merge UNRSL network, UNRSL portable and USGS data into a common pickfile data base. The following is an example of the input format of the first motion data base used in the earthquake relocation process. The format is essentially that used in-house at UNR. More information is provided in the pick files for the October through December time periods which cover the time UNRSL was determining first motions. P-wave and S-wave arrival times are referenced to the minute during which they occurred and are weighted by the analyst. Polarity information of the first arrival is also included, either u for up or d for down. Polarity information for the September through December time period (UNRSL first motion data) must be corrected with a reversed station list. See von Seggern (1993) for a detailed description of network processing parameters.

Reference Minute						Magnitude
A 9207161434		.00				
E						1.36
RLSM	Pe	6.14	0	S	7.29	2
LSM	Piu	6.13	1		7.28	3
LOP	Piu	7.87	1			
CDH1	Ped	7.22	1			
YMT1	Piu	9.35	2			
YMT2	Piu	8.00	1			
YMT3	Pid	6.97	1			
YMT4	Peu	8.08	1		10.63	4
YMT5	Peu	8.70	2		10.61	4
MCY	Ped	10.15	3			
TMBR	Peu	10.67	3			
Station		Ptime	Wt.		Stime	Wt.

VI-C. Little Skull Mountain Earthquake Location, Station Files, and Velocity Model.

The final technical report contains details on the relocation procedure. The following data files are included on 9-track tape. Program FASTPONG (von Seggern, 1993) was used in the relocation of Little Skull Mountain earthquakes. See technical report for details on relocation procedure.

Relocated Hypocenters - lsm.hypo
Station file with P-wave station corrections - sta_4.str
Velocity Model - vel.hof

Hypo71 Format - Fastpong Output File

Origin Time	Lat	Lon	Depth	ML	#	GAP	rms	close	far
920629 1014	22.47	36 43.17	116 17.76	11.77	5.6	16	27	0.08	3.33	419.31

close - closest station
far - most distant station
- number of station used in location less than 75 km.

Velocity Model - a variation of the Hoffman and Mooney (1984) Velocity Model

vel	depth
5.85	0.0
6.0	1.0
6.35	25.0
6.6	30.0
7.8	35.0

Station Location File - example of input station location file.

Sta	Lat	Lon	Elev	P-wave residual
BGB	37 2.24	116 13.75	1730	0.0500

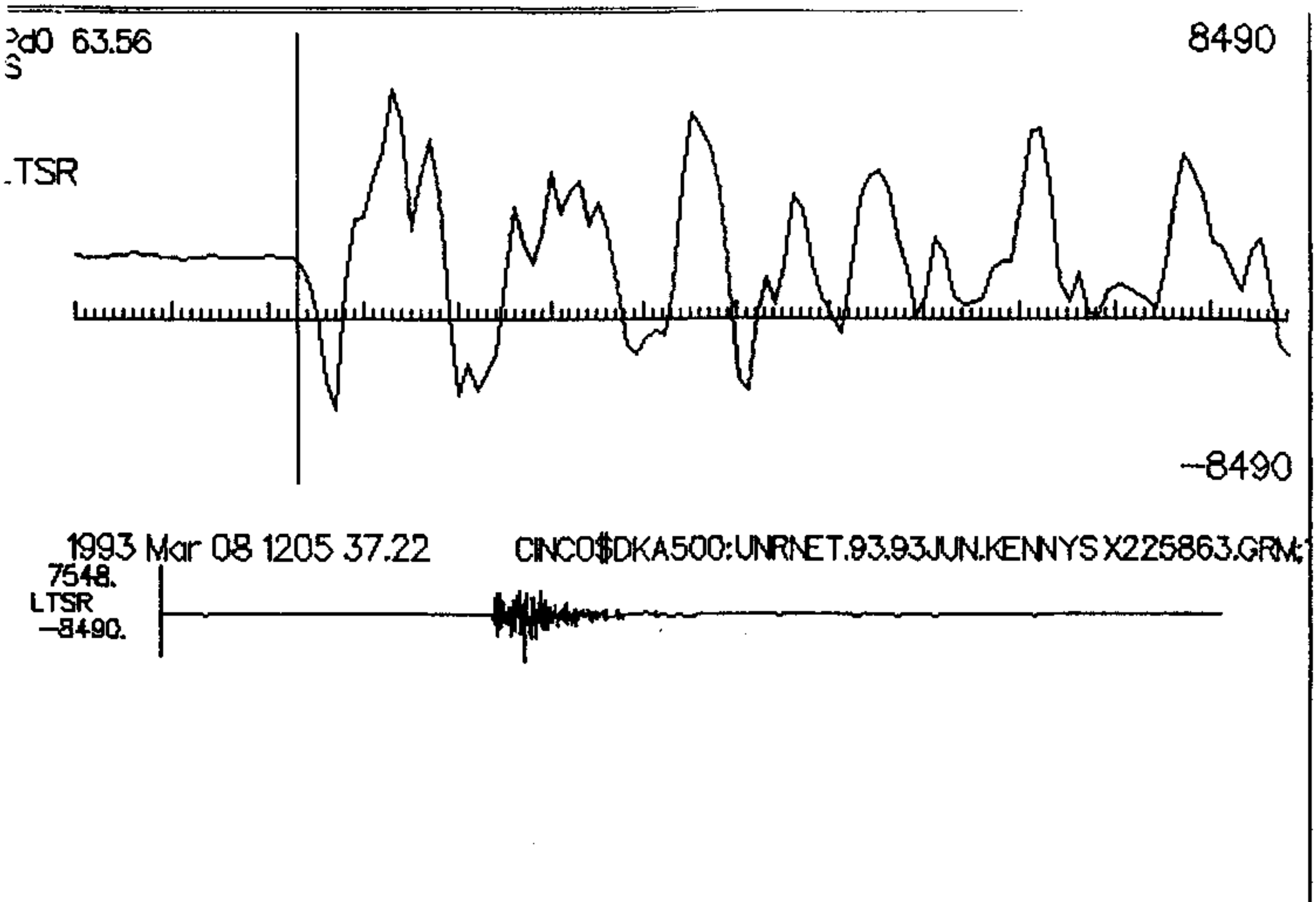
References:

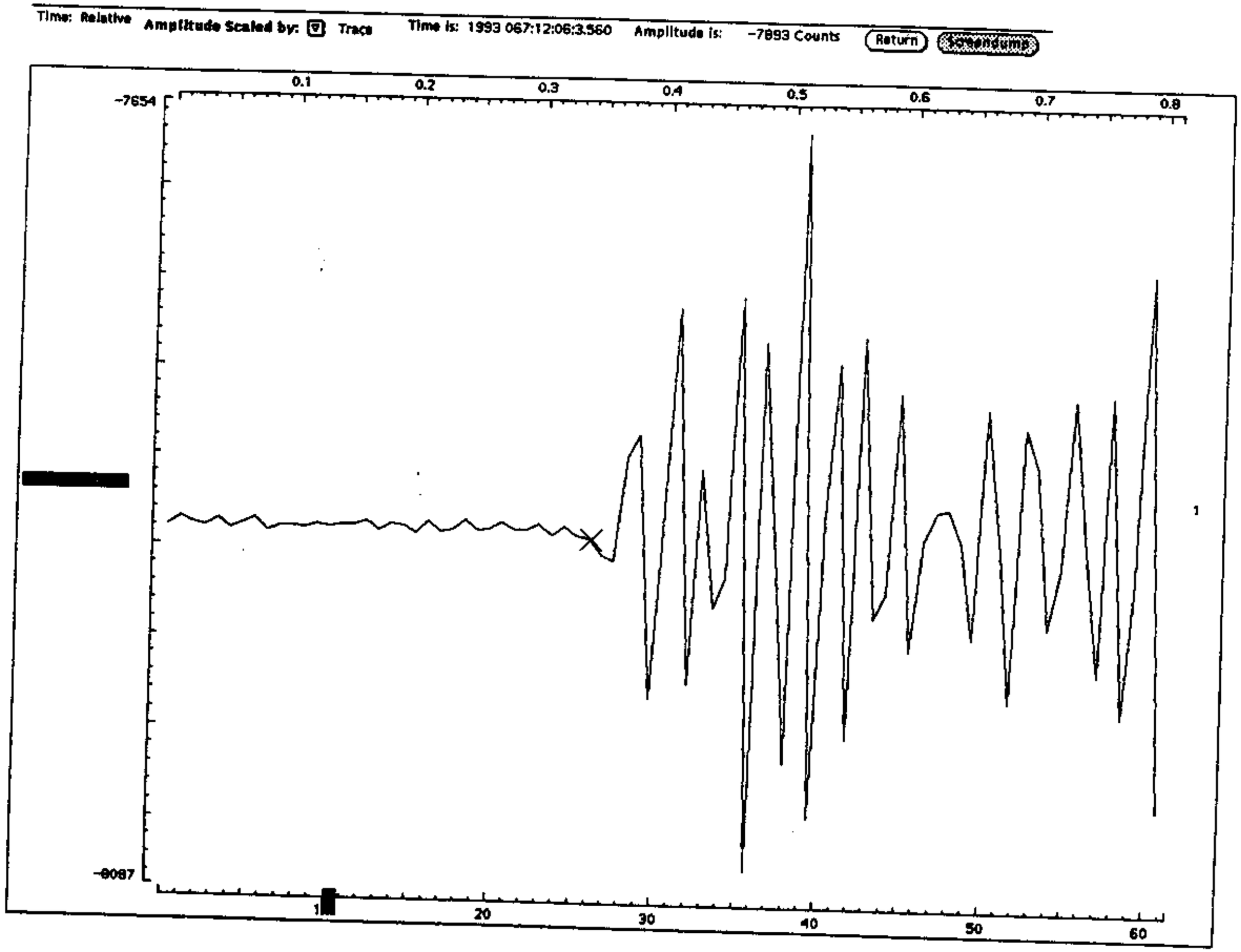
Hoffman, L.R. and W.D. Mooney, A seismic study of Yucca Mountain and vicinity, Southern Nevada; Data report and preliminary results, U.S. Geological Survey, Open File Report 83-588, 1984.

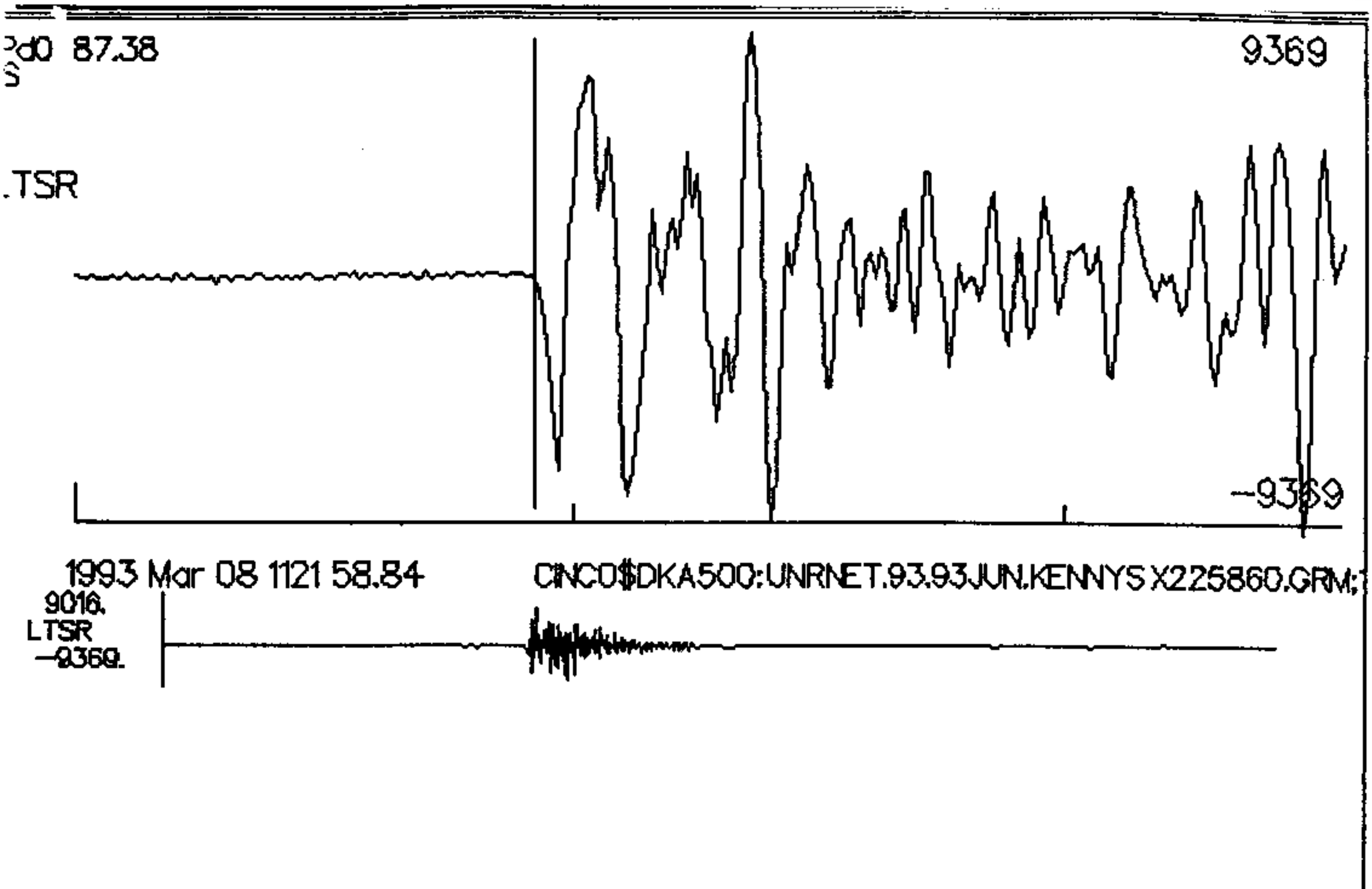
Meremonte, M, E. Cranswick, J. Gomberg,, D. Worley, D. Carver, J. Brooks, J. Banfill, R Overturf, and T. Bice, Report on the seismological field investigations of the 29, June 1992 Little Skul Mountain earthquake, U.S. Geological Survey, Open-File Report 93-555, 1993.

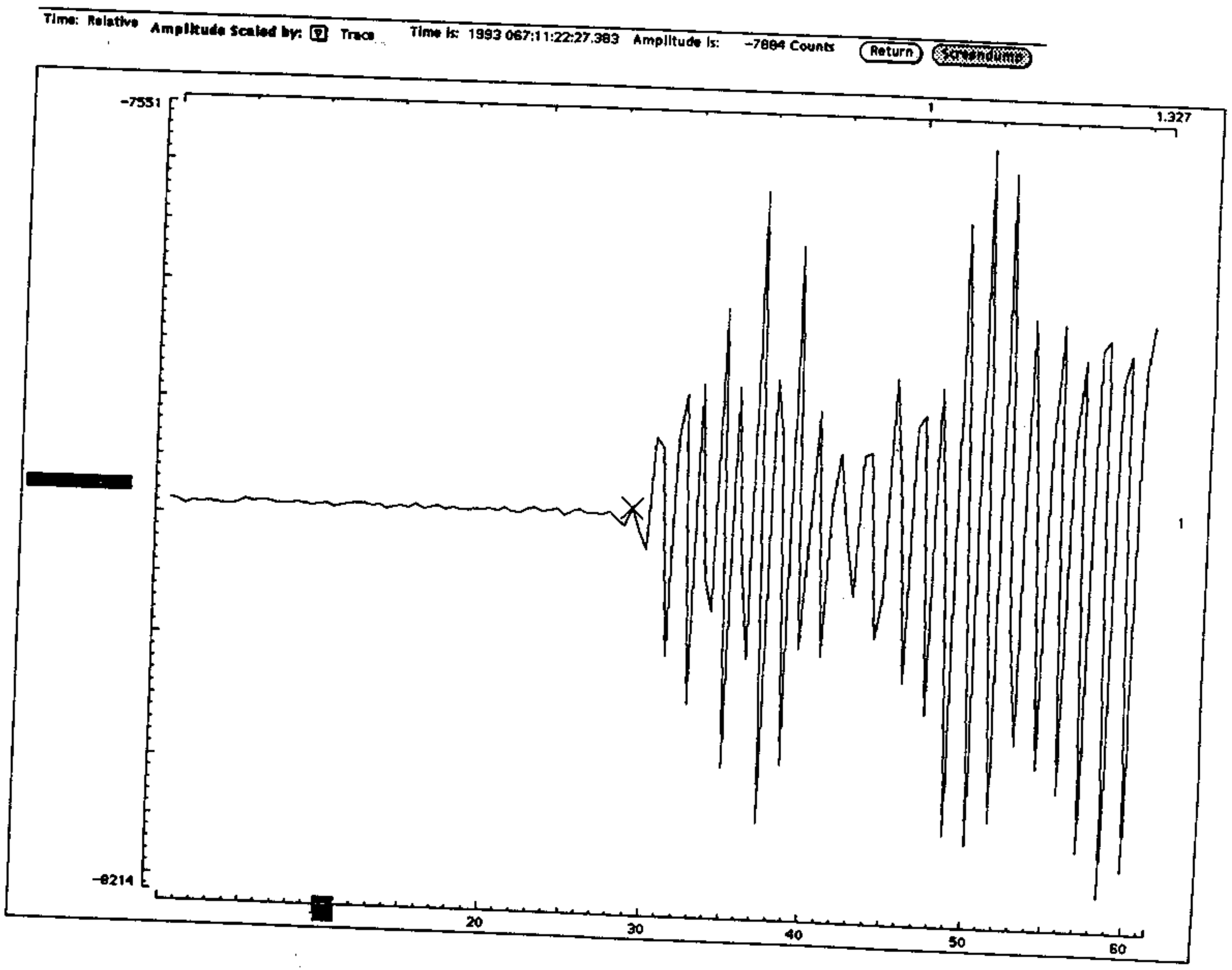
Tapley, W.C. and J.E. Tull, Guide to the Unix version of Sac, Lawrence Livermore National Labortory, Revision 4, 1991.

von Seggern, D., Seismic event waveforms for the southern Great Basin Seismic Network; October 1, 1992 to December 31, 1992, Tech. Data Record Package GS940183117412.001, submitted to the USGS/Yucca Mountain Project, Denver, Colorado, 1993.


2d0 63.56
S
8490
.TSR
-8490
1993 Mar 08 1205 37.22
CINCO$DKA500:UNRNET.93.93JUN.KENNYS X225863.GRM;1
7548.
LTSR
-8490.


Time: Relative
Amplitude Scaled by: Trace
Time is: 1993 067:12:06:3.560
Amplitude is: -7893 Counts
Return
Screendump
-7654
-9087
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1
20
30
40
50
60


87.38
9369
.TSR
-9369
1993 Mar 08 1121 58.84
CINCO$DKA500:UNRNET.93.93JUN.KENNYS X225860.GRM;
9016.
LTSR
-9369.


Time: Relative
Amplitude Scaled by: Trace
Time is: 1993 067:11:22:27.383
Amplitude is: -7884 Counts
Return
Screendump
-7551
-8214
1
1.327
1
20
30
40
50
60