

U. S. DEPARTMENT OF THE INTERIOR

U. S. GEOLOGICAL SURVEY

ZAYANTE SEISMIC EXPERIMENT: DATA REPORT

by

Zayante Seismic Experiment Team

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INTRODUCTION

During the Loma Prieta aftershock sequence, 24 sites in the epicentral area were equipped with PASSCAL Reftek recorders and Mark Products L-22 seismometers in order to collect aftershock data. Preliminary analysis of the recordings showed that some sites had very good signal-to-noise ratios. In order to investigate the effect of velocity heterogeneity beneath the sites, we installed a small 6-station array at three of the better sites (see Figure 1). Each array was arranged as two concentric triangles, the inner with a center-to-apex distance of 20-25 meters, and the outer with a center-to-apex distance of 200-300 meters (see Figure 2).

Analysis of data recorded by these arrays showed that waveforms on the horizontal components had very low coherence, and particle motions were significantly different on different instruments. This was true even for sites only 20 meters apart. To investigate this phenomenon, we decided to study the horizontal particle motions of events recorded at the ZAYA array located at the Zayante vineyard. We analyzed 10 aftershocks which had different focal mechanisms and azimuths (see Figure 1). Our analysis was restricted to the shear waves from each event since shear waves cause most of the damage to buildings during earthquakes.

For each event, we determined the shear wave polarization direction and compared it with the direction expected from the focal mechanism (Bonamassa et al., 1991; Vidale et al., 1991). This was done for the direct and scattered shear waves, using a five-second window starting at the shear wave arrival. We found that the polarization direction was

controlled by the site more than the source. The analysis of the initial 0.5 second of the shear wave arrival shows good agreement with the expected direction of motion, but later arrivals are often larger and in different directions. We call this phenomenon directional site resonance.

EXPLOSION EXPERIMENT

In May 1991 Donna Eberhart-Phillips of the USGS conducted a two-day explosion experiment in the Santa Cruz mountains. We used this occasion to deploy a small aperture array in the same area where the ZAYA array had been deployed. It was our intention to completely instrument the area formerly within the inner triangle of the ZAYA array. However, there were many obstacles to the deployment of 20 instruments. Furthermore, during the survey of the area, we discovered that an old shack had been razed decades ago, and the detritus had been buried close by. Thus we decided to deploy the array near station Z5 (Figure 2). The observed directional site resonance at Z5 changes continuously with frequency, going from nearly North-South at 1 Hz to nearly East-West at 10 Hz. The array was deployed along the side of a gently sloping hill (Figure 2) and had dimensions of 40 \times 60 meters.

Analysis of particle motion from the recorded explosions shows that the polarization direction changes smoothly across the array, and it seems to be more consistent for the stations at the top of the hill than at the bottom. The polarization direction at some instruments appears to be influenced more by the site than by the location of the explosions. The site-dependence and frequency-dependence of the shear wave polarization does not apply to the entire wave train. Rather, it applies only to energy arriving after the first shear wave pulse. Therefore, anisotropy or similar phenomena cannot explain the data since they would act on the whole wave train. The observed site effect acts on the reverberations or scattered energy. We interpret the directional resonances as the result of geological features along the ray-path to the surface that amplify the particle motion in selected frequency

bands, in particular directions. This direction-dependent amplification alters the particle motion.

The actual geologic features that cause this amplification are not known. Perhaps lateral gradients in near-surface shear wave velocity could cause resonances that change across short distances. Since the Loma Prieta data show that the preferred direction can change on a scale of 25 meters and can remain constant through the shear wave onset and coda, these features must be very close to the receivers, probably within a few tens of meters. These observations, and the lack of detailed geologic information about the area suggest a need to conduct a shallow refraction survey.

SHALLOW REFRACTION EXPERIMENT

For this refraction experiment, we used two types of seismic sources. We used a sledge hammer as a source of compressional waves and an air-powered shear-wave generator designed by Liu et al. (1988) as a source of shear waves. The array consisted of 23 Mark Products L-22, three-component seismometers arranged as a cross oriented north-south and east-west (see Figure 3). Each sensor was buried to a depth between 1 and 2 feet. In order to improve coupling with the ground and to help thermal insulation of the sensors, the bottom of each hole was covered with sand and sand was packed around each seismometer after leveling. The exact location of sensors is listed in Table 1a and the location of sources in Table 1b. Since it was time consuming to set up the shear wave source, we did not attempt to use it at every sensor location. Rather, we operated the shear wave source at both ends of each line of geophones and at the center of the array (see Figure 3). At station N6 (center of the array) the shear source was operated in both N-S and E-W orientations. The shear source was operated in both left-hand and right-hand shear modes. The sledge hammer source was used at each seismometer location as well as at each shear source location.

The recording system was a 64 channel, portable, PC-based seismic system designed by W. H. K. Lee (Lee, 1989; Lee and Dodge, 1992). This system uses a 16 MHz 386sx portable PC with a Data Translation A/D board and Quesig multiplexer. The system digitizes up to 64 channels with 16-bit resolution at up to 200 samples/second/channel. It displays digitized data in real time and saves data continuously or by event. Although the system is portable, it requires AC power which is supplied by a 12-volt battery via

an uninterruptible power system. To simultaneously monitor all 23 of the 3-component geophones requires more channels than the PC system had available, so we simply switched cables so that the line containing the source always had a full complement of 12 sensors.

COLLECTED DATA

Each source was applied between 5 and 10 times so that signals could be stacked for noise reduction. However, in this report, we present 204 typical waveforms collected from each source. These waveforms are shown in Figures 6-210, and are also included as files on the diskettes that accompany this report.

Compressional sources were located at each seismometer location (labelled Pxxx, where xxx is the station number), and at shear source locations (labelled as P1, P2, P3, and P4), as shown in Figure 3 (P2 was repeated one more time, and labelled P2A and P2B in Table 2). Please note that S1 and P1 were located next to station N1, and S5 and S6 were located next to station N6. In addition, N6 is at the center of the array so that it is also part of the east-west line, between stations E3 and E4. Thus there are 27 compressional sources recorded on three components along 2 lines, for a total of 162 waveforms. Table 2 is an index to the waveforms which relates the source, waveform file, line and component, and the page on which the waveform is displayed.

Shear sources S4, S6, and S3 were located along the east-west line of the array and were oriented north-south. Shear sources S1, S5, and S2 were located along the north-south line of the array and were oriented east-west. Source S2 was at the north end of the array and was oriented north-south. Each source was recorded in both right-hand and left-hand mode and S2 was repeated one more time (labelled S2A and S2B in Table 2), so there are a total of 14 three-component shear source recordings included in this data report.

The seismic records were plotted using a program called SudsPlot (Banfill, 1992). Data

processing procedure of the PC-based system is described in Lee and Dodge (1992).

REFERENCES

- Banfill, R., Plotting seismograms and maps, in "A Course on: PC-Based Seismic Networks" edited by W. H. K. Lee and D. A. Dodge, U.S. Geol. Surv. Open-file Report 92-441, 190-206, 1992.
- Bonamassa, O., J.E. Vidale, H. Houston, and S.Y. Schwartz, Directional resonances and the influence of near-surface geology on ground motion, *Geophys. Res. Lett.*
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- Liu, H. P., R. E. Warrick, R. E. Westerlund, J. B. Fletcher, and G. L. Maxwell, An air-powered impulsive shear-wave source with repeatable signals, *Bull. Seism. Soc. Am.*, 78, 355-369, 1988.
- Vidale, J.E., O. Bonamassa, and H. Houston, Directional site resonances observed from the 1 October 1987 Whittier Narrows earthquake and 4 October aftershock, *Earthquake Spectra*, 7, 107-126, 1991.

Table 1a. Station locations

Station Name	Inclined Distance (meters)	Azimuth (degrees)	Vertical Angle (degrees)	Horizontal Distance (meters)	North Projection of HD (meters)	East Projection of HD (meters)	Vertical Distance (meters)	Corrected Altitude (meters)
N1	49.064	180°45'42"	91°00'24"	49.056	-49.052	-0.652	-0.862	-2.030
N2	39.261	180°52'30"	93°33'38"	39.185	-39.180	-0.598	-2.438	-2.387
N3	29.685	179°39'44"	94°20'10"	29.599	-29.598	+0.174	-2.244	-2.193
N4	20.049	179°58'30"	95°42'50"	19.939	-19.939	+0.009	-1.995	-1.944
N5	10.117	179°46'18"	98°41'30"	10.001	-10.001	+0.040	-1.529	-1.478
N6	0	00°00'00"	00°00'00"	0.000	0.000	0.000	0.000	0.000
N7	10.058	358°47'03"	83°37'48"	9.995	9.993	-0.212	+1.116	+1.167
N8	19.820	358°54'06"	81°45'36"	19.601	19.597	-0.376	+2.838	+2.889
N9	29.963	359°37'30"	80°48'36"	29.578	29.577	-0.194	+4.785	+4.836
N10	40.023	359°55'36"	79°43'42"	39.382	39.382	-0.050	+7.137	+7.188
N11	49.730	359°49'42"	80°16'42"	49.016	49.061	-0.147	+8.398	+8.449
N12	59.707	00°00'30"	80°24'21"	58.872	58.872	+0.009	+9.951	+10.002

Station Name	Inclined Distance (meters)	Azimuth (degrees)	Vertical Angle (degrees)	Horizontal Distance (meters)	North Projection of HD (meters)	East Projection of HD (meters)	Vertical Distance (meters)	Corrected Altitude (meters)
E1	30.302	269°38'24"	98°00'50"	30.024	-0.189	-30.023	-4.227	-4.176
E2	20.170	268°44'21"	96°49'54"	20.027	-0.441	-20.022	-2.399	-2.348
E3	10.358	268°42'42"	96°31'50"	10.291	-0.231	-10.288	-1.178	-1.127
E4	0.000	00°00'00"	00°00'00"	0.000	0.000	0.000	0.000	0.000
E5	9.705	89°57'54"	89°35'00"	9.705	+0.006	+9.705	+0.071	+0.122
E6	19.979	89°48'54"	87°53'10"	19.965	+0.064	+19.965	+0.737	+0.788
E7	29.838	89°48'00"	87°23'48"	29.807	+0.104	+29.807	+1.355	+1.406
E8	39.811	89°32'42"	86°48'28"	39.749	+0.316	+39.748	+2.217	+2.268
E9	49.810	89°40'36"	86°10'18"	49.699	+0.280	+49.698	+3.326	+3.377
E10	59.698	89°38'21"	85°25'12"	59.507	+0.375	+59.506	+4.761	+4.812
E11	69.567	89°49'42"	84°54'00"	69.292	+0.208	+69.292	+6.184	+6.235
E12	79.344	90°02'48"	84°36'48"	78.994	-0.064	+78.994	+7.449	+7.500

Table 1b. Source locations

Source Name	Name of Closest Station	Distance from the Nearest Station	Azimuth to the Nearest station (clockwise from North)
S1	N1	1.1m South	0°
P1	N1	0.9m East	270°
S2	N12	33.1m N31W	329°
P2	N12	33.1m	329°
S3	E11	9.5m	59°
P3	E11	9.5m	59°
S4	E1	7.7m	270°
P4	E1	7.7m	270°
S5	N7	4.6m	0°
S6	N6	0.3m	90°

Table 2 Index to the collected data

<u>SOURCE</u>	<u>FILE NAME</u>	<u>LINE / COMPONENT</u>	<u>PAGE</u>
P1	92082004.CT1	N-S / VERTICAL	24
		N-S / NORTH	25
		N-S / EAST	26
		E-W / VERTICAL	27
		E-W / NORTH	28
		E-W / EAST	29
P2A	92082009.CT1	N-S / VERTICAL	30
		N-S / NORTH	31
		N-S / EAST	32
		E-W / VERTICAL	33
		E-W / NORTH	34
		E-W / EAST	35
P2B	9208200F.CT1	N-S / VERTICAL	36
		N-S / NORTH	37
		N-S / EAST	38
		E-W / VERTICAL	39
		E-W / NORTH	40
		E-W / EAST	41
P3	9208200L.CT1	N-S / VERTICAL	42
		N-S / NORTH	43
		N-S / EAST	44
		E-W / VERTICAL	45
		E-W / NORTH	46
		E-W / EAST	47
P4	9208202A.CT1	N-S / VERTICAL	48
		N-S / NORTH	49
		N-S / EAST	50
		E-W / VERTICAL	51
		E-W / NORTH	52
		E-W / EAST	53
PN2	9208210A.CT1	N-S / VERTICAL	54
		N-S / NORTH	55
		N-S / EAST	56
		E-W / VERTICAL	57
		E-W / NORTH	58
		E-W / EAST	59

<u>SOURCE</u>	<u>FILE NAME</u>	<u>LINE / COMPONENT</u>	<u>PAGE</u>
PN3	9208200M.CT1	N-S / VERTICAL	60
		N-S / NORTH	61
		N-S / EAST	62
		E-W / VERTICAL	63
		E-W / NORTH	64
		E-W / EAST	65
PN4	92082000.CT1	N-S / VERTICAL	66
		N-S / NORTH	67
		N-S / EAST	68
		E-W / VERTICAL	69
		E-W / NORTH	70
		E-W / EAST	71
PN5	9208200Q.CT1	N-S / VERTICAL	72
		N-S / NORTH	73
		N-S / EAST	74
		E-W / VERTICAL	75
		E-W / NORTH	76
		E-W / EAST	77
PN6	9208200S.CT1	N-S / VERTICAL	78
		N-S / NORTH	79
		N-S / EAST	80
		E-W / VERTICAL	81
		E-W / NORTH	82
		E-W / EAST	83
PN7	9208200X.CT1	N-S / VERTICAL	84
		N-S / NORTH	85
		N-S / EAST	86
		E-W / VERTICAL	87
		E-W / NORTH	88
		E-W / EAST	89
PN8	9208200Y.CT1	N-S / VERTICAL	90
		N-S / NORTH	91
		N-S / EAST	92
		E-W / VERTICAL	93
		E-W / NORTH	94
		E-W / EAST	95

<u>SOURCE</u>	<u>FILE NAME</u>	<u>LINE / COMPONENT</u>	<u>PAGE</u>
PN9	9208200Z.CT1	N-S / VERTICAL	96
		N-S / NORTH	97
		N-S / EAST	98
		E-W / VERTICAL	99
		E-W / NORTH	100
		E-W / EAST	101
PN10	92082010.CT1	N-S / VERTICAL	102
		N-S / NORTH	103
		N-S / EAST	104
		E-W / VERTICAL	105
		E-W / NORTH	106
		E-W / EAST	107
PN11	92082023.CT1	N-S / VERTICAL	108
		N-S / NORTH	109
		N-S / EAST	110
		E-W / VERTICAL	111
		E-W / NORTH	112
		E-W / EAST	113
PN12	92082026.CT1	N-S / VERTICAL	114
		N-S / NORTH	115
		N-S / EAST	116
		E-W / VERTICAL	117
		E-W / NORTH	118
		E-W / EAST	119
PE1	9208202C.CT1	N-S / VERTICAL	120
		N-S / NORTH	121
		N-S / EAST	122
		E-W / VERTICAL	123
		E-W / NORTH	124
		E-W / EAST	125
PE2	9208202D.CT1	N-S / VERTICAL	126
		N-S / NORTH	127
		N-S / EAST	128
		E-W / VERTICAL	129
		E-W / NORTH	130
		E-W / EAST	131

<u>SOURCE</u>	<u>FILE NAME</u>	<u>LINE / COMPONENT</u>	<u>PAGE</u>
PE3	92082100.CT1	N-S / VERTICAL	132
		N-S / NORTH	133
		N-S / EAST	134
		E-W / VERTICAL	135
		E-W / NORTH	136
		E-W / EAST	137
PE4	92082101.CT1	N-S / VERTICAL	138
		N-S / NORTH	139
		N-S / EAST	140
		E-W / VERTICAL	141
		E-W / NORTH	142
		E-W / EAST	143
PE5	92082102.CT1	N-S / VERTICAL	144
		N-S / NORTH	145
		N-S / EAST	146
		E-W / VERTICAL	147
		E-W / NORTH	148
		E-W / EAST	149
PE6	92082103.CT1	N-S / VERTICAL	150
		N-S / NORTH	151
		N-S / EAST	152
		E-W / VERTICAL	153
		E-W / NORTH	154
		E-W / EAST	155
PE7	92082104.CT1	N-S / VERTICAL	156
		N-S / NORTH	157
		N-S / EAST	158
		E-W / VERTICAL	159
		E-W / NORTH	160
		E-W / EAST	161
PE8	92082106.CT1	N-S / VERTICAL	162
		N-S / NORTH	163
		N-S / EAST	164
		E-W / VERTICAL	165
		E-W / NORTH	166
		E-W / EAST	167

<u>SOURCE</u>	<u>FILE NAME</u>	<u>LINE / COMPONENT</u>	<u>PAGE</u>
PE9	92082107.CT1	N-S / VERTICAL	168
		N-S / NORTH	169
		N-S / EAST	170
		E-W / VERTICAL	171
		E-W / NORTH	172
		E-W / EAST	173
PE10	92082108.CT1	N-S / VERTICAL	174
		N-S / NORTH	175
		N-S / EAST	176
		E-W / VERTICAL	177
		E-W / NORTH	178
		E-W / EAST	179
PE11	92082109.CT1	N-S / VERTICAL	180
		N-S / NORTH	181
		N-S / EAST	182
		E-W / VERTICAL	183
		E-W / NORTH	184
		E-W / EAST	185
S1-1	92082003.CT1	N-S / VERTICAL	186
		N-S / NORTH	187
		N-S / EAST	188
		E-W / VERTICAL	189
		E-W / NORTH	190
		E-W / EAST	191
S1-2	92082003.CT2	N-S / VERTICAL	192
		N-S / NORTH	193
		N-S / EAST	194
		E-W / VERTICAL	195
		E-W / NORTH	196
		E-W / EAST	197
S2A-1	92082008.CT1	N-S / VERTICAL	198
		N-S / NORTH	199
		N-S / EAST	200
		E-W / VERTICAL	201
		E-W / NORTH	202
		E-W / EAST	203

<u>SOURCE</u>	<u>FILE NAME</u>	<u>LINE / COMPONENT</u>	<u>PAGE</u>
S2A-2	92082008.CT2	N-S / VERTICAL	204
		N-S / NORTH	205
		N-S / EAST	206
		E-W / VERTICAL	207
		E-W / NORTH	208
		E-W / EAST	209
S2B-1	9208200C.CT1	N-S / VERTICAL	210
		N-S / NORTH	211
		N-S / EAST	212
		E-W / VERTICAL	213
		E-W / NORTH	214
		E-W / EAST	215
S2B-2	9208200C.CT2	N-S / VERTICAL	216
		N-S / NORTH	217
		N-S / EAST	218
		E-W / VERTICAL	219
		E-W / NORTH	220
		E-W / EAST	221
S3-1	9208200H.CT1	N-S / VERTICAL	222
		N-S / NORTH	223
		N-S / EAST	224
		E-W / VERTICAL	225
		E-W / NORTH	226
		E-W / EAST	227
S3-2	9208200H.CT2	N-S / VERTICAL	228
		N-S / NORTH	229
		N-S / EAST	230
		E-W / VERTICAL	231
		E-W / NORTH	232
		E-W / EAST	233
S4-1	9208200V.CT1	N-S / VERTICAL	234
		N-S / NORTH	235
		N-S / EAST	236
		E-W / VERTICAL	237
		E-W / NORTH	238
		E-W / EAST	239

<u>SOURCE</u>	<u>FILE NAME</u>	<u>LINE / COMPONENT</u>	<u>PAGE</u>
S4-2	9208200V.CT2	N-S / VERTICAL	240
		N-S / NORTH	241
		N-S / EAST	242
		E-W / VERTICAL	243
		E-W / NORTH	244
		E-W / EAST	245
S5-1	92082020.CT1	N-S / VERTICAL	246
		N-S / NORTH	247
		N-S / EAST	248
		E-W / VERTICAL	249
		E-W / NORTH	250
		E-W / EAST	251
S5-2	92082020.CT2	N-S / VERTICAL	252
		N-S / NORTH	253
		N-S / EAST	254
		E-W / VERTICAL	255
		E-W / NORTH	256
		E-W / EAST	257
S6-1	92082029.CT1	N-S / VERTICAL	258
		N-S / NORTH	259
		N-S / EAST	260
		E-W / VERTICAL	261
		E-W / NORTH	262
		E-W / EAST	263
S6-2	92082029.CT2	N-S / VERTICAL	264
		N-S / NORTH	265
		N-S / EAST	266
		E-W / VERTICAL	267
		E-W / NORTH	268
		E-W / EAST	269

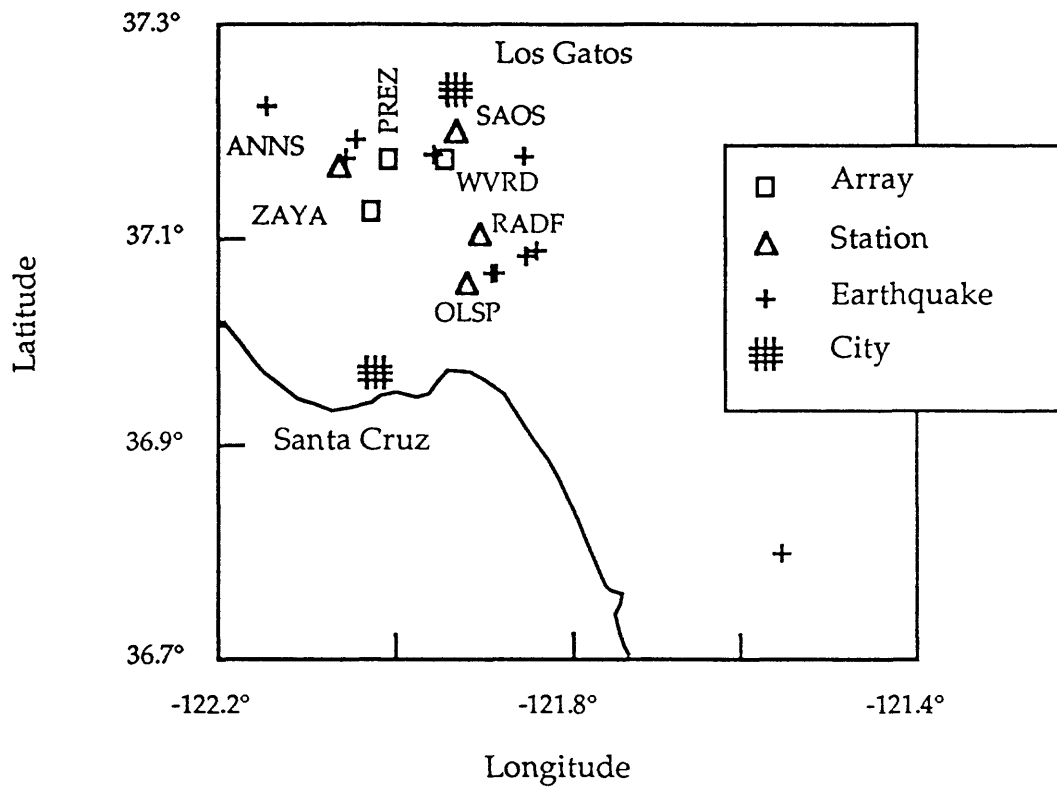


Fig.1 The area map shows the locations of stations, and 6-station arrays deployed in the Santa Cruz Mountains after the 18 October 1989 Loma Prieta, California, earthquake. The epicenters of ten aftershocks are also shown.

Map of the 6-Station Array, Very Dense Array, and Shallow Refraction Seismology Lines in the Santa Cruz Mountains

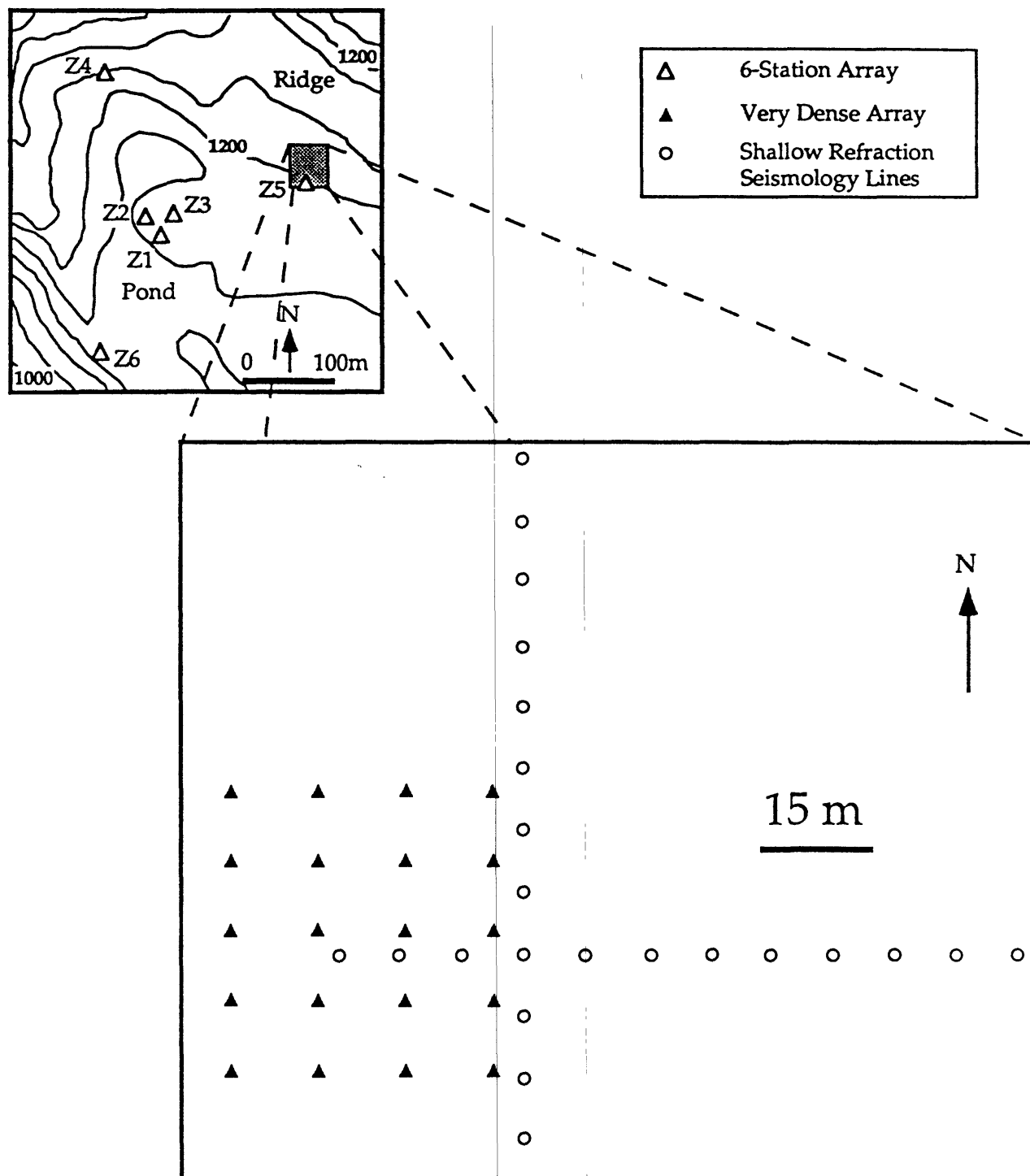


Fig.2 Map of the 6-station array, the very dense array, and the shallow refraction seismology lines deployed on the Santa Cruz Mountains.

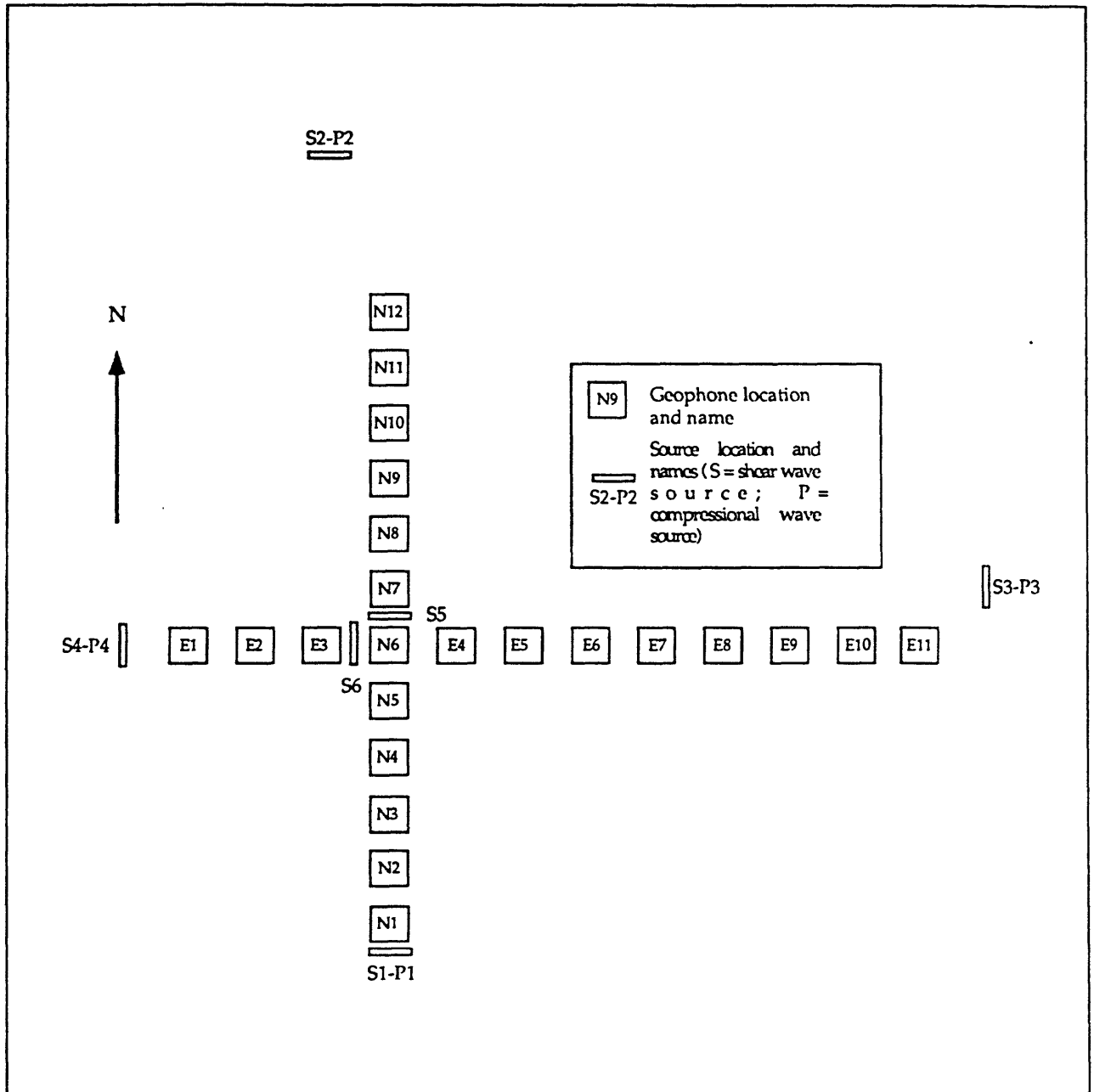


Fig. 3 Map of geophone and source geometries. The map shows shear wave sources locations and co-sited compressional wave sources. Compressional wave sources were also used at each geophone site (not shown).

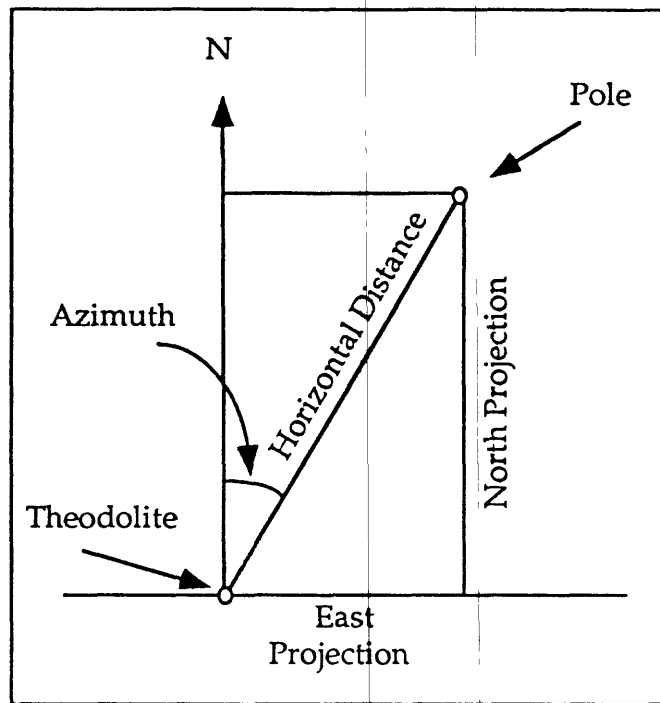


Fig.4a Horizontal map showing the geometry of the theodolite-pole system and the parameters listed in tables 1a and 1b. The east projection of the horizontal distance is positive in the East direction, and the north projection is positive in the North direction. The azimuth is defined positive clockwise from North.

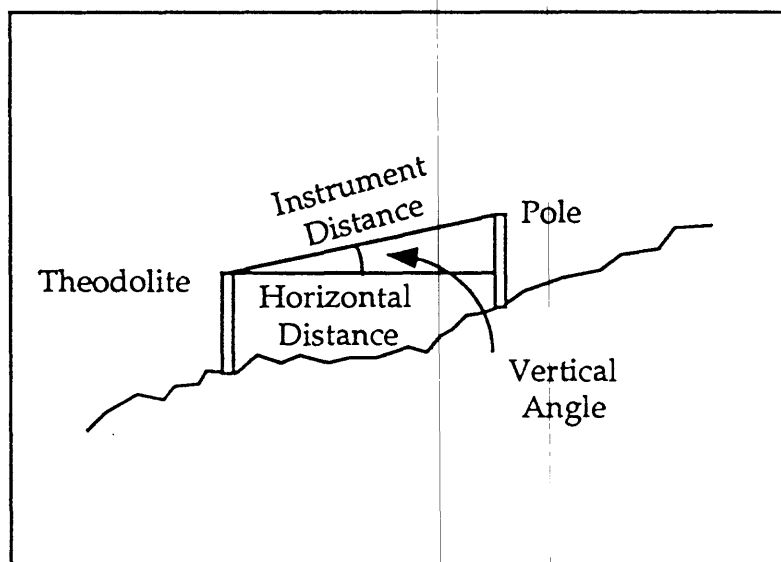
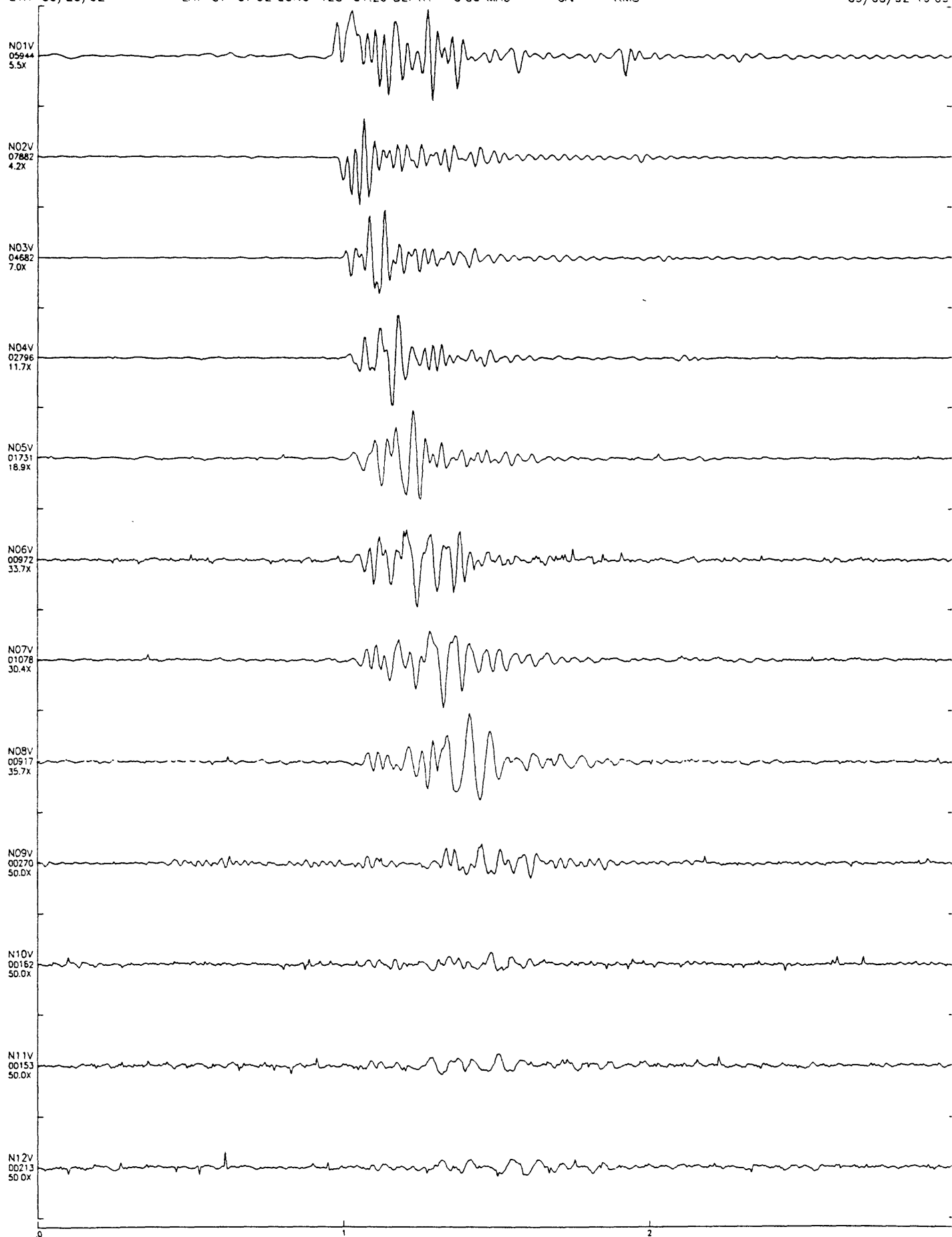


Fig.4b Vertical view showing the geometry of the theodolite-pole system and the parameters listed in tables 1a and 1b. A value of 90° for the vertical angle implies that pole and theodolite are on the same plane, a value smaller than 90° implies that the pole is in a higher position (0° is vertical upwards).

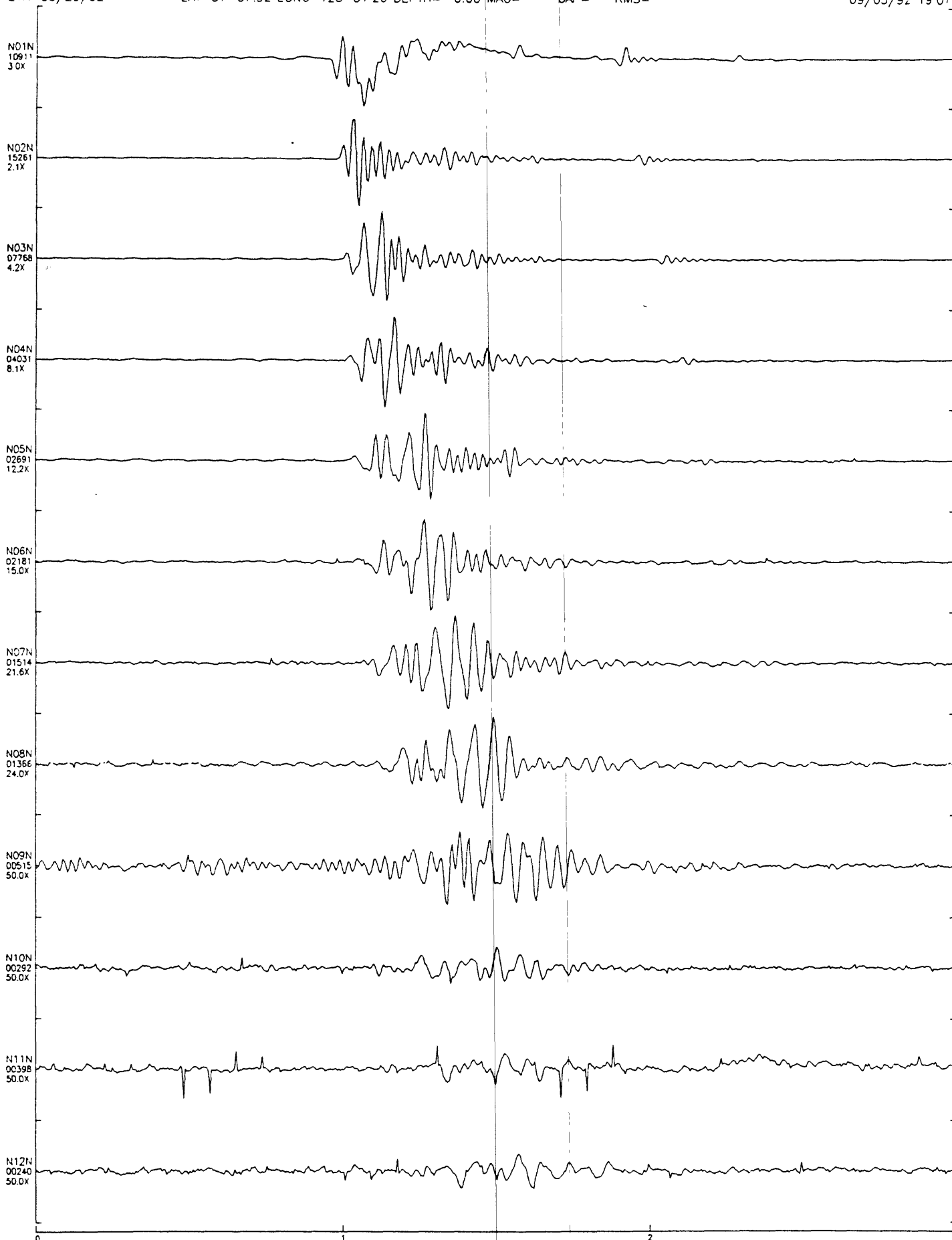
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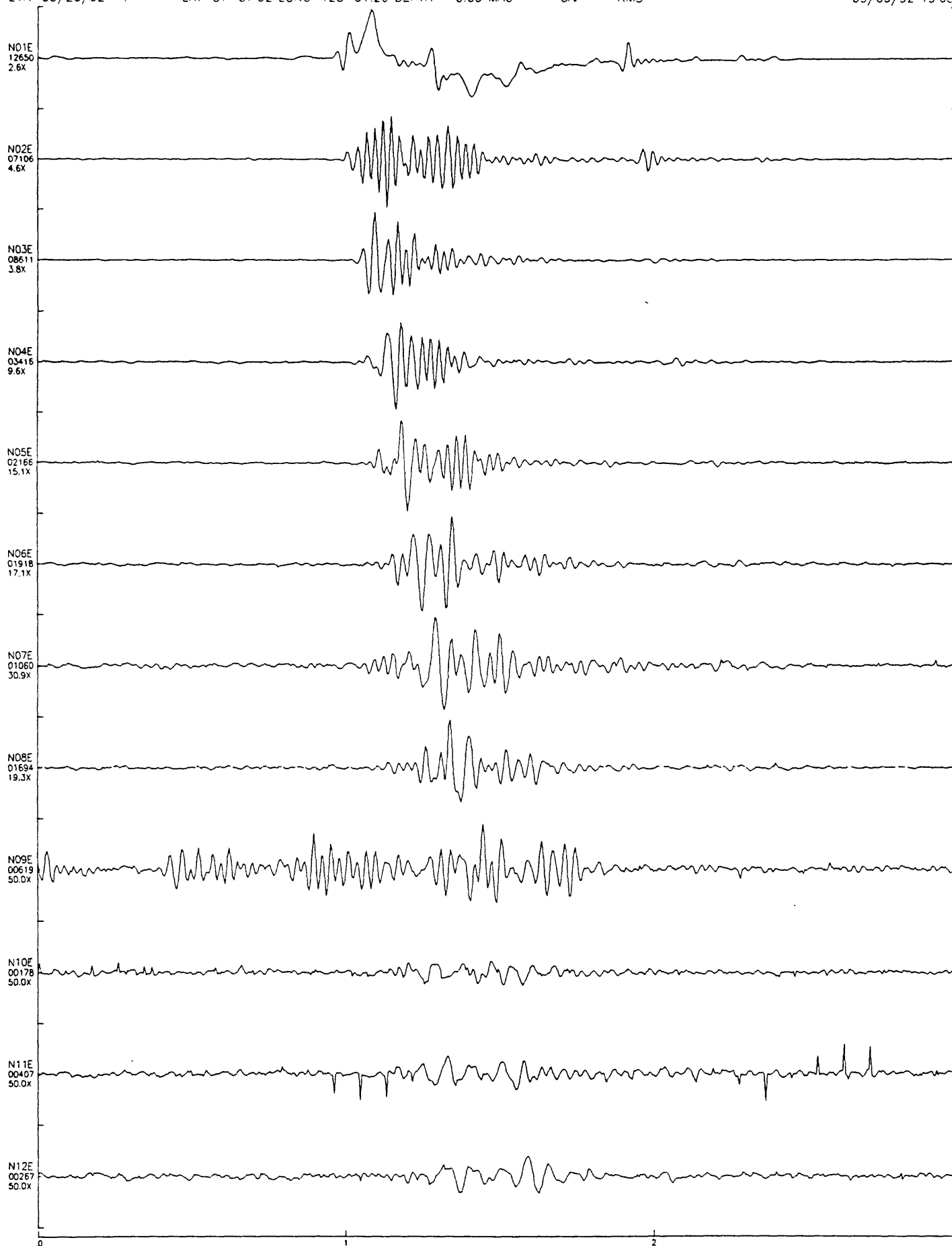
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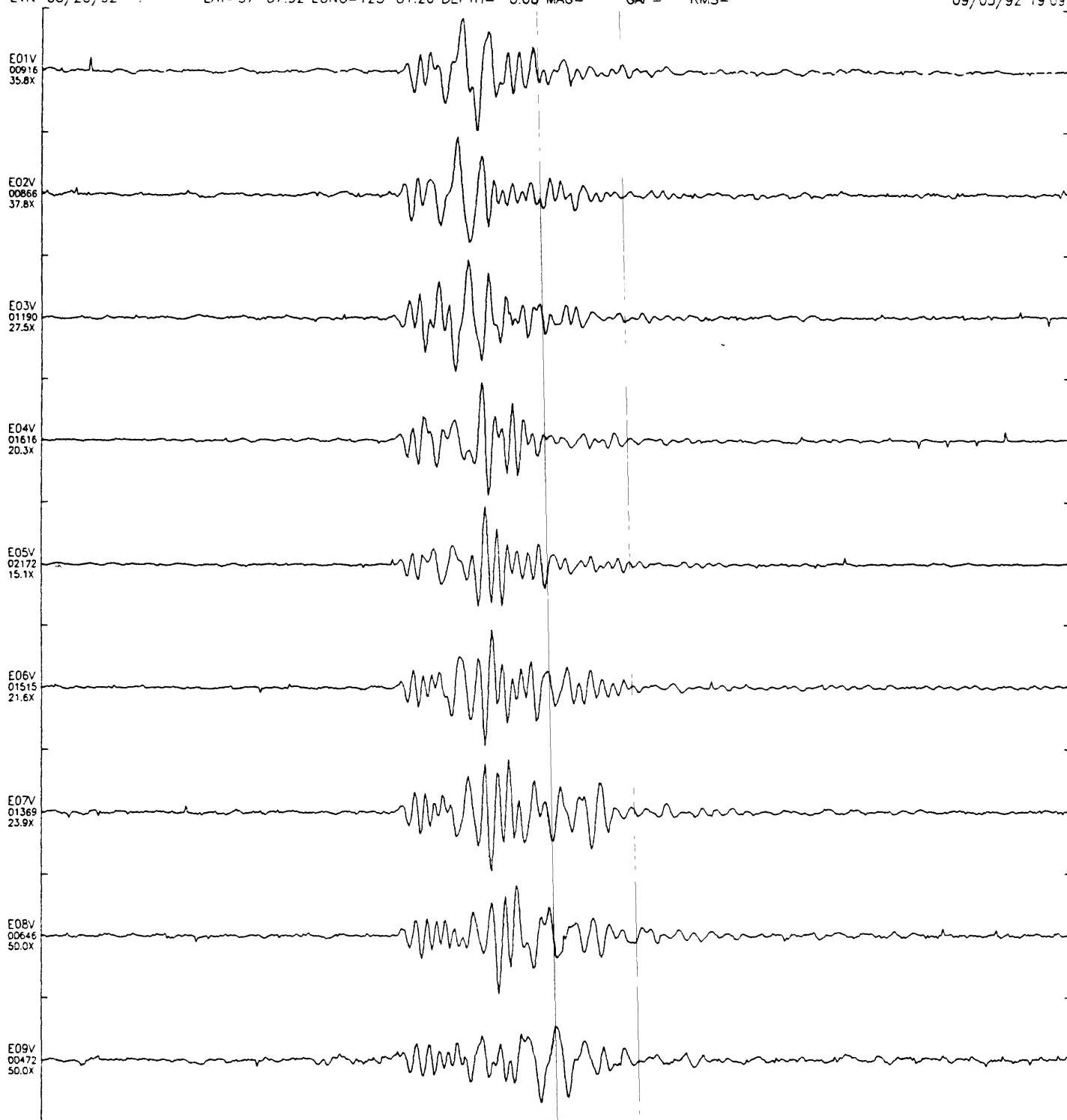
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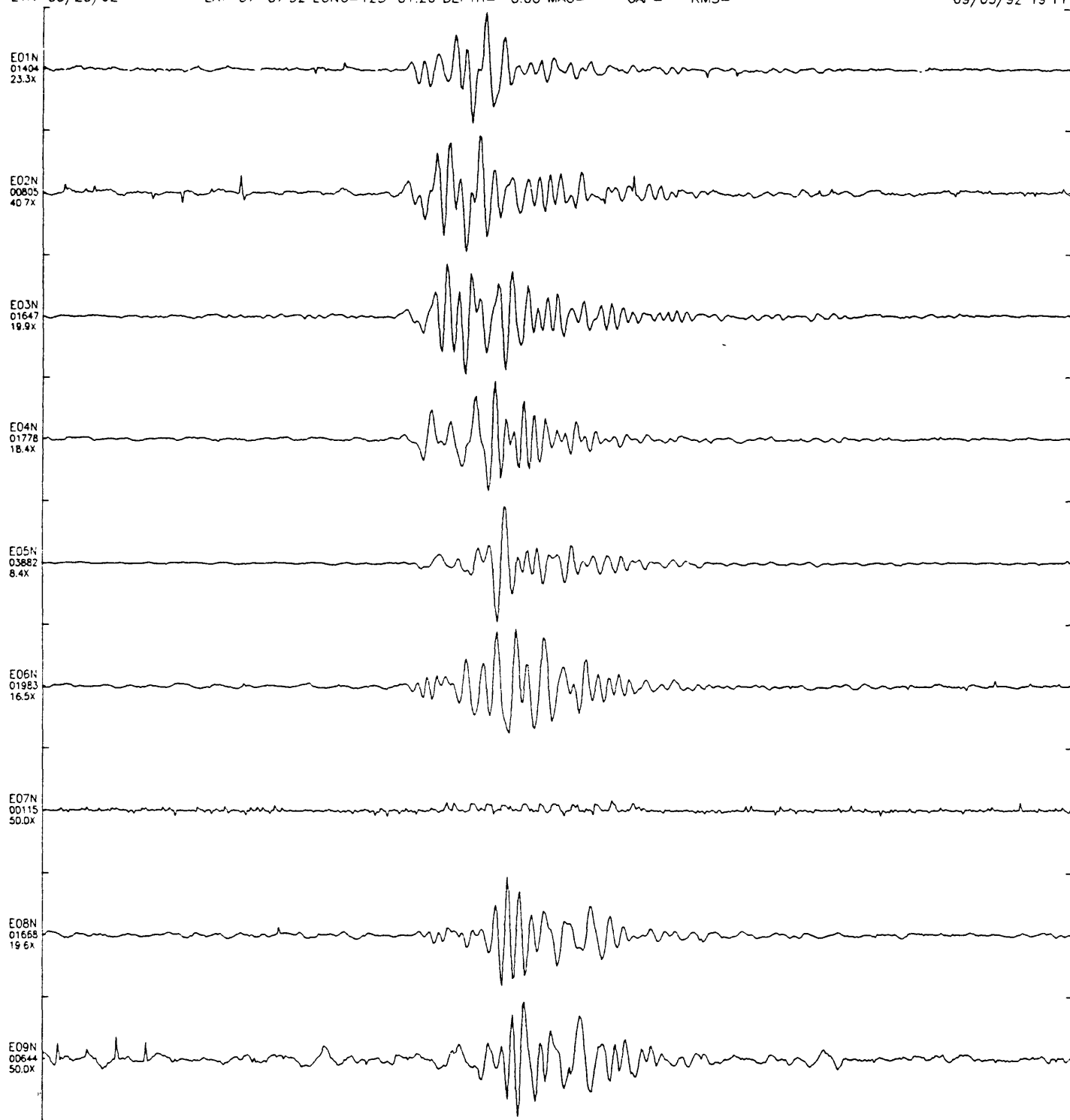
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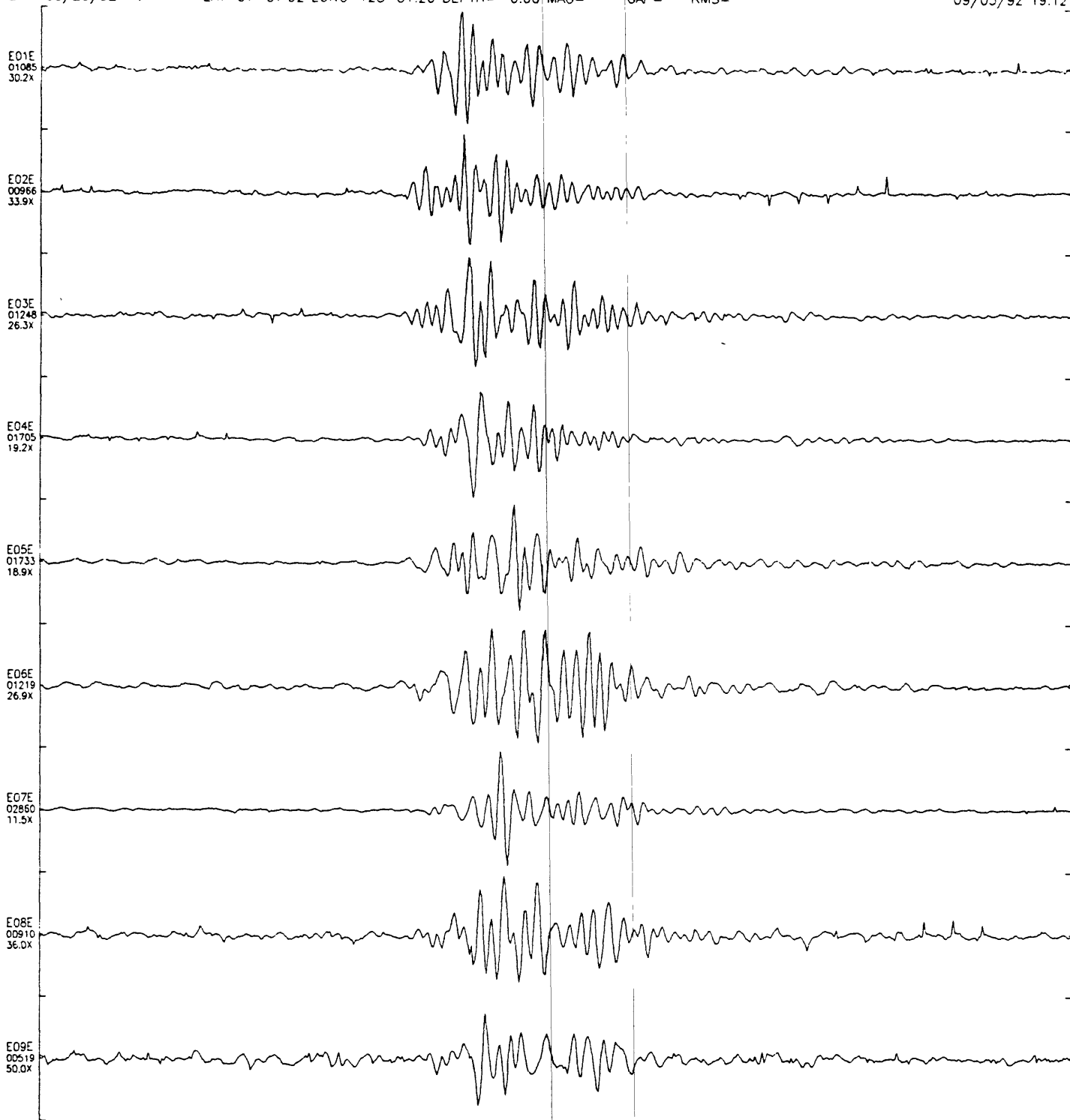
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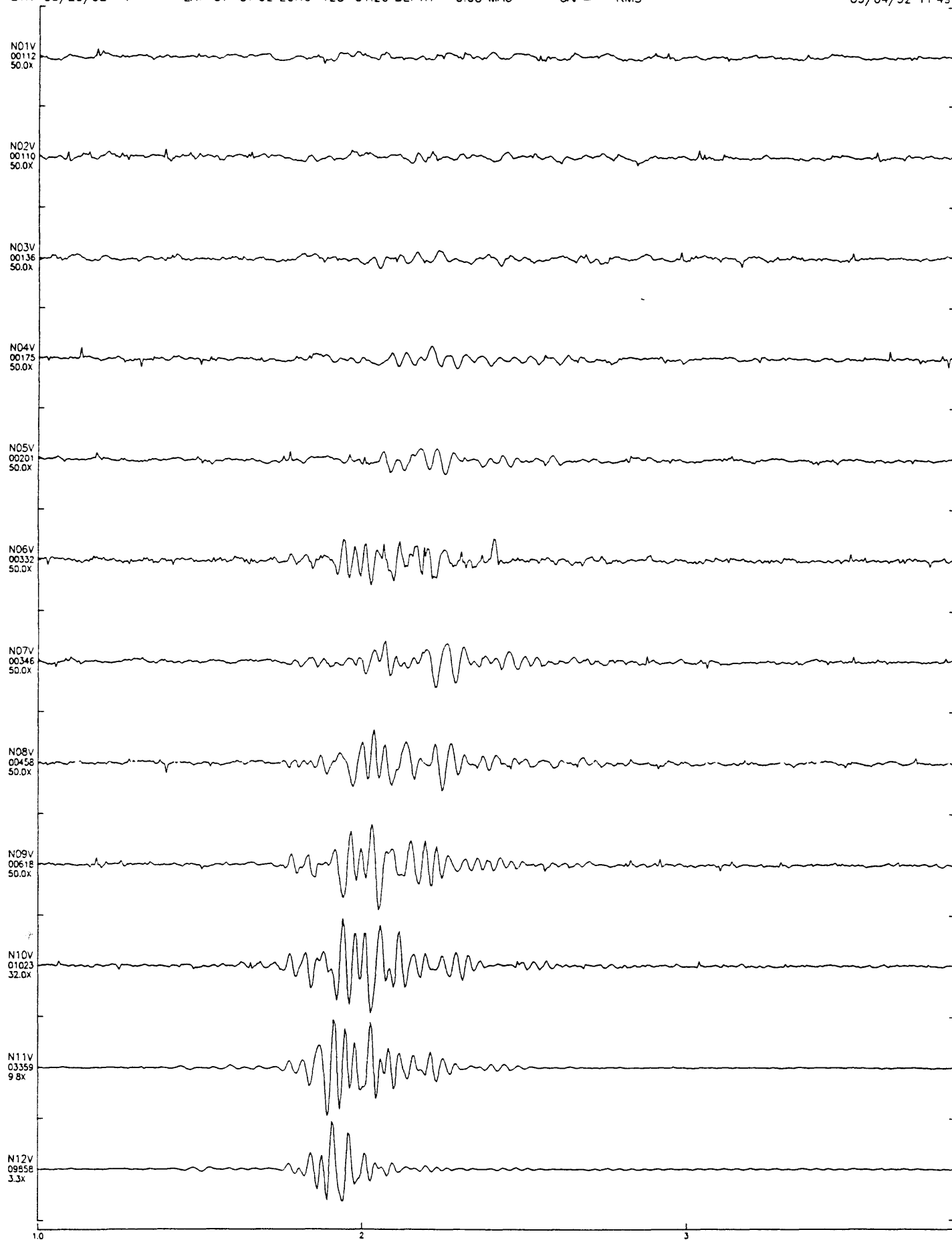
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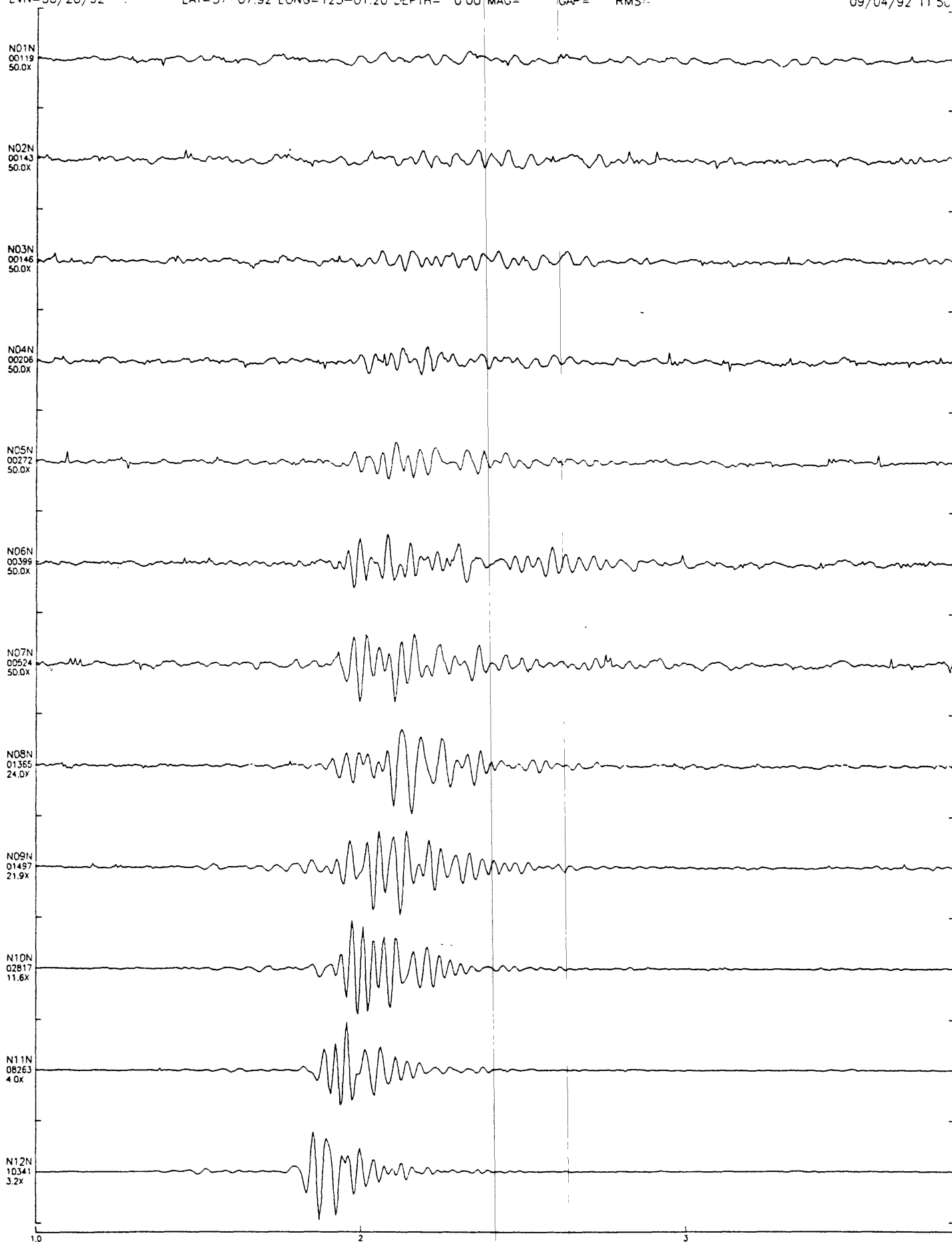
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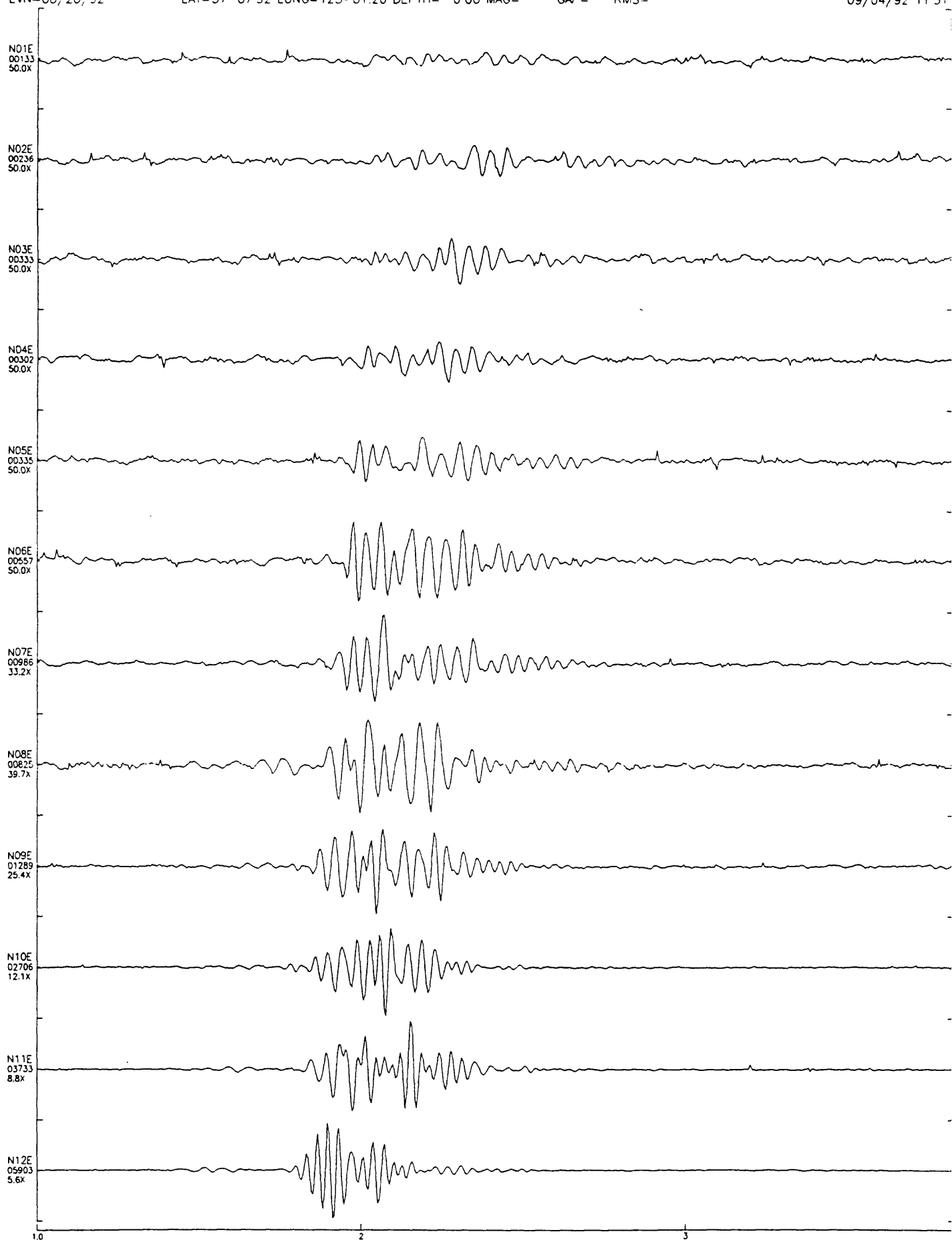
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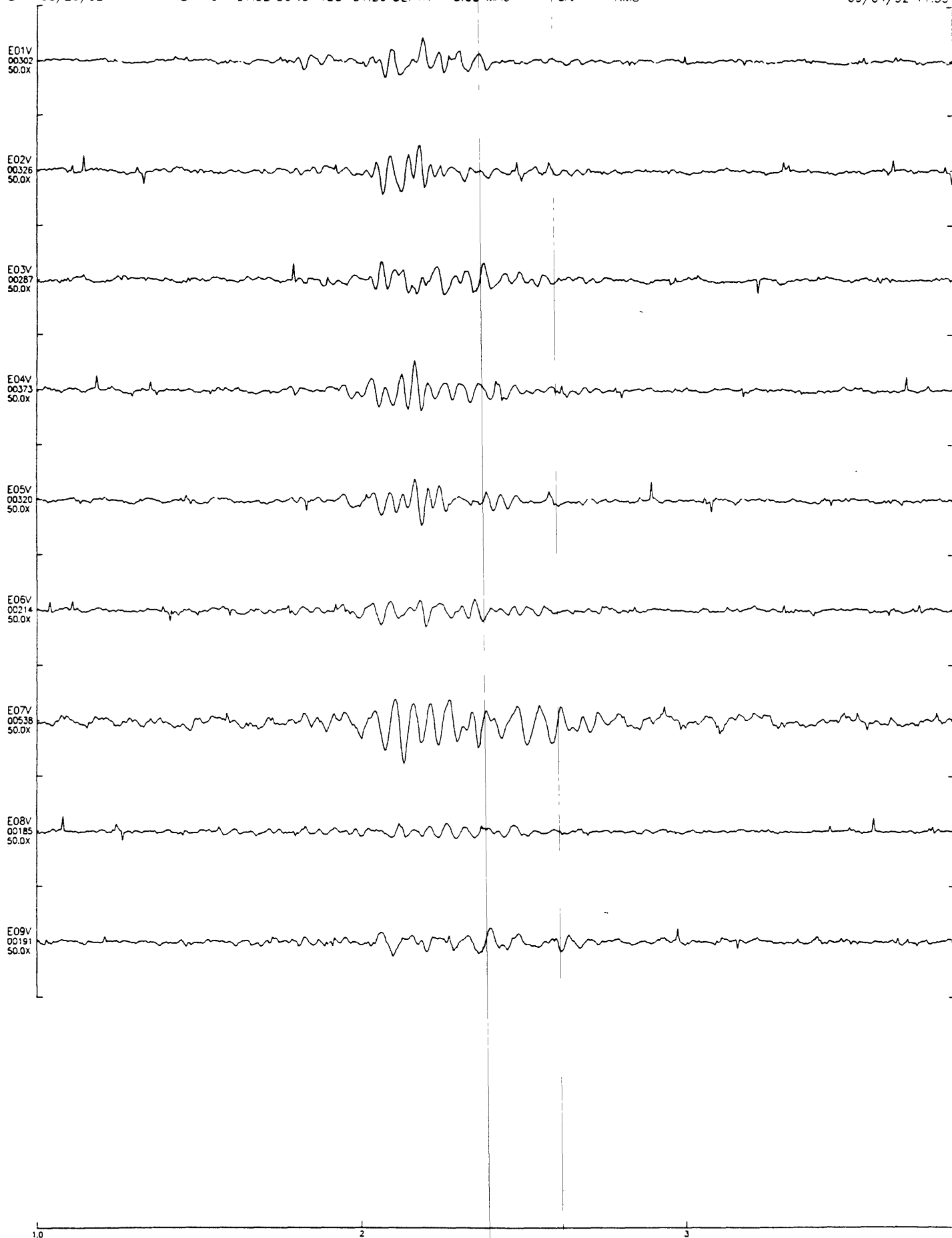


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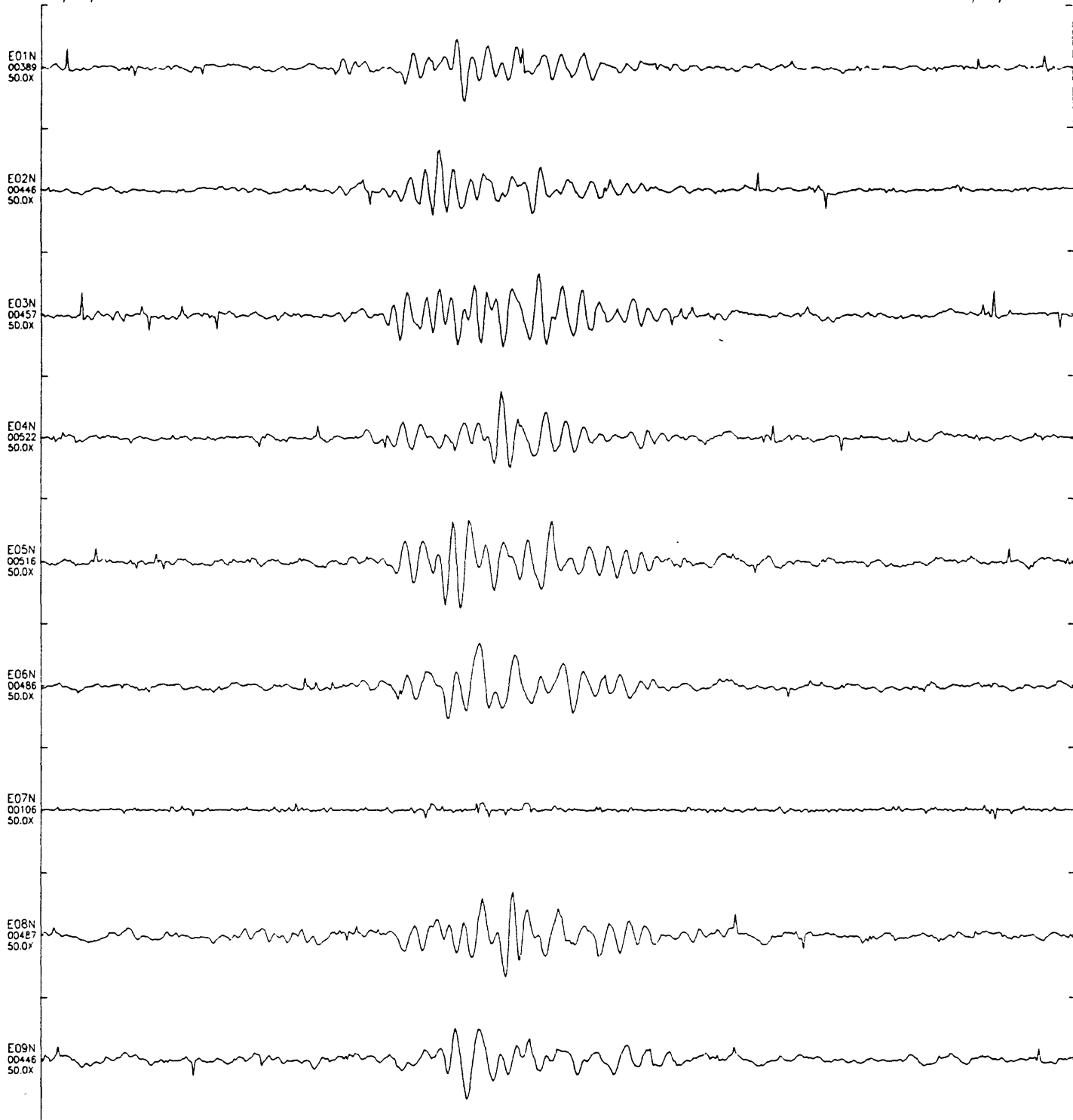
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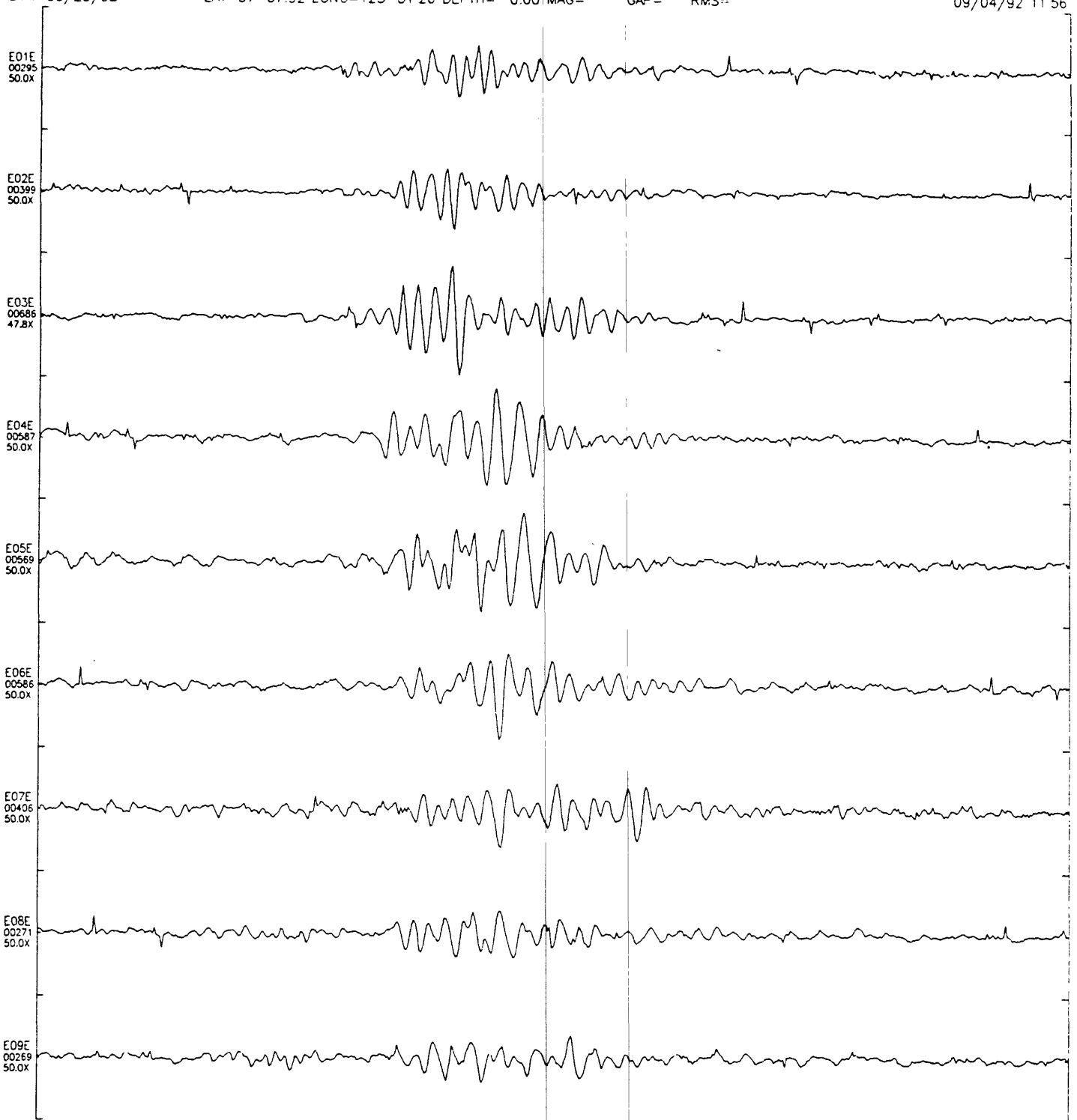
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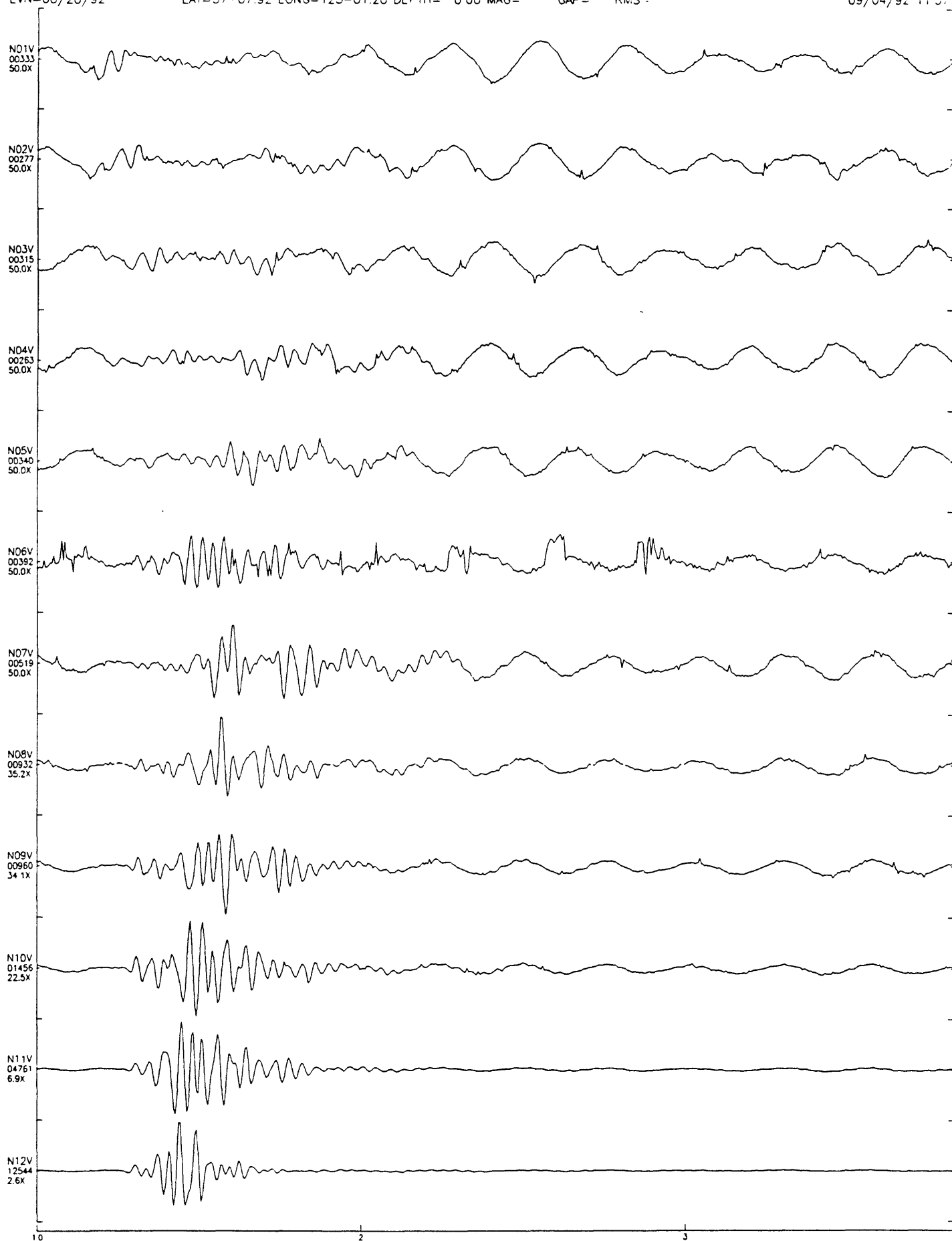
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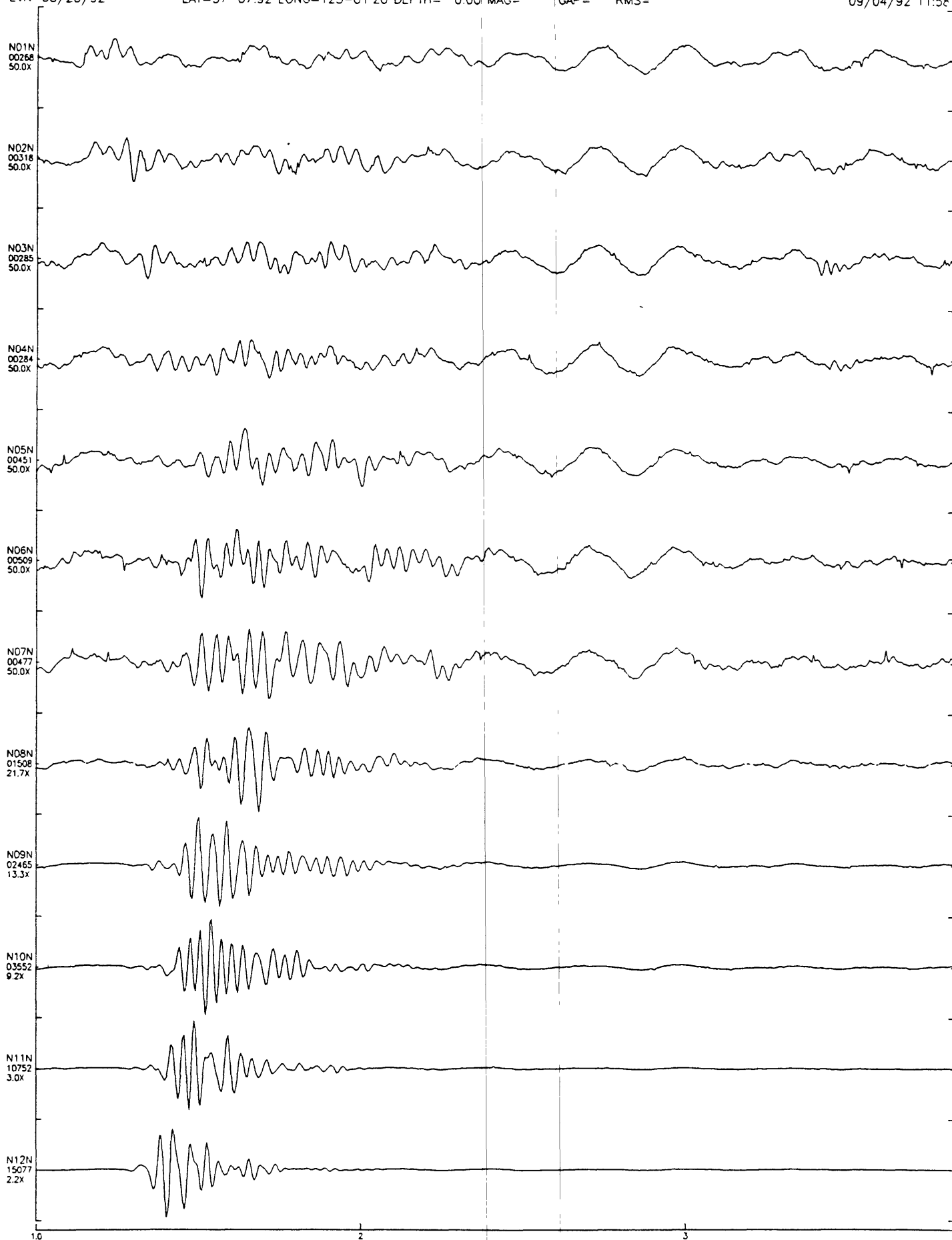
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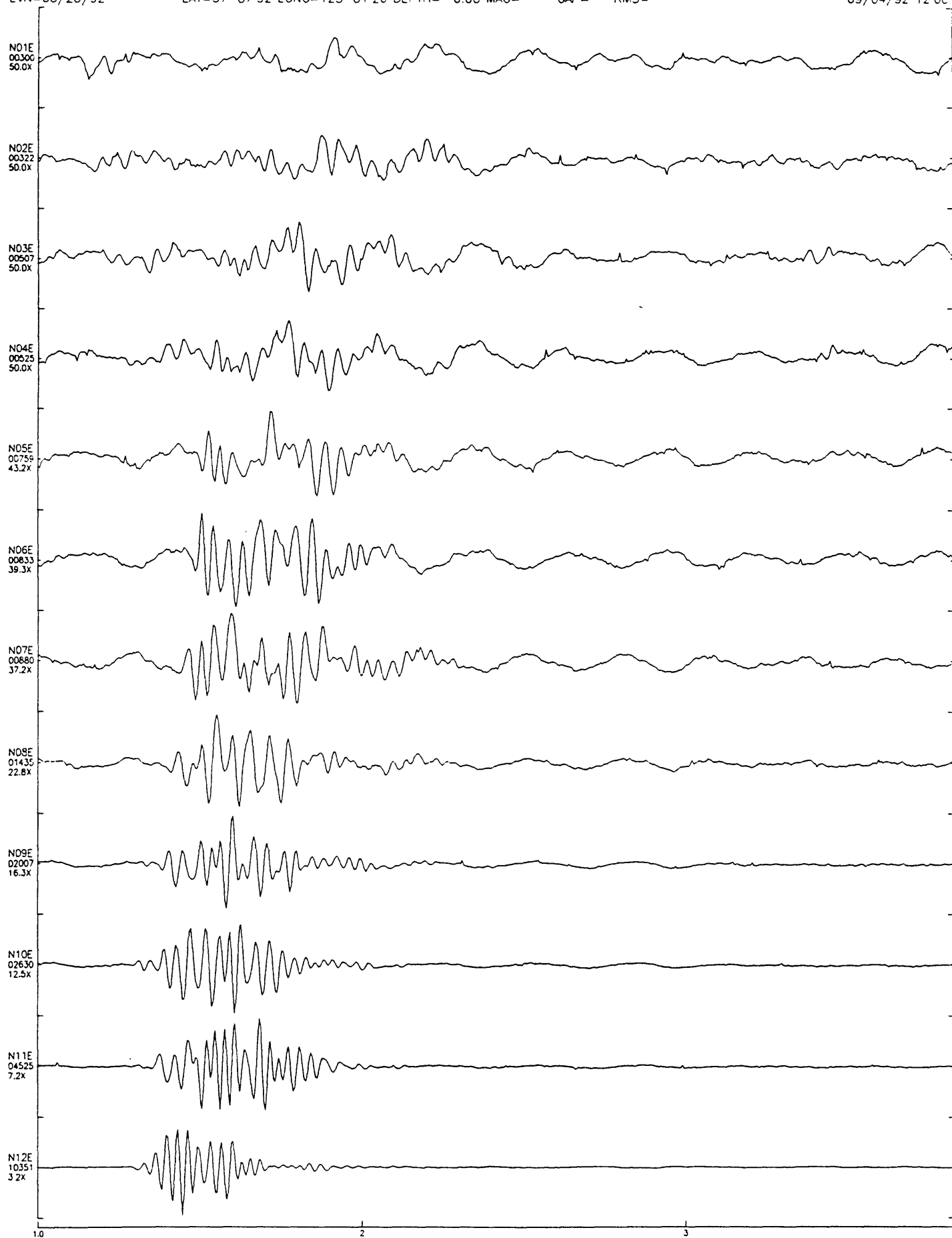


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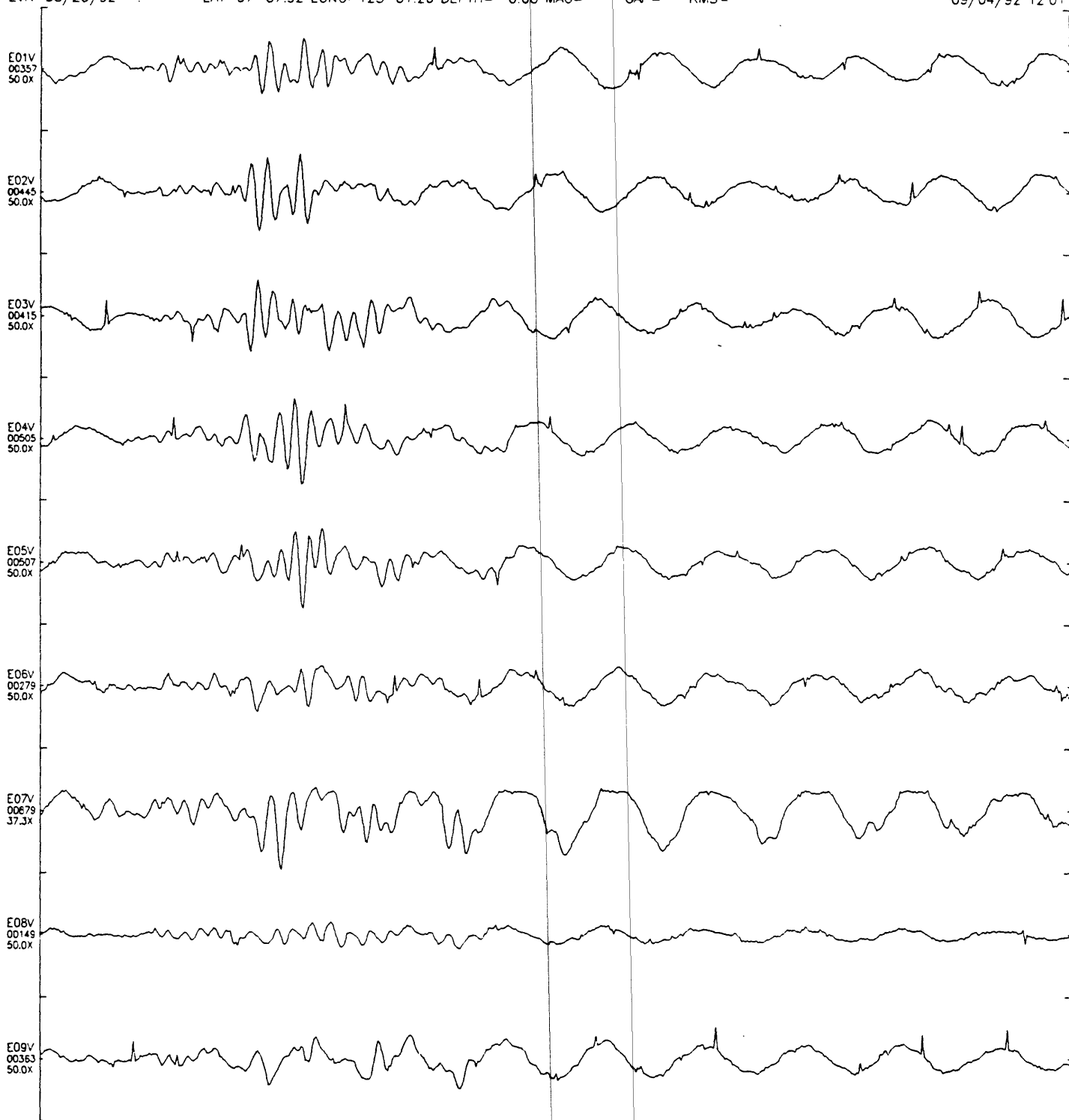




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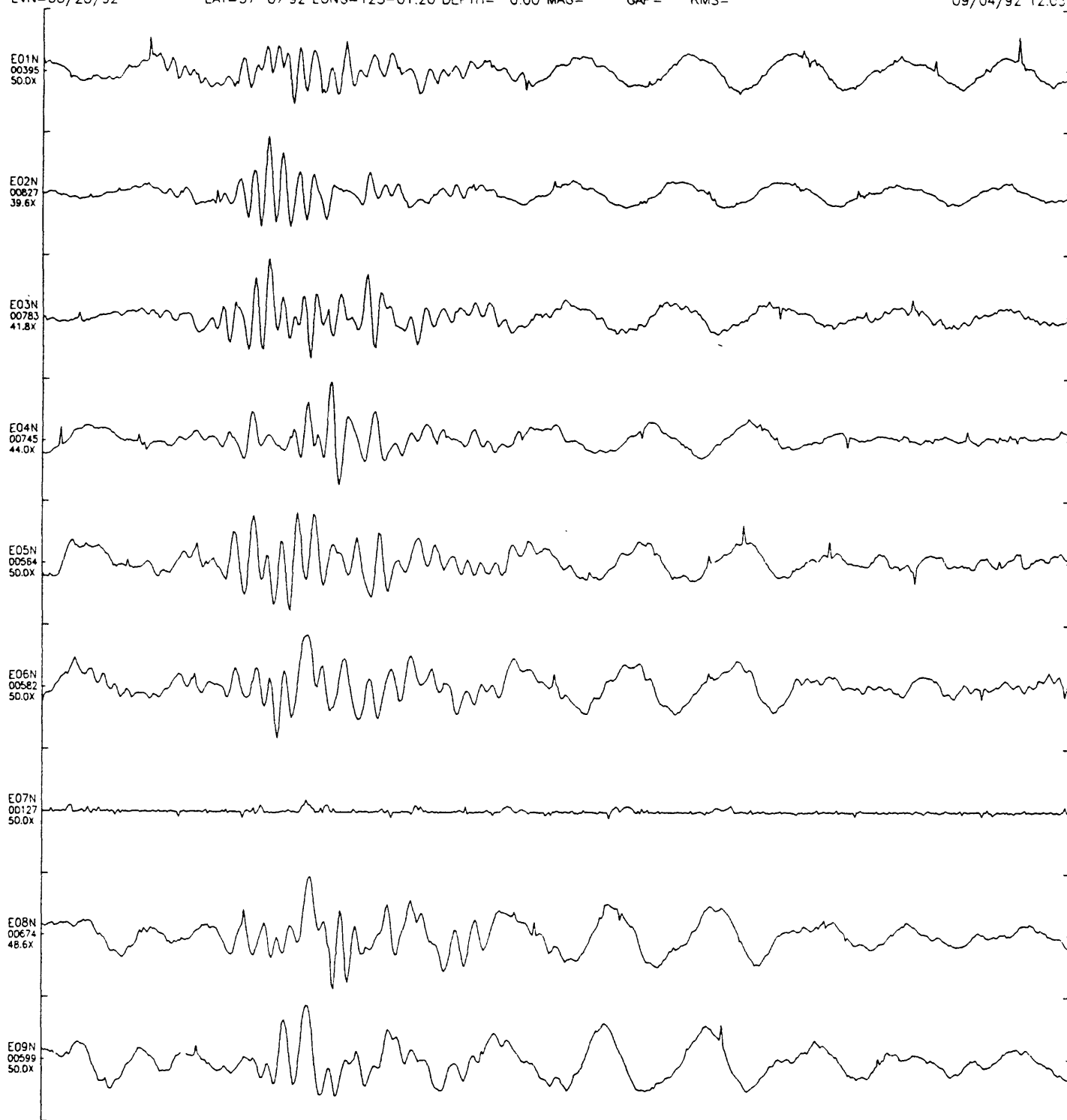
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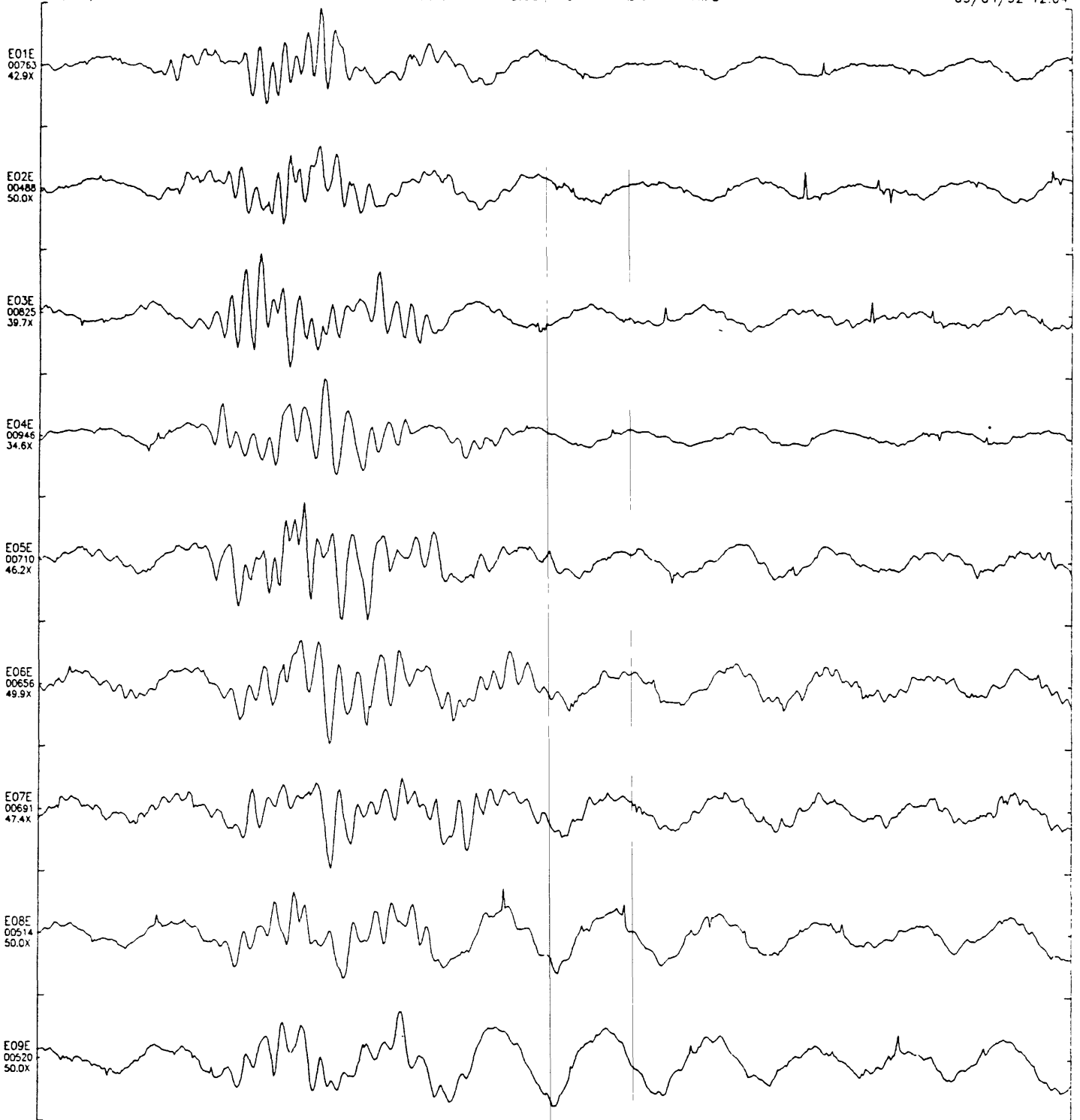
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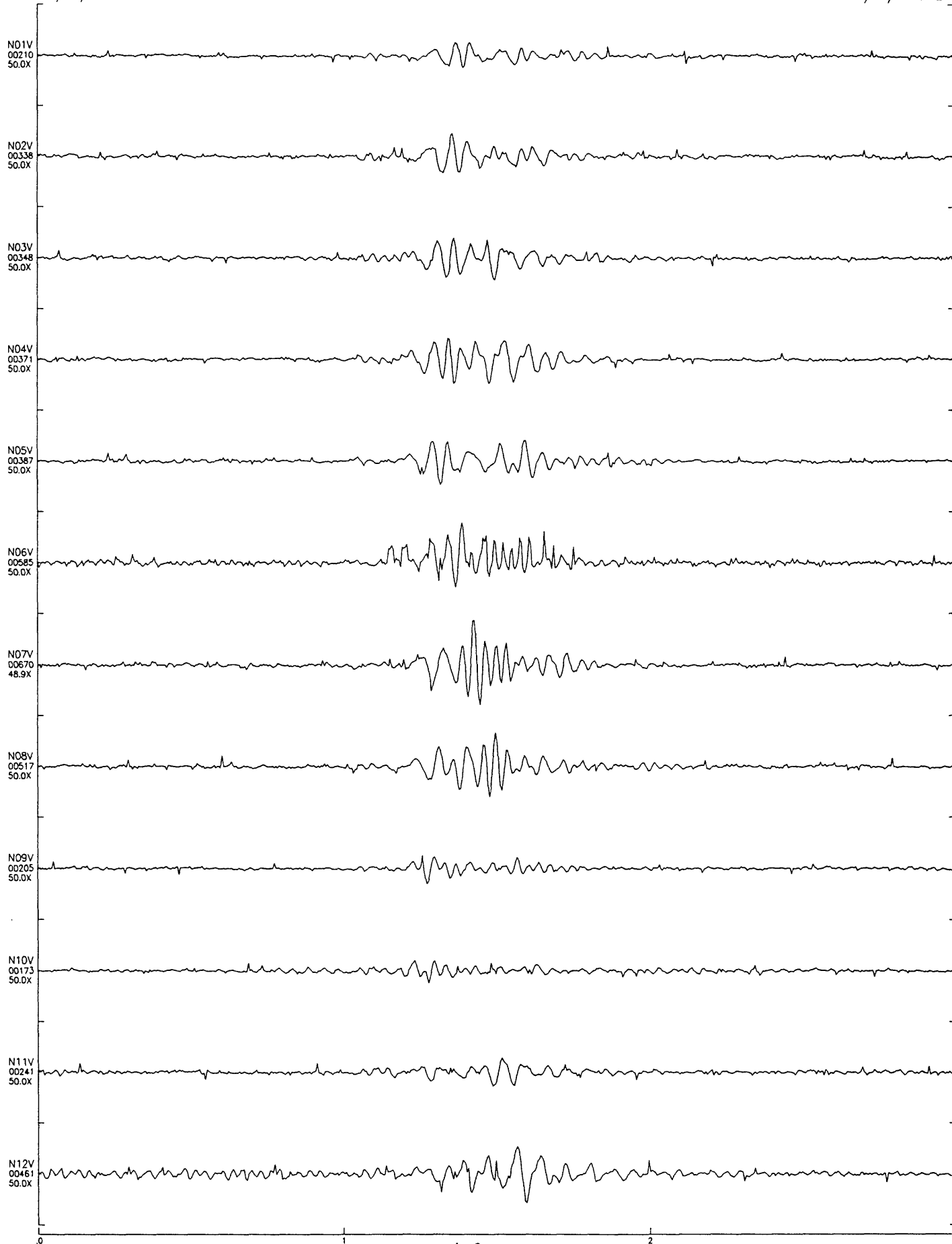
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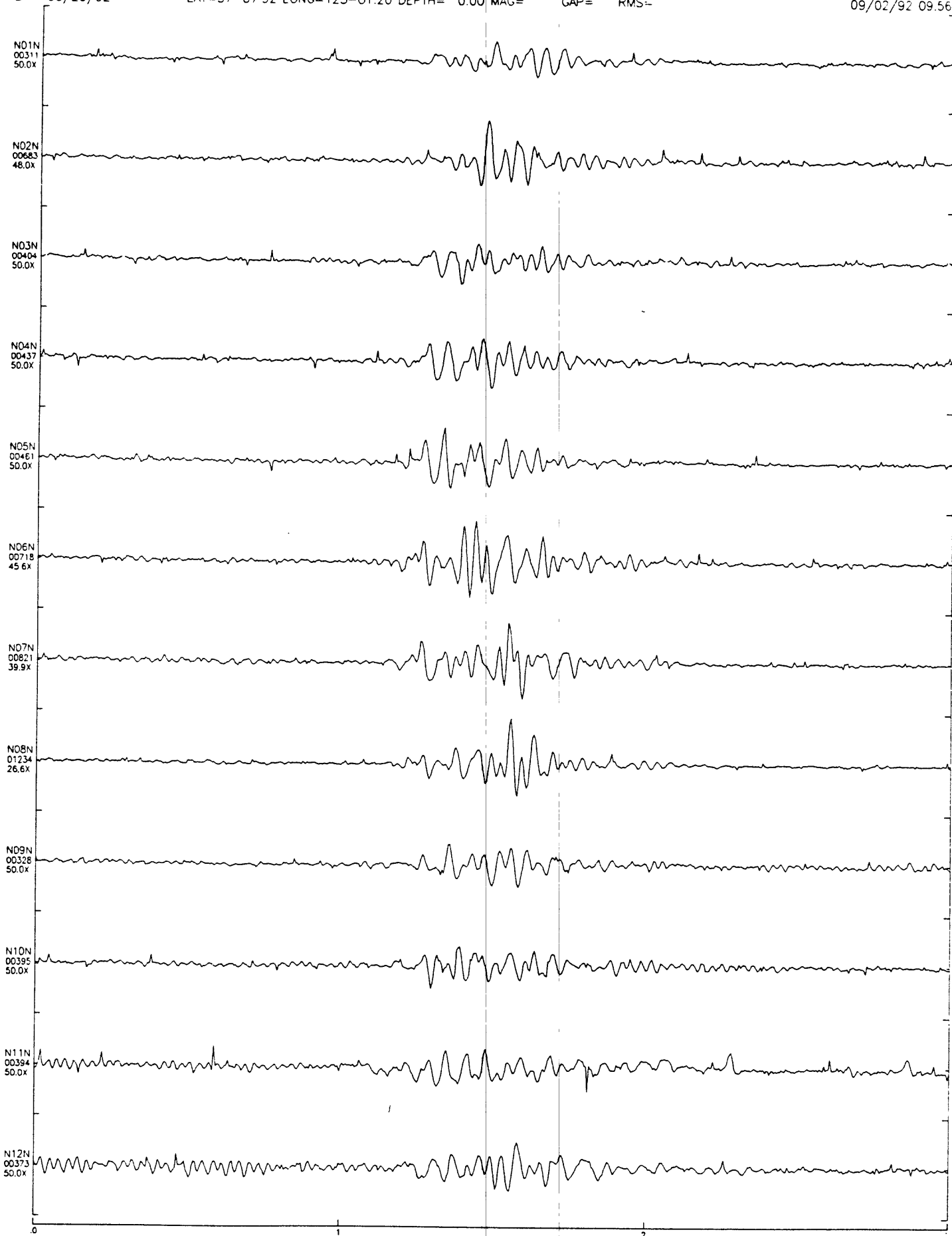
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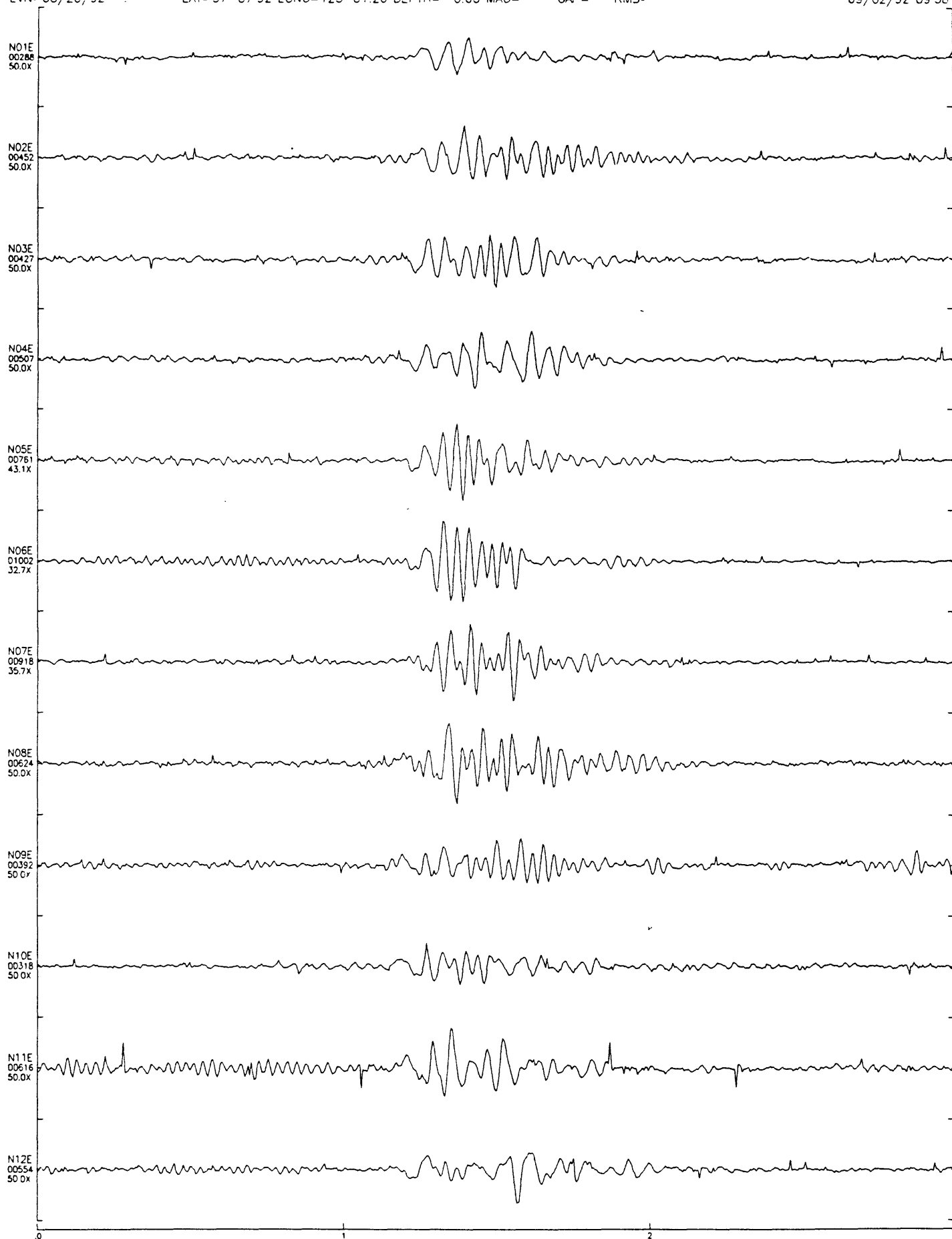
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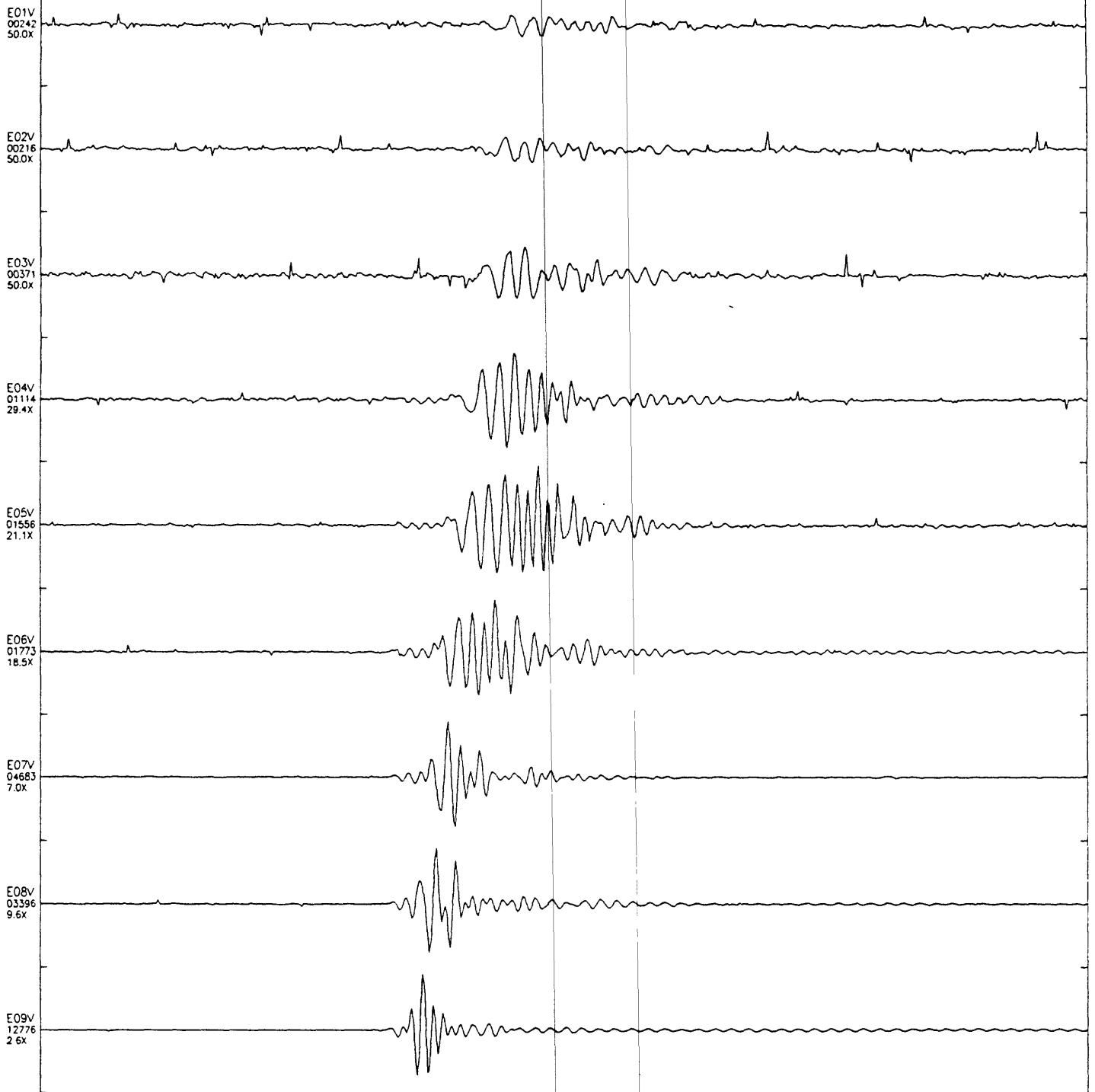
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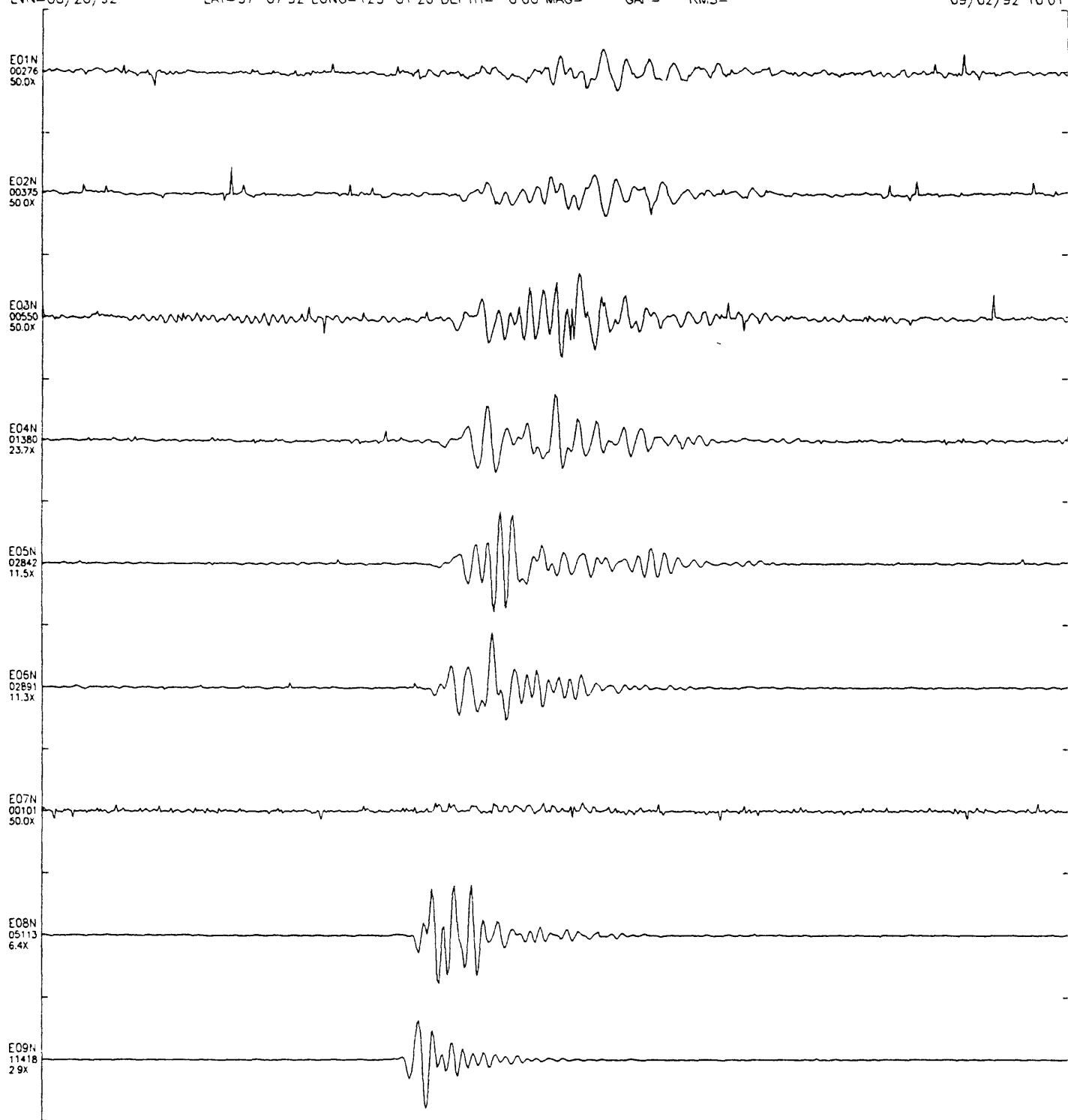
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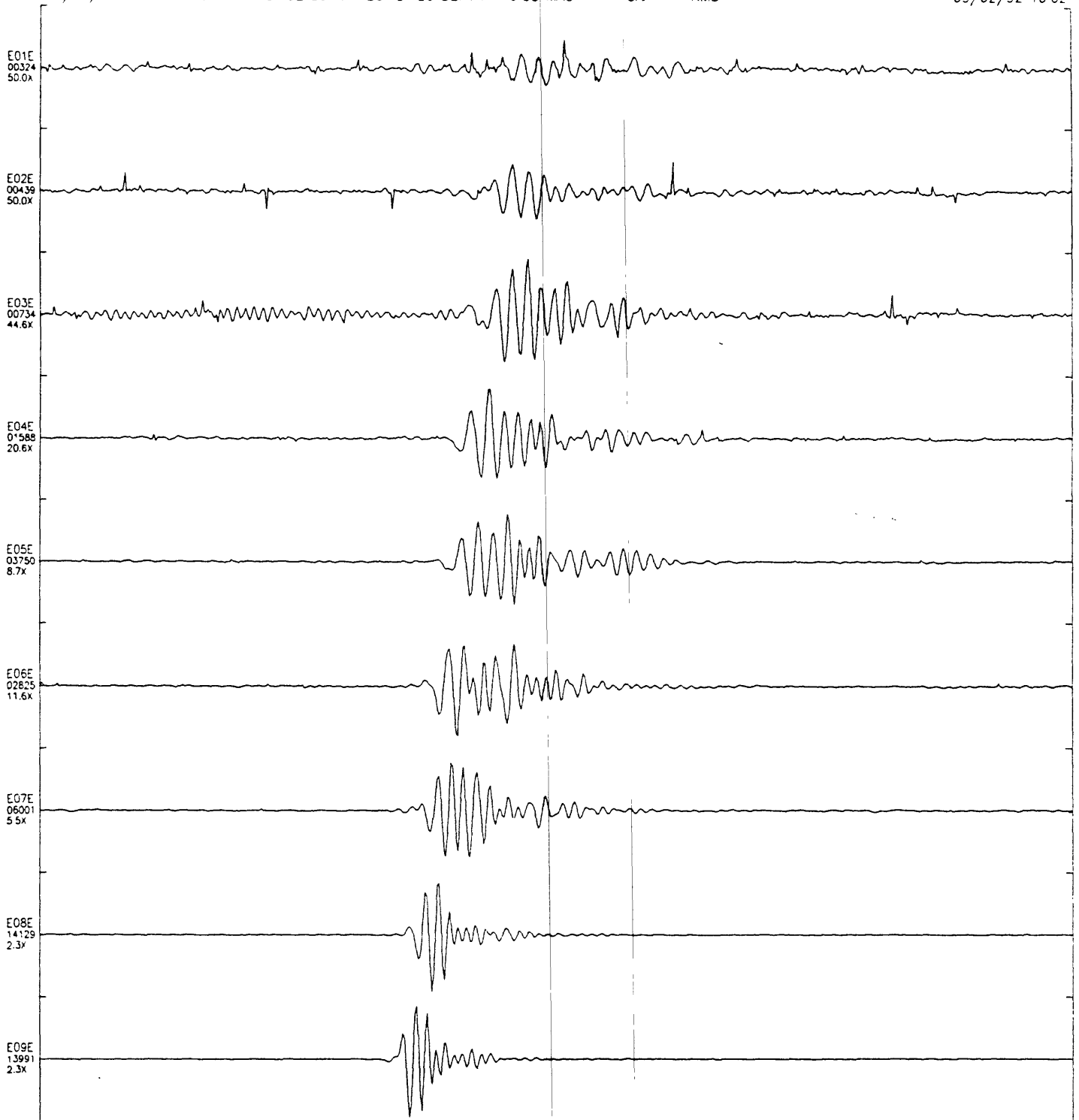
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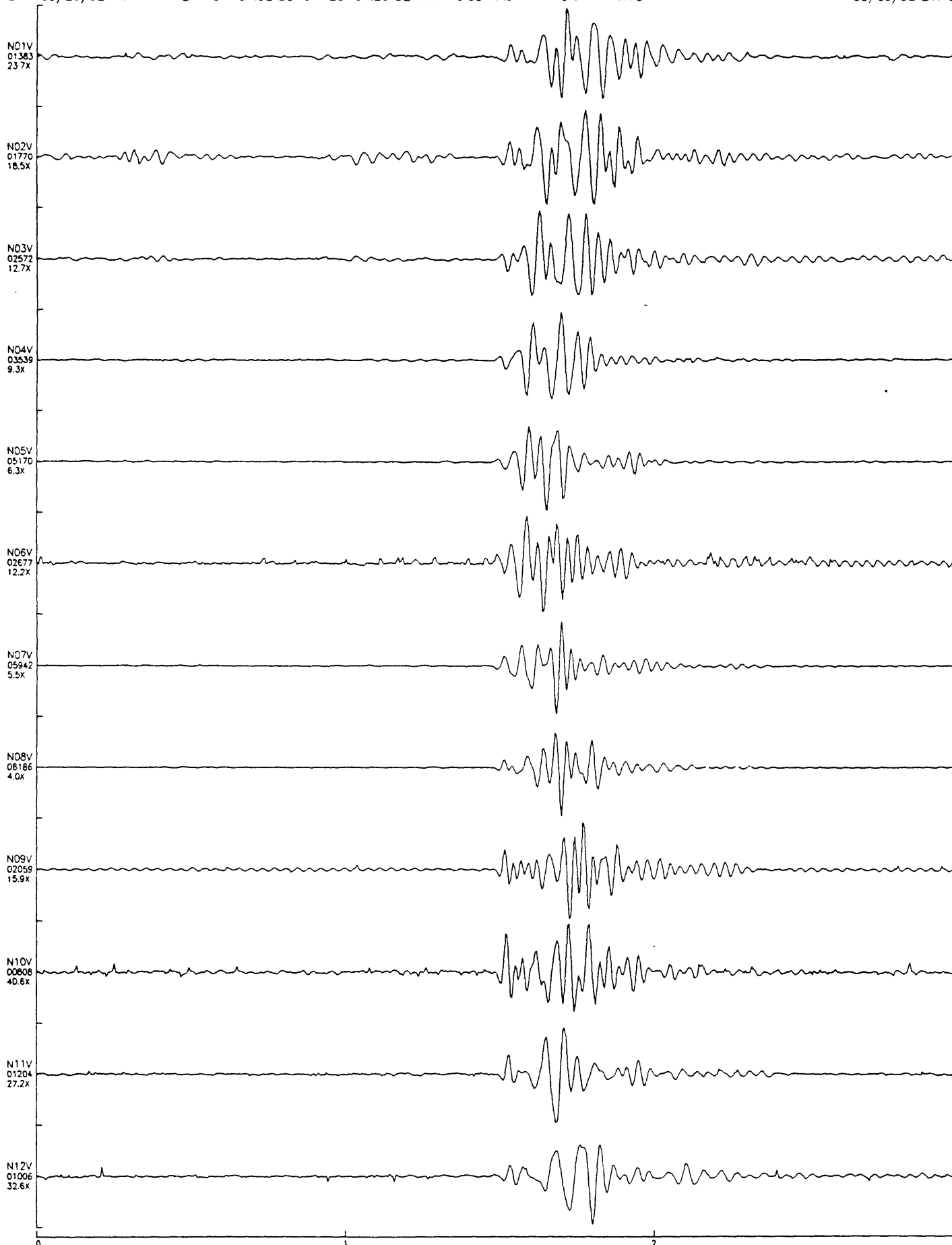
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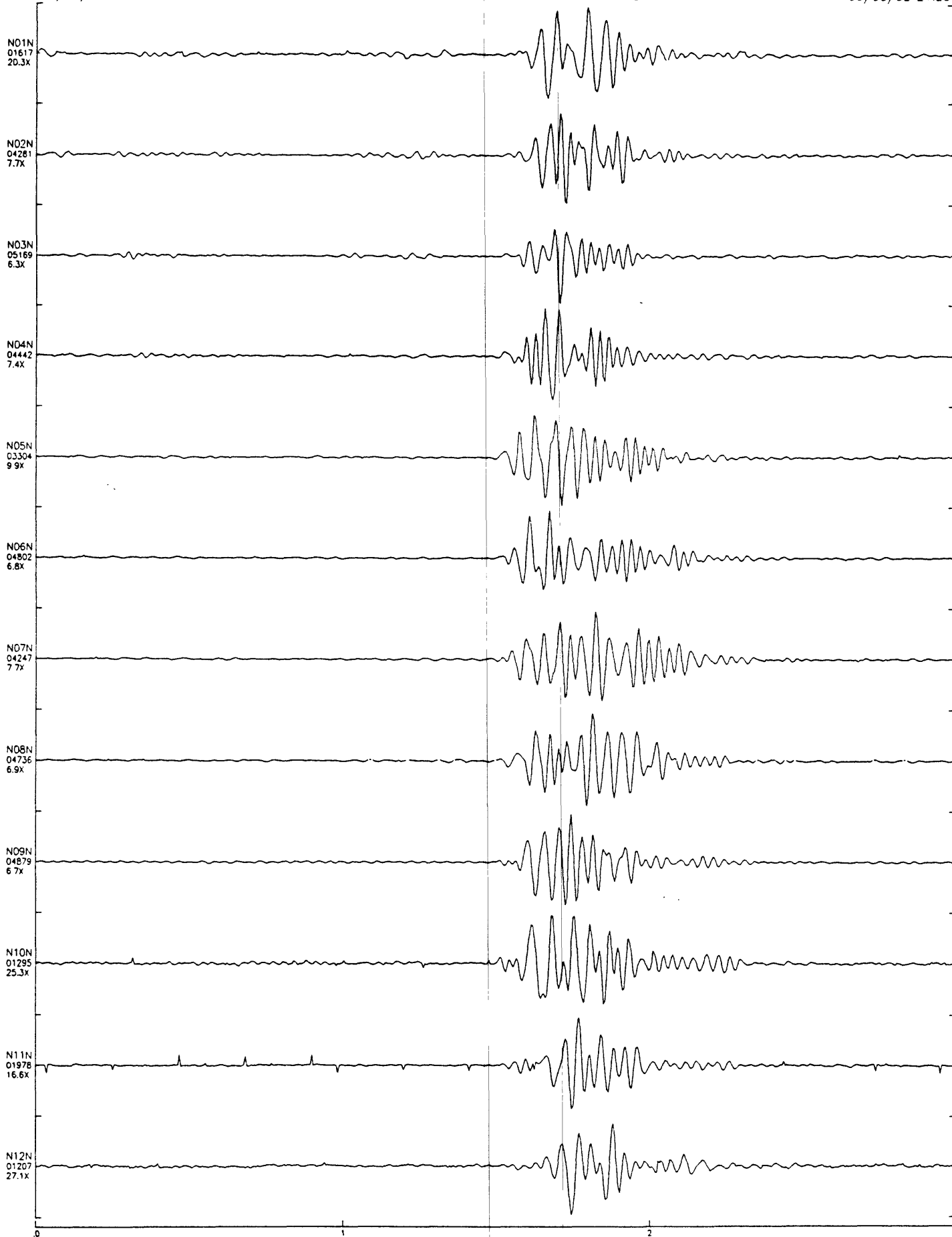
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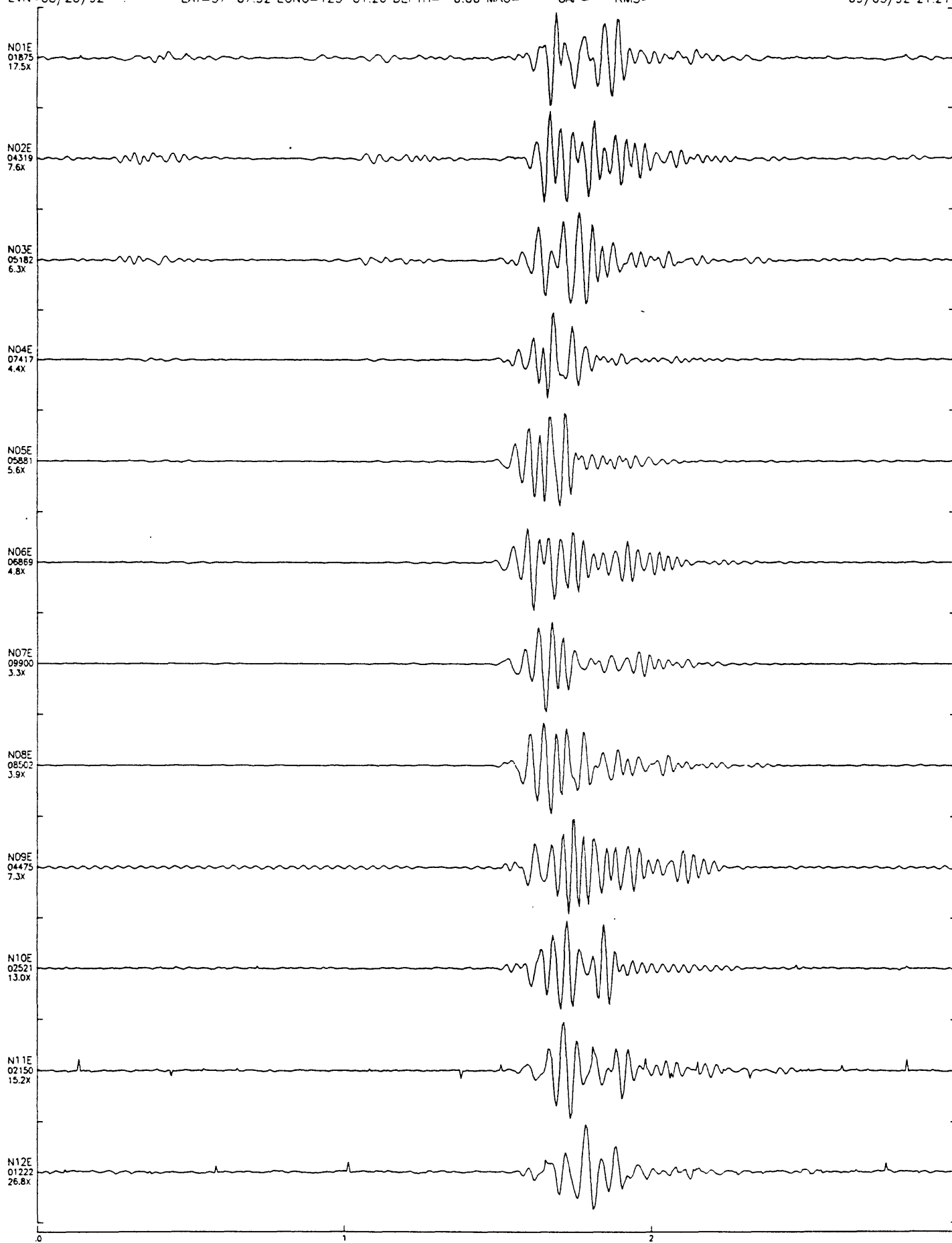
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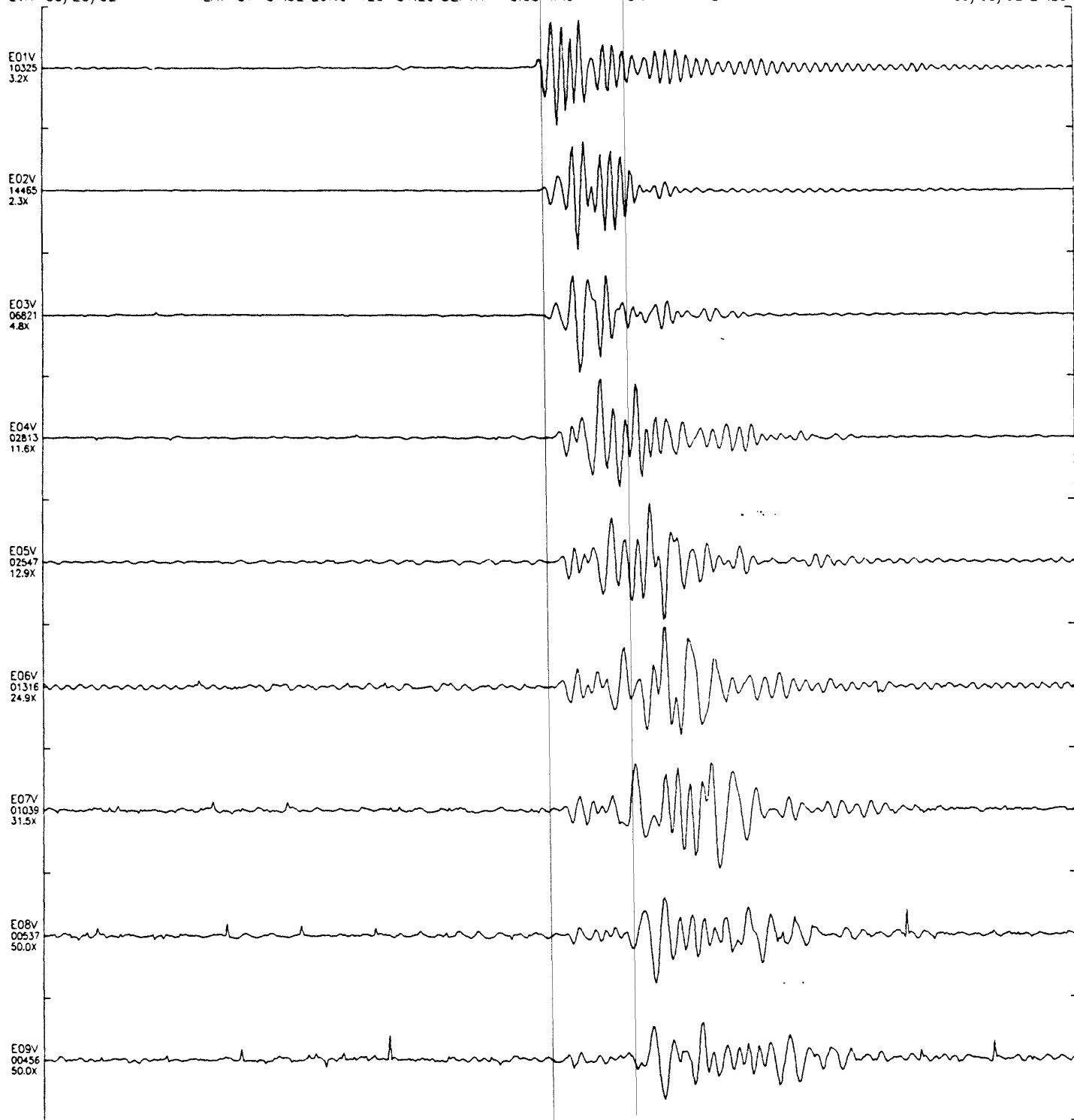
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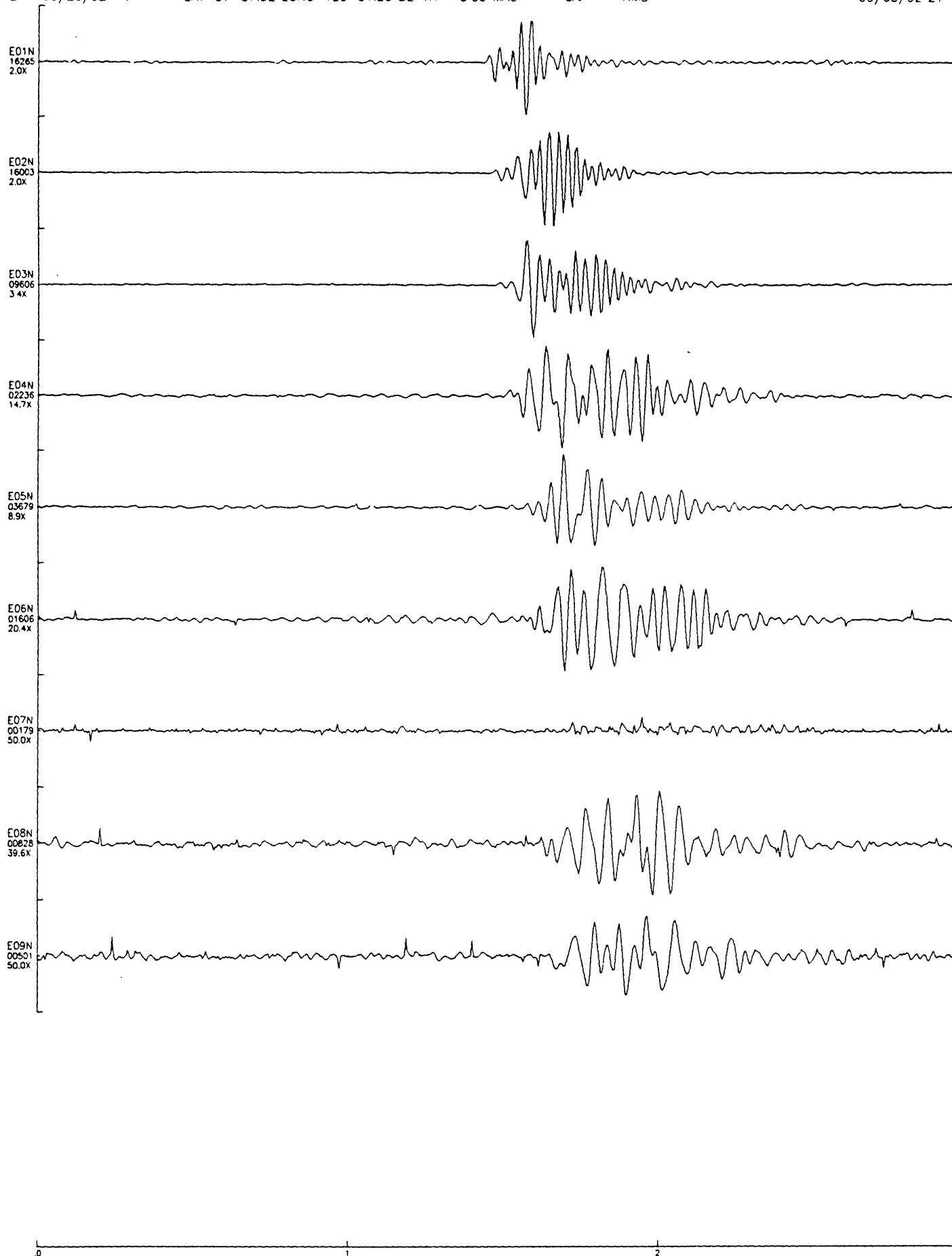
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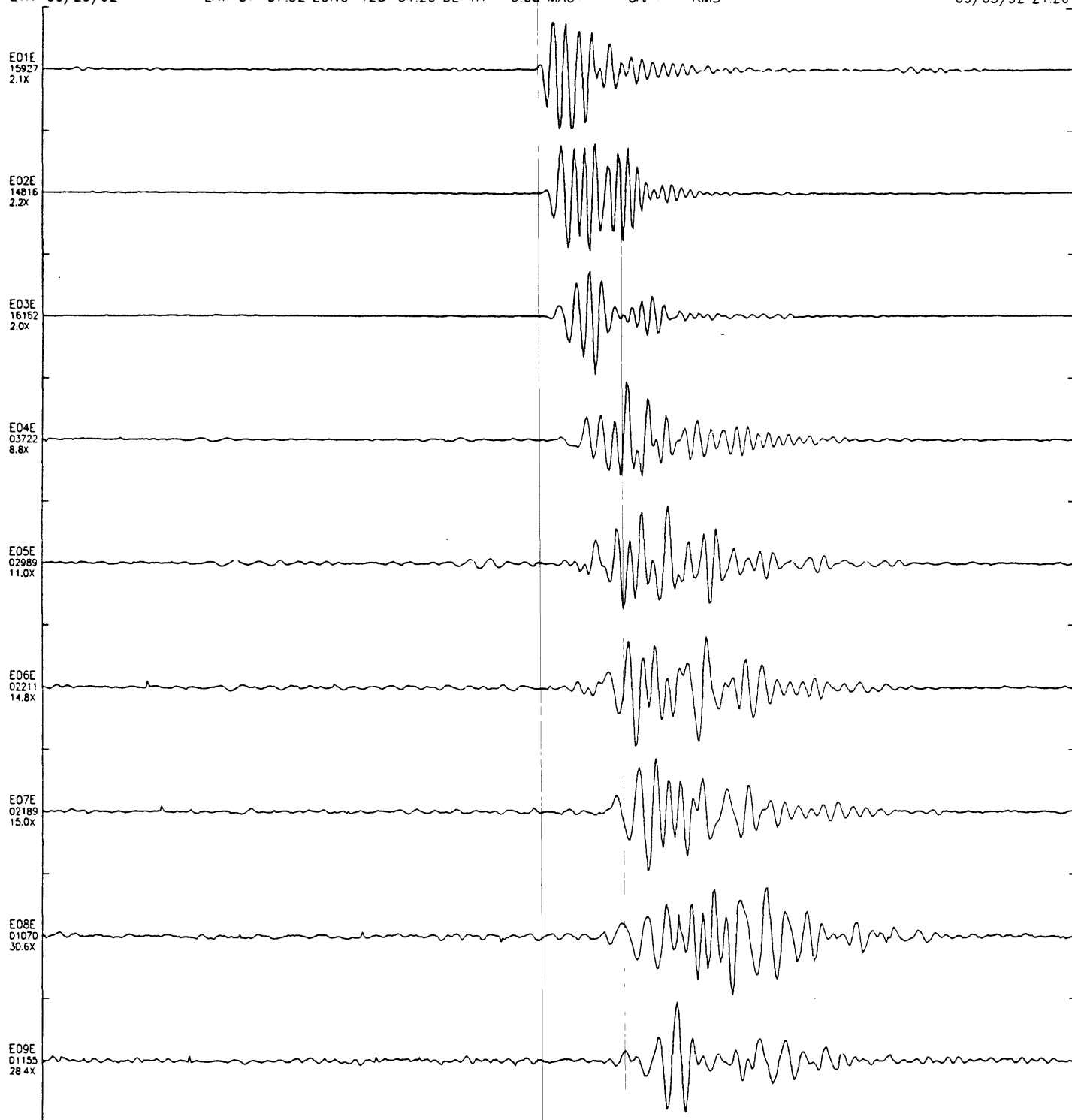
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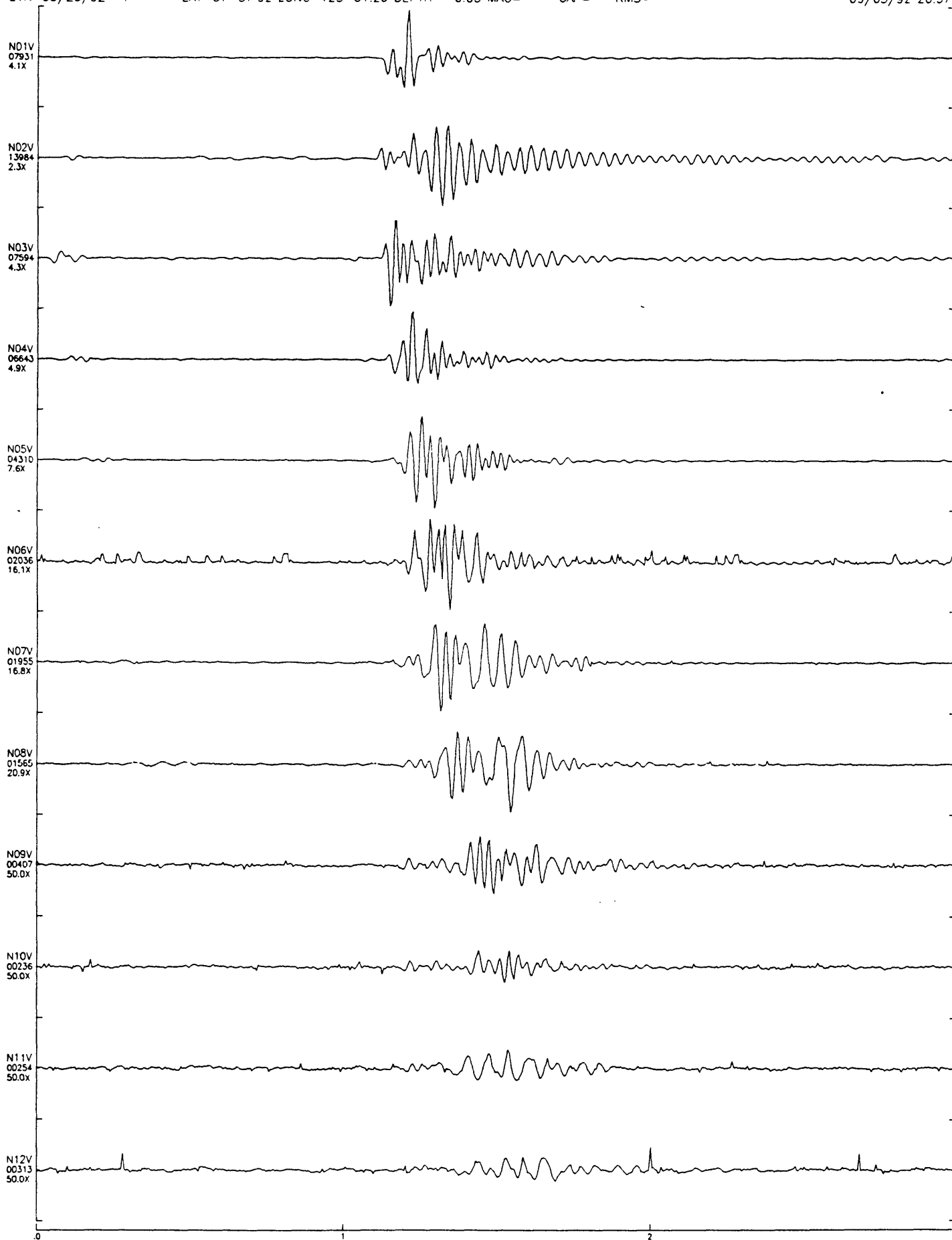
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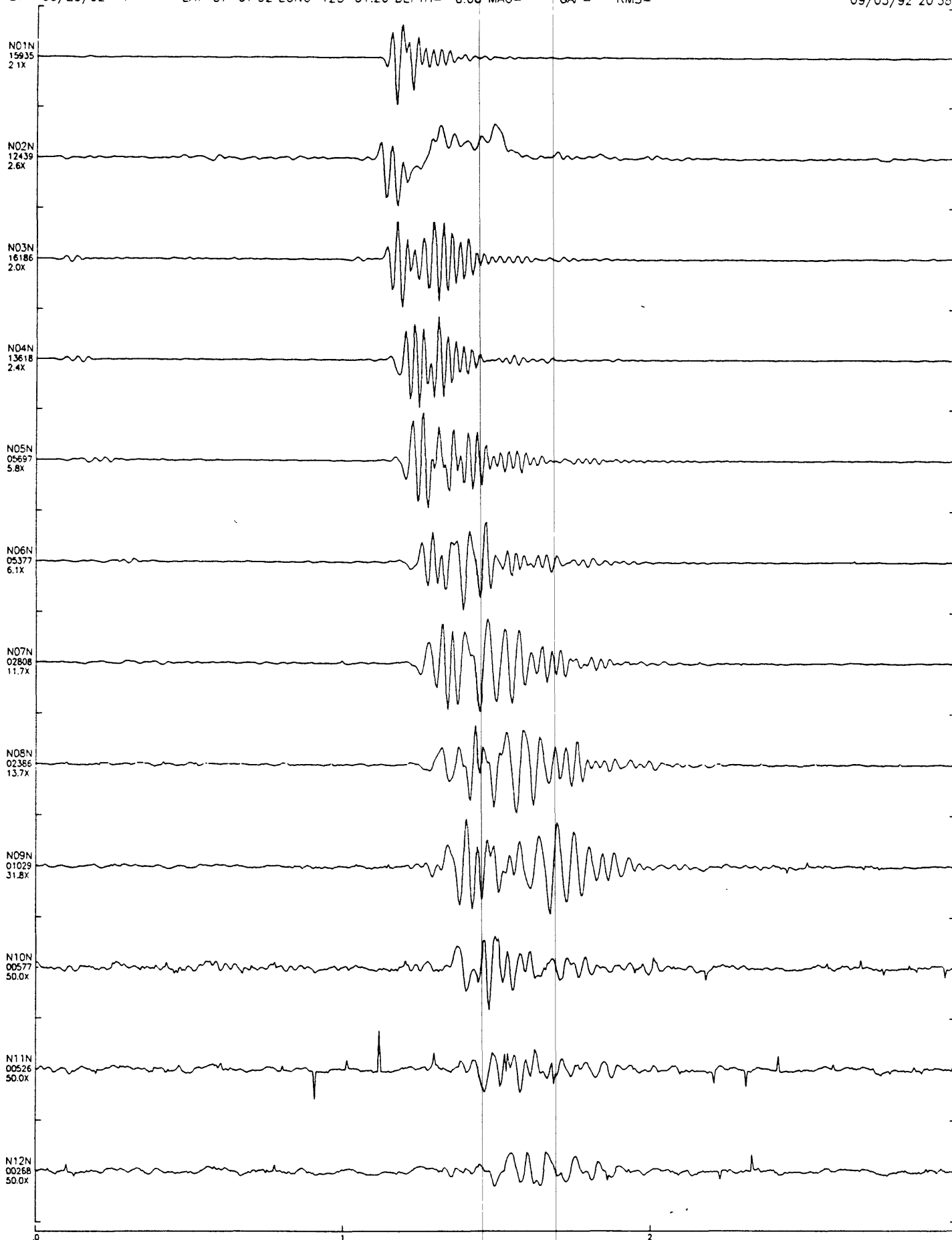
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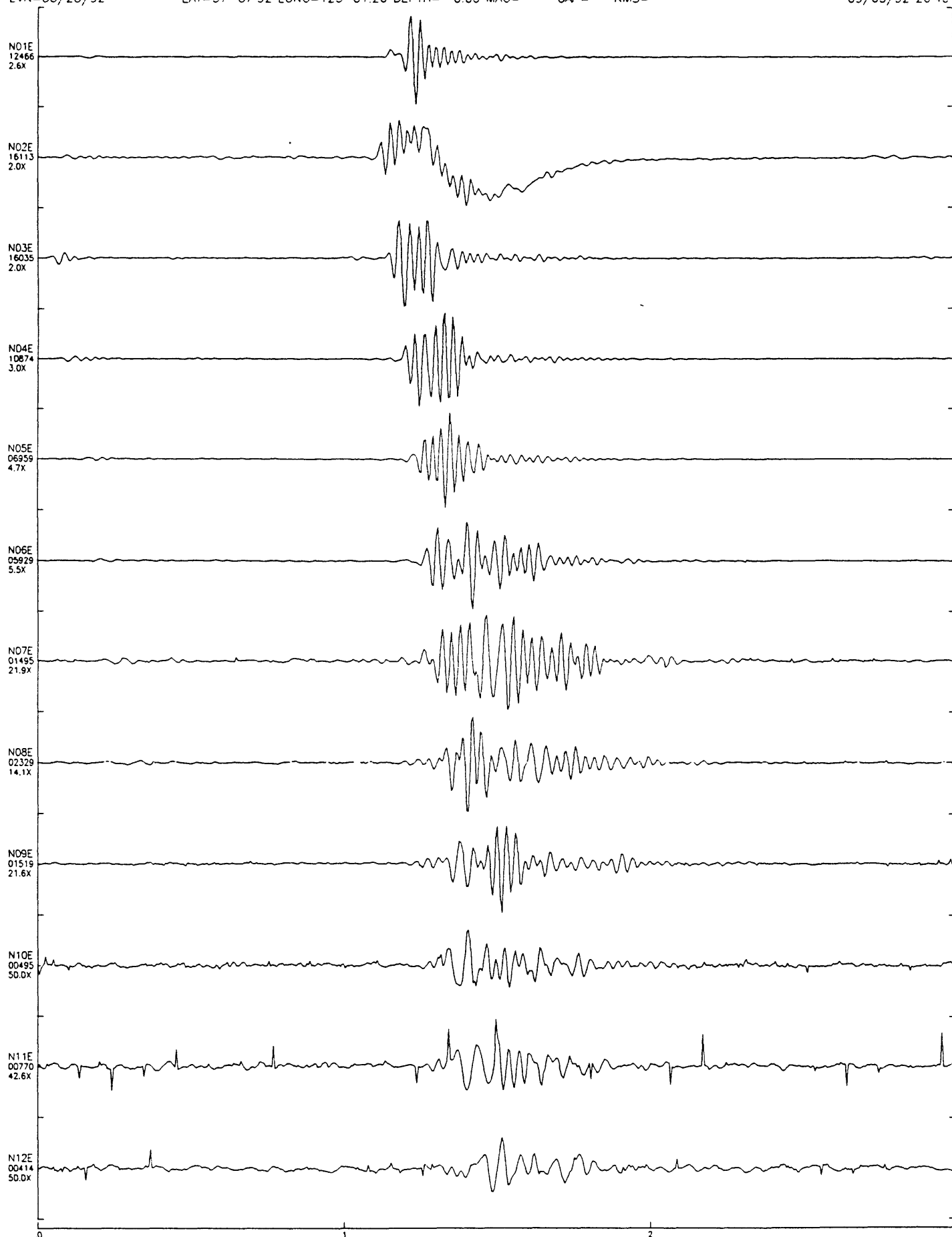
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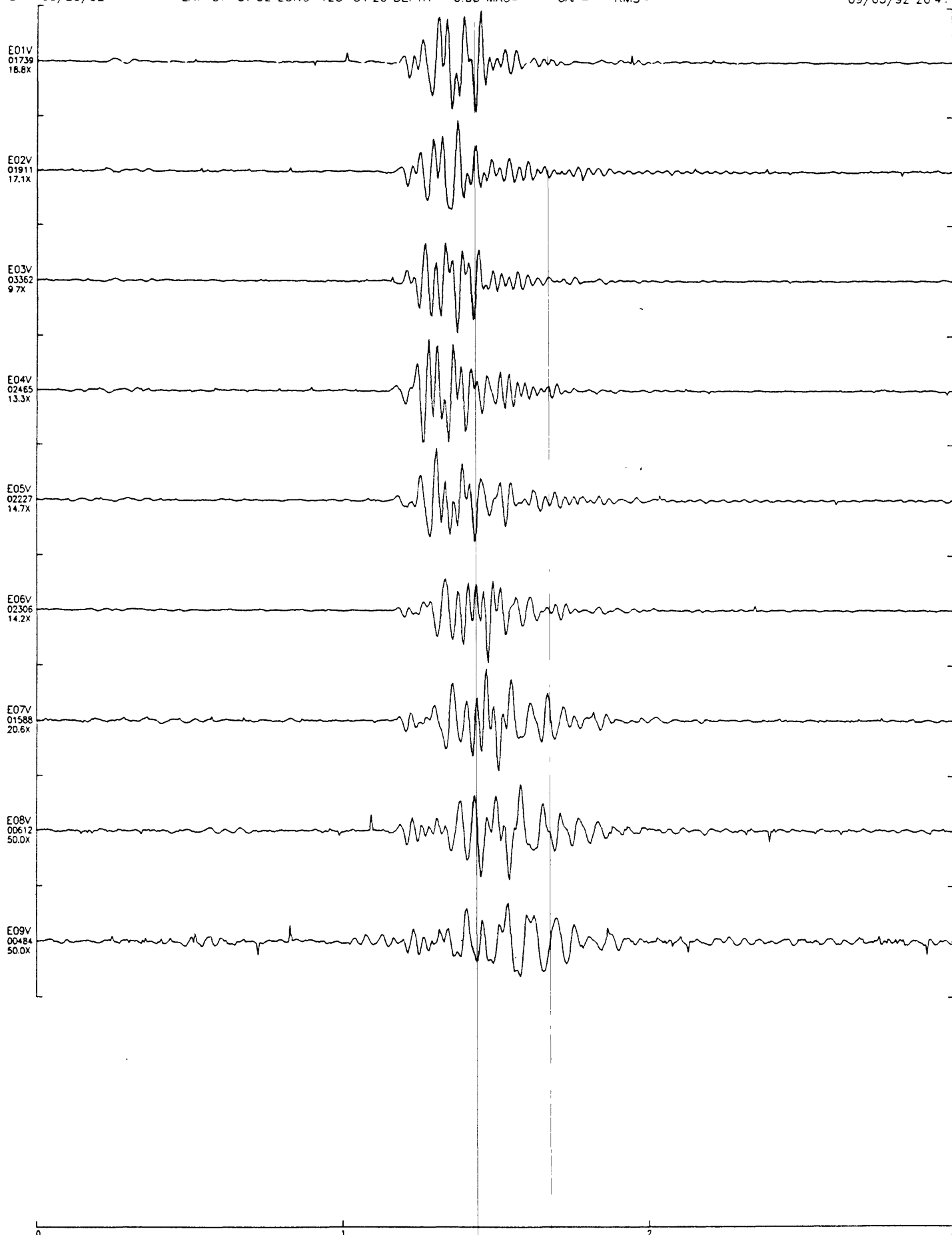
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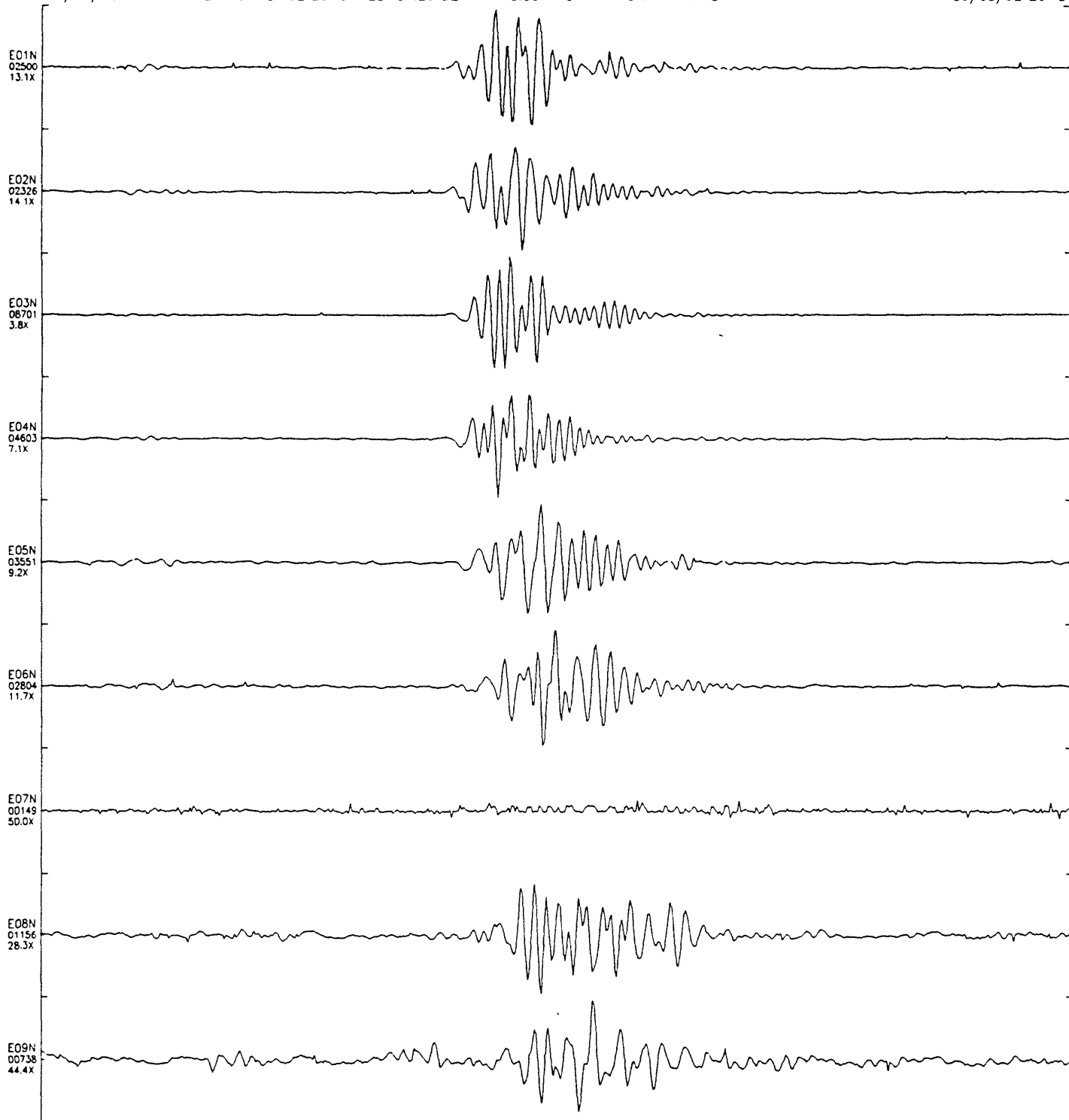
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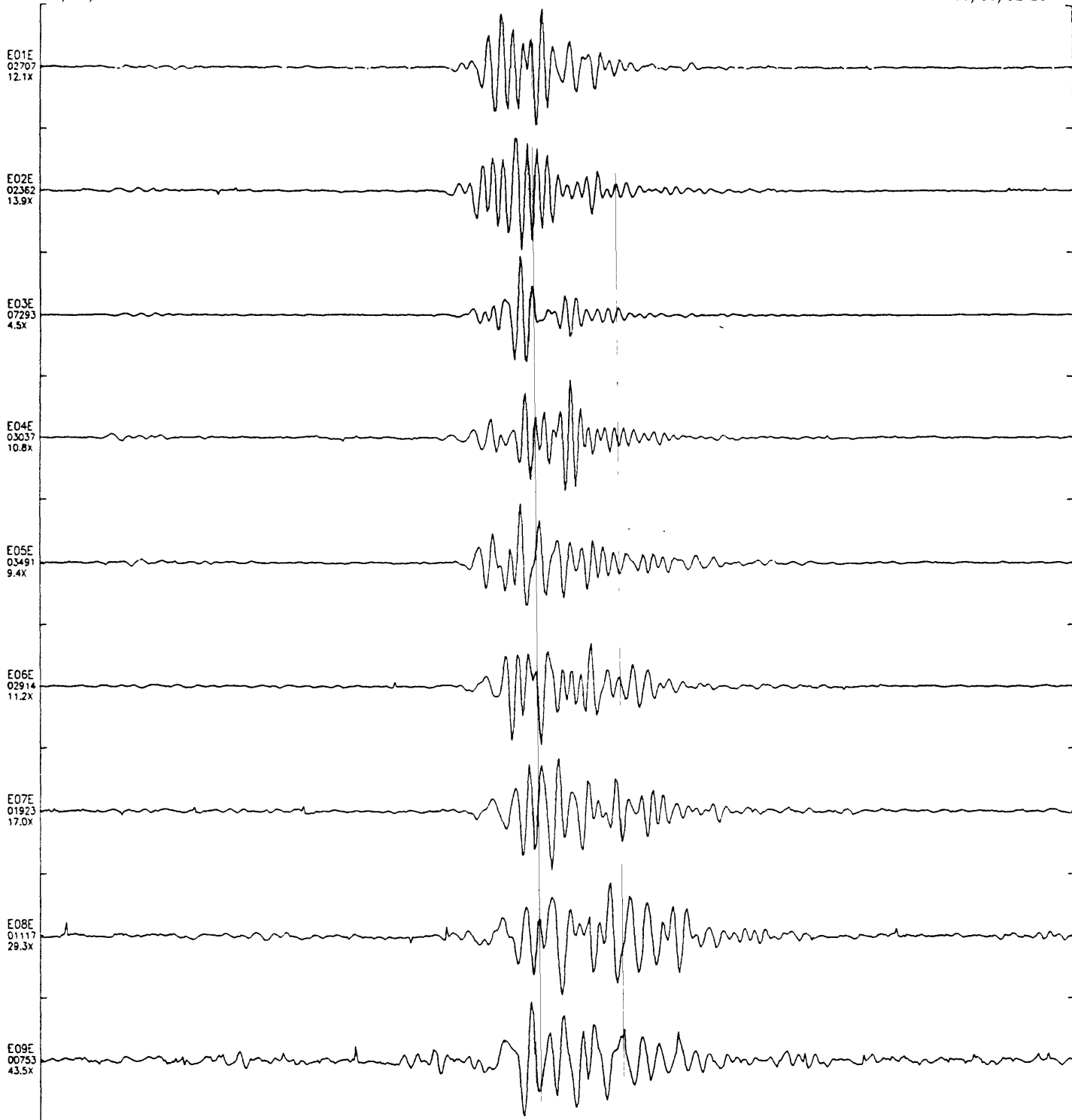
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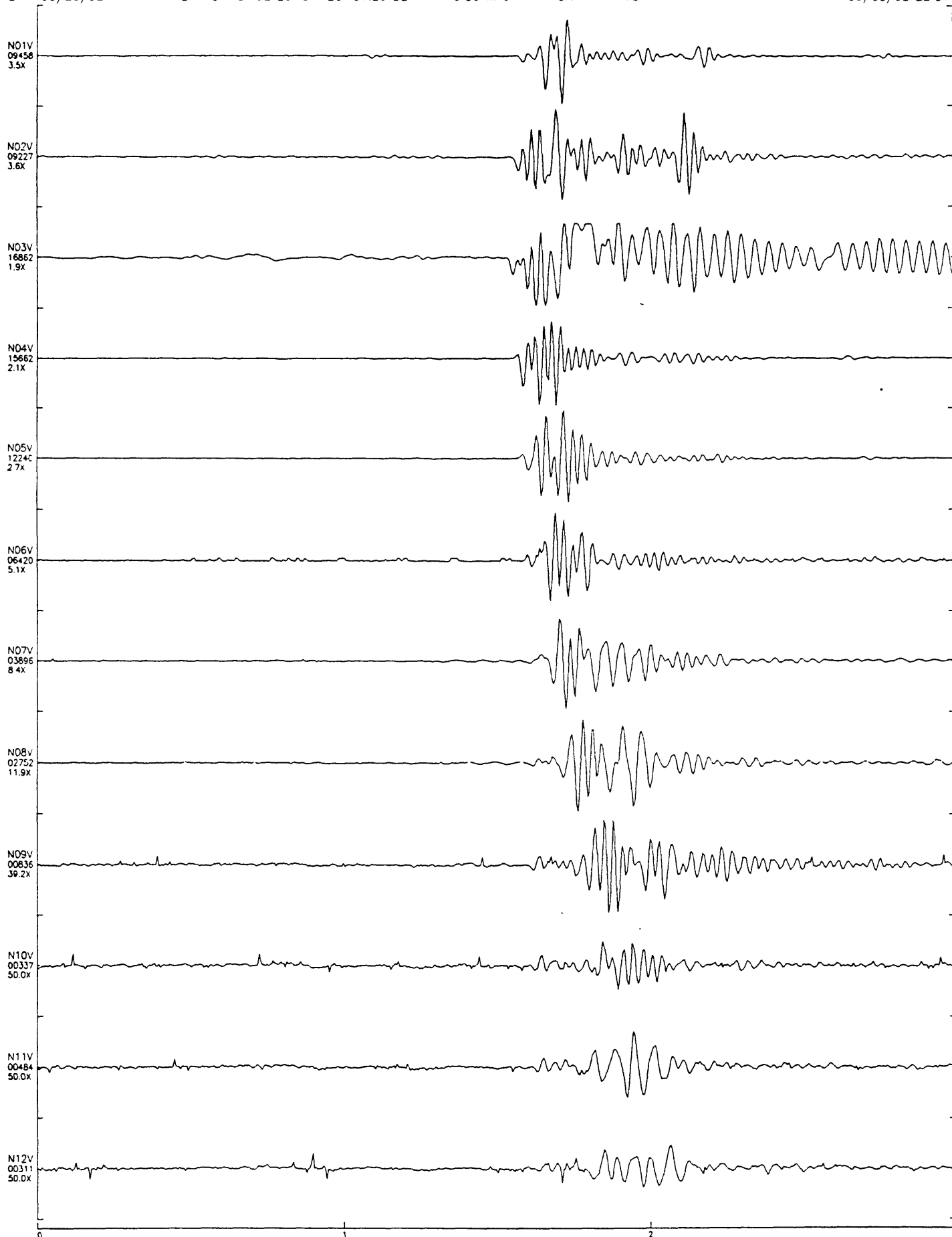
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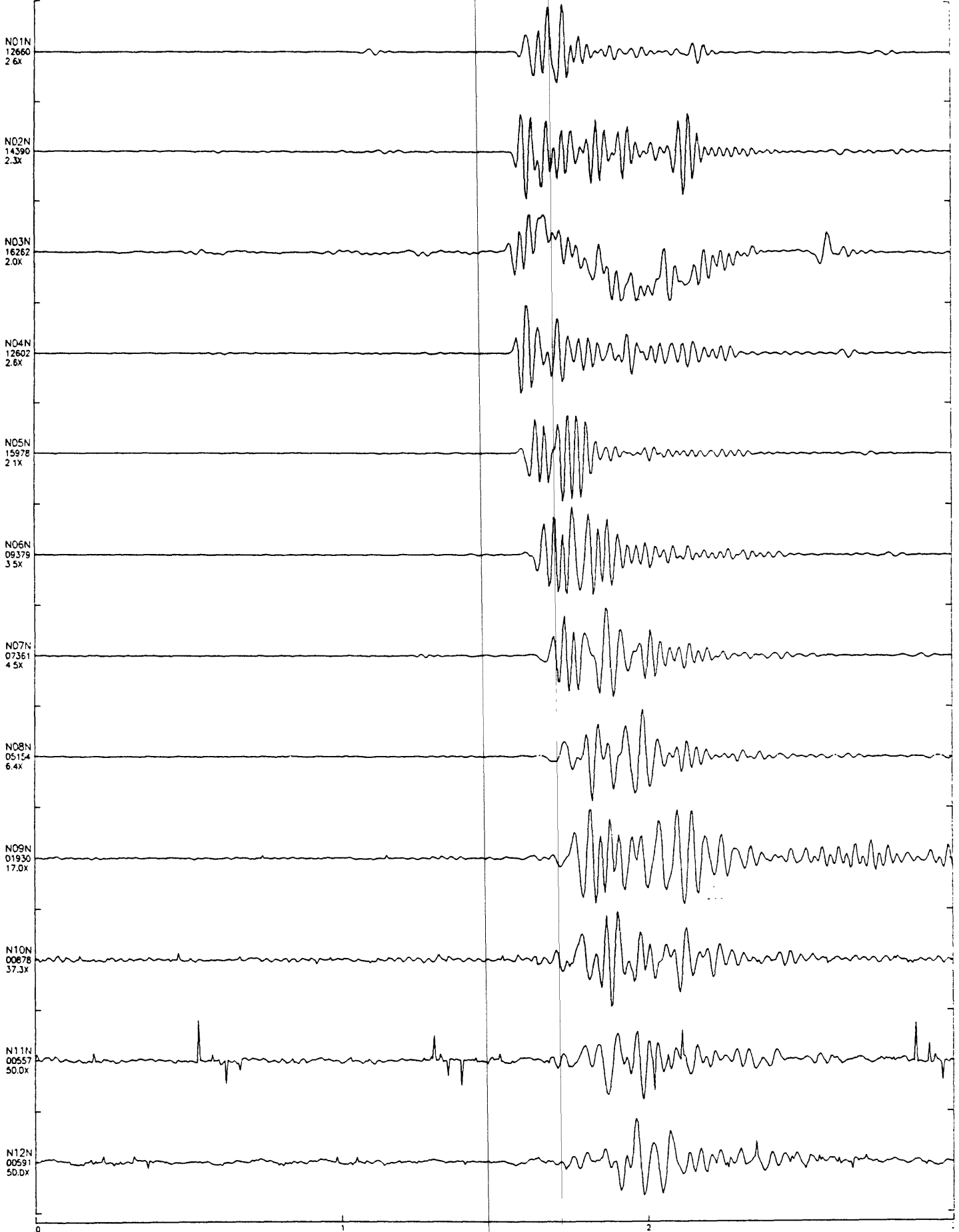
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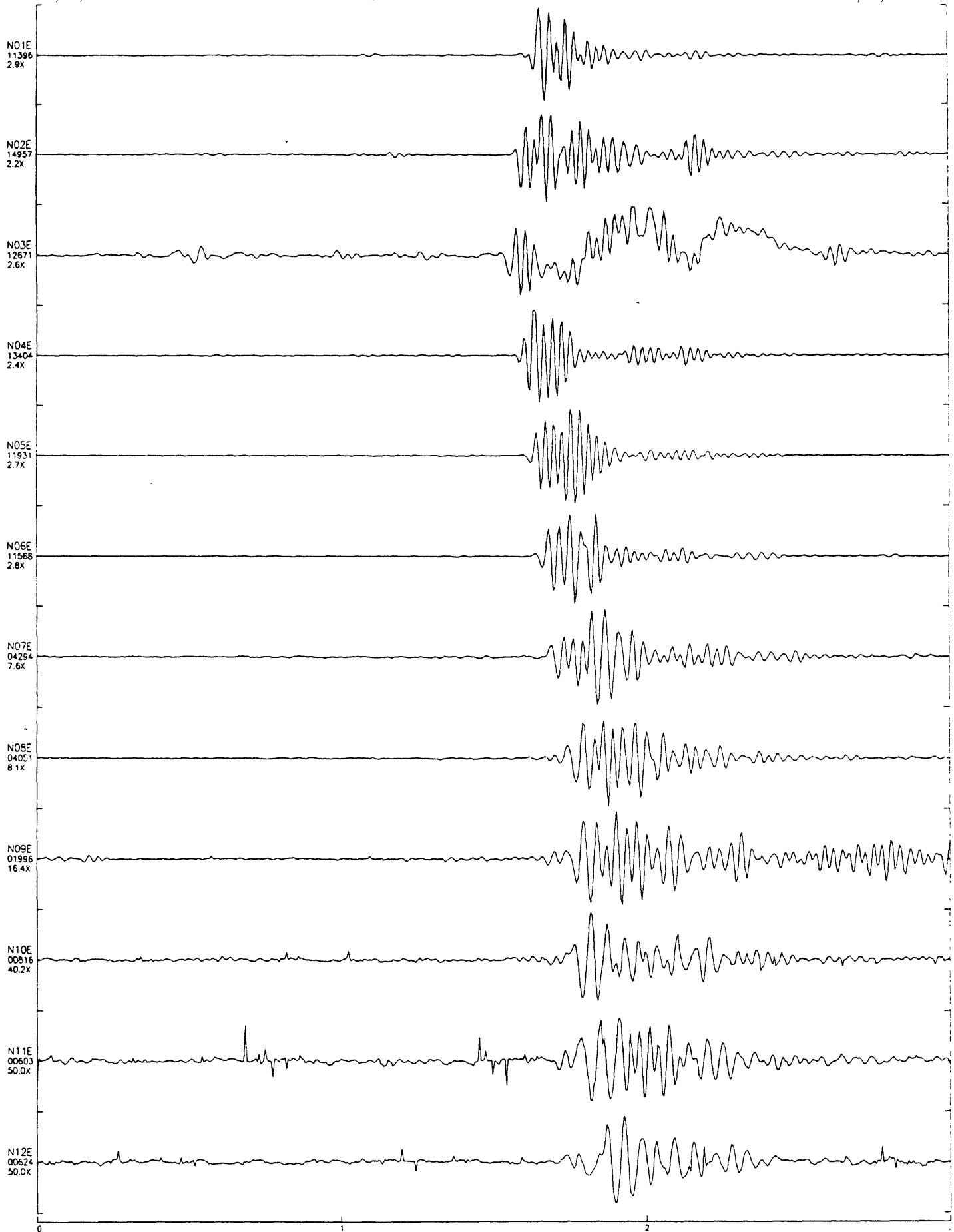
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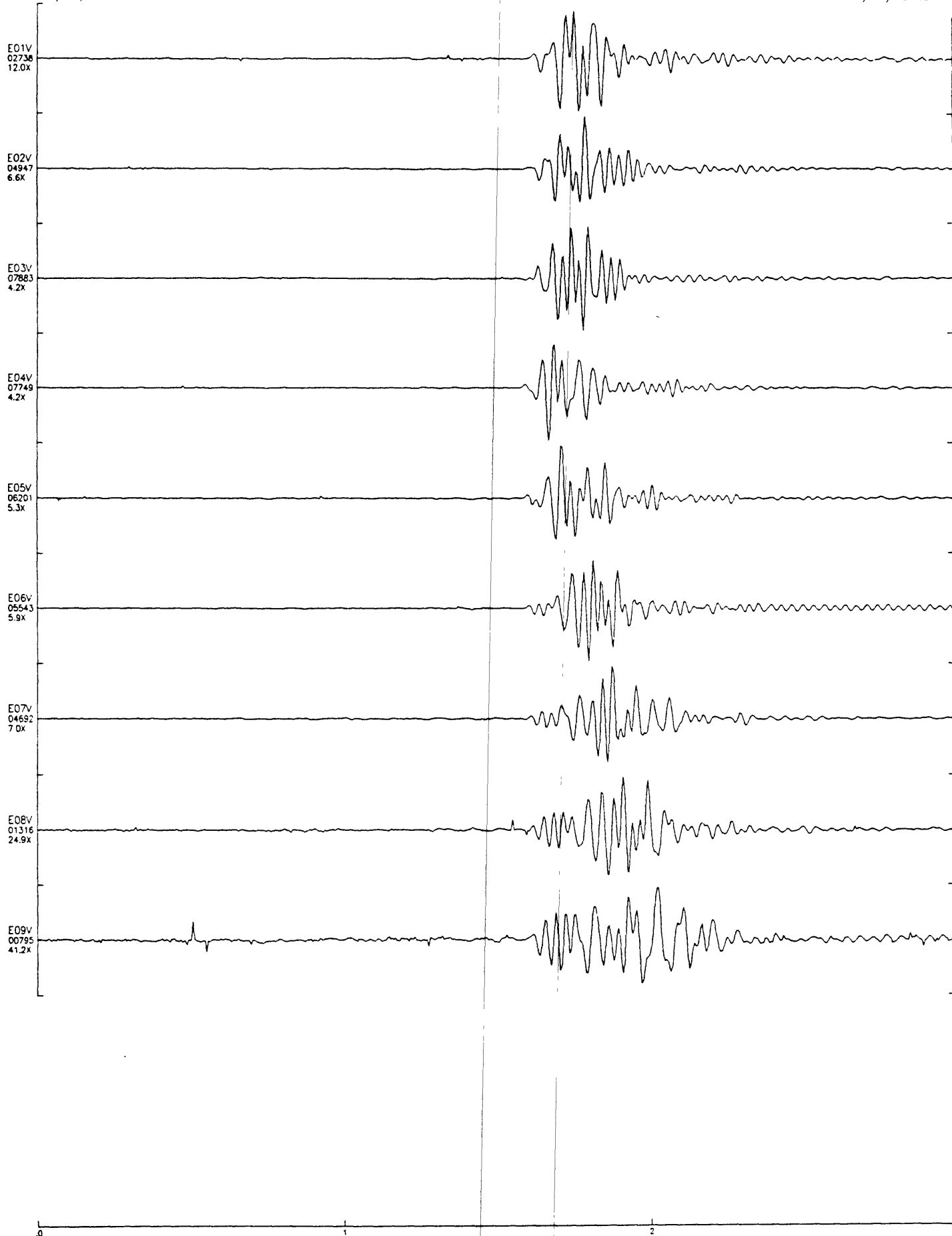




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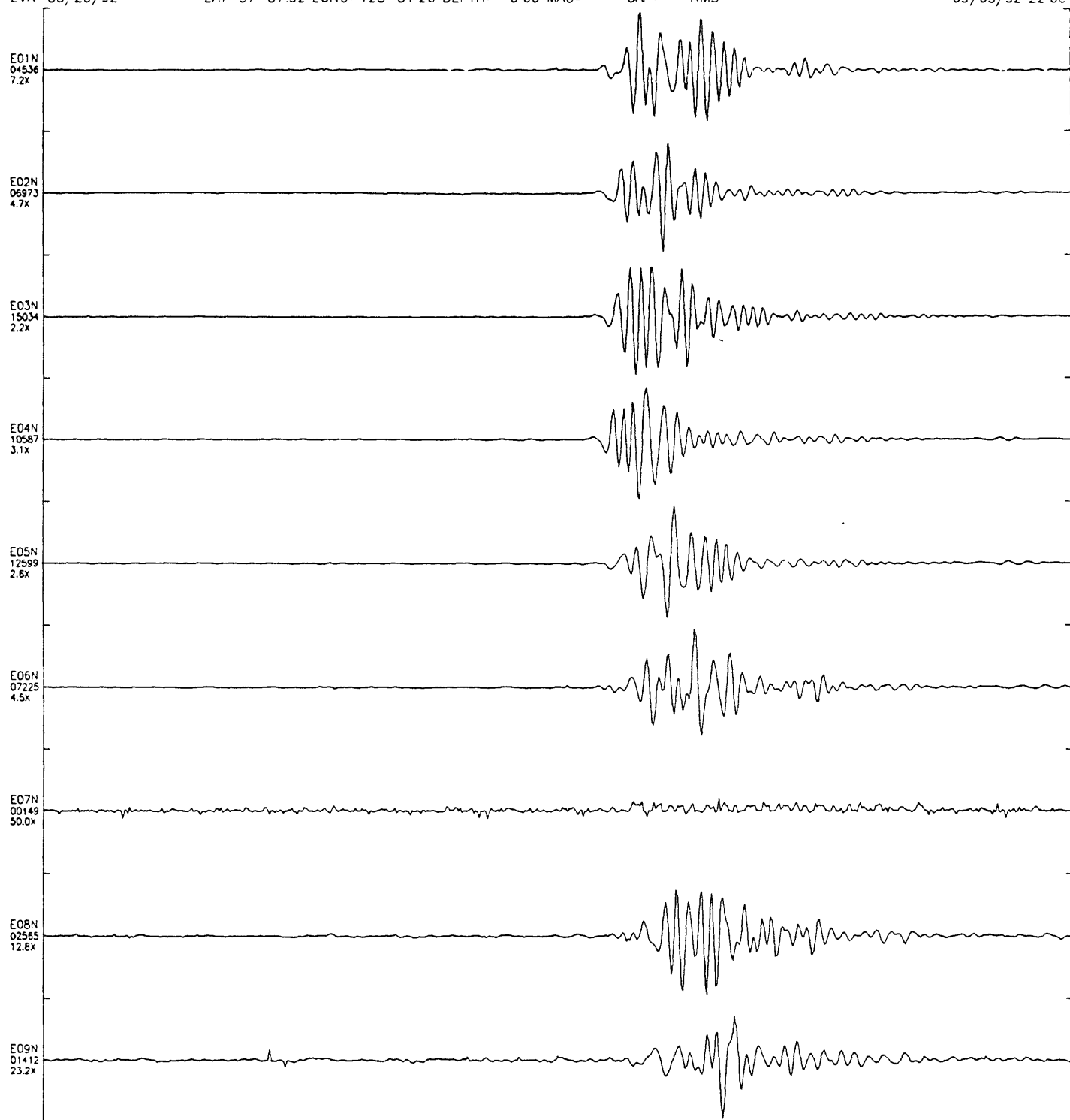
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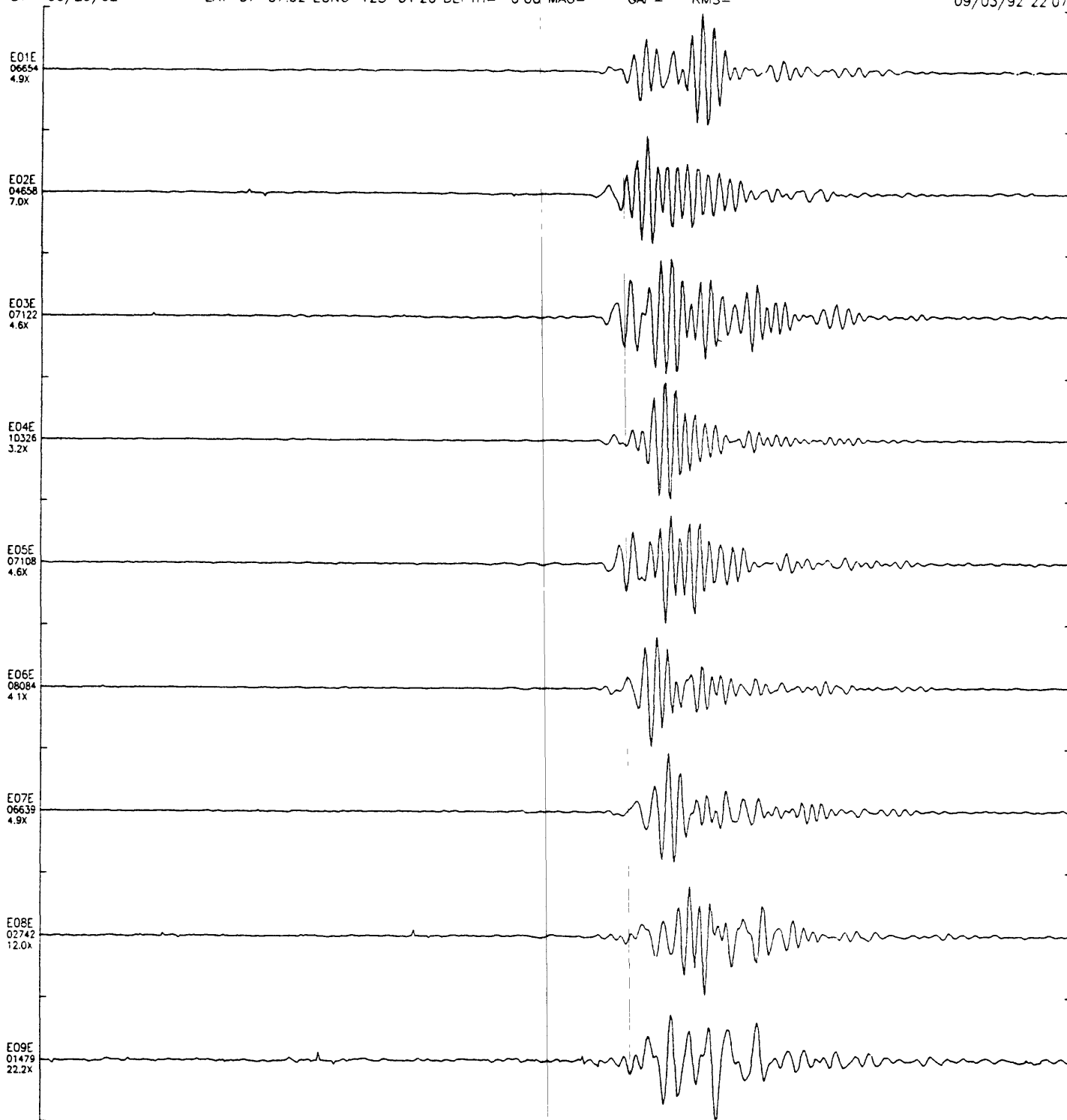
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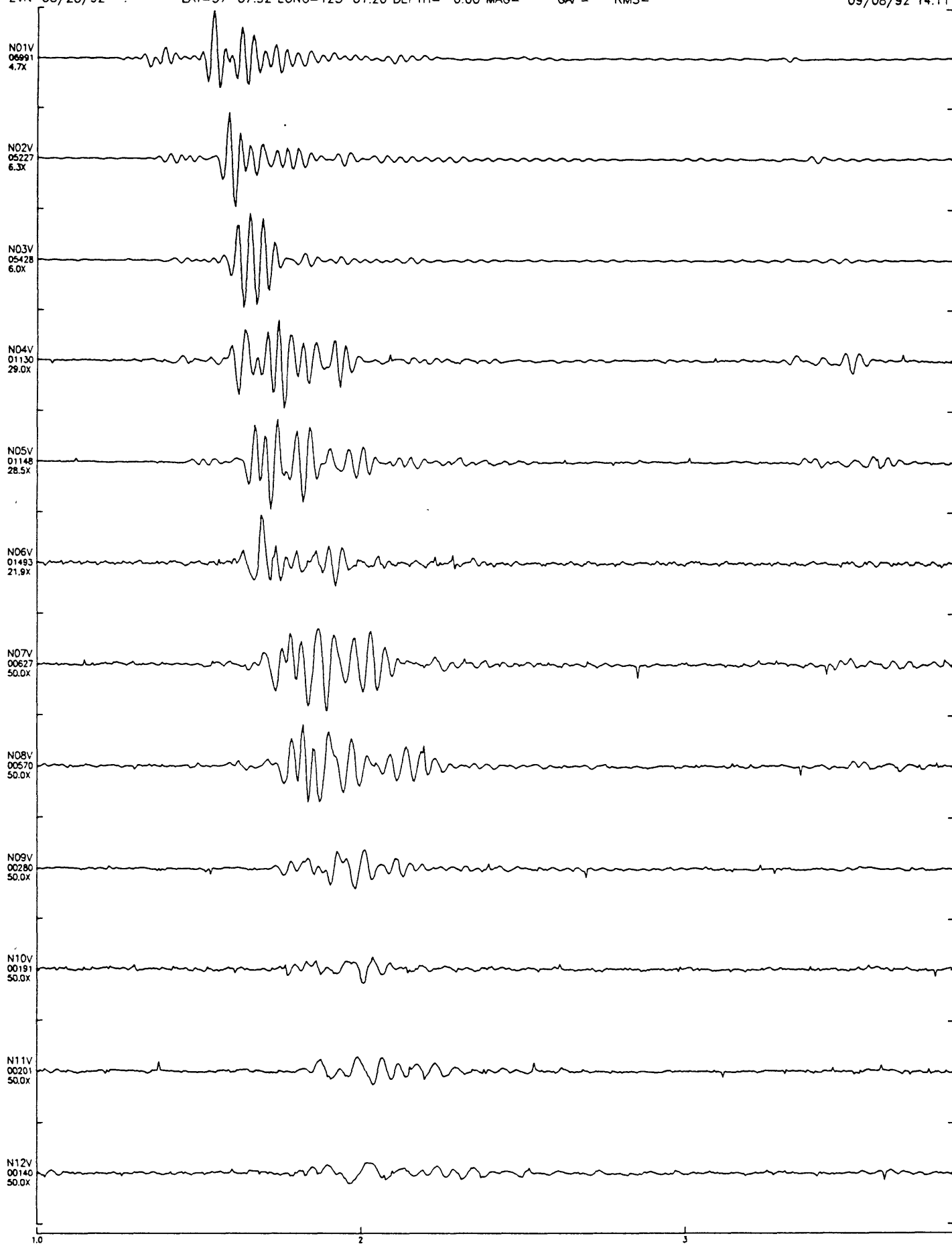
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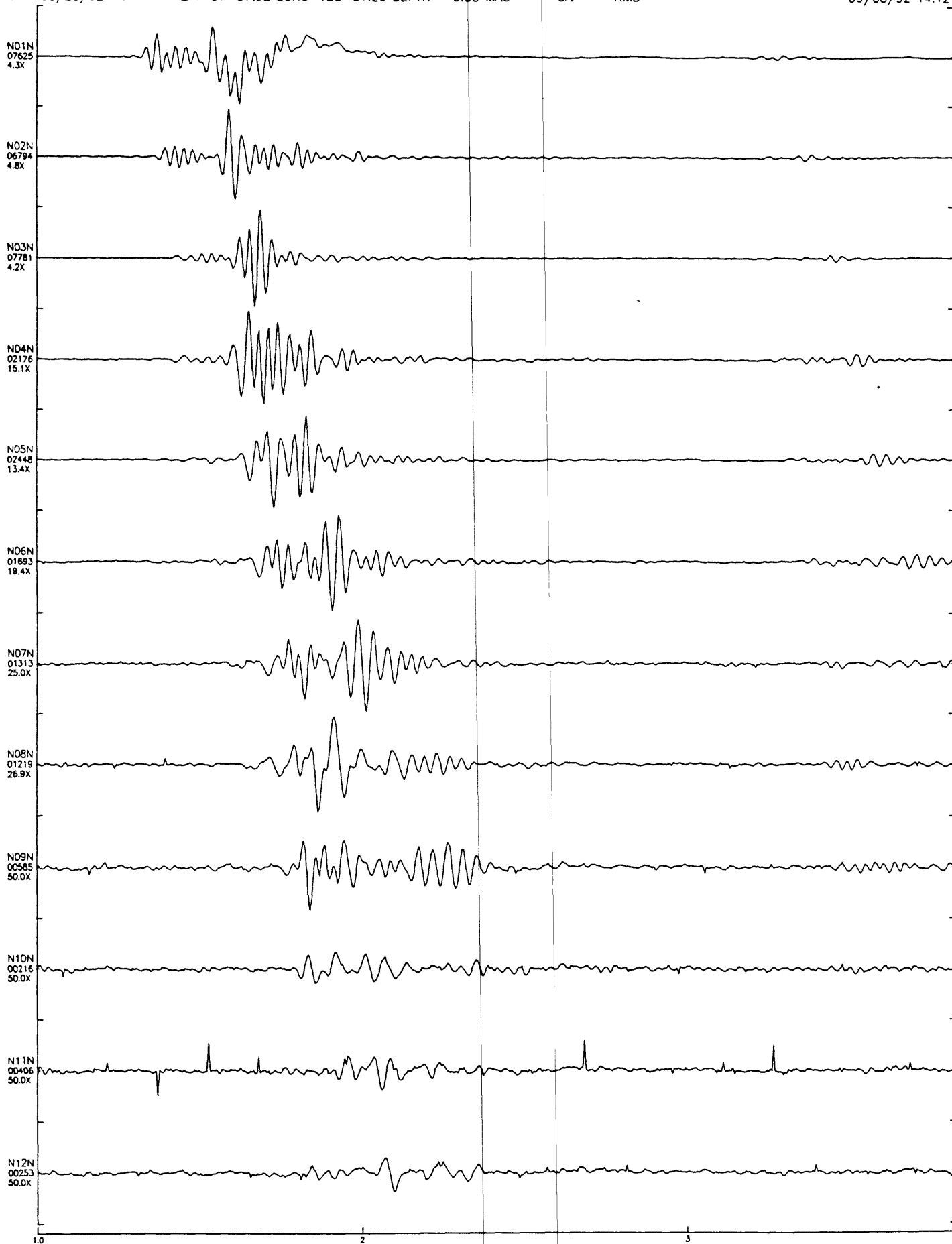
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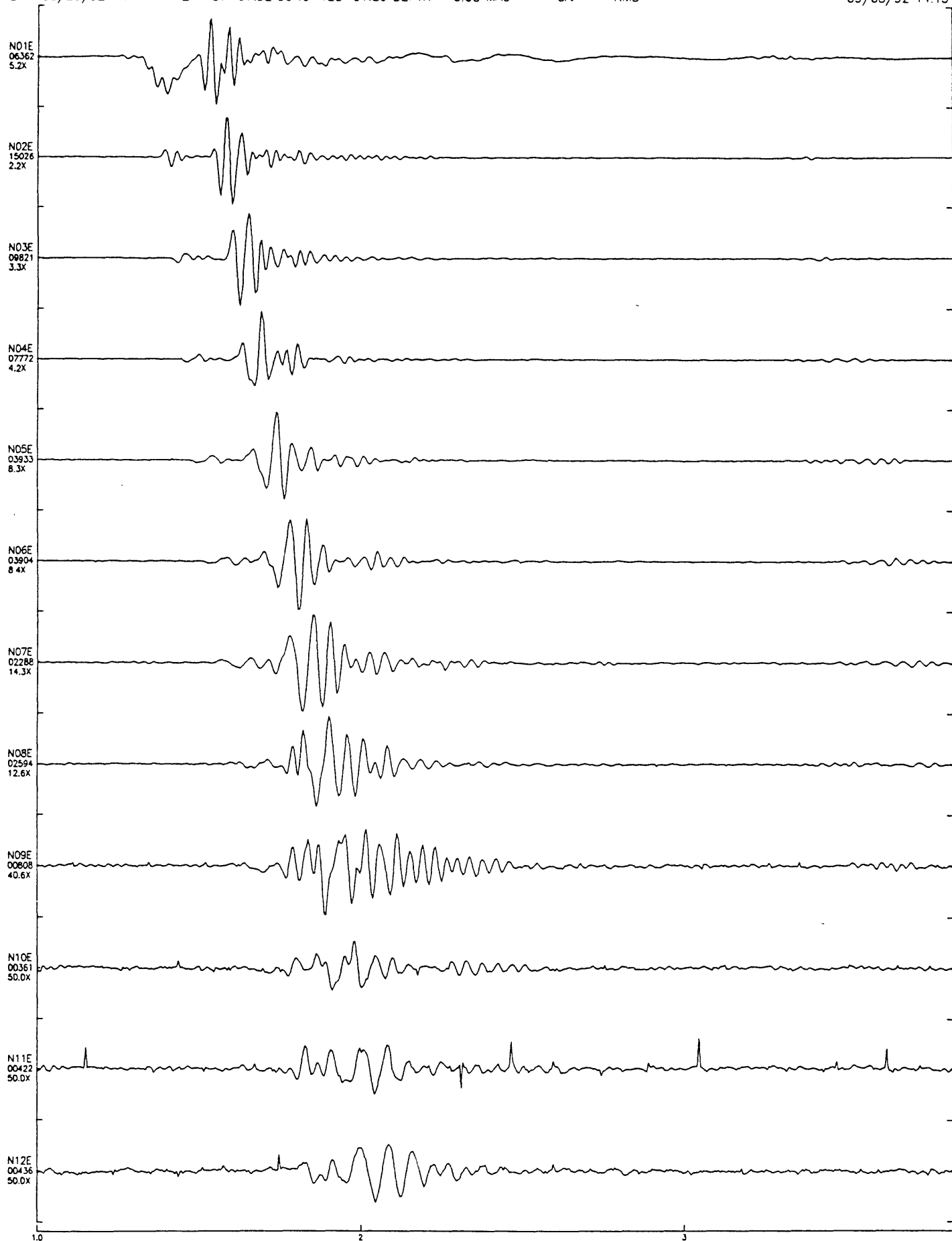
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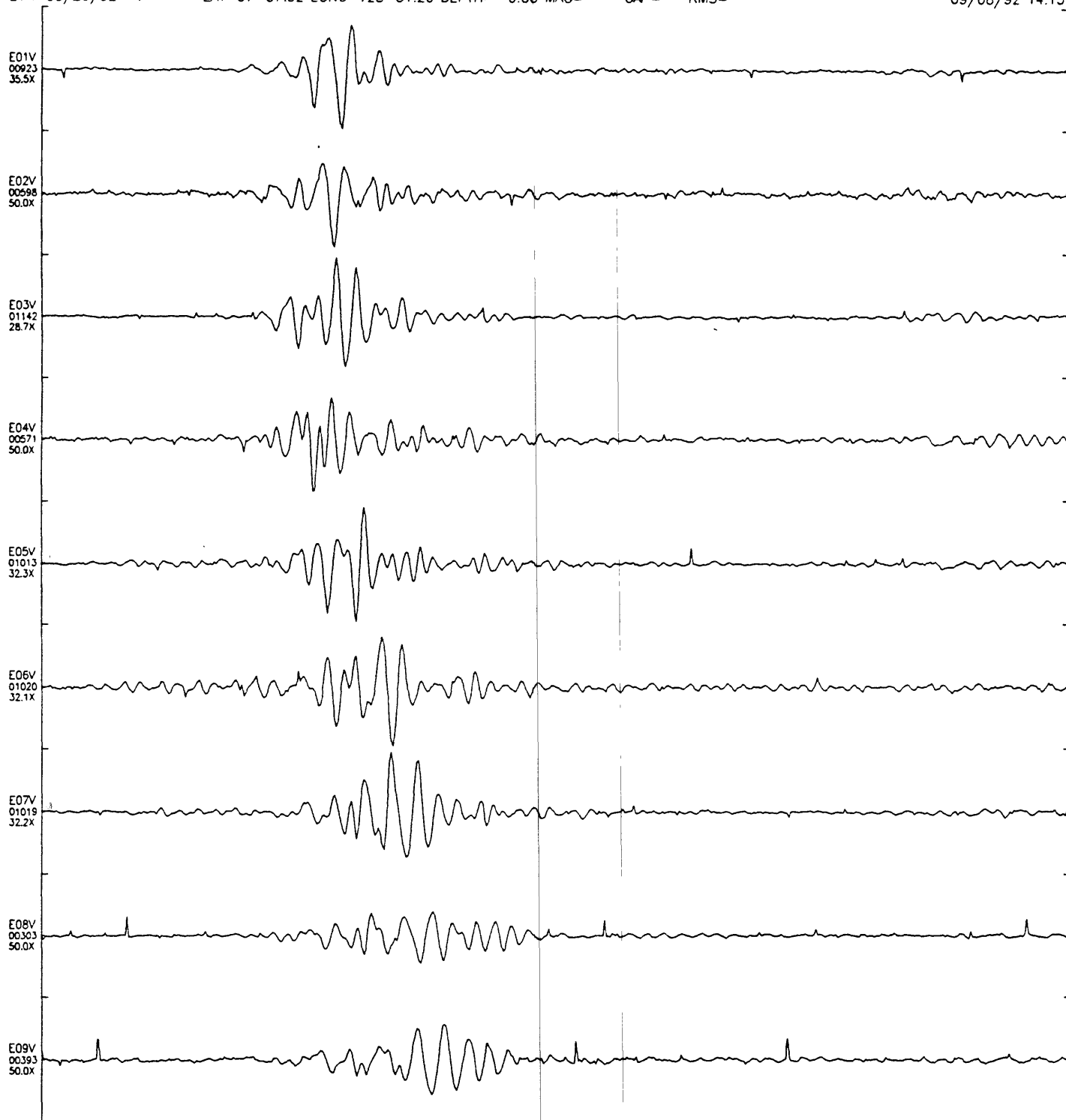
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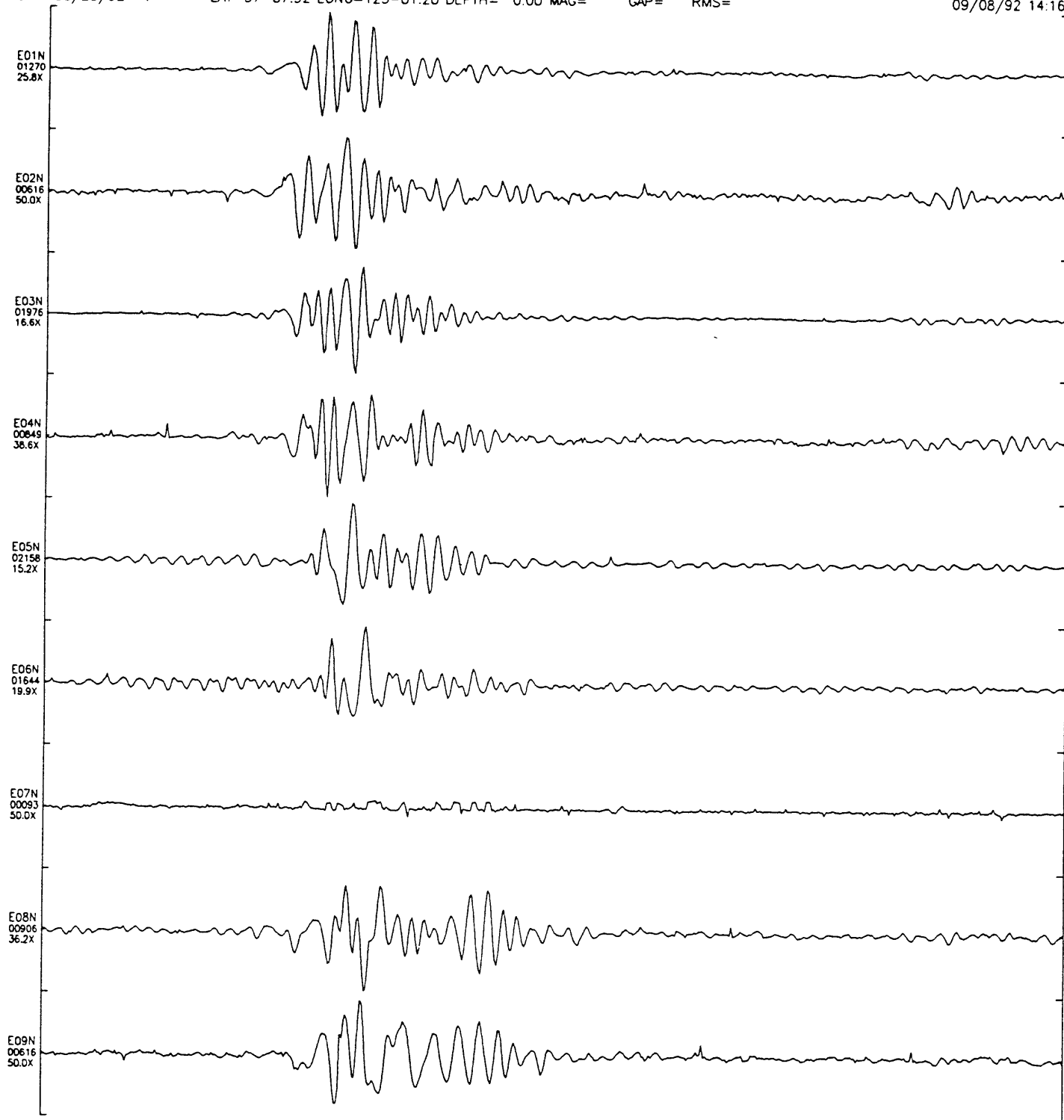
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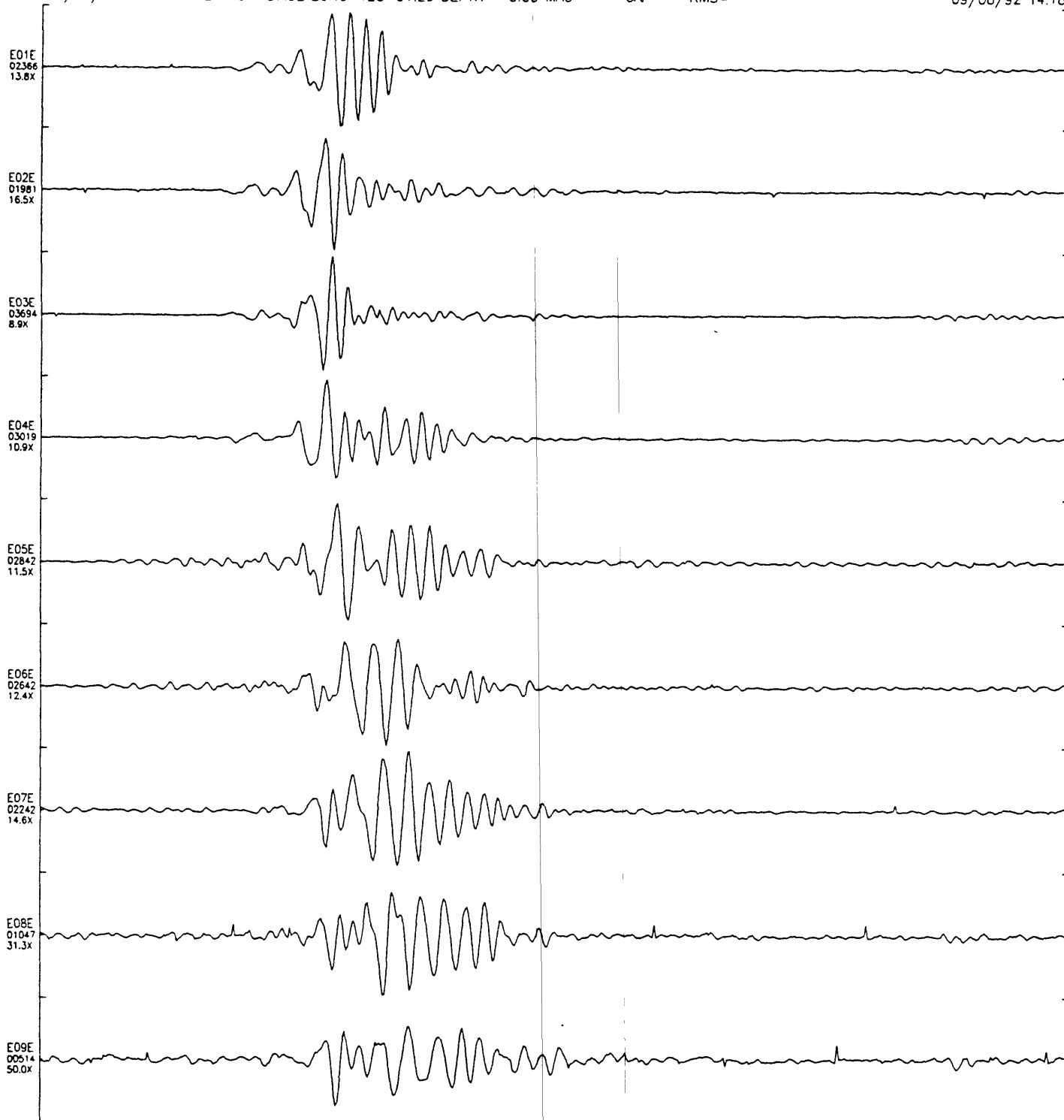
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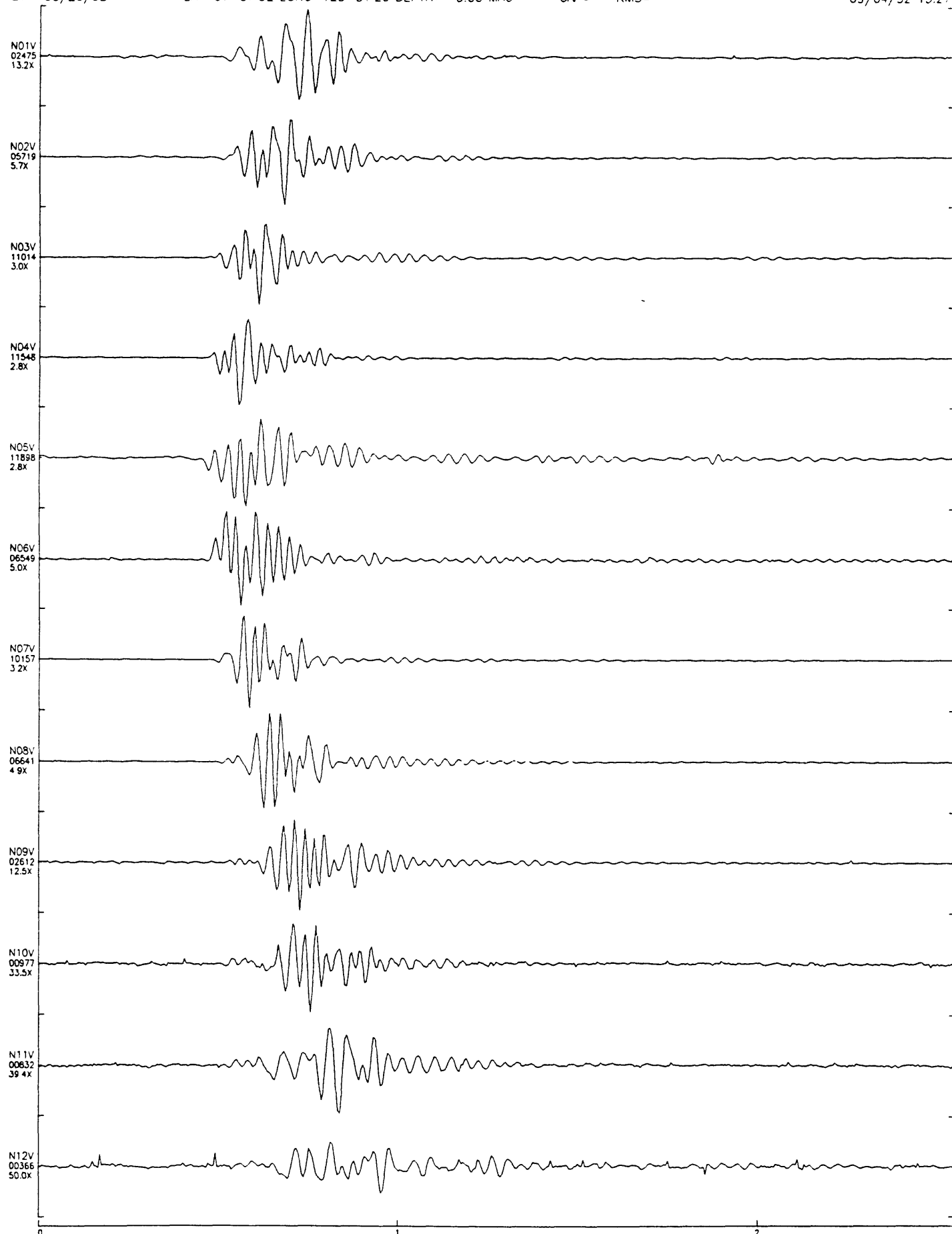
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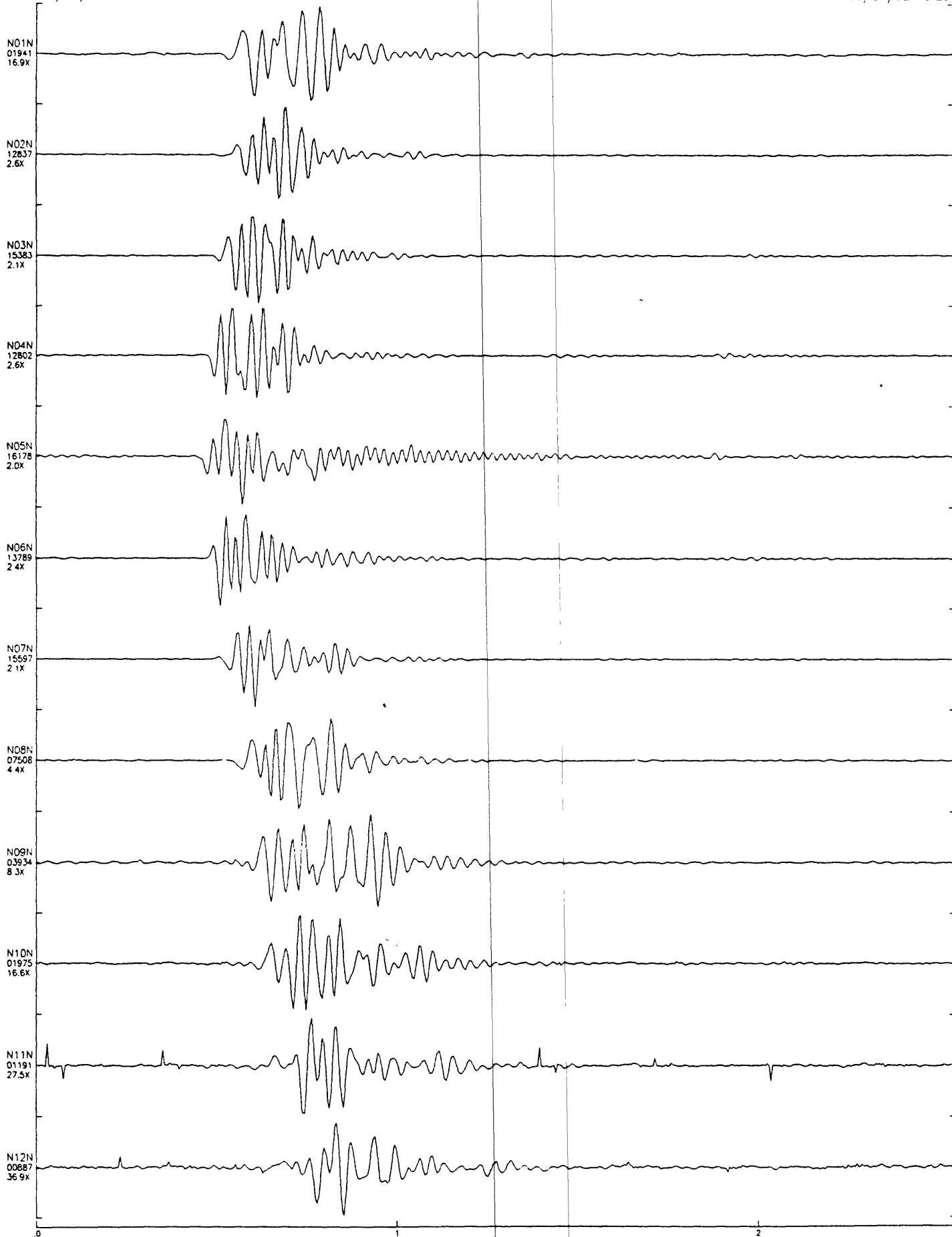
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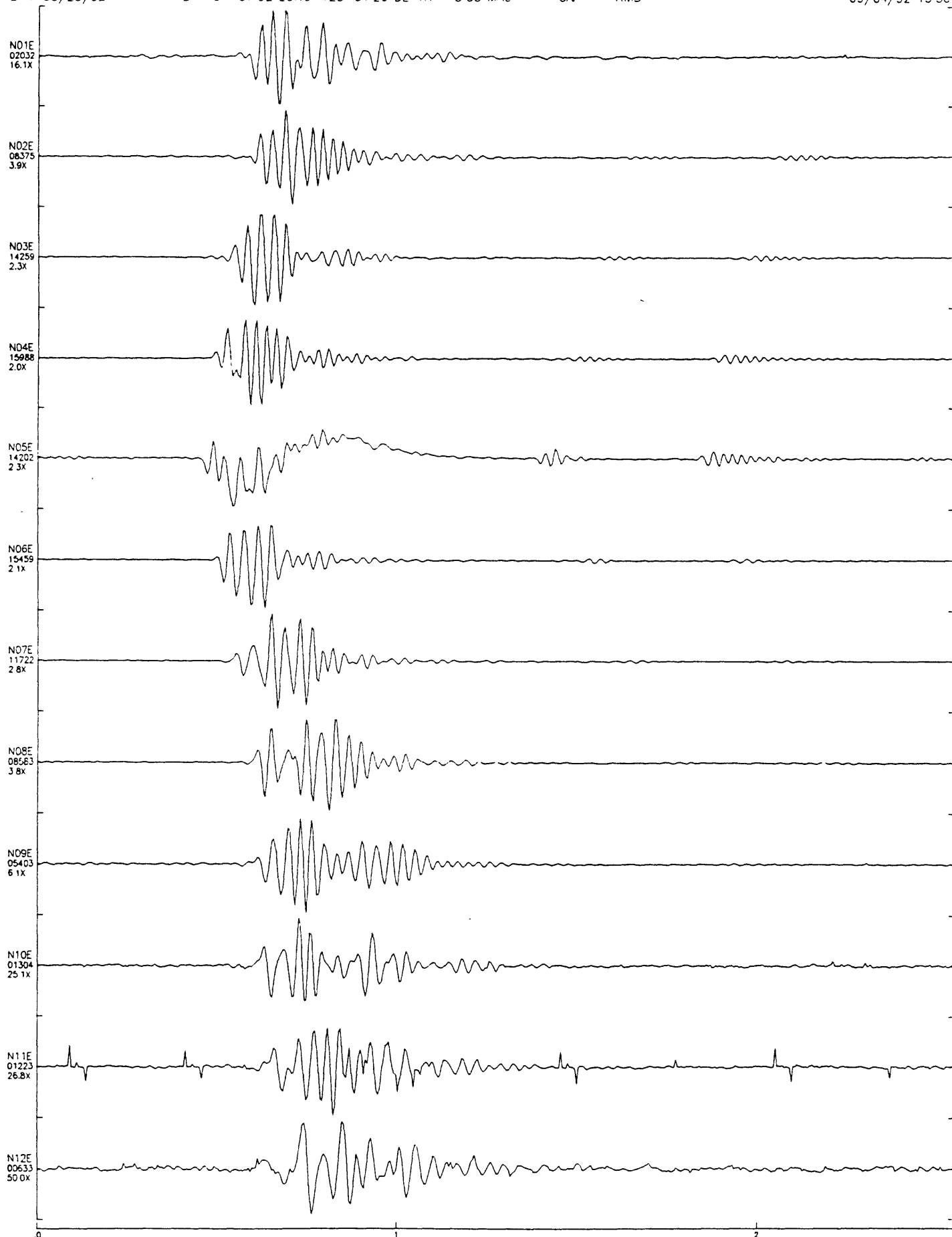
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09/04/92 15.29



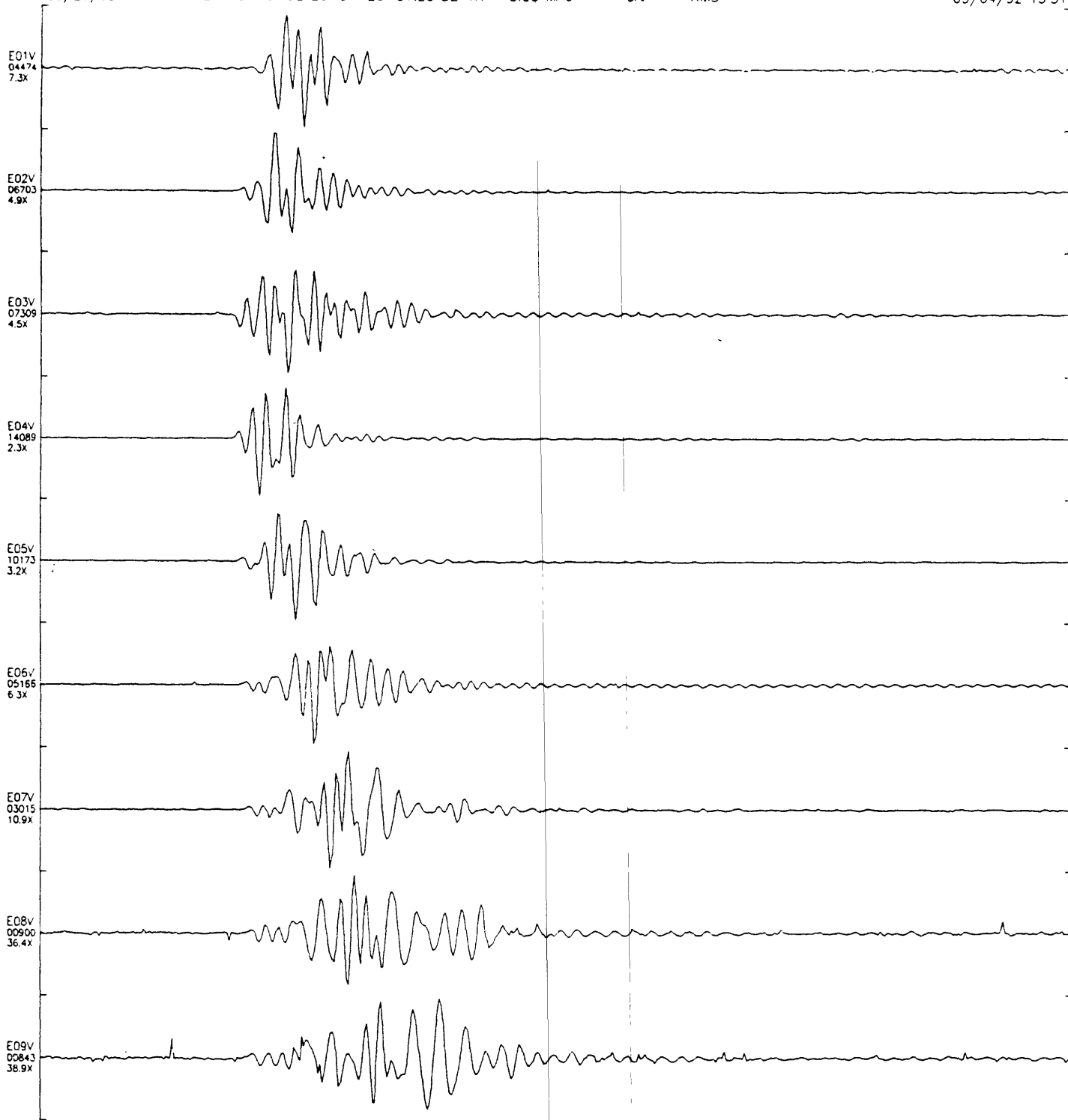
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Sheet 1
09/04/92 15 30



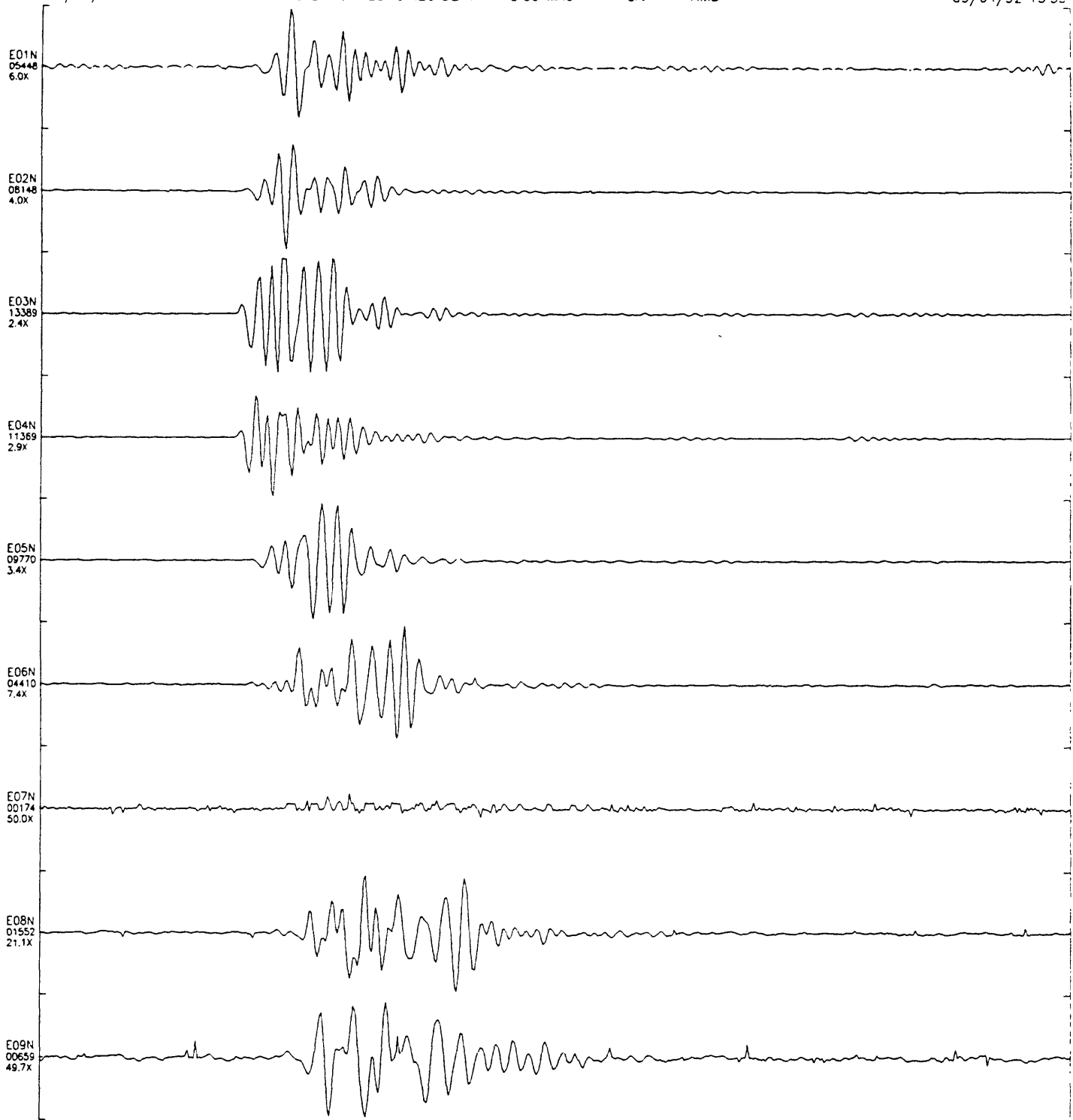
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EVN=08/20/92 LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/04/92 15 31



IST=08/20/92 22:48 08.156 SPS=200.321 DEC=1 D:\9208200Q.CT1
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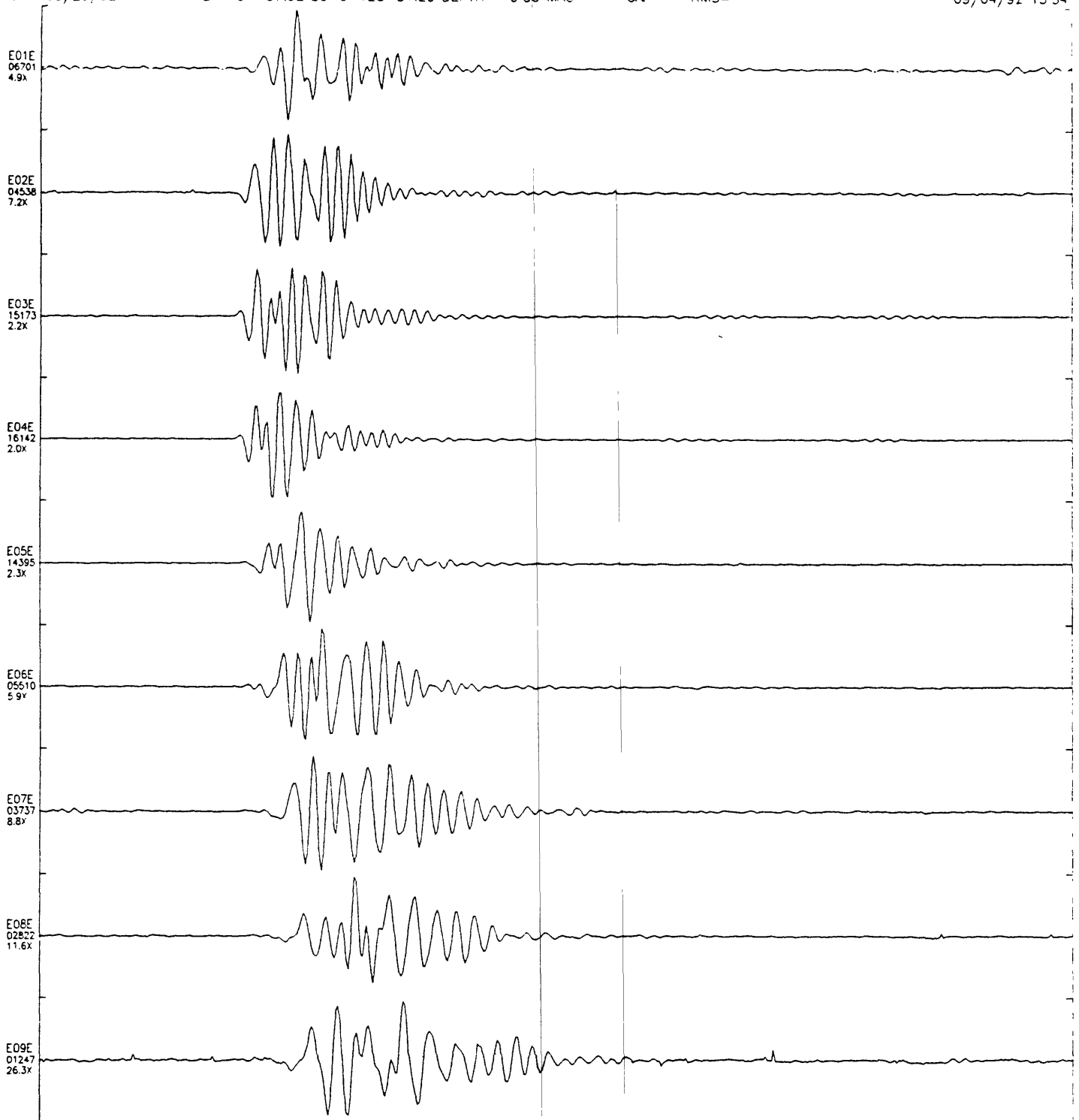
Sheet 1
09/04/92 15 33



IST=08/20/92 22:48 08.156 SPS=200.321 DEC=1 D.\9208200Q.CT1
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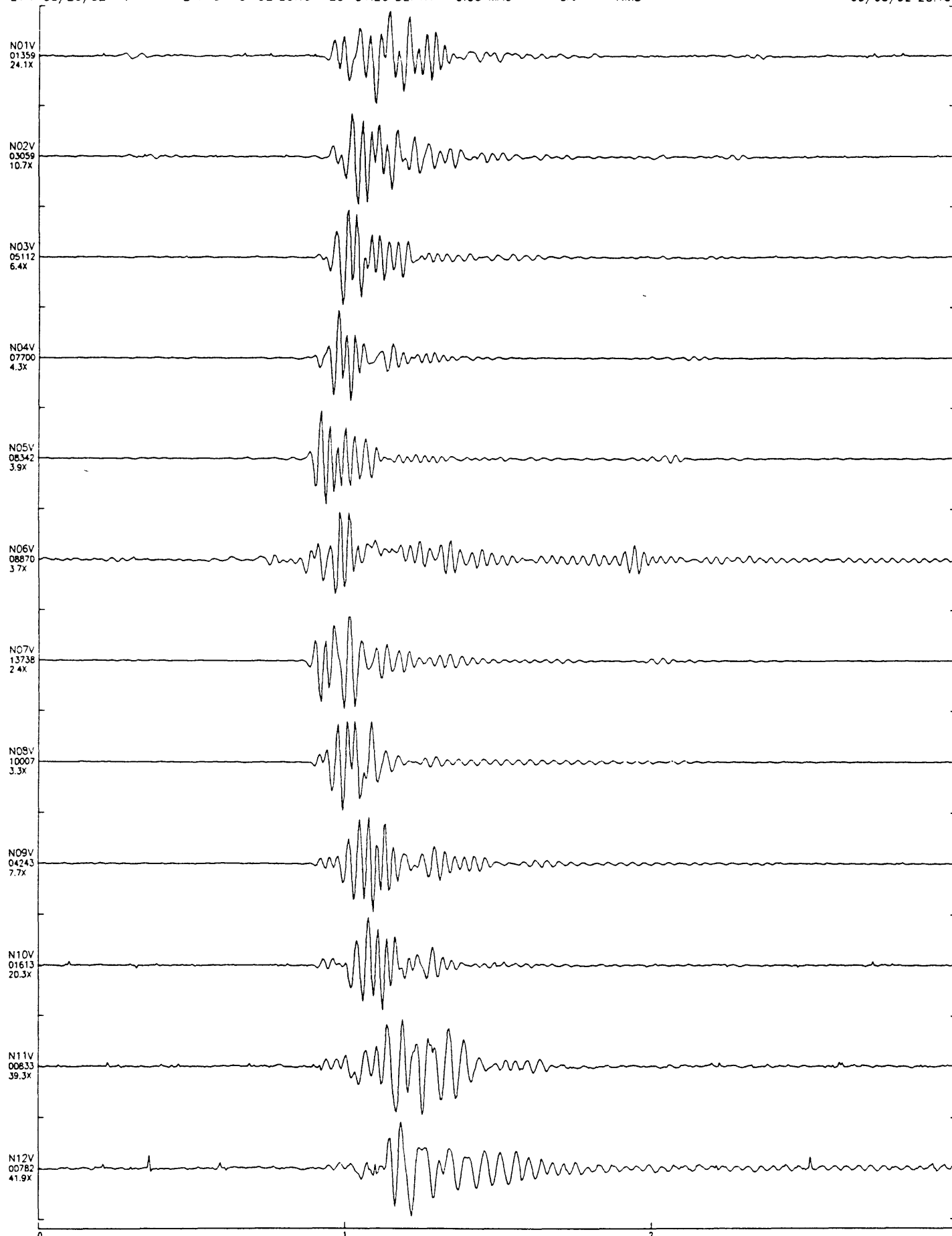
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09/04/92 15 34



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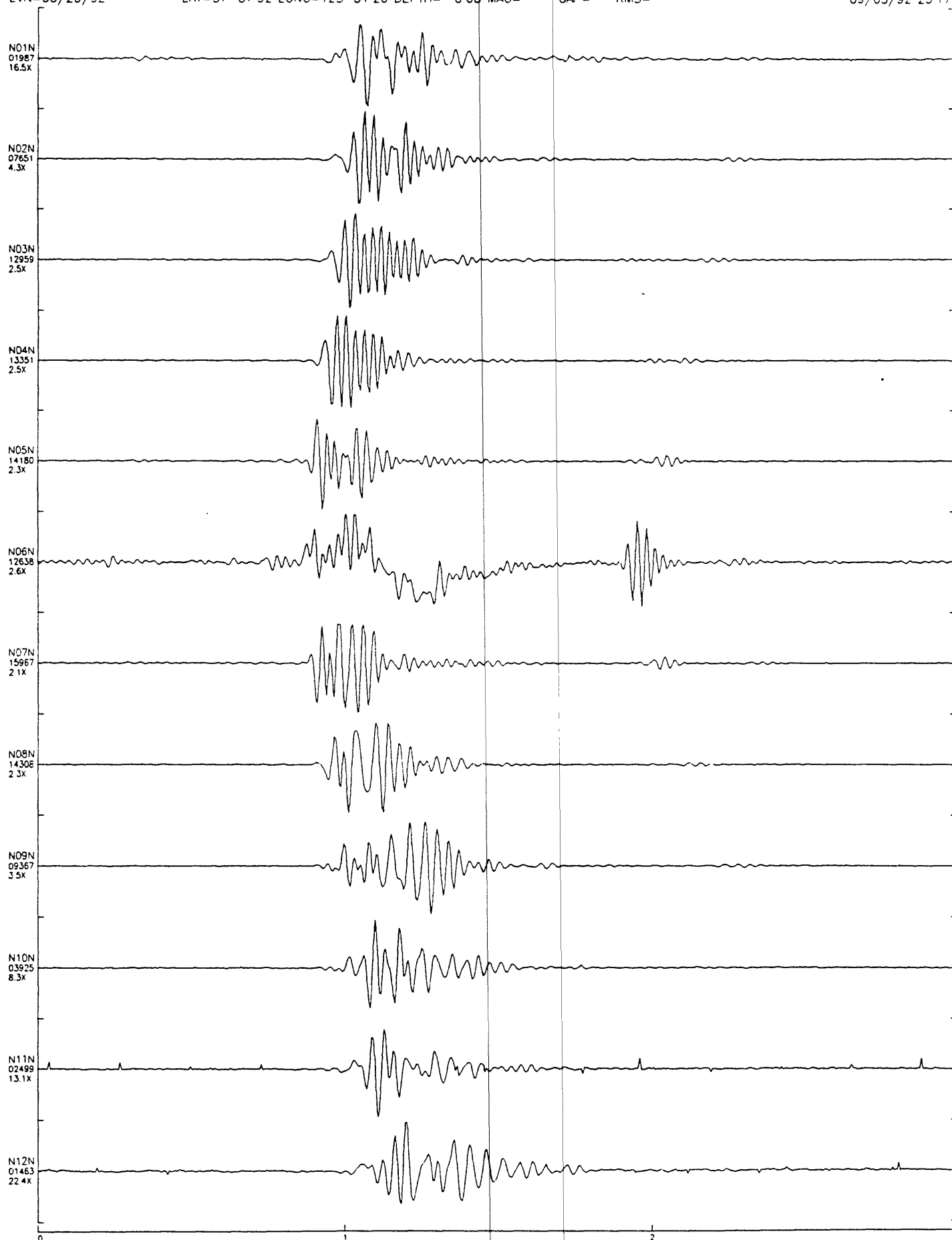
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Sheet 1
09/03/92 23:15



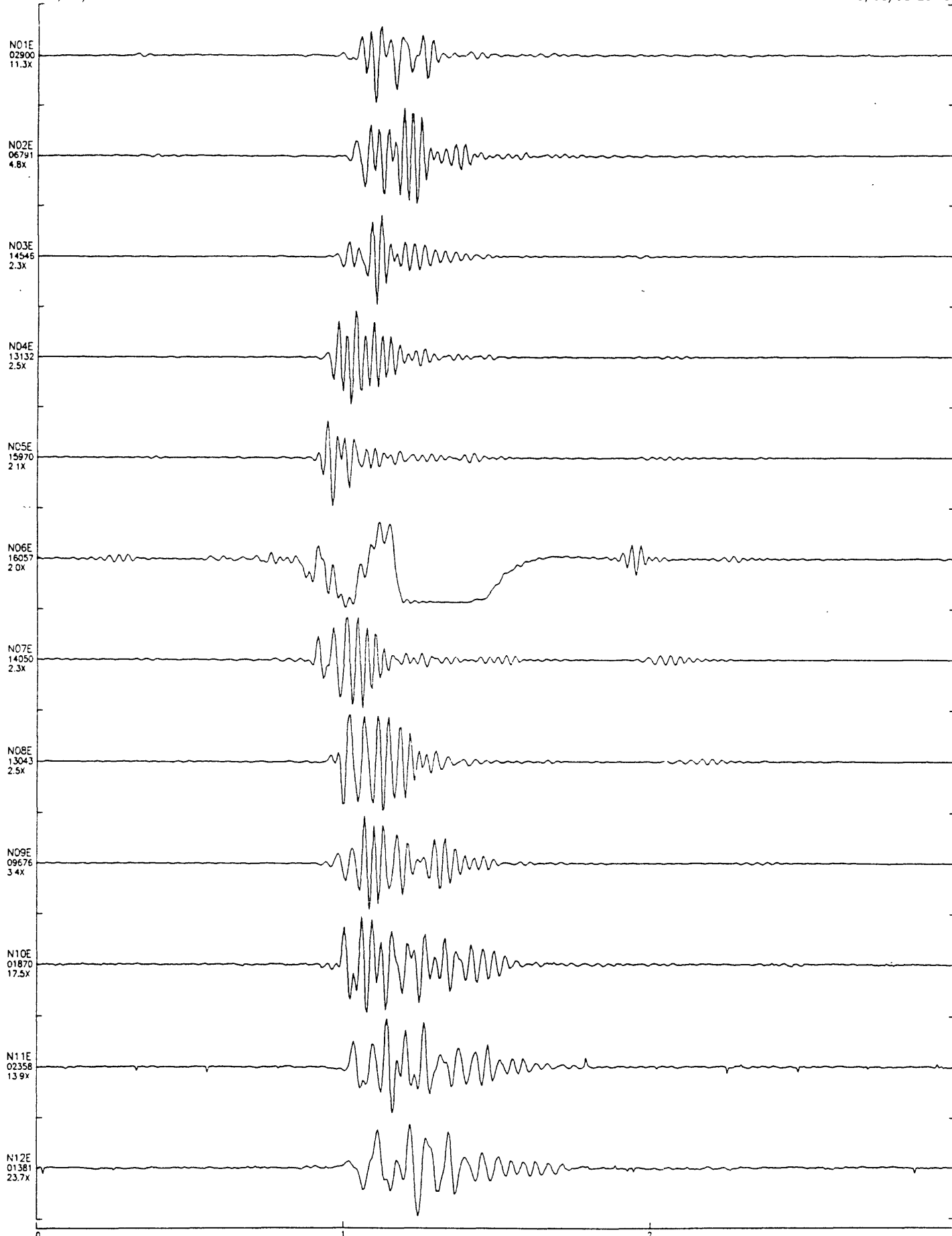
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EVN=08/20/92 LAT=37-07 92 LONG=123-01 20 DEPTH= 0 00 MAG= GAP= RMS=

Sheet 1
09/03/92 23 17



IST=08/20/92 22:53 02.085 SPS=200.321 DEC=1 D:\9208200S.CT1
EVN=08/20/92 LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/03/92 23 18



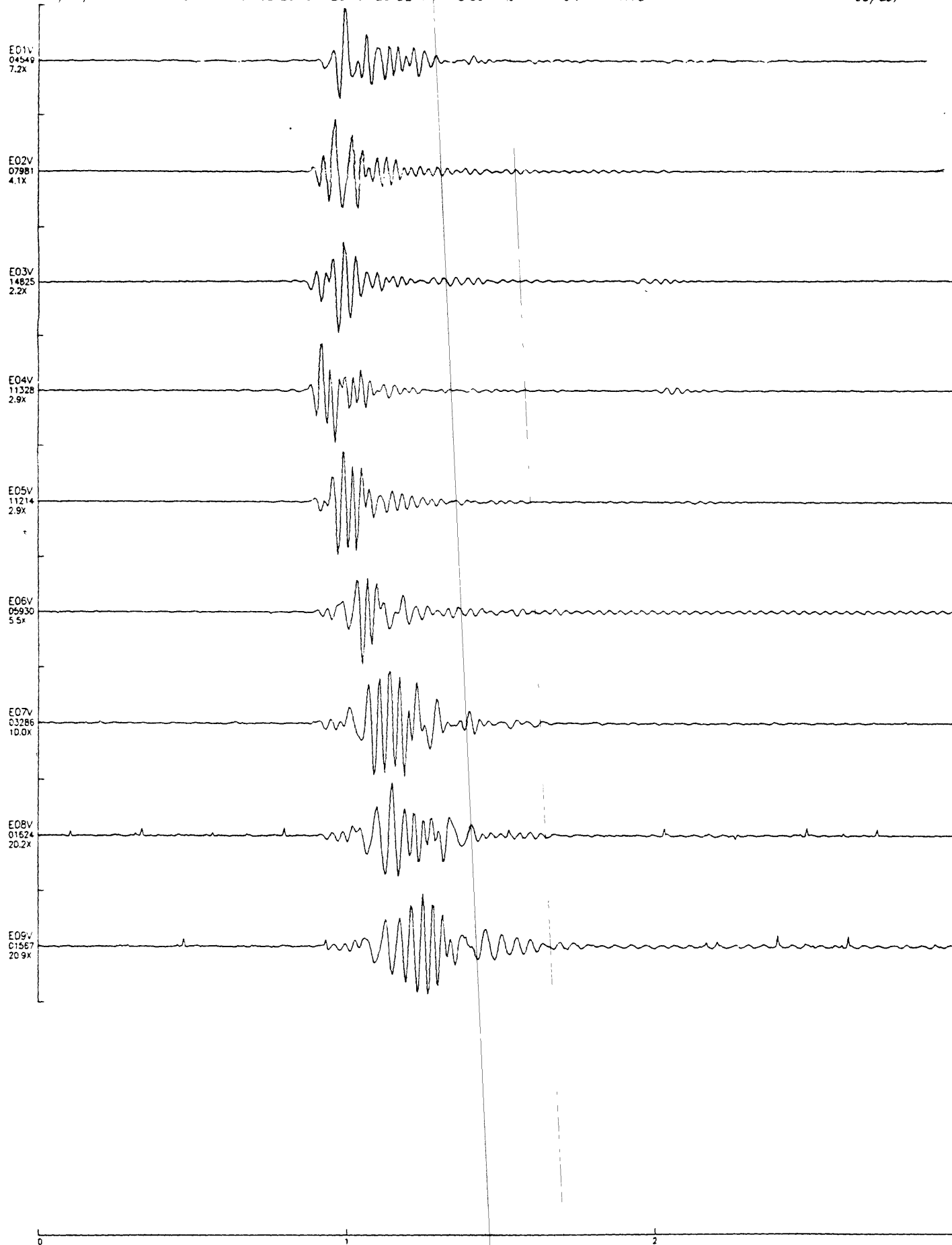
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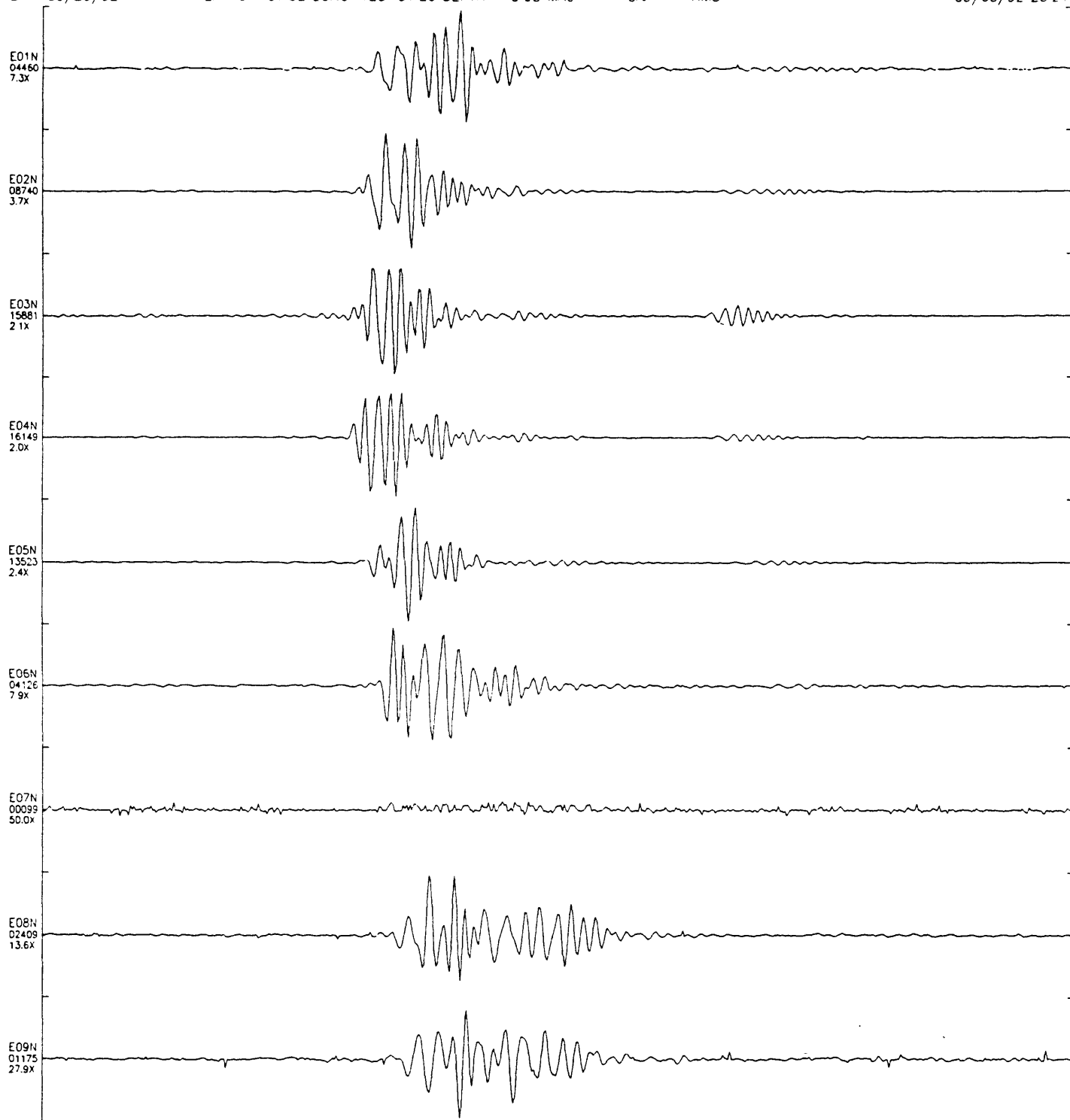
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09/03,

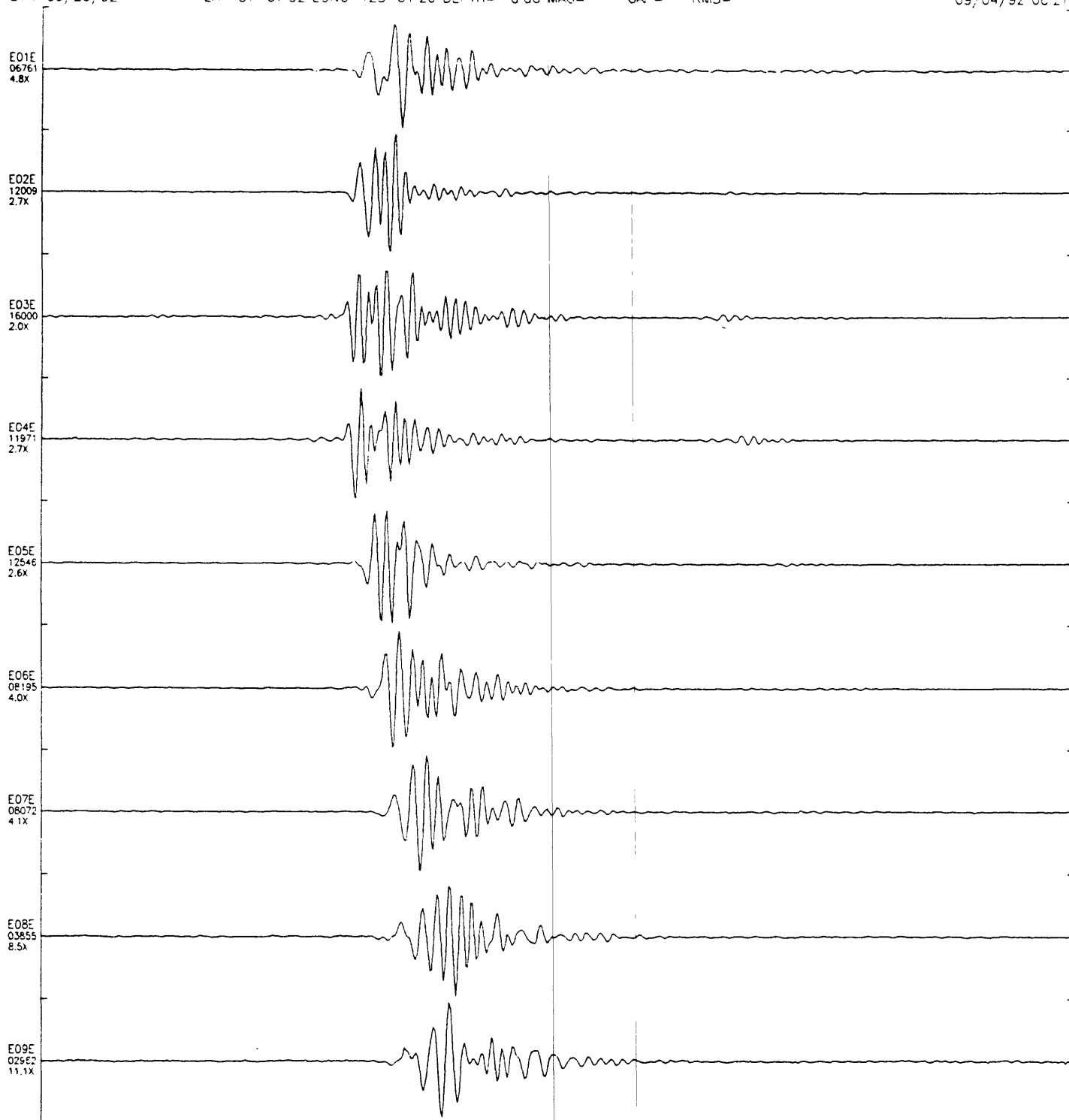




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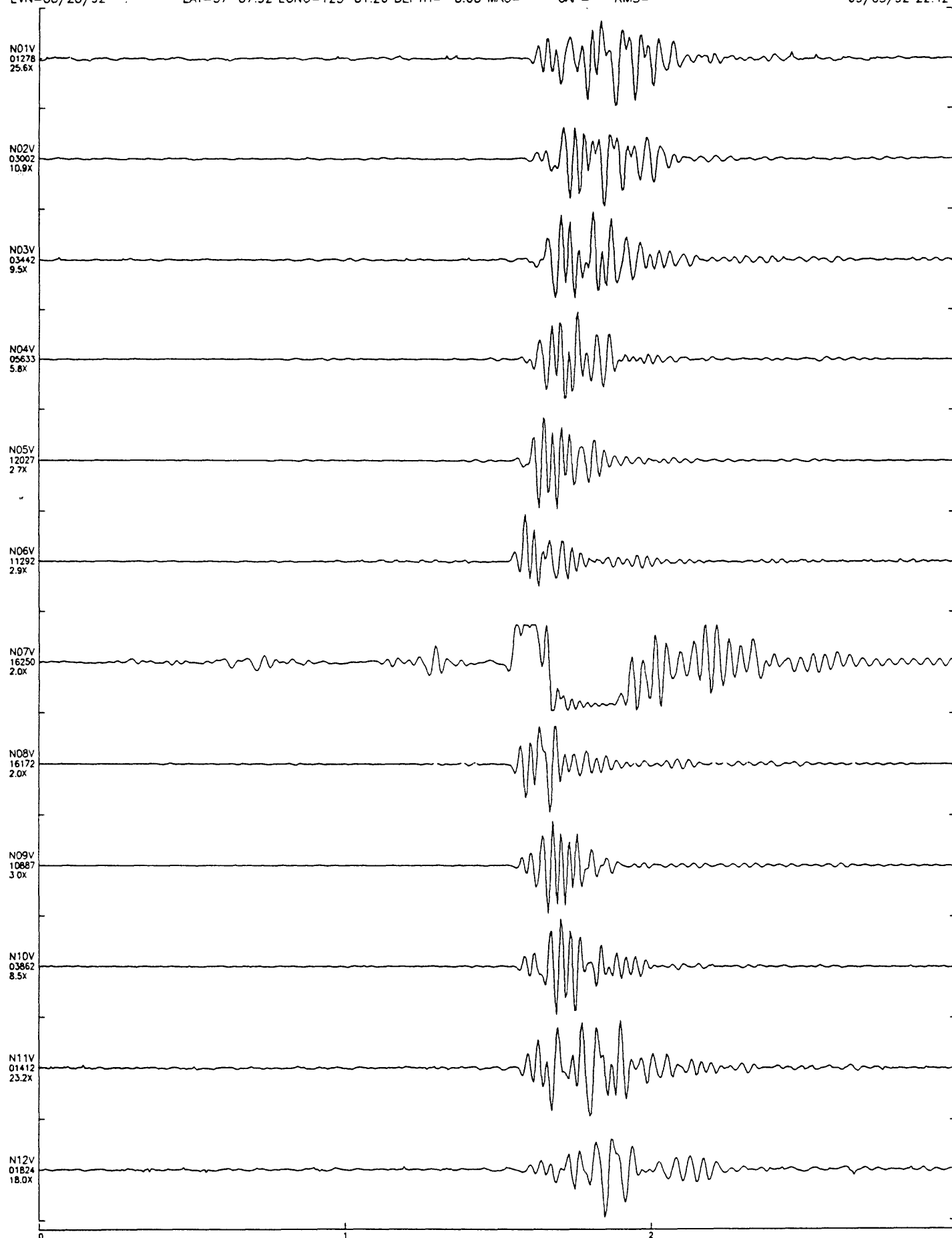
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09/04/92 08 27



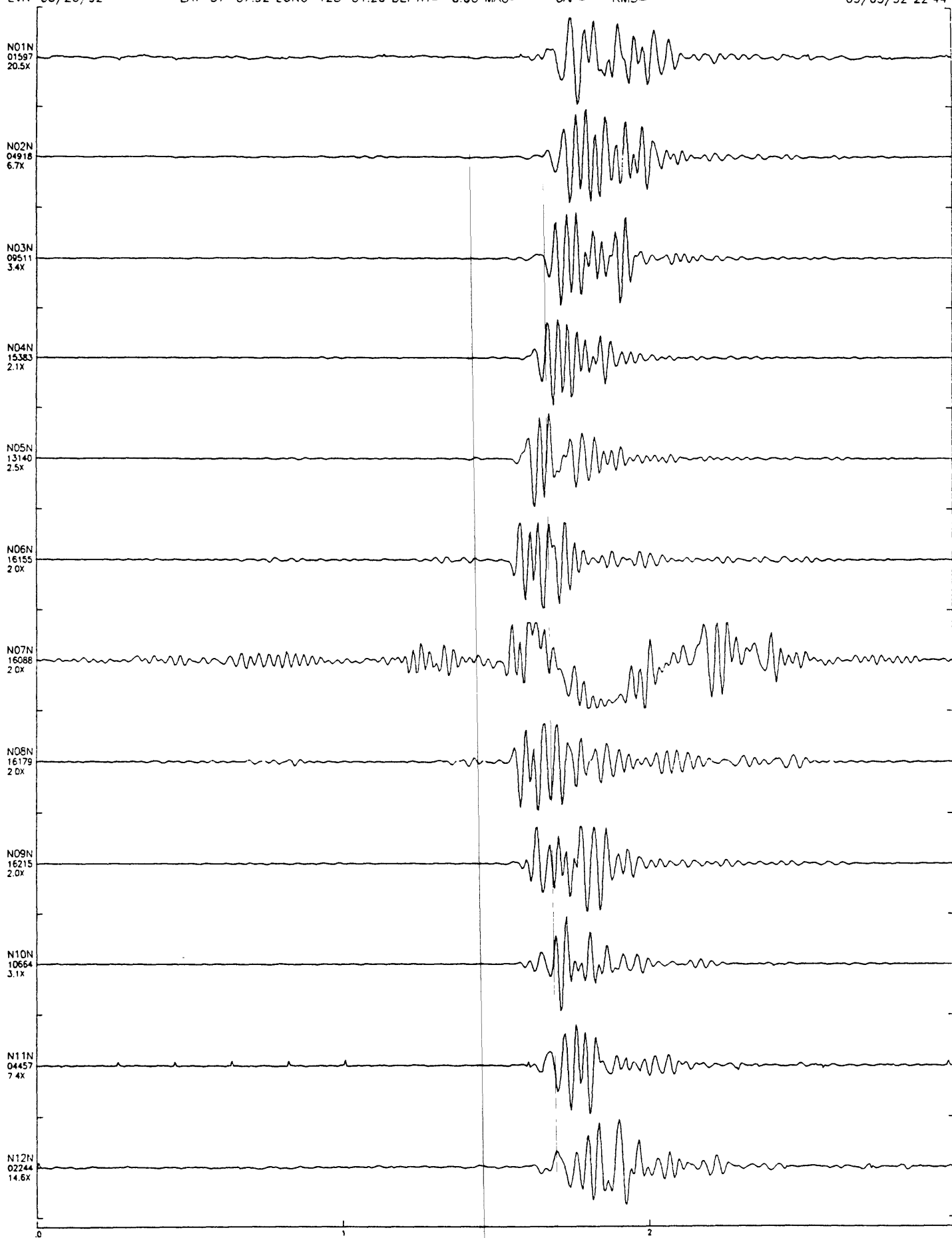
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Sheet 1
09/03/92 22:42



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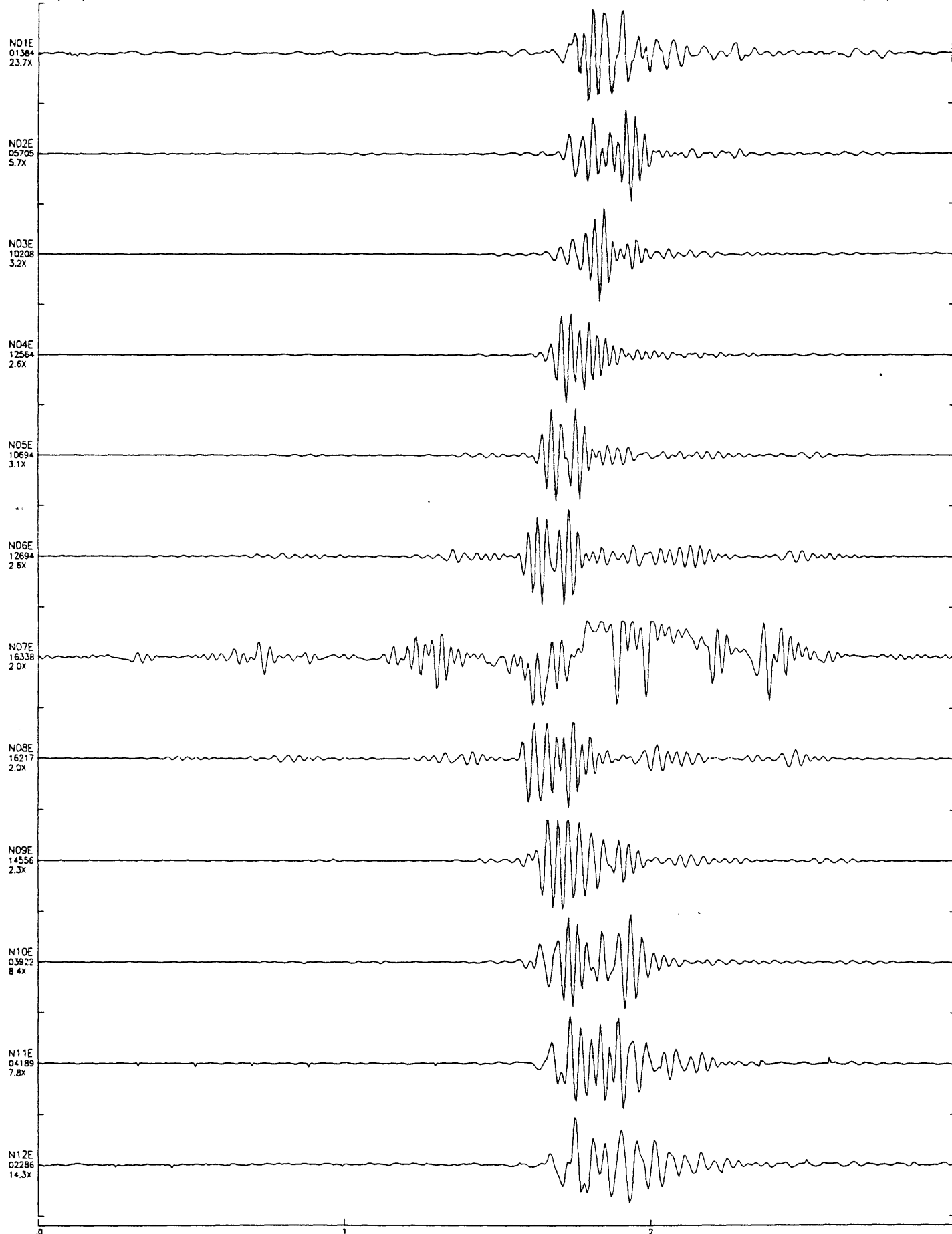
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09/03/92 22 44

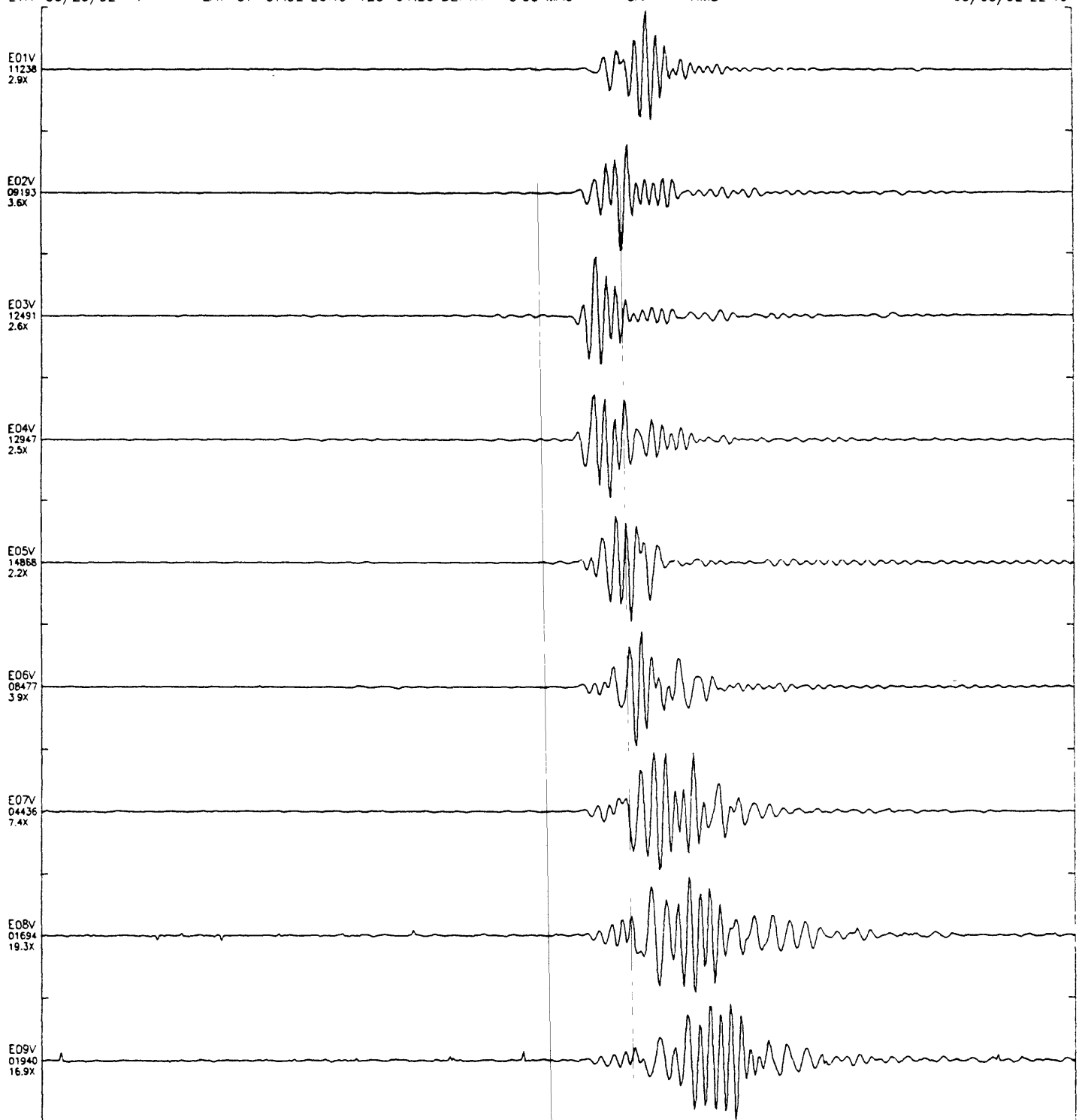


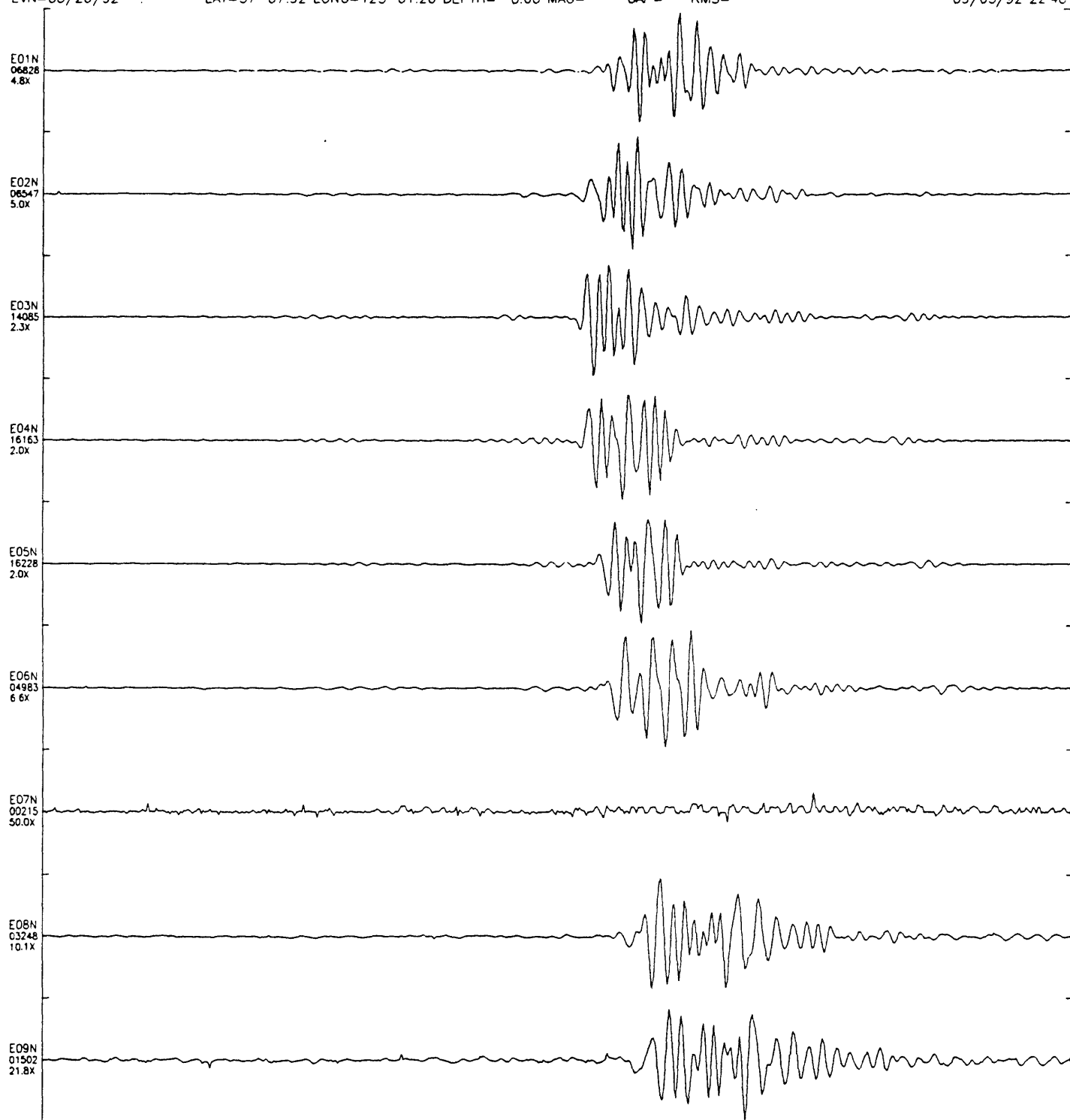
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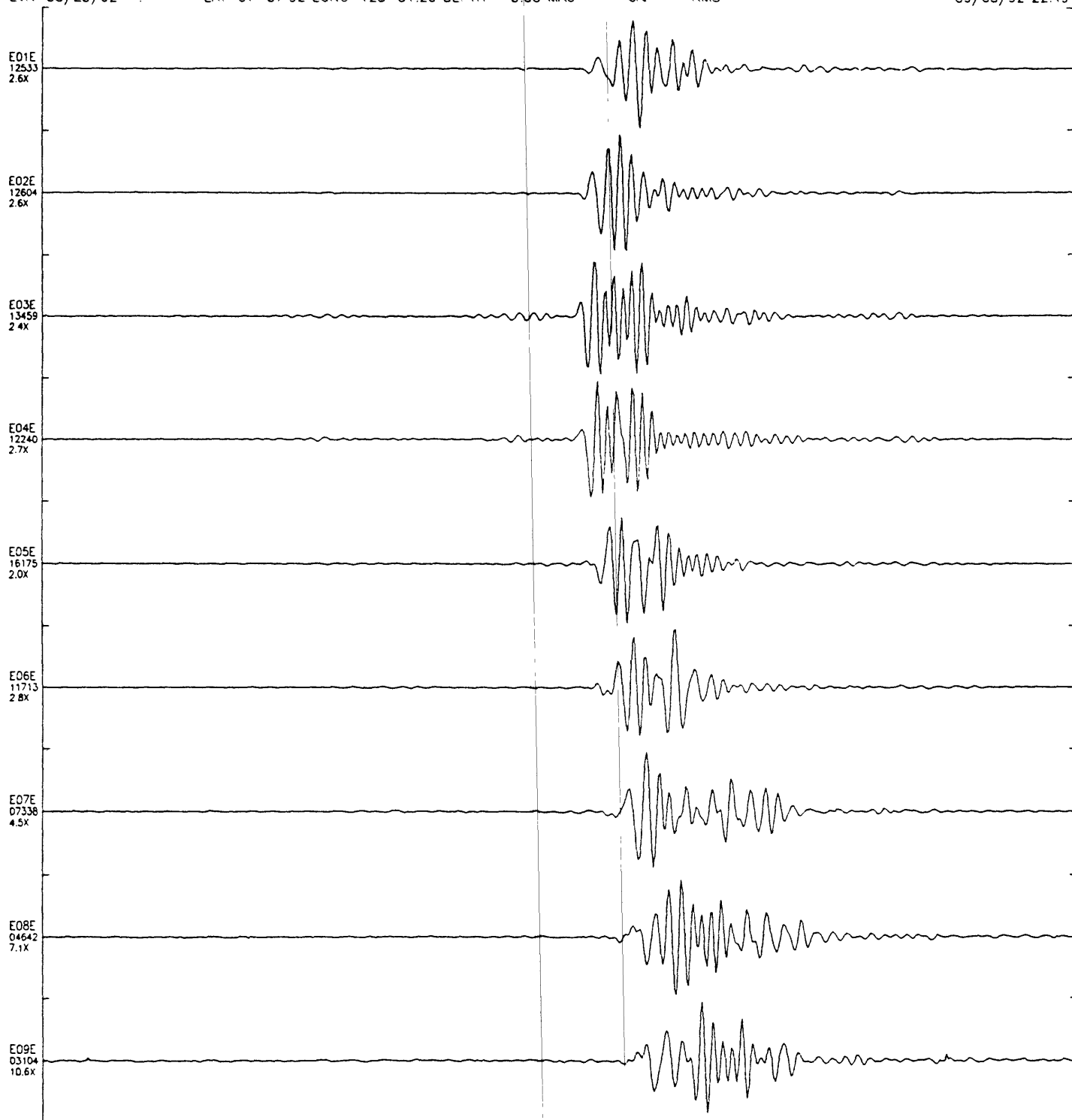






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09/03/92 22:49

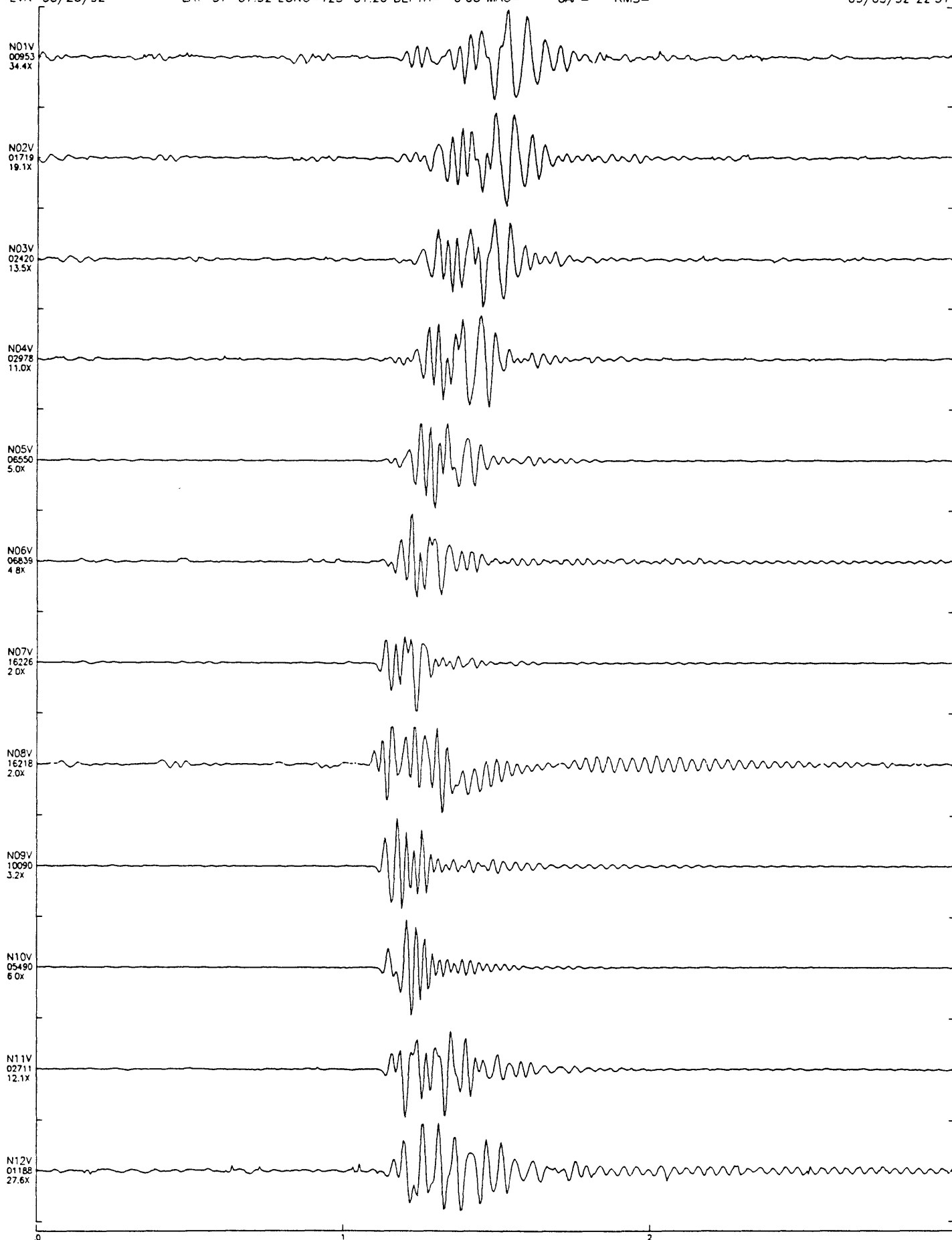


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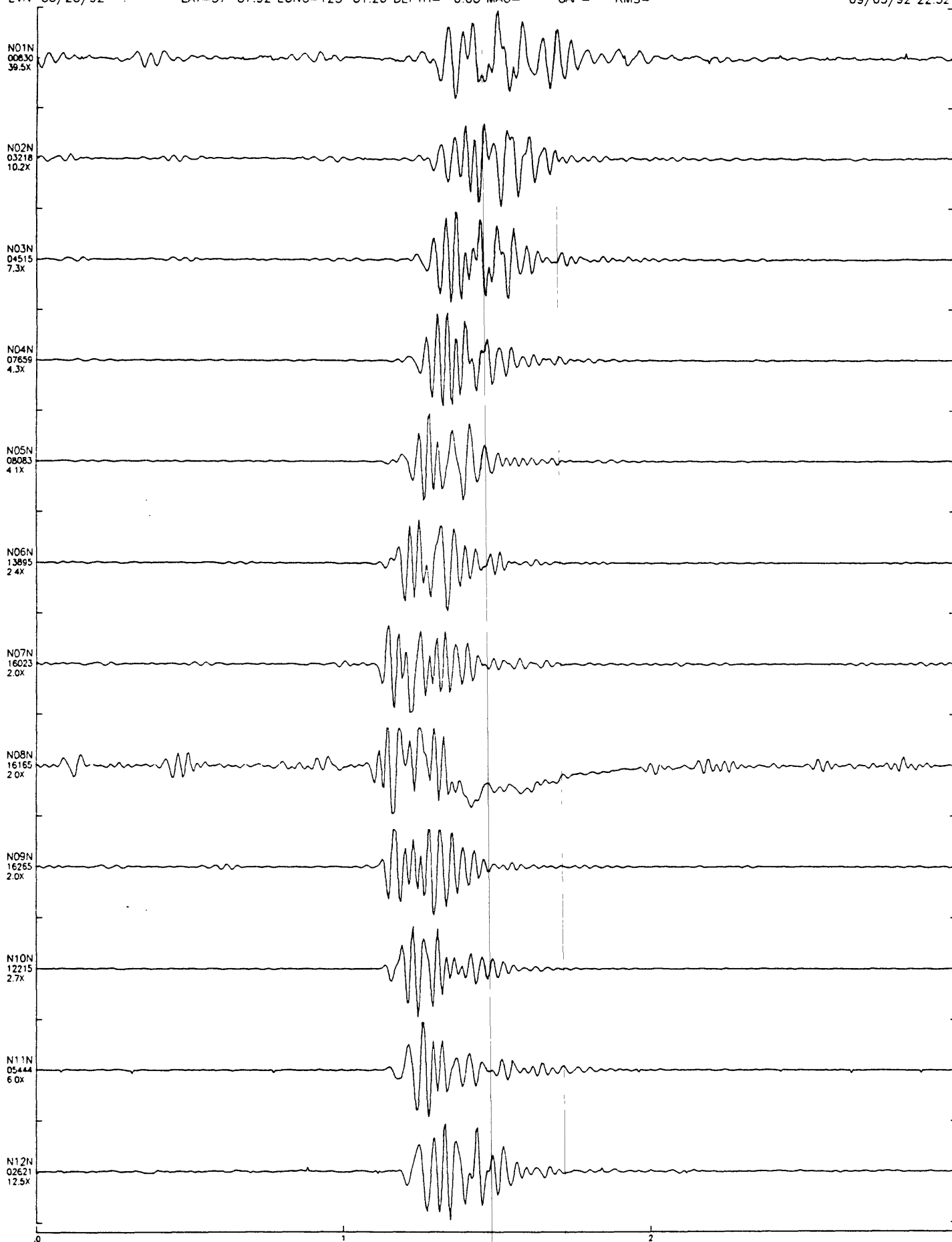
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09/03/92 22 51



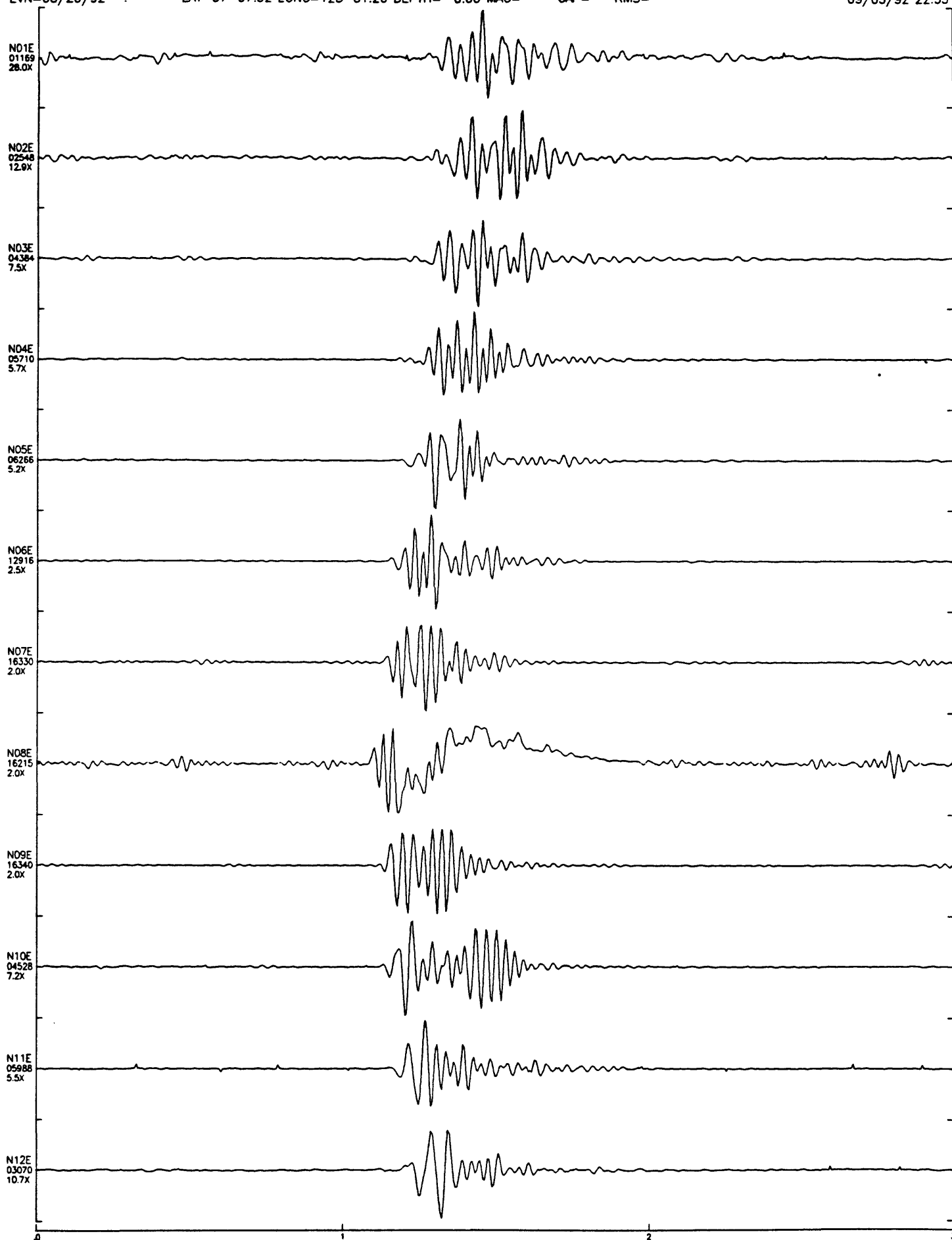
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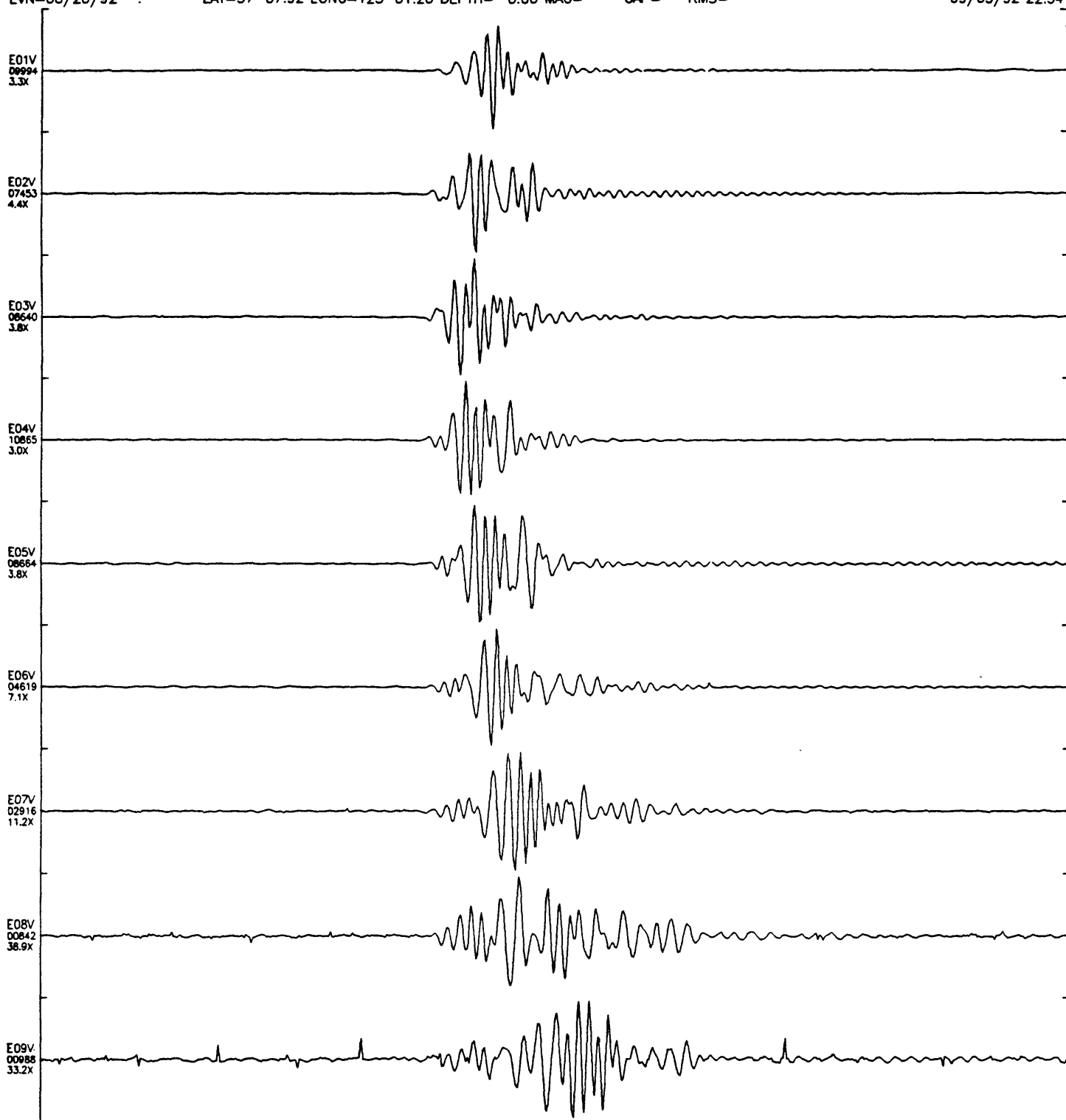
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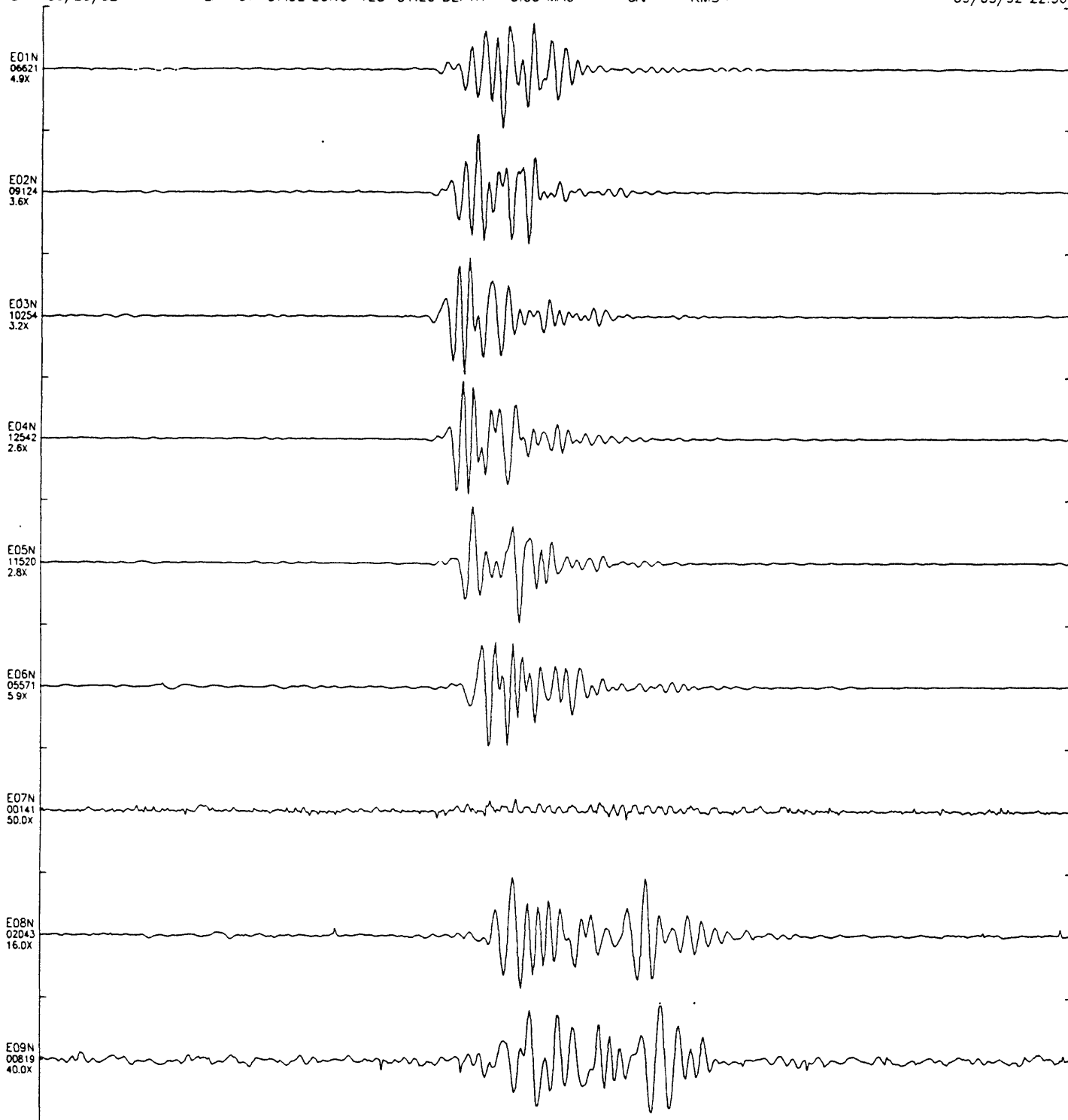


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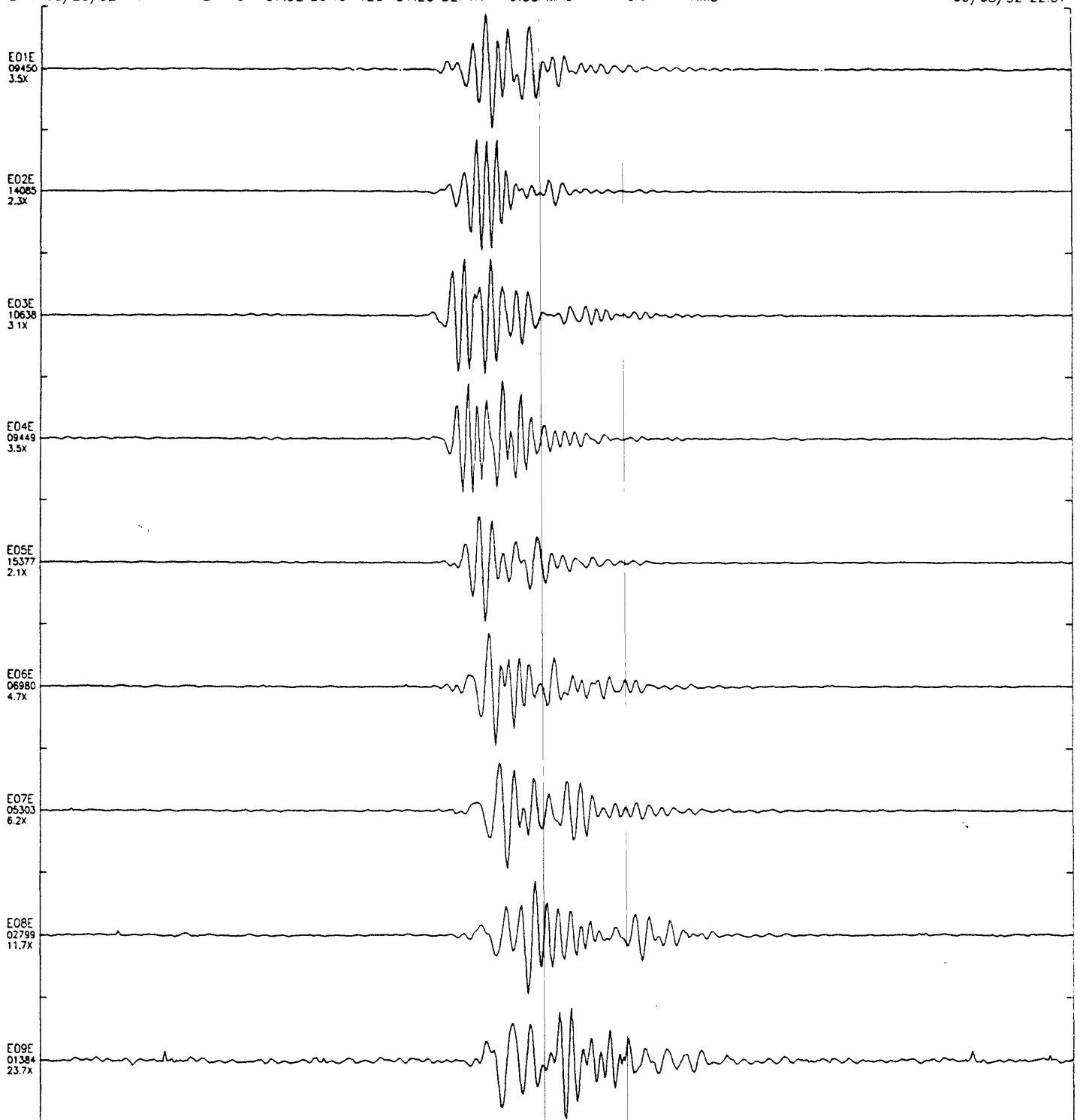
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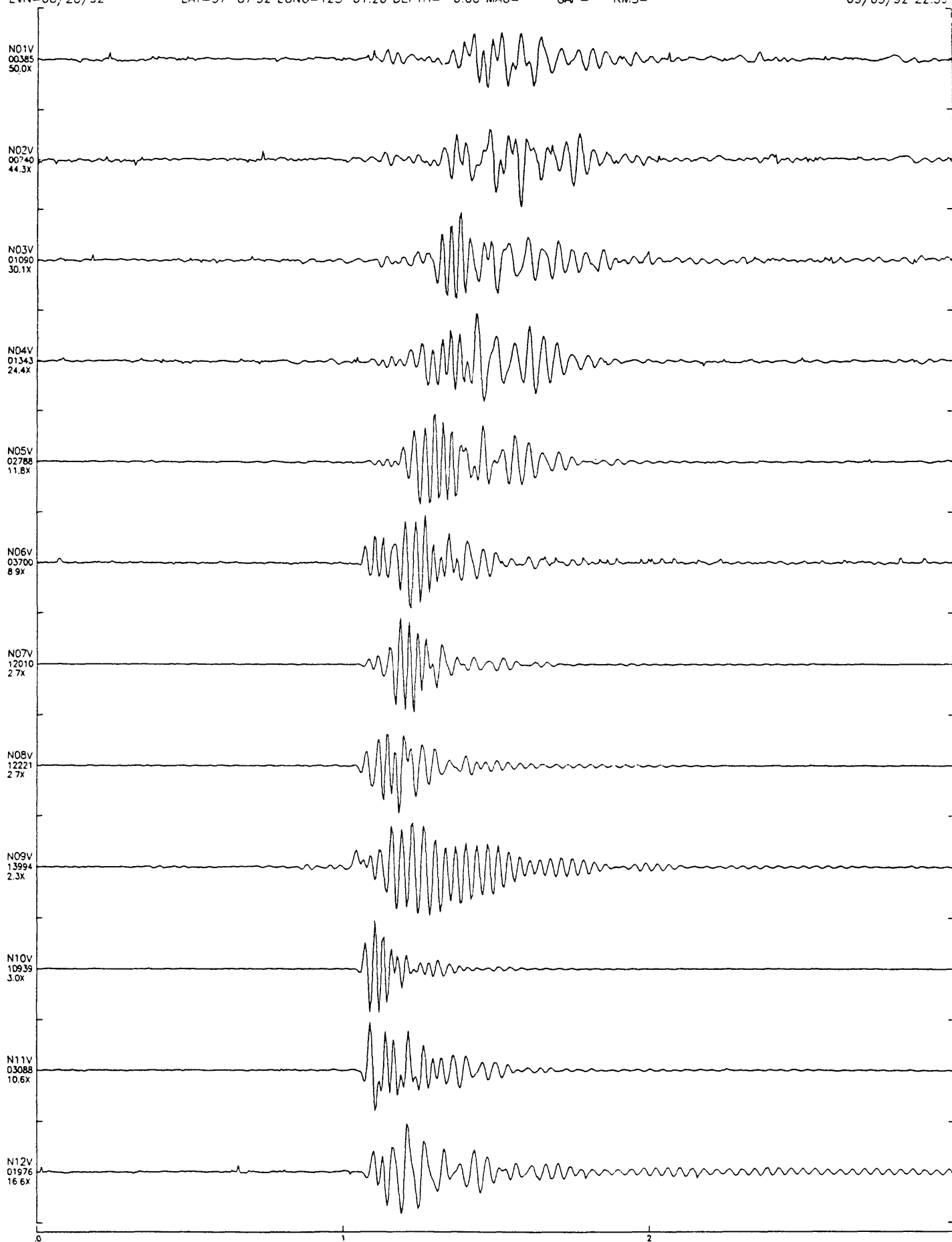
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09/03/92 22:57



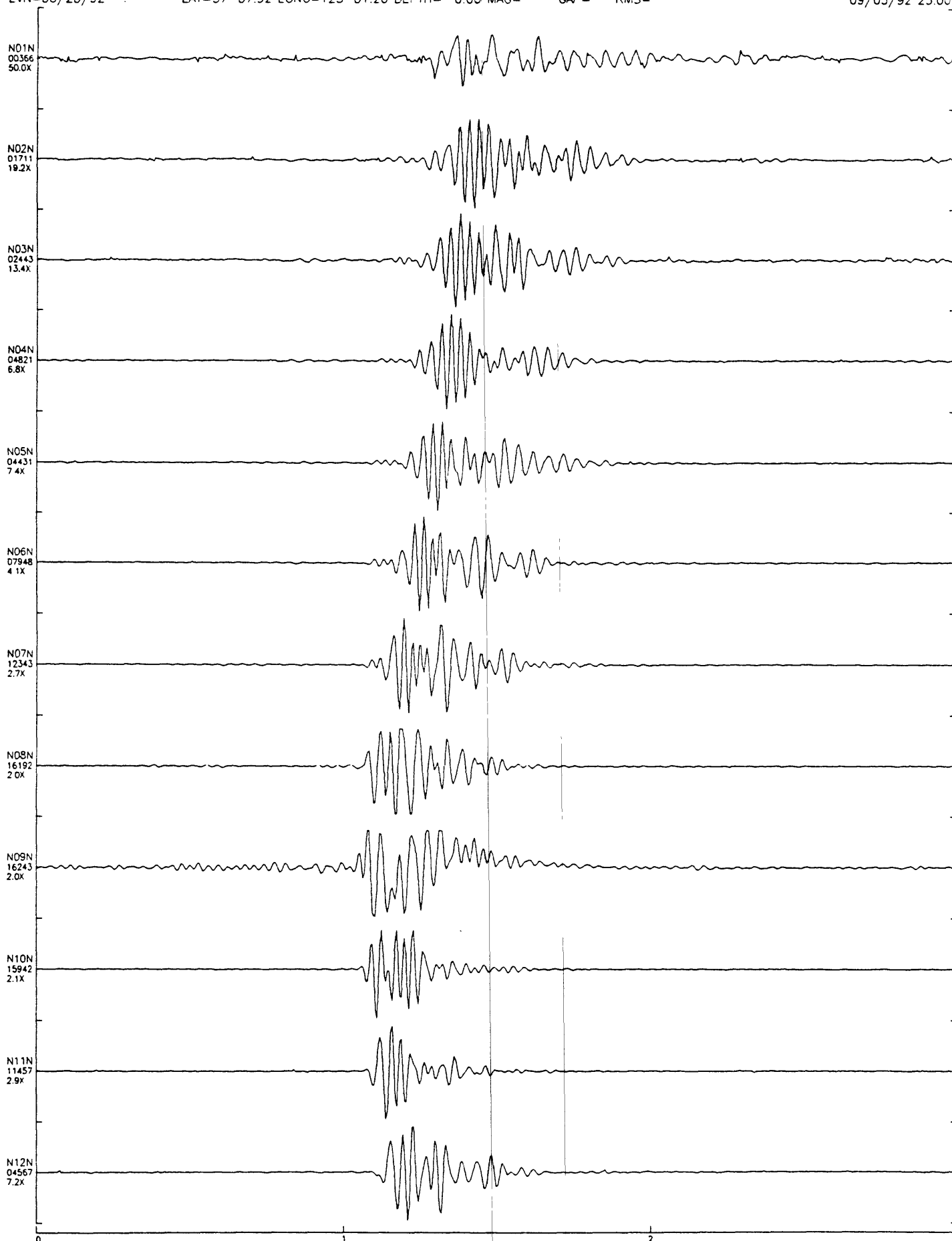
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09/03/92 22:59



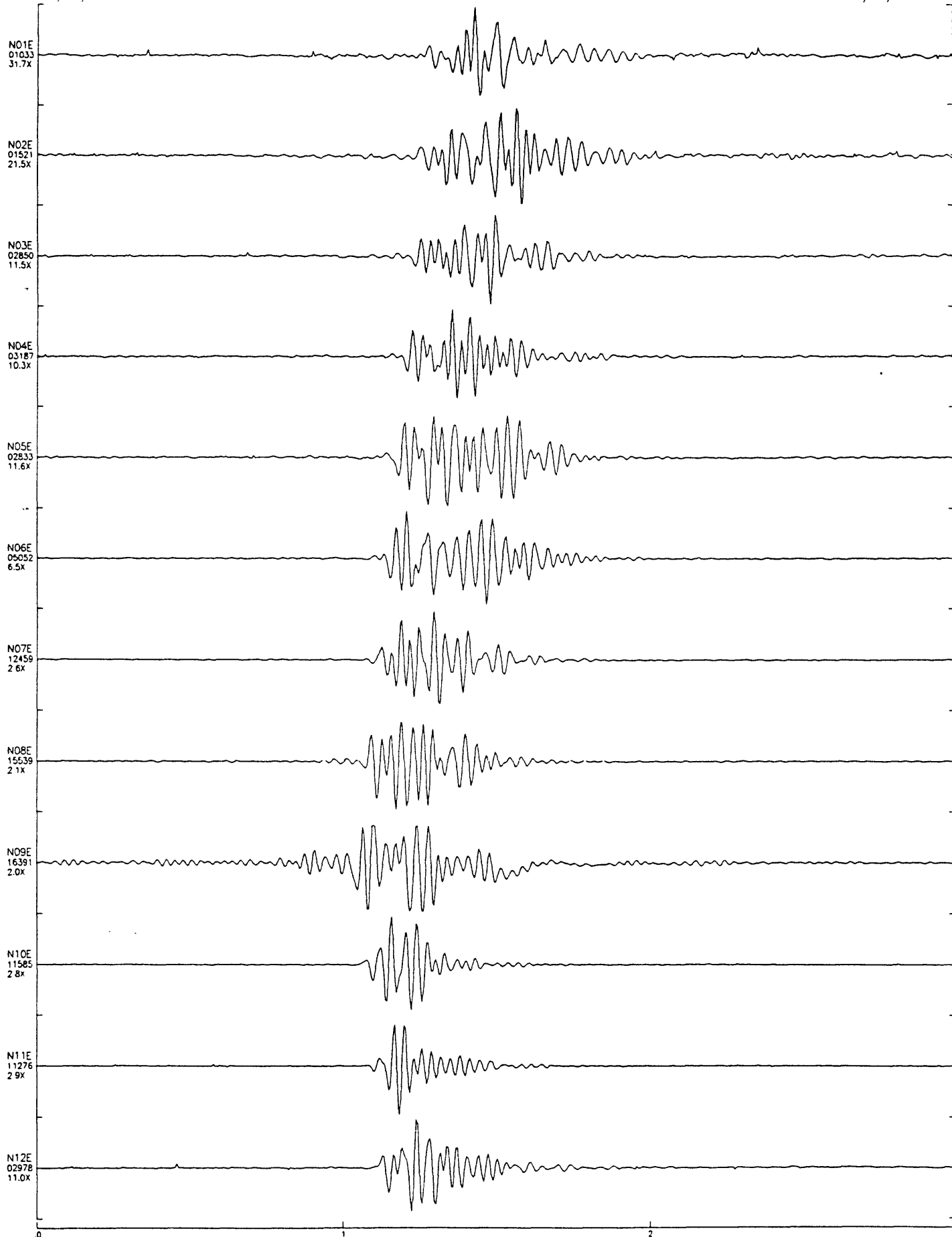
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Sheet 1
09/03/92 23:00



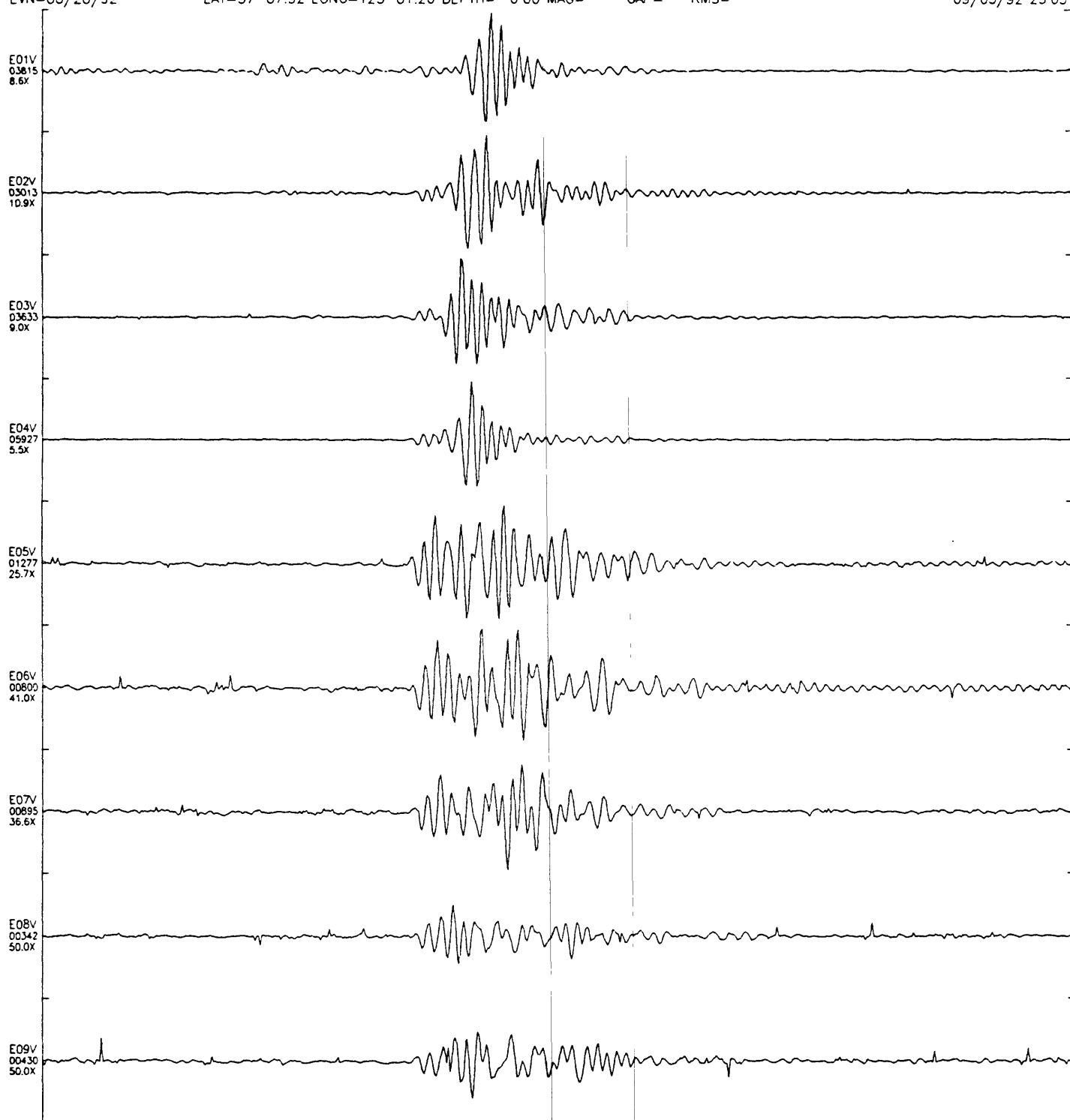
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EVN=08/20/92 LAT=37-07 92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

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09/03/92 23 01



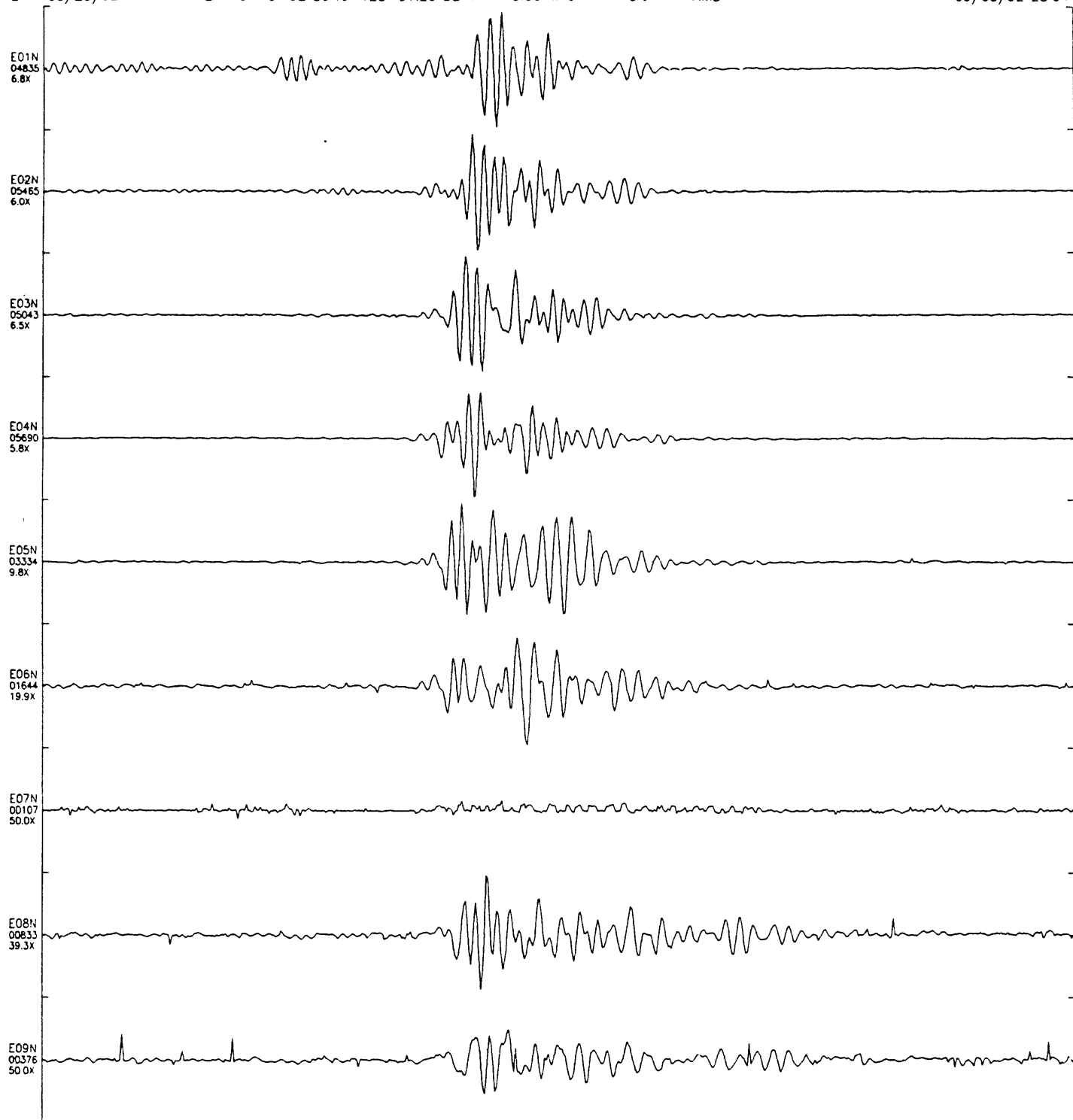
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EVN=08/20/92 LAT=37-07.92 LONG=123-01.20 DEPTH= 0 00 MAG= GAP= RMS=

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09/03/92 23 03



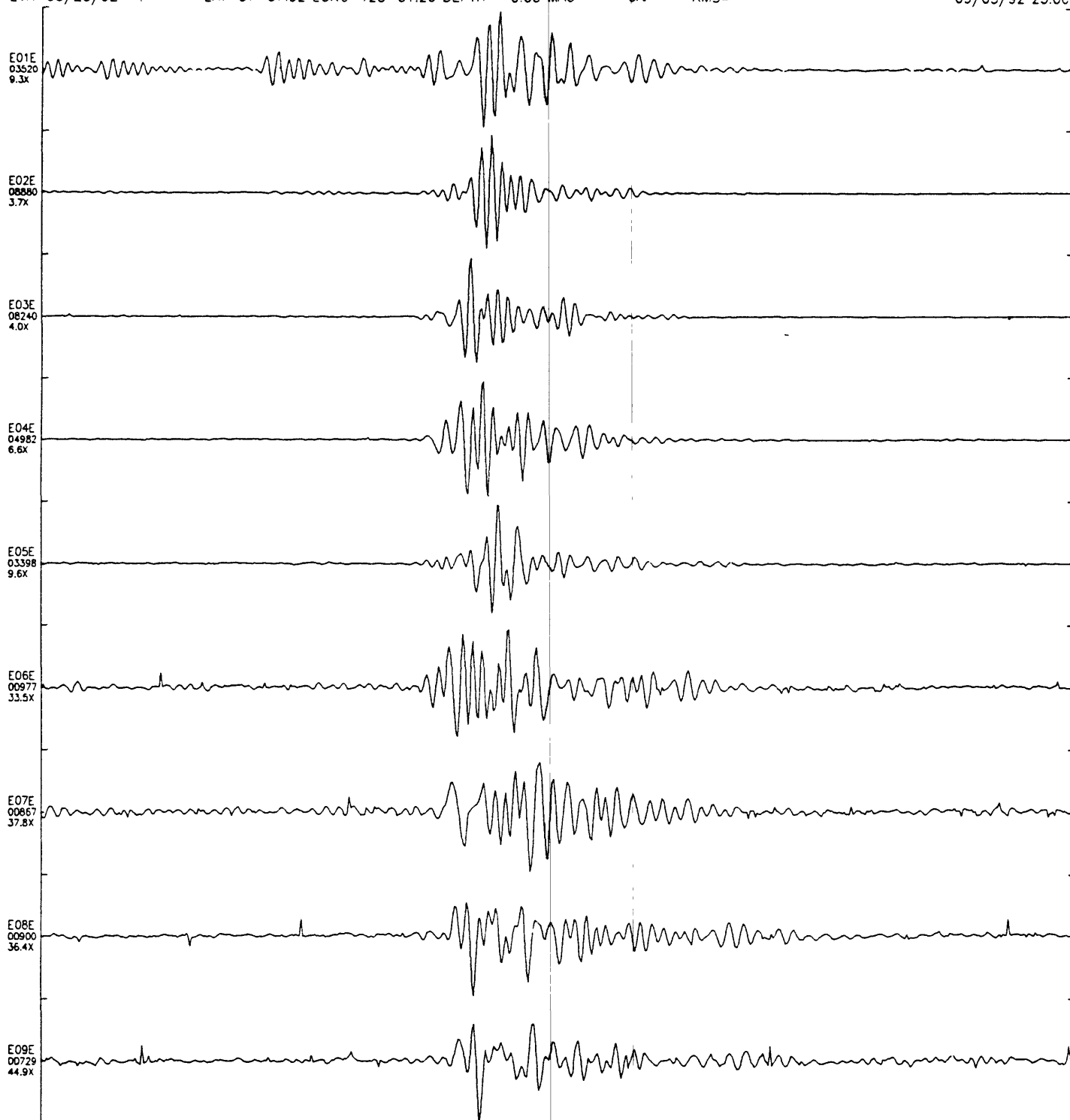
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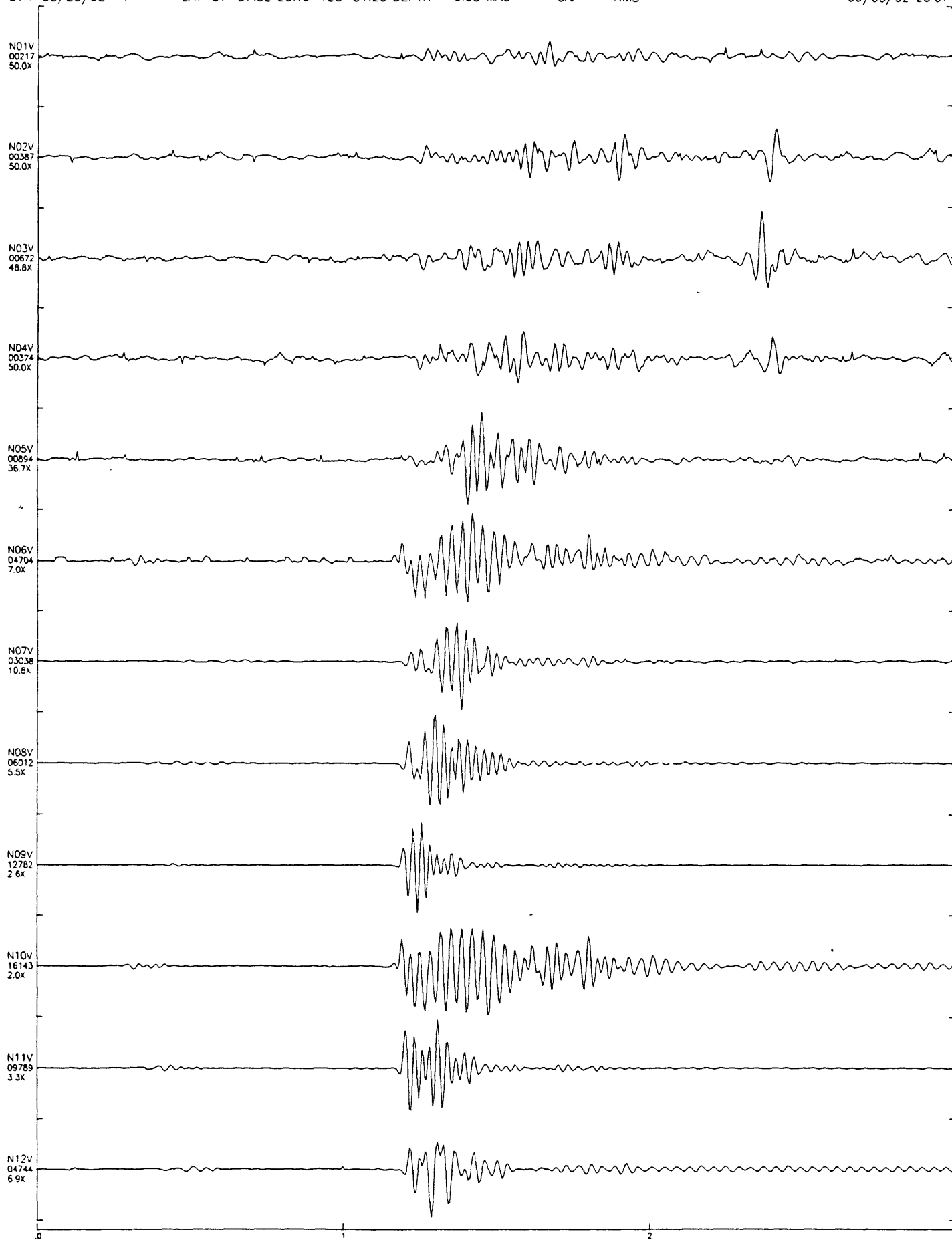
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09/03/92 23 04



IST=08/20/92 23:08 04.319 SPS=200.321 DEC=1 D.\9208200Z.CT1
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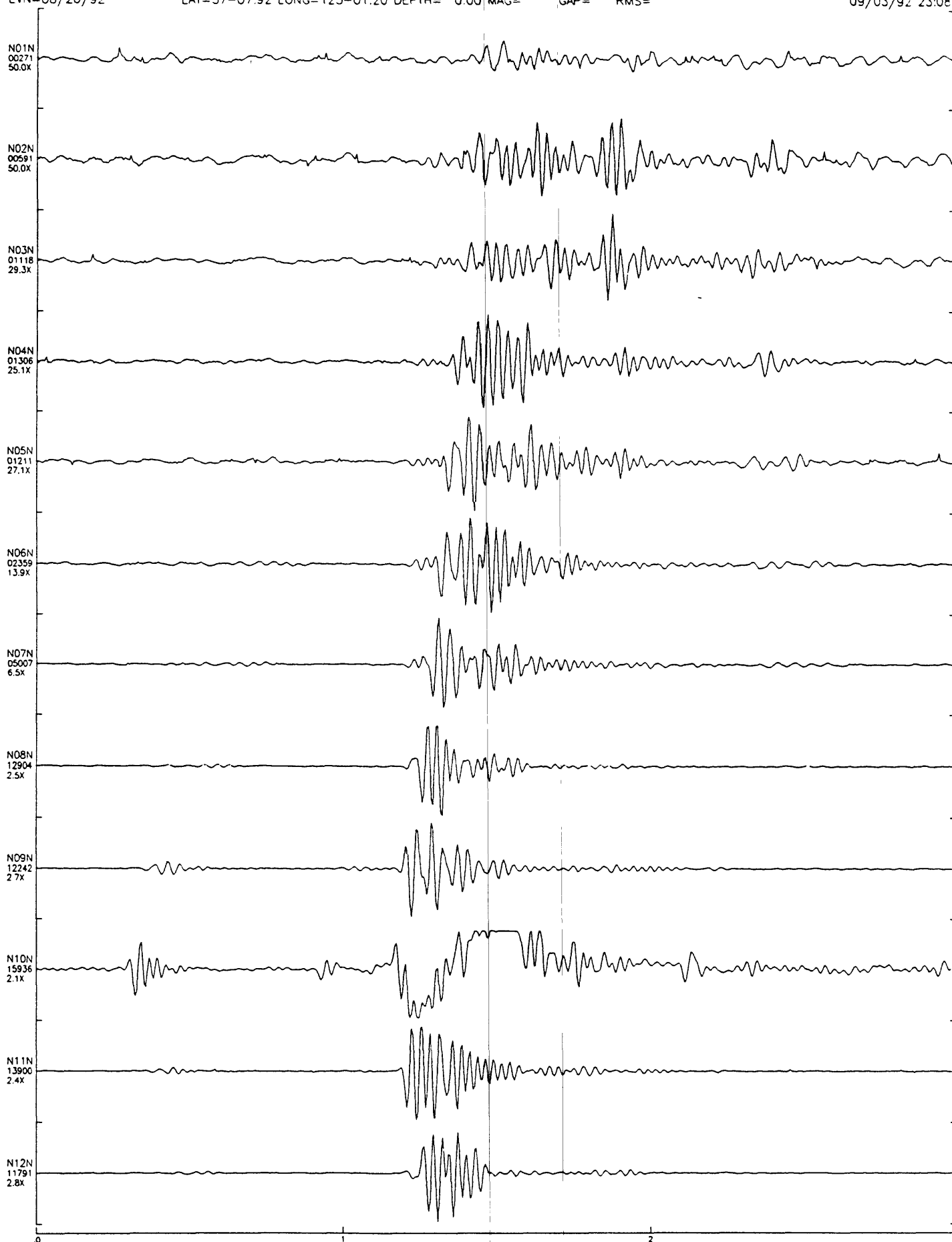
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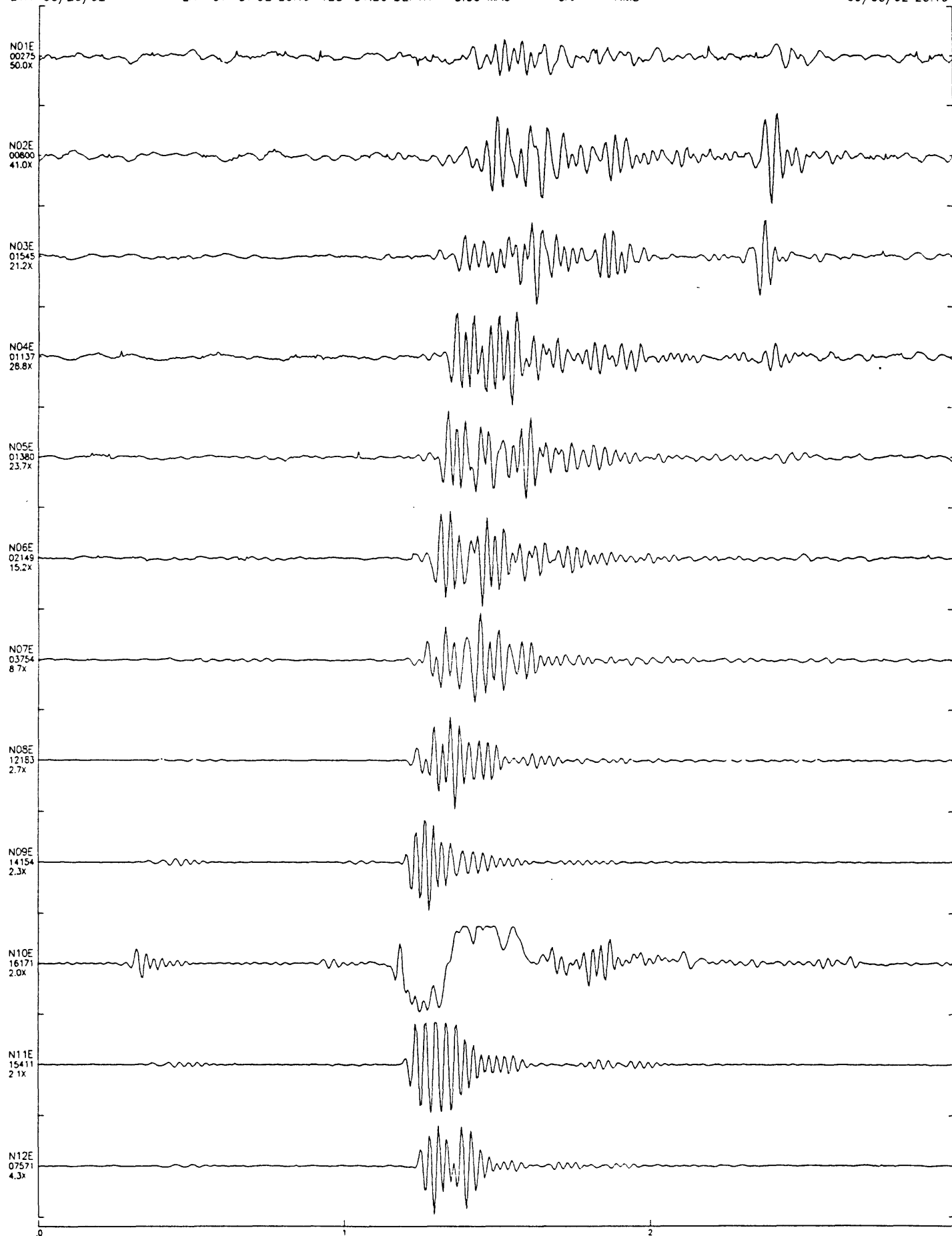
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09/03/92 23:08



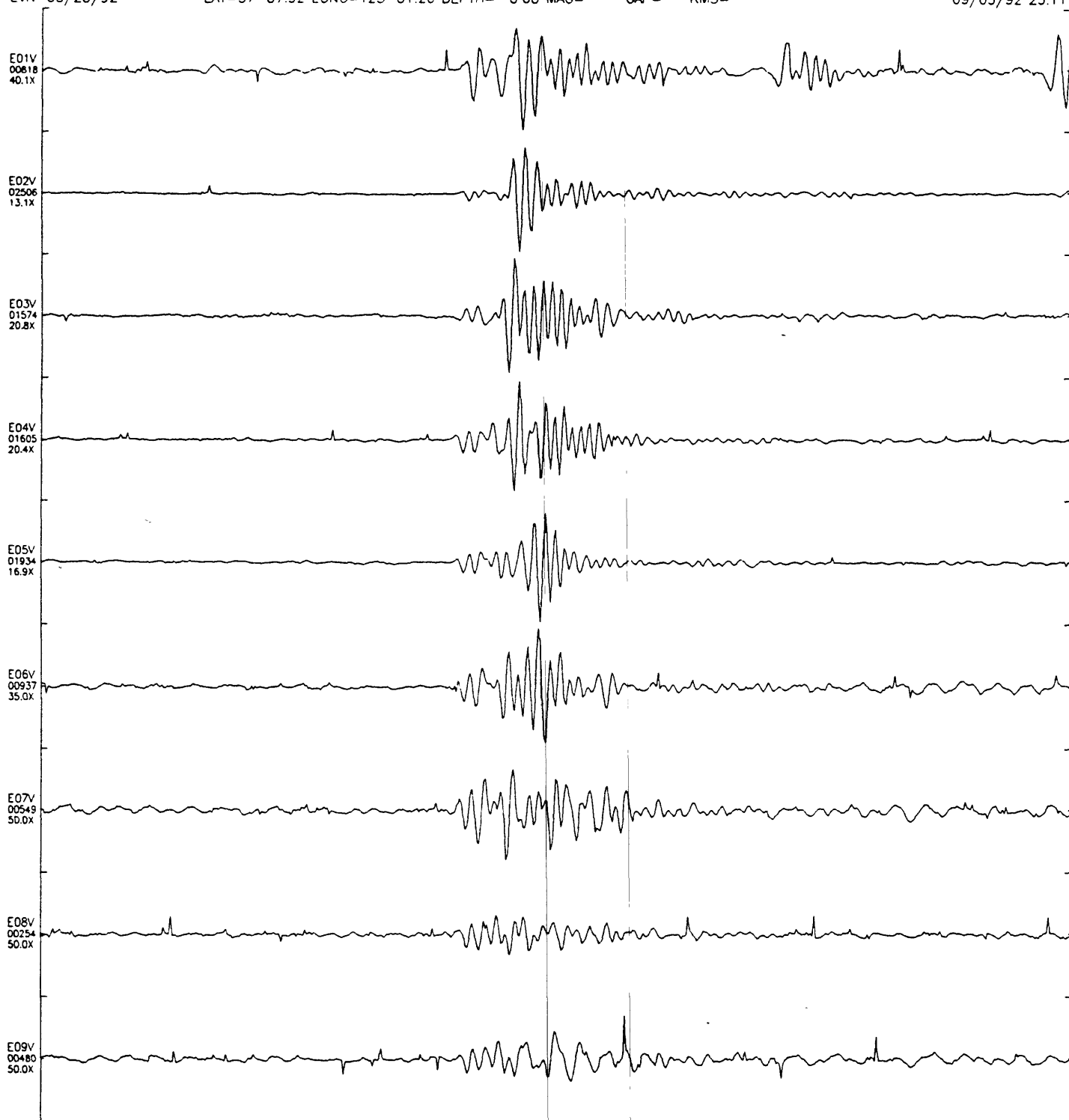
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09/03/92 23:10



IST=08/20/92 23:11 01.955 SPS=200.321 DEC=1 D:\92082010.CT1
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09/03/92 23.11

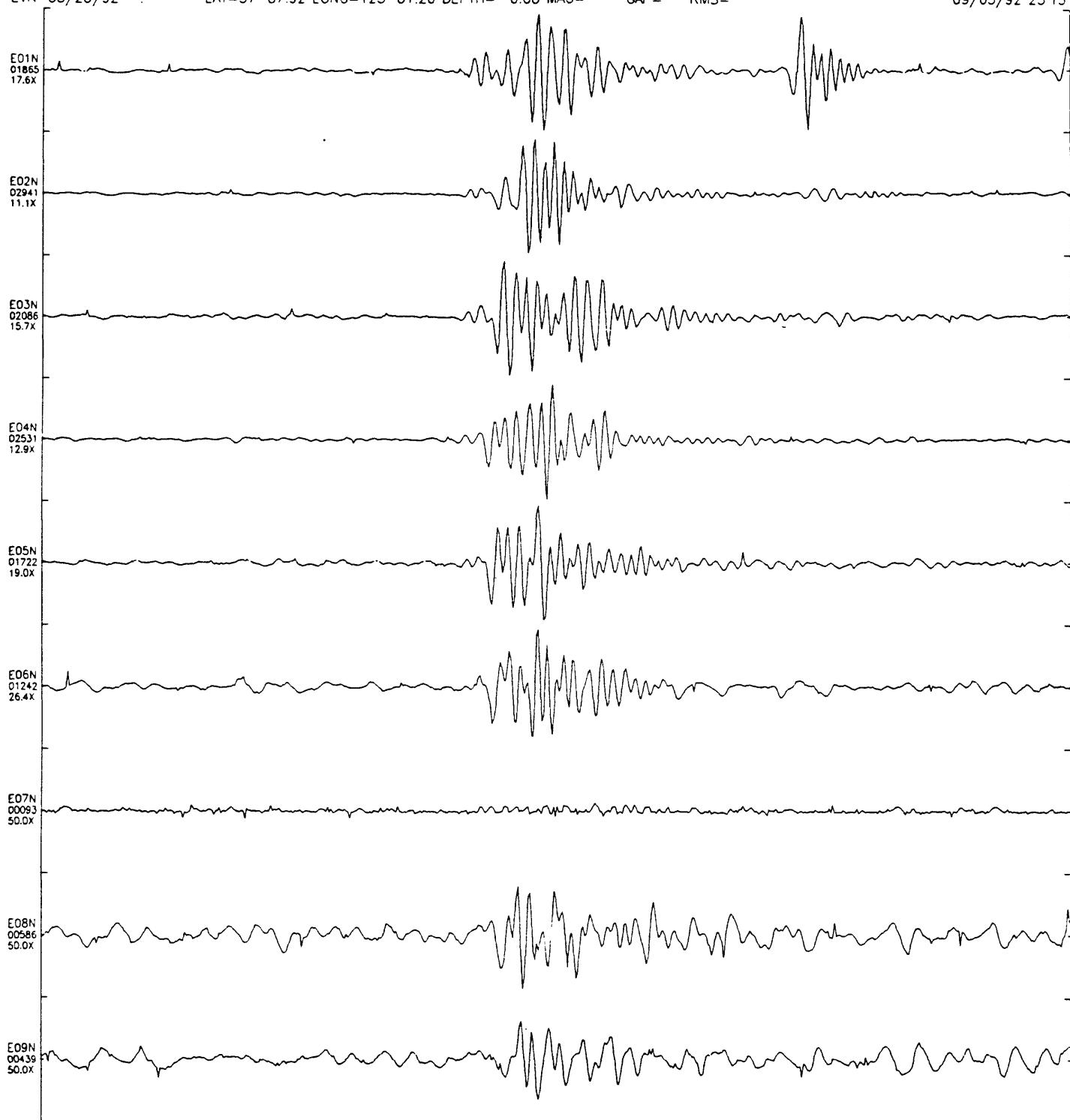


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105

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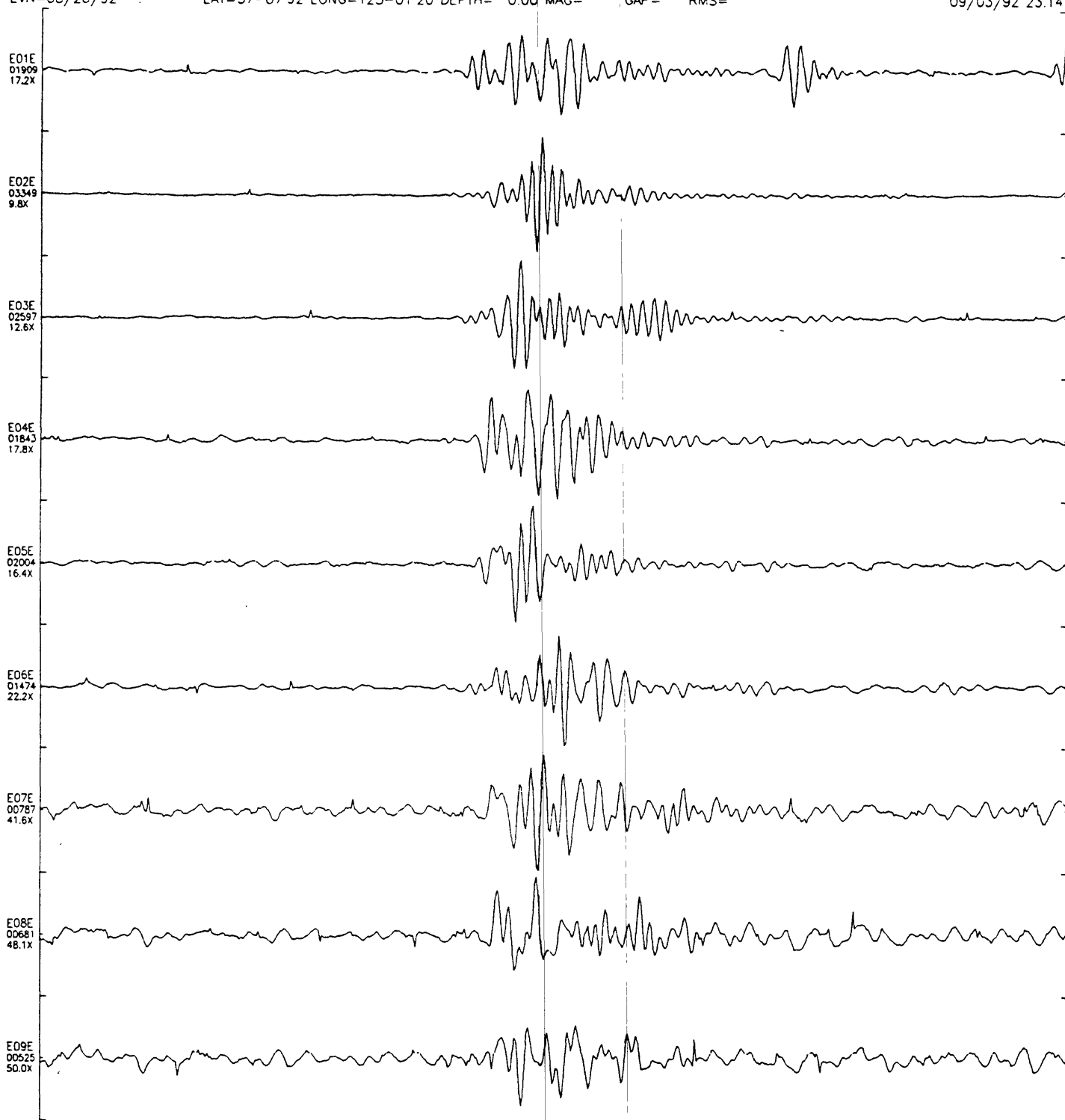
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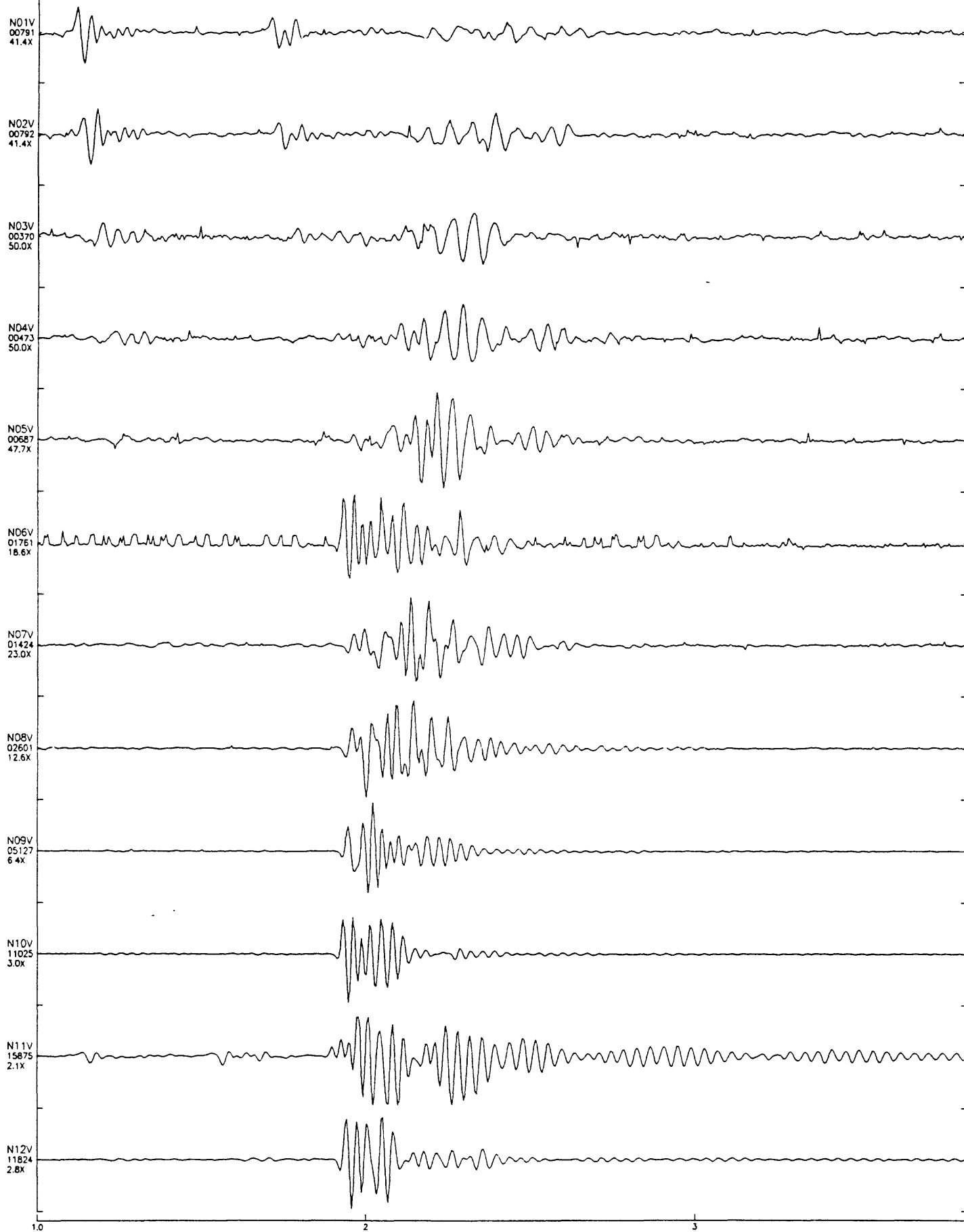
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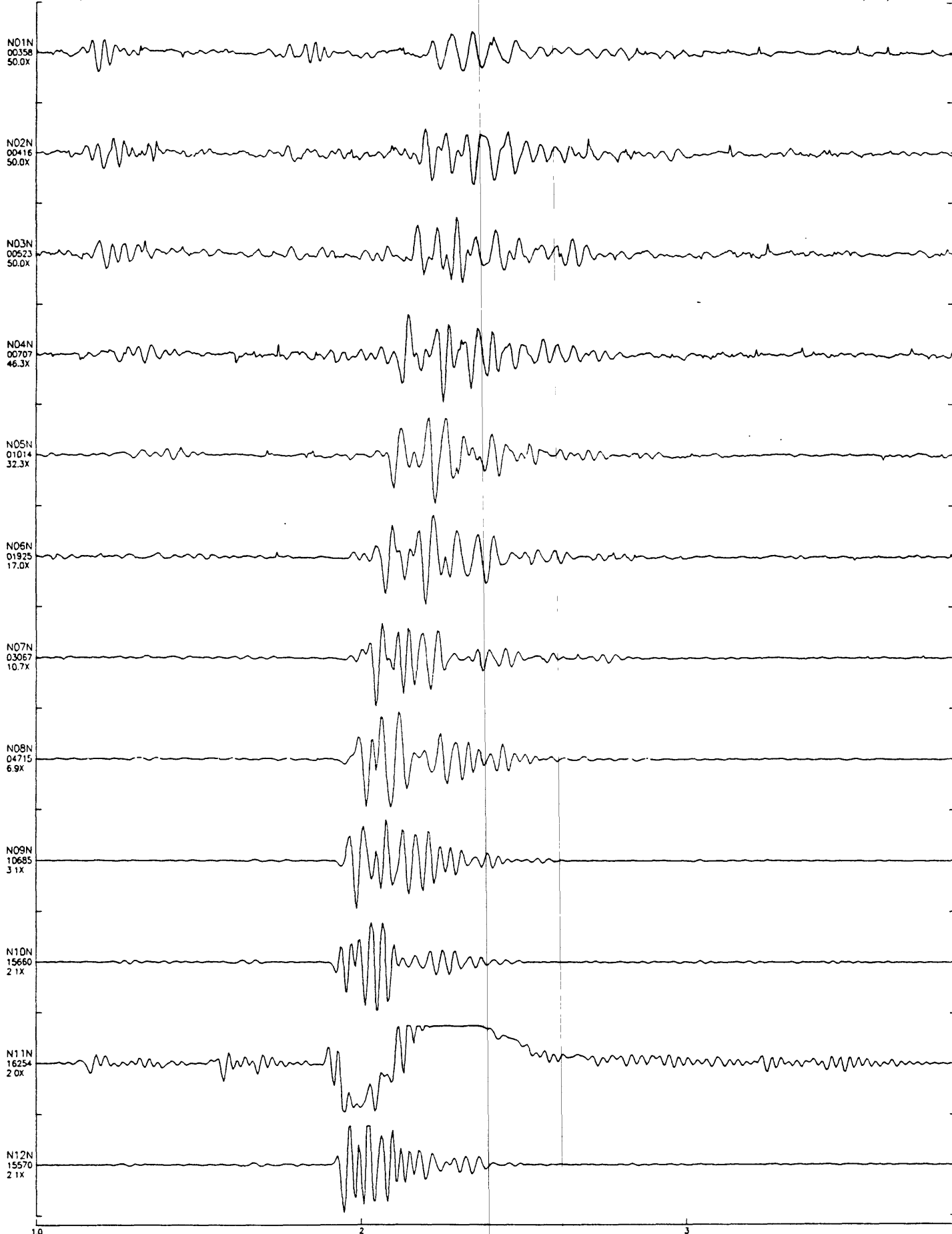
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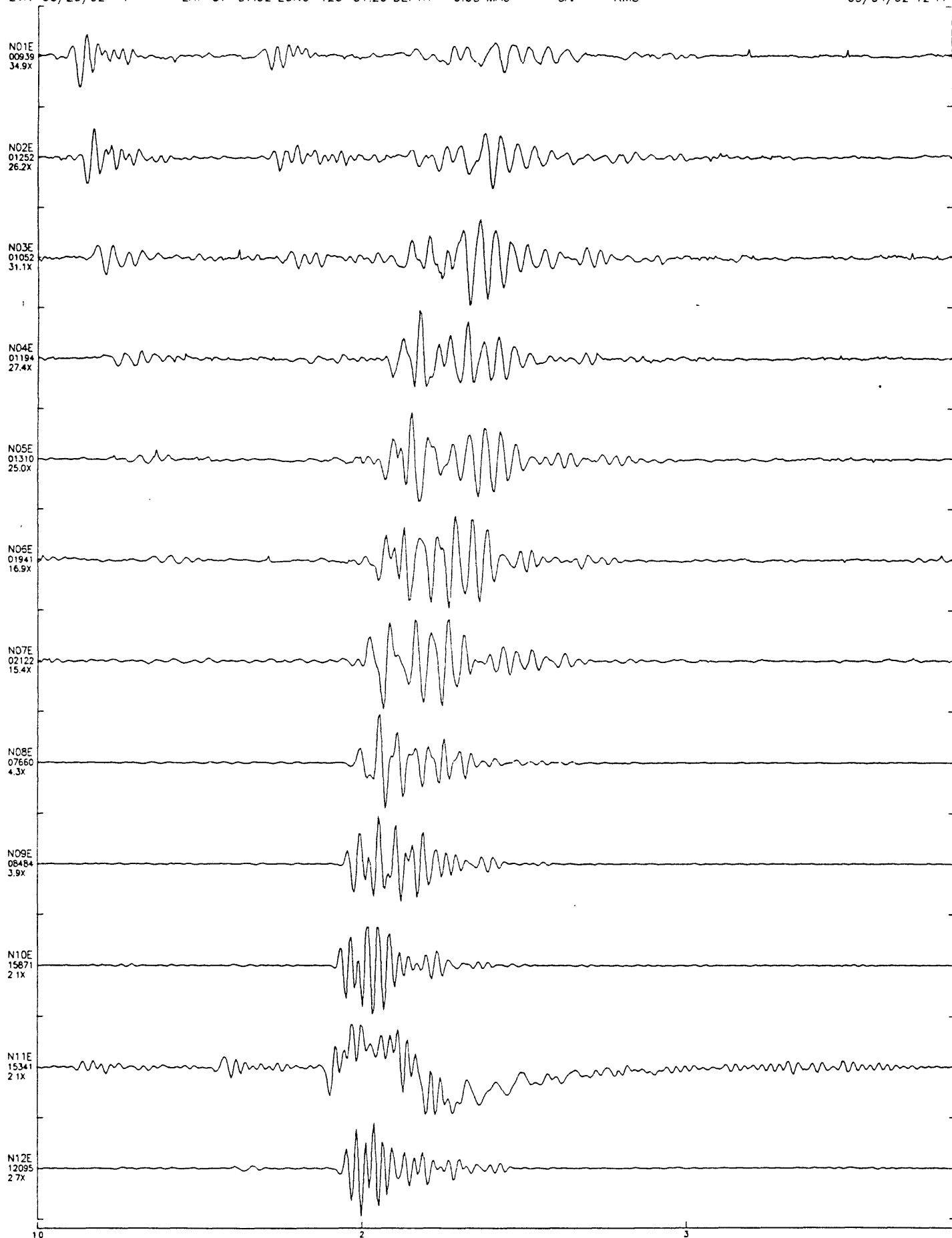
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IST=08/20/92 23:27 56.498 SPS=200.321 DEC=1 D:\92082023.CT1
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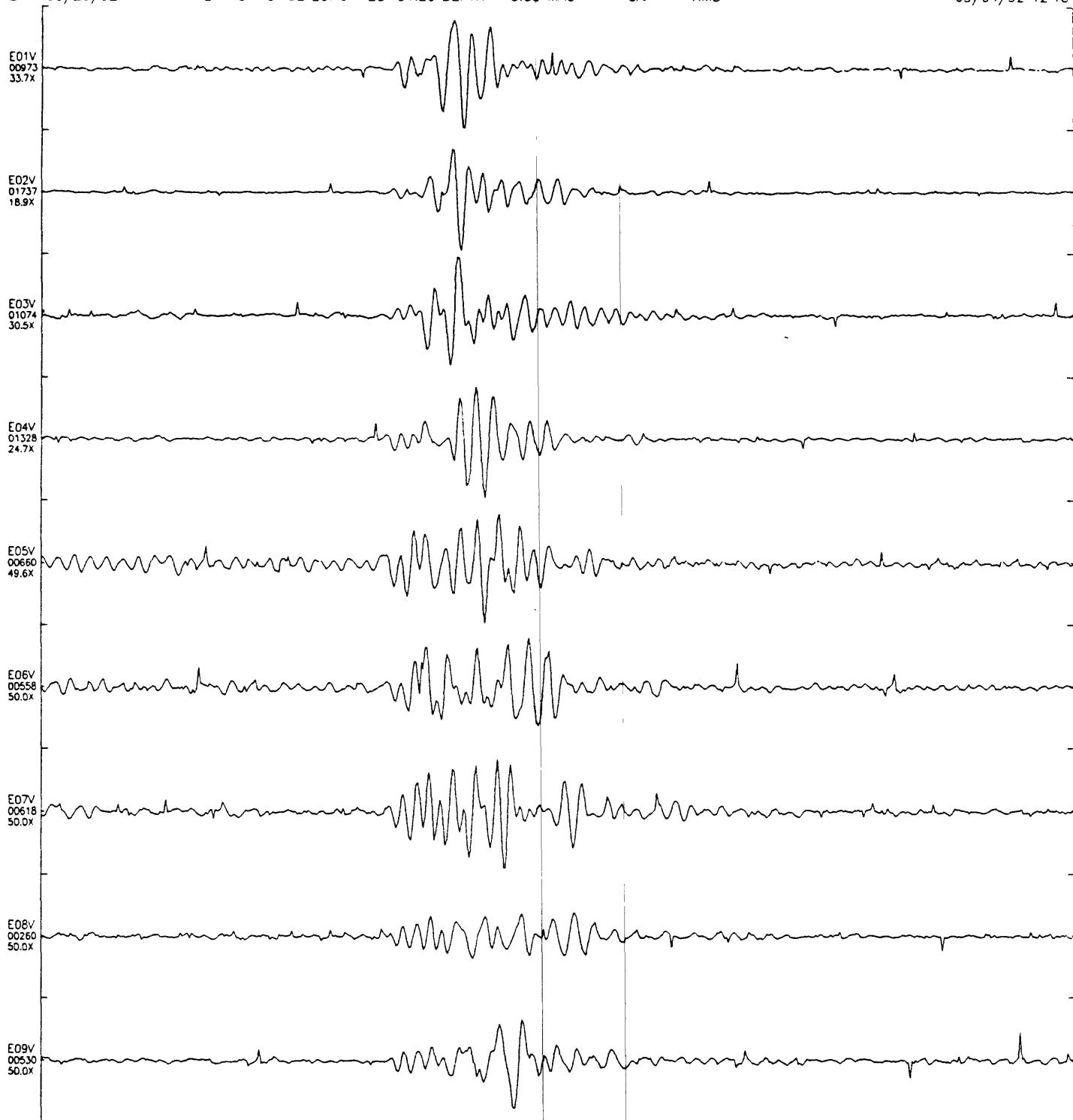
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09/04/92 12 15





IST=08/20/92 23:27 56.498 SPS=200.321 DEC=1 D.\92082023.CT1
EVN=08/20/92 : LAT=37-07 92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/04/92 12 18



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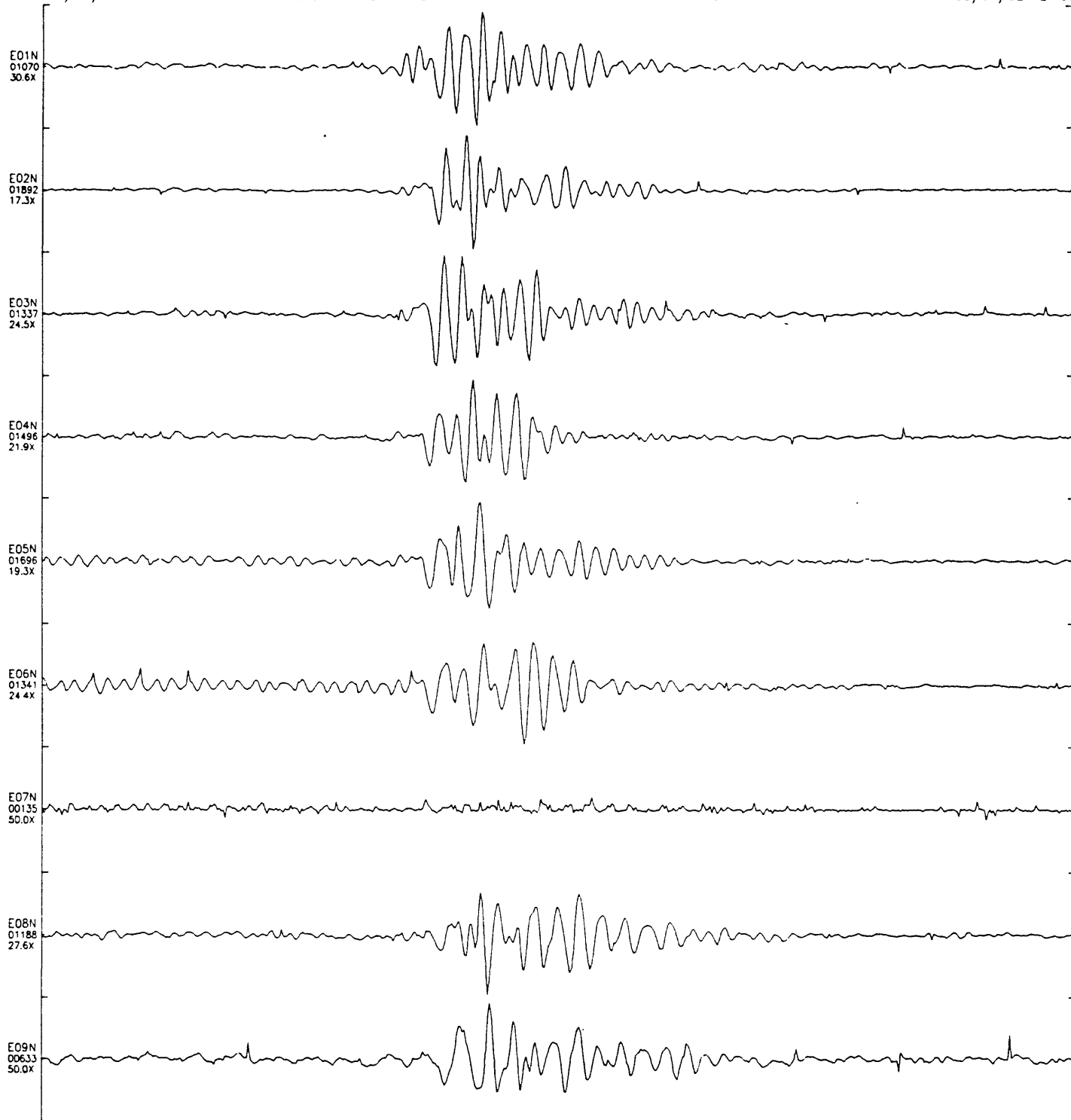
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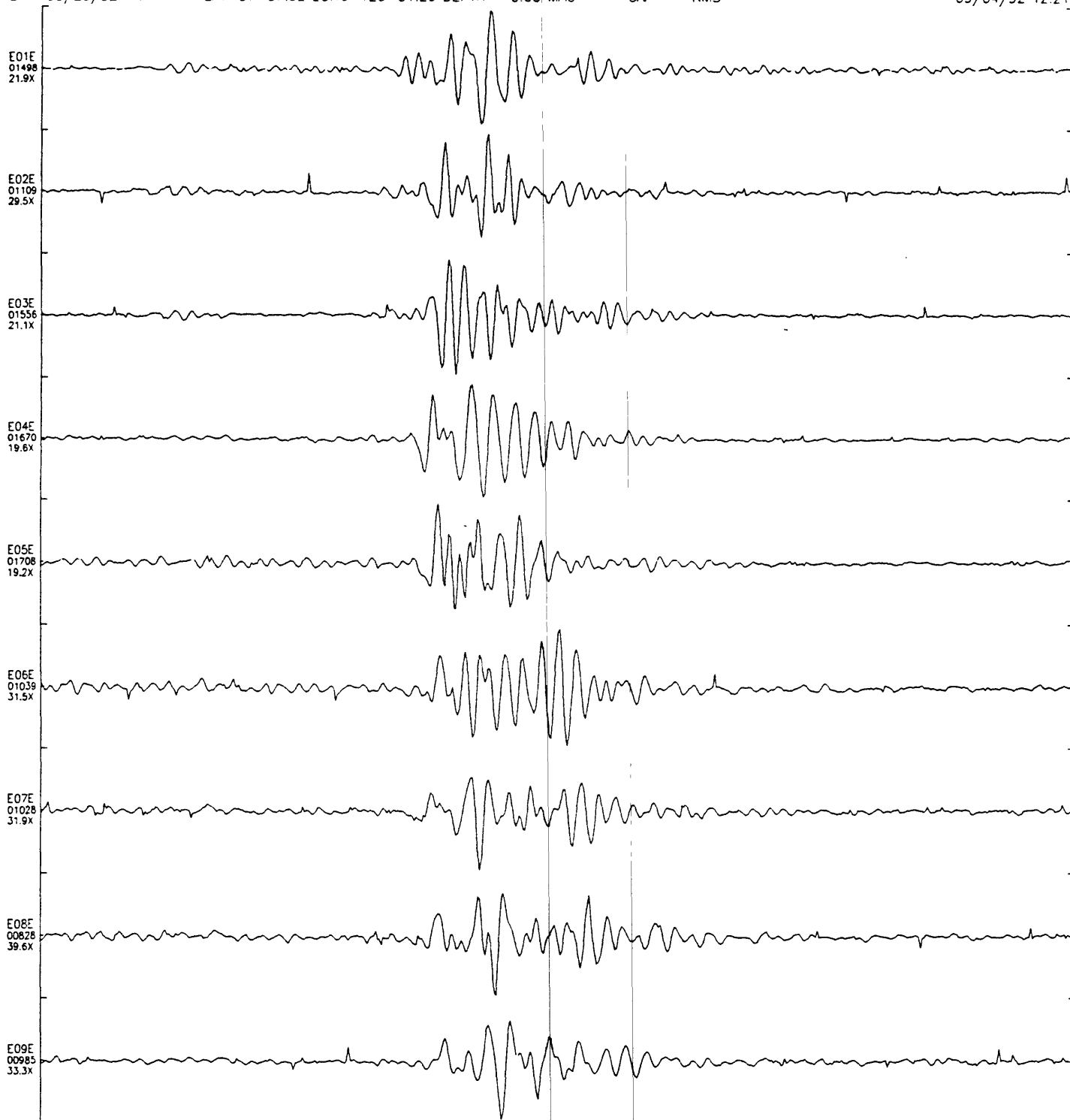
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Sheet 1
09/04/92 12 19



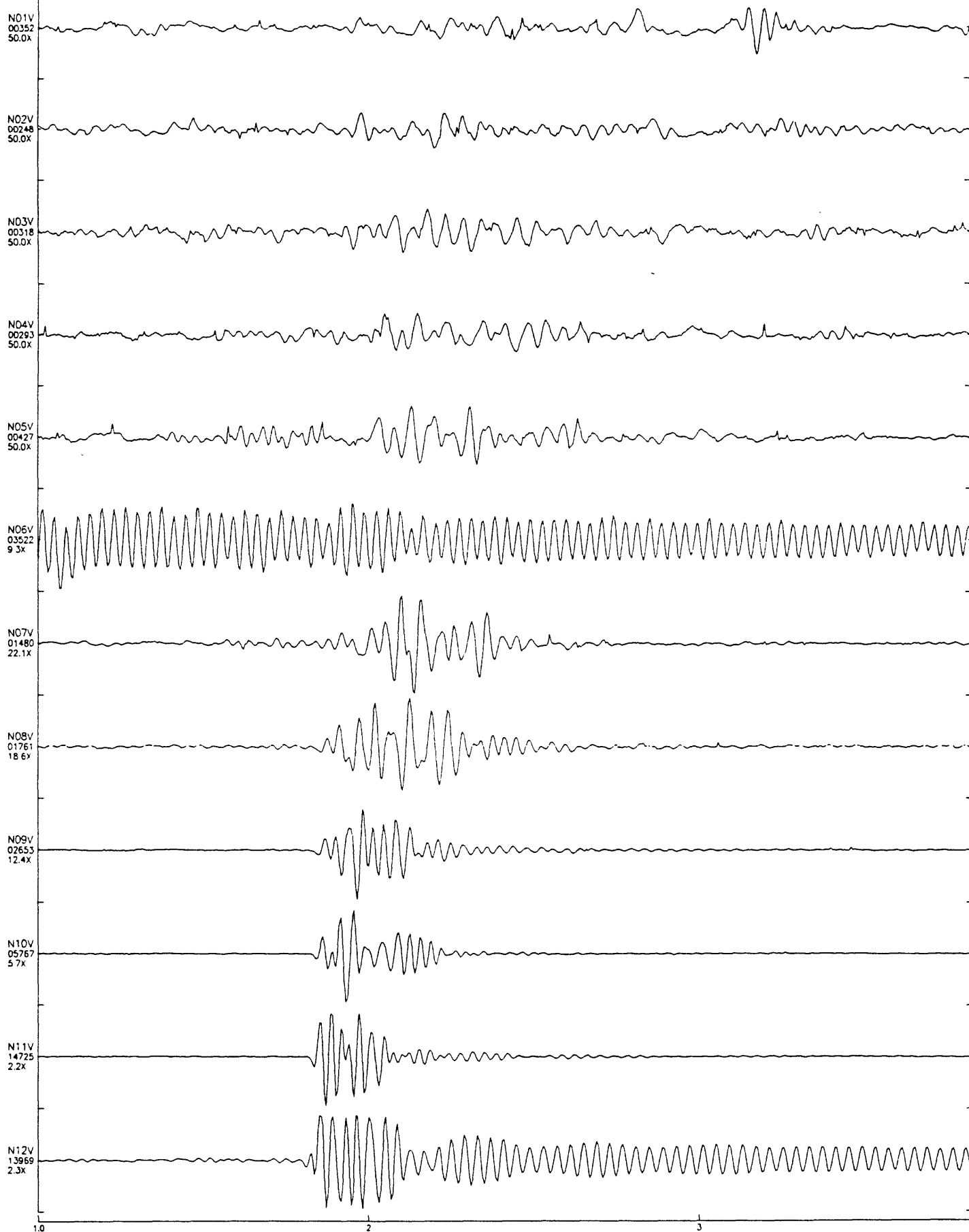
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09/04/92 12:21



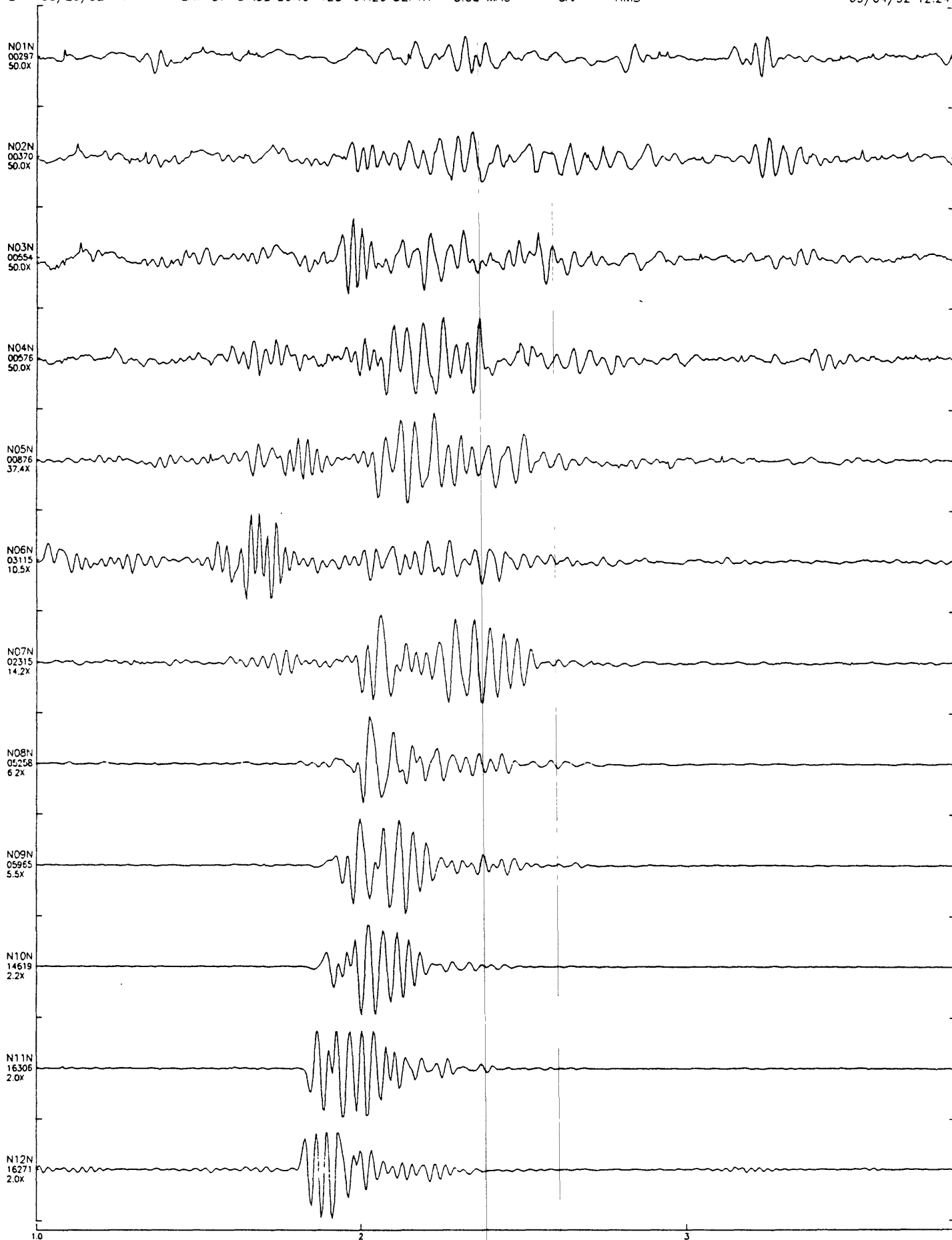
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Sheet 1
09/04/92 12.22



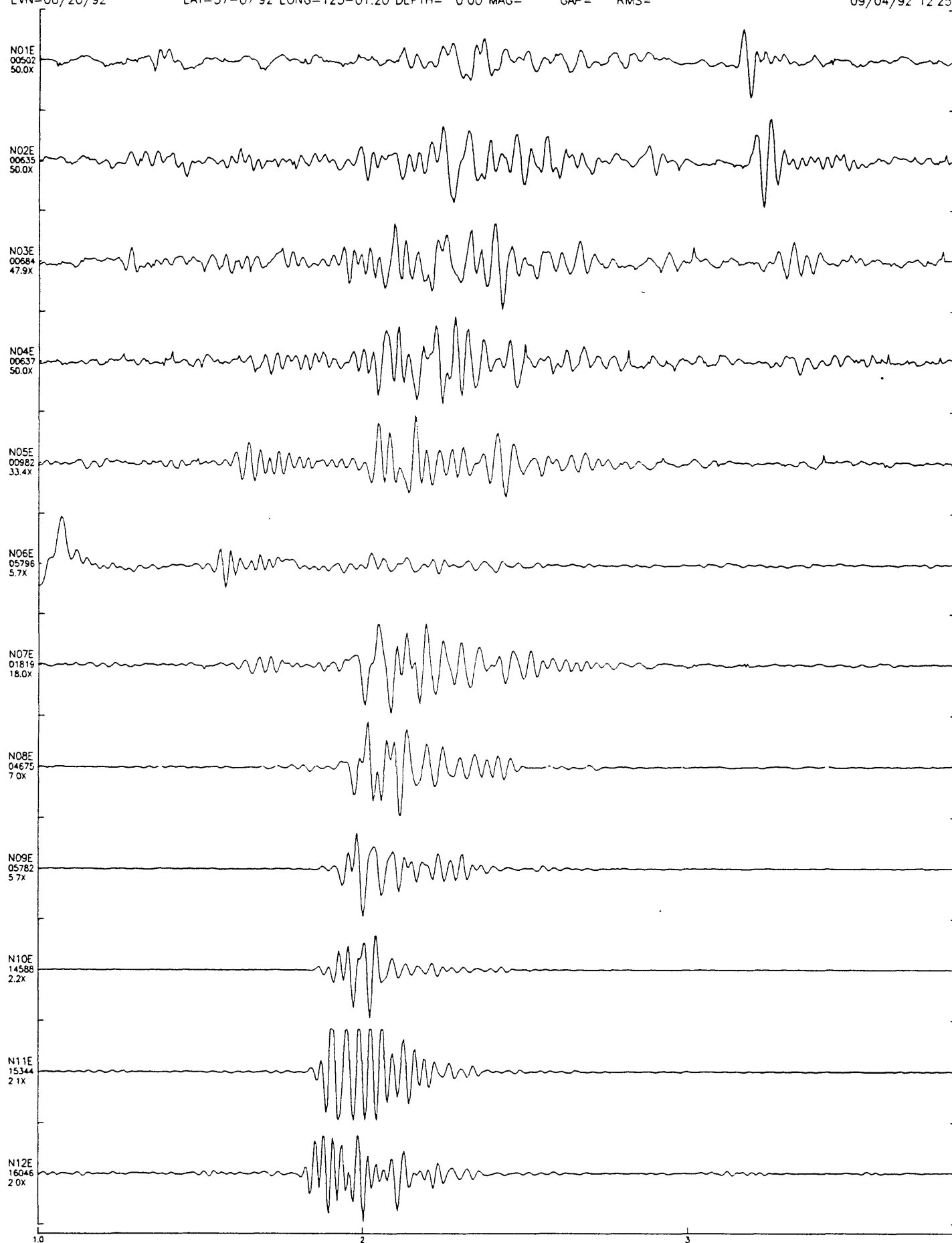
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Sheet 1
09/04/92 12.24



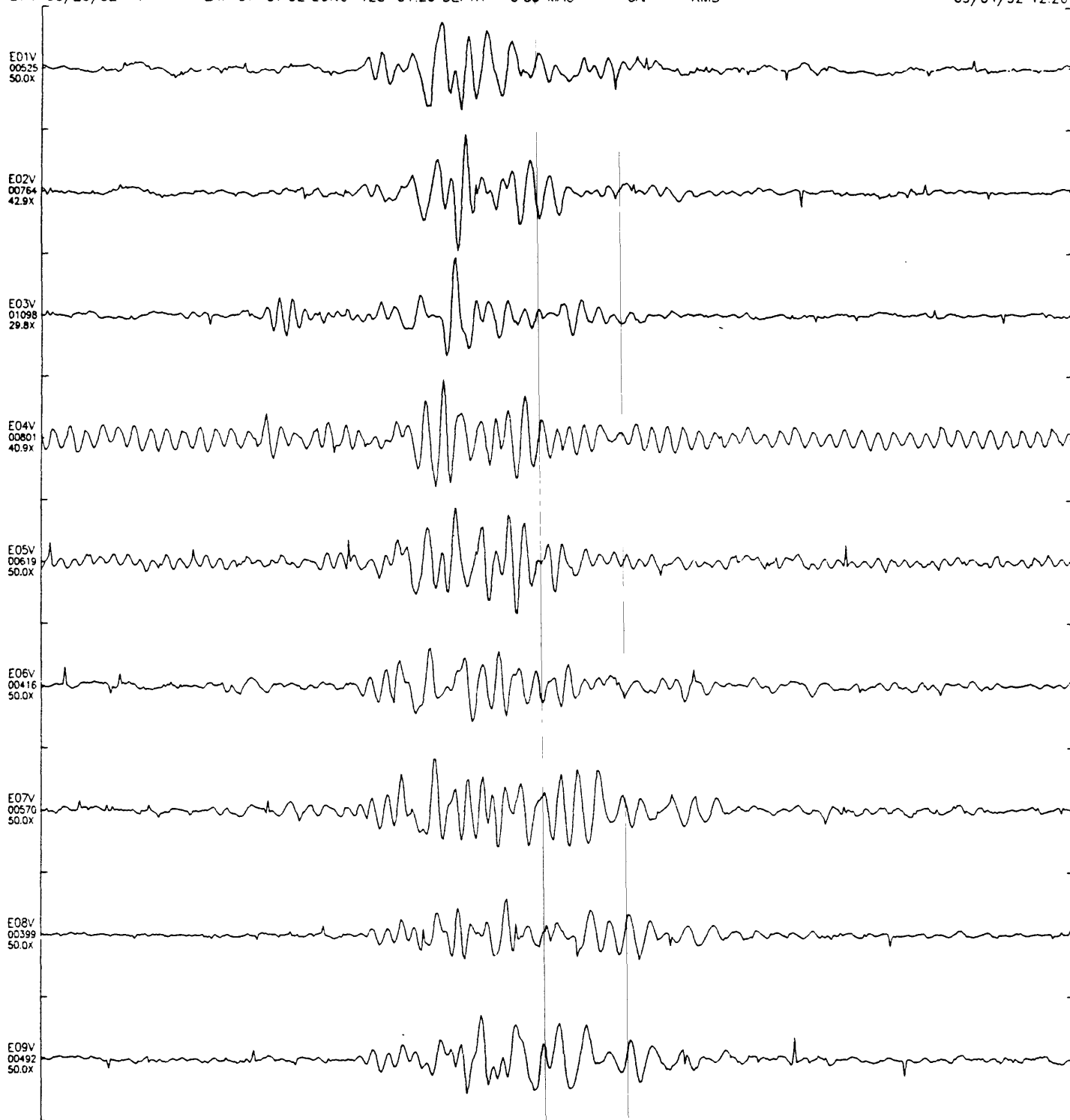
IST=08/20/92 23:36 55.794 SPS=200.321 DEC=1 D.\92082026.CT1
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Sheet 1
09/04/92 12 25



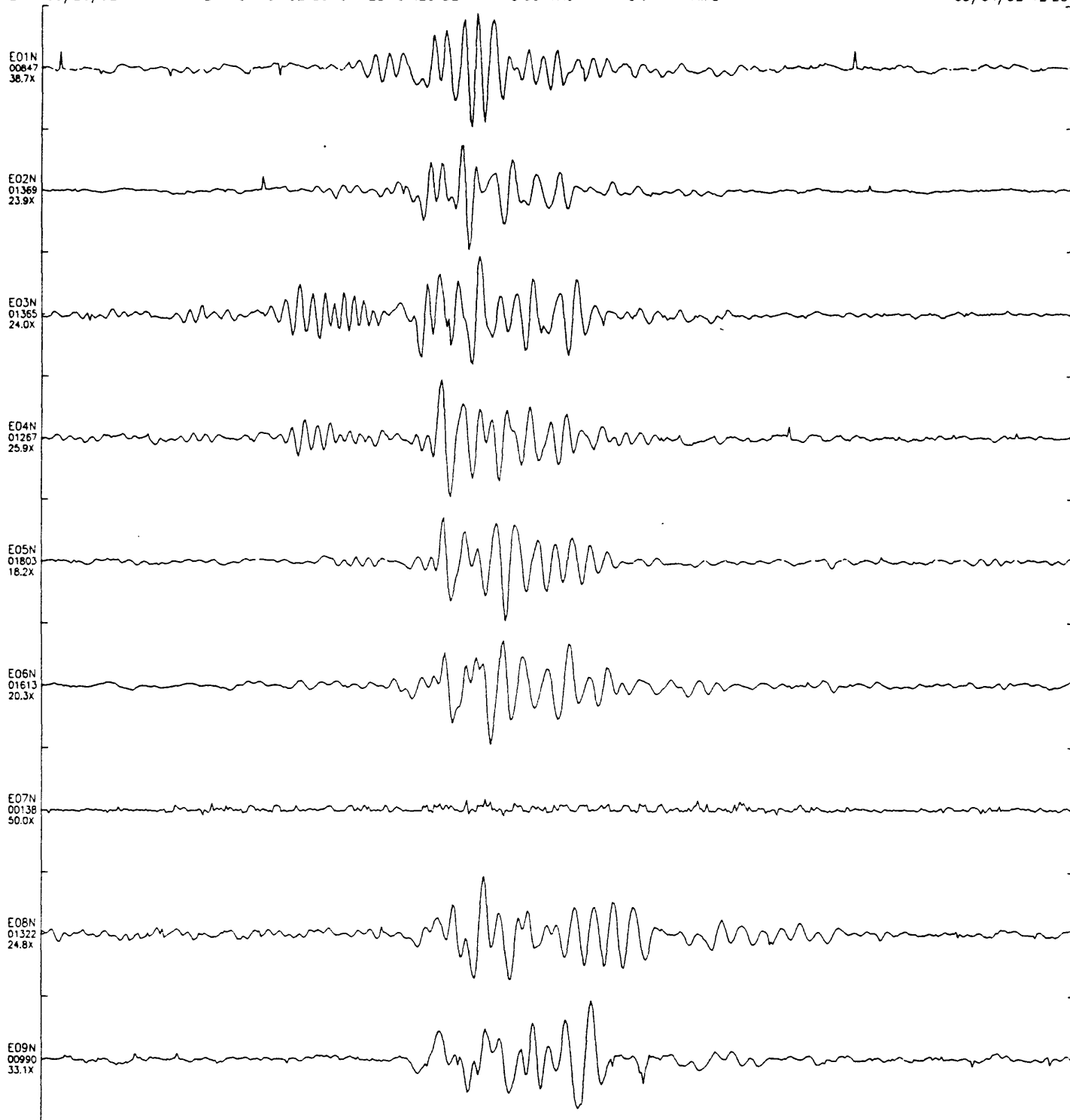
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Sheet 1
09/04/92 12:26



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Sheet 1
09/04/92 12 26



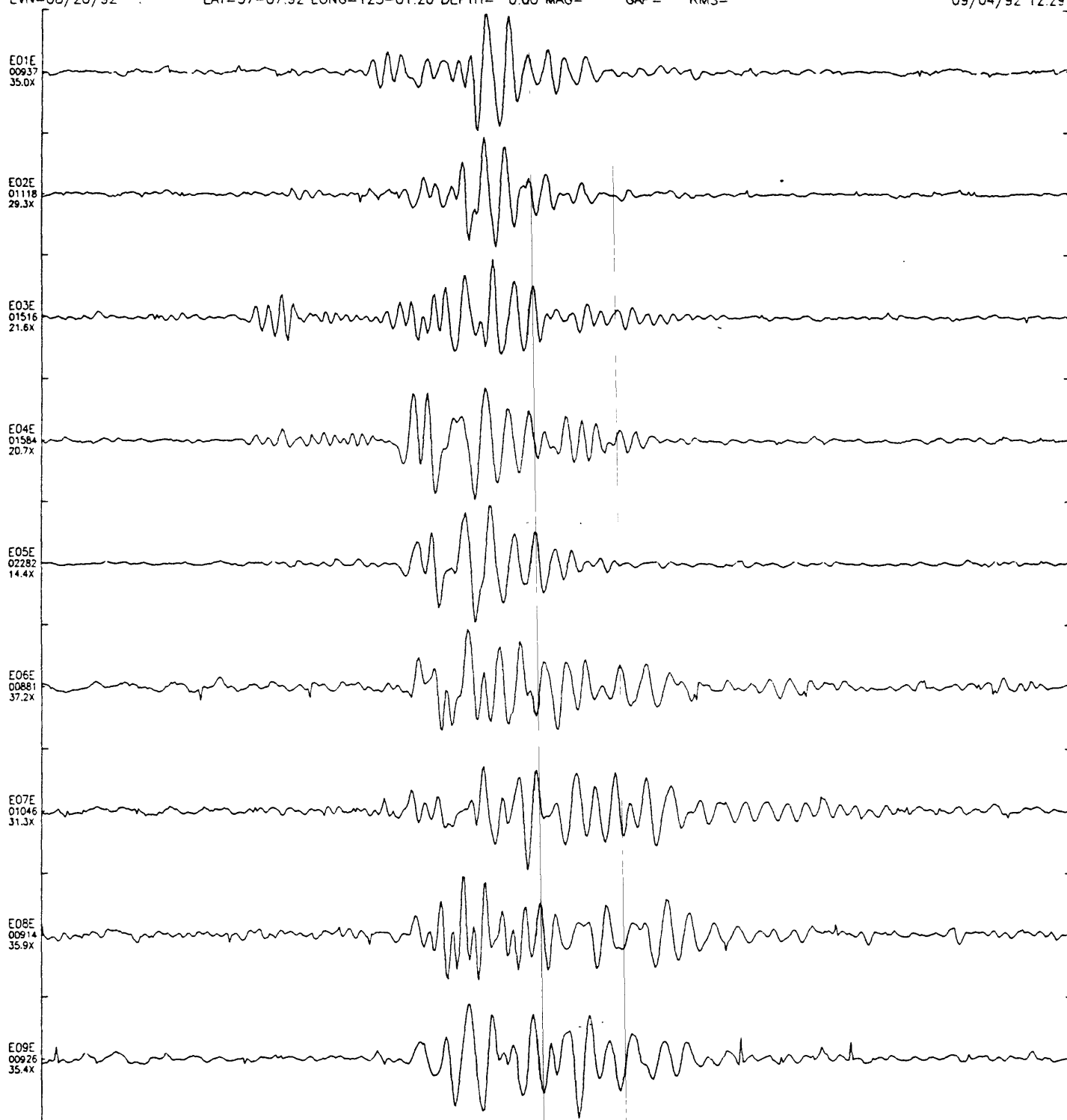
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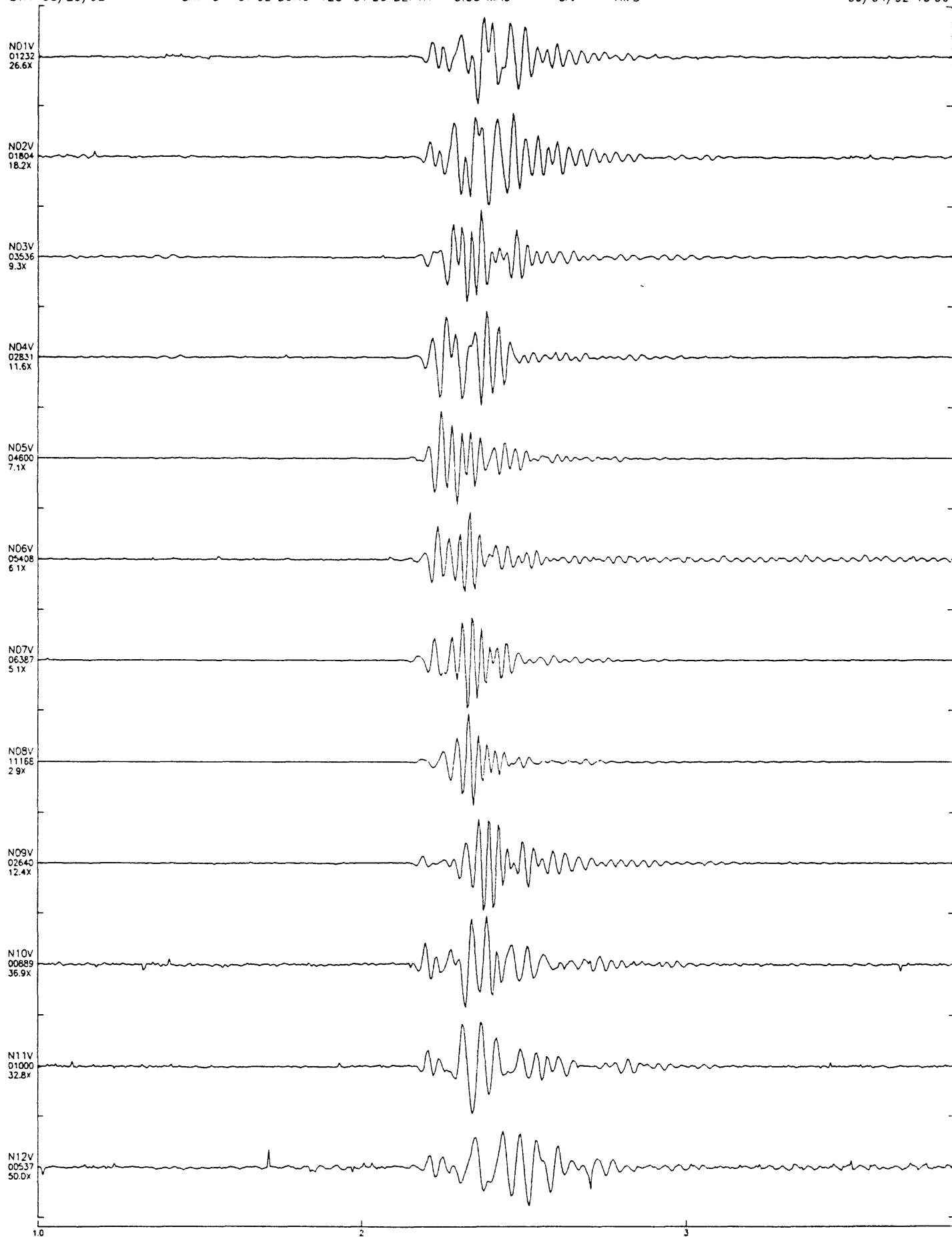
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Sheet 1
09/04/92 12.29



IST=08/20/92 23:57 01.898 SPS=200.321 DEC=1 D:\9208202C.CT1
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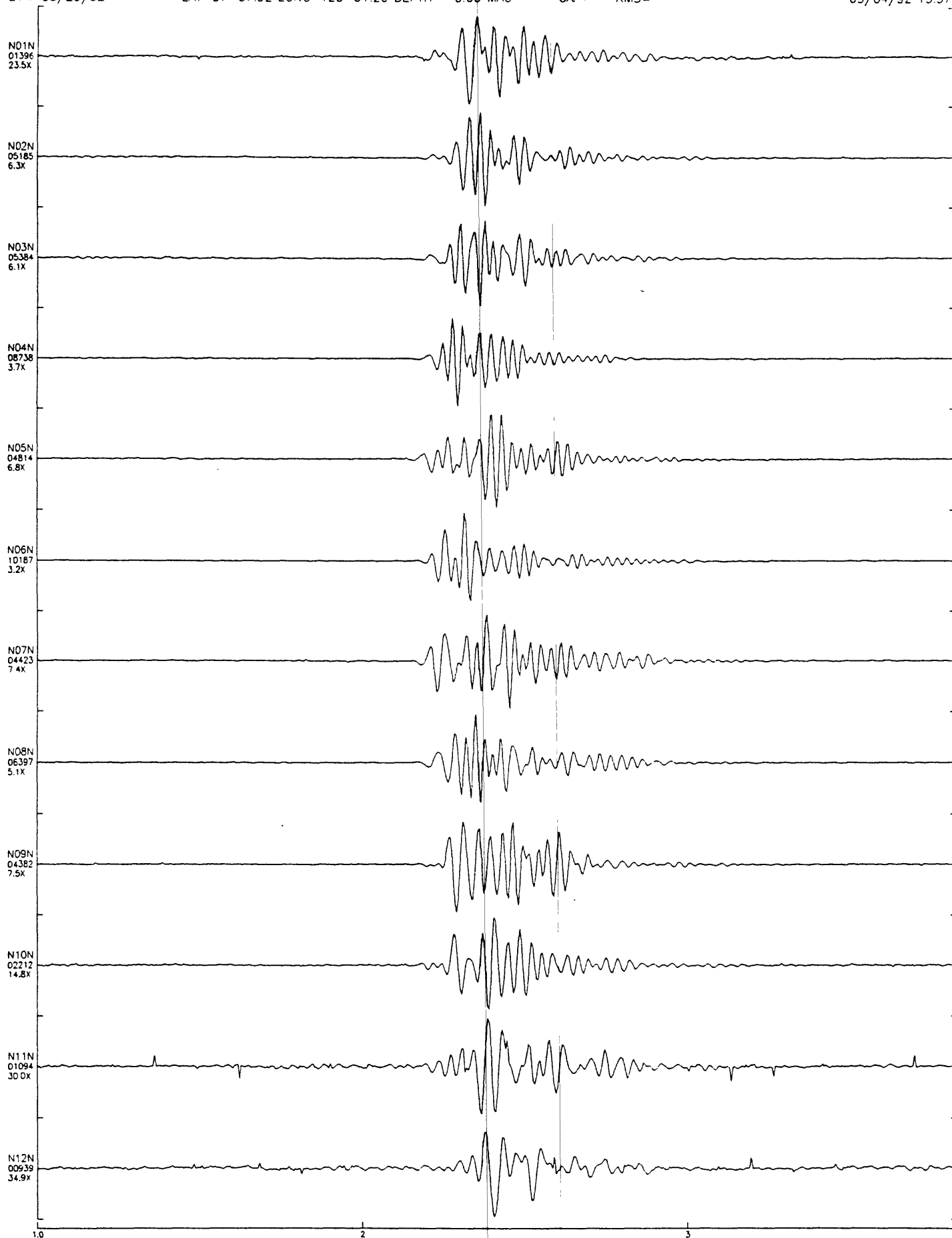
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09/04/92 15 56



120

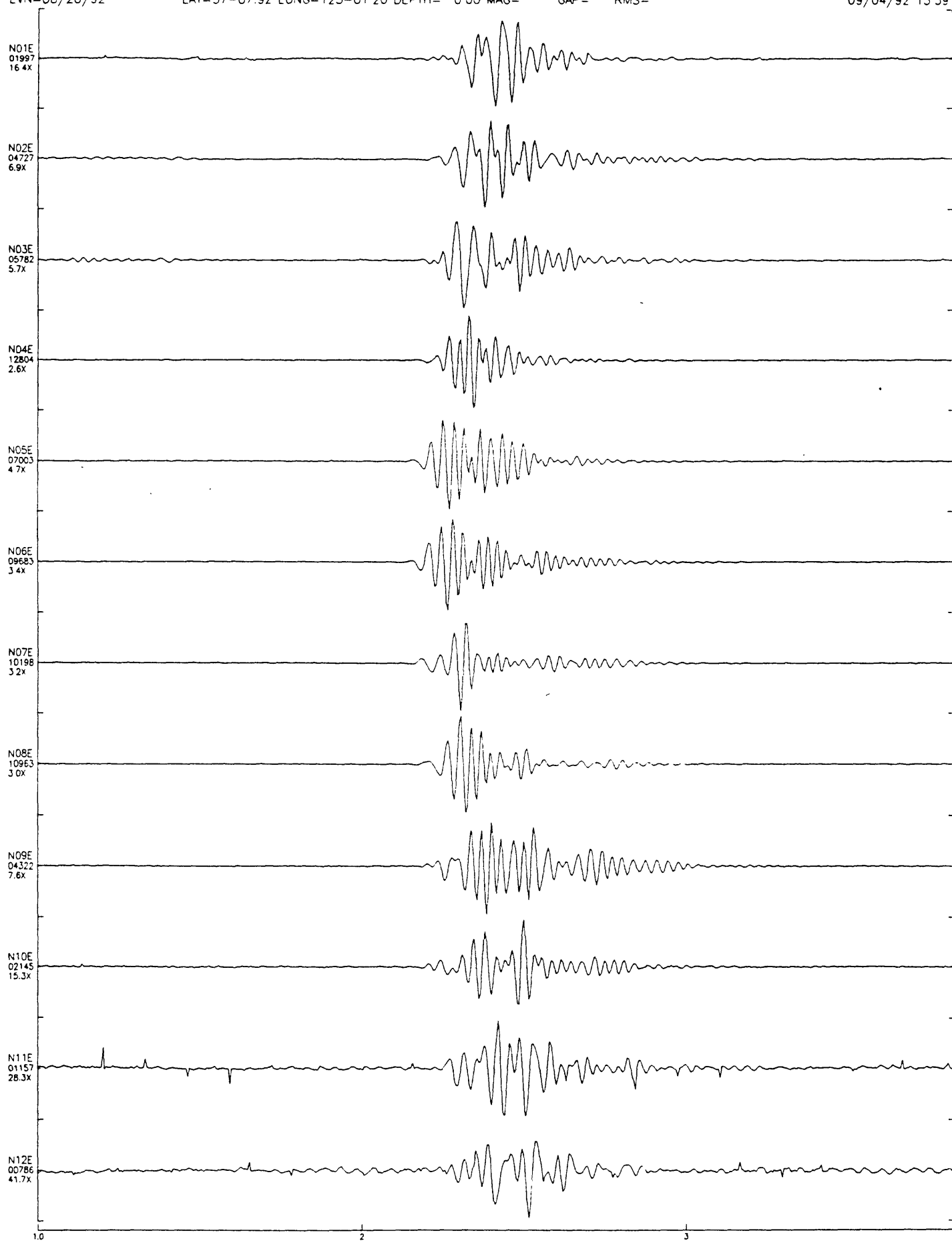
IST=08/20/92 23:57 01.898 SPS=200.321 DEC=1 D:\9208202C.CT1
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Sheet 1
09/04/92 15:57



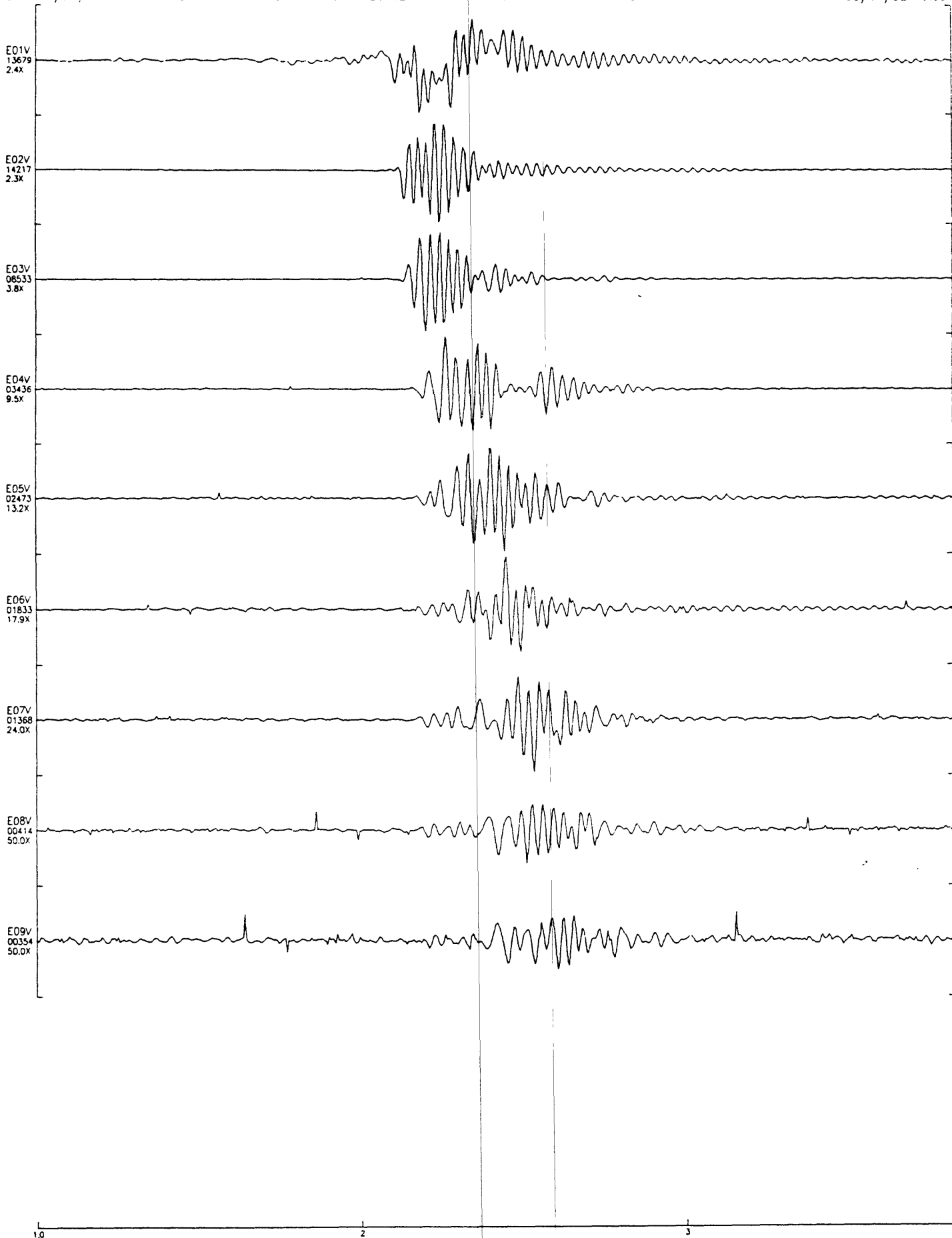
IST=08/20/92 23:57 01.898 SPS=200.321 DEC=1 D \ 9208202C.CT1
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Sheet 1
09/04/92 15:59



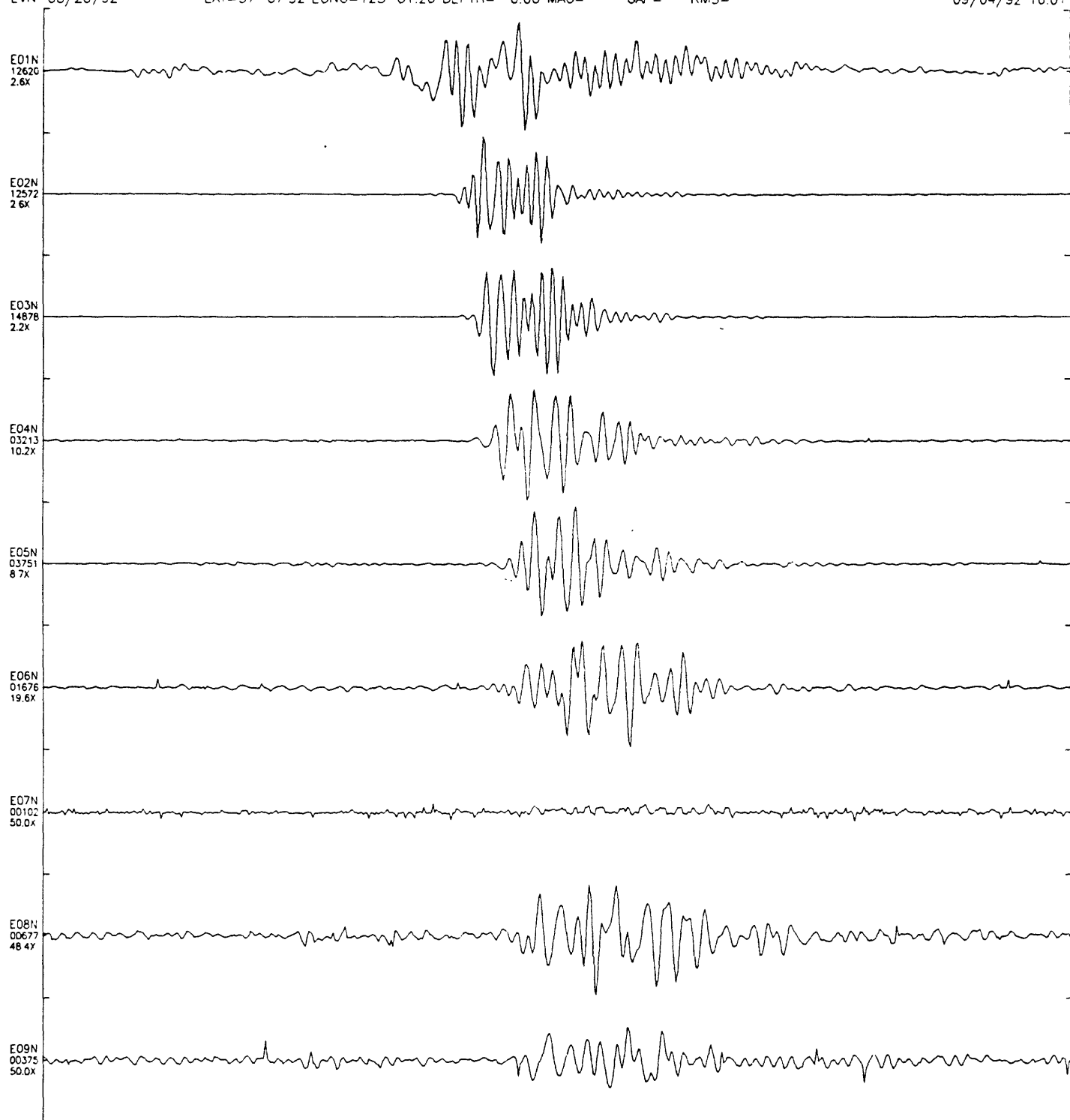
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Sheet 1
09/04/92 16:00



IST=08/20/92 23:57 01.898 SPS=200.321 DEC=1 D.\9208202C.CT1
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Sheet 1
09/04/92 16:01



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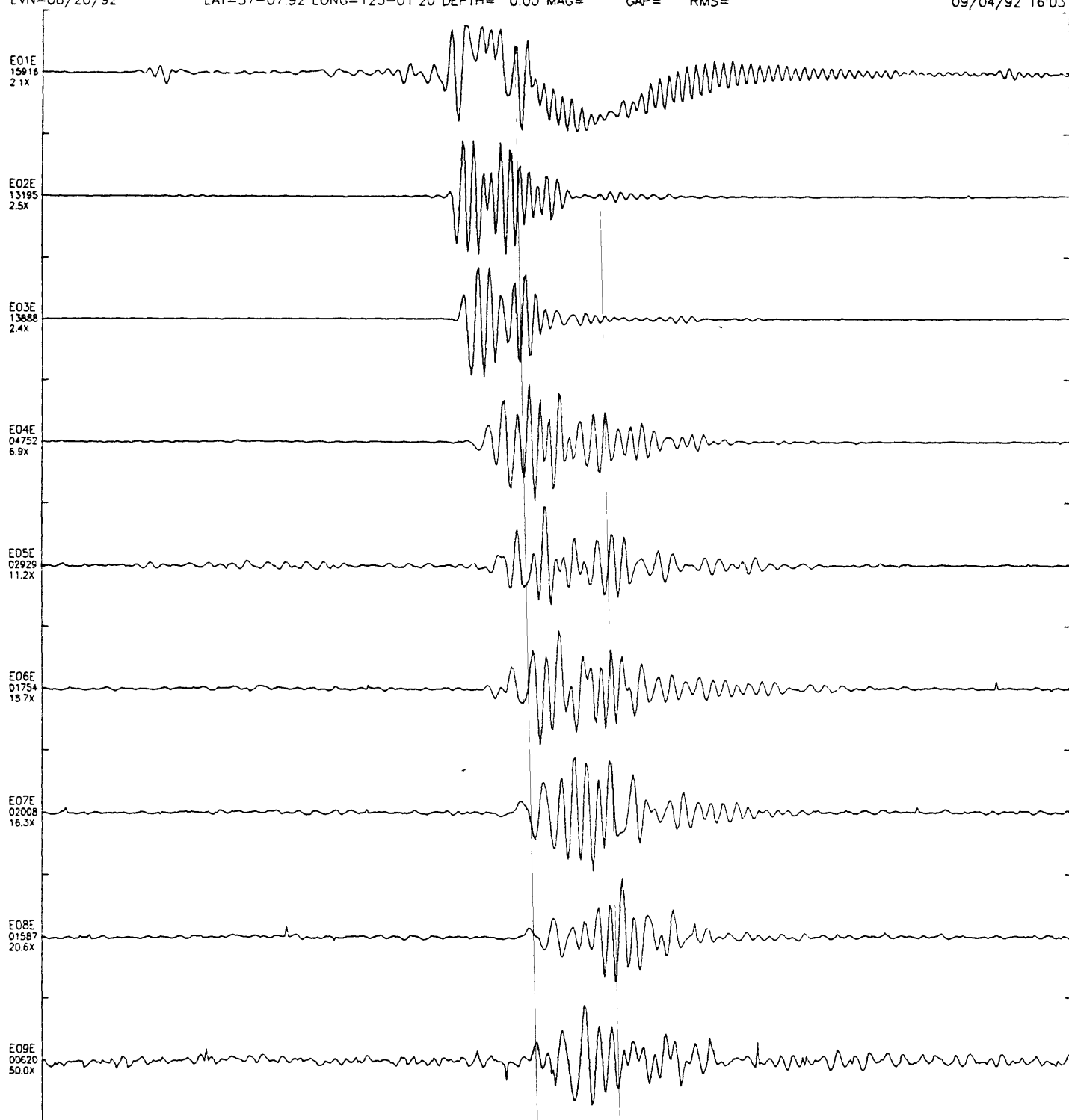
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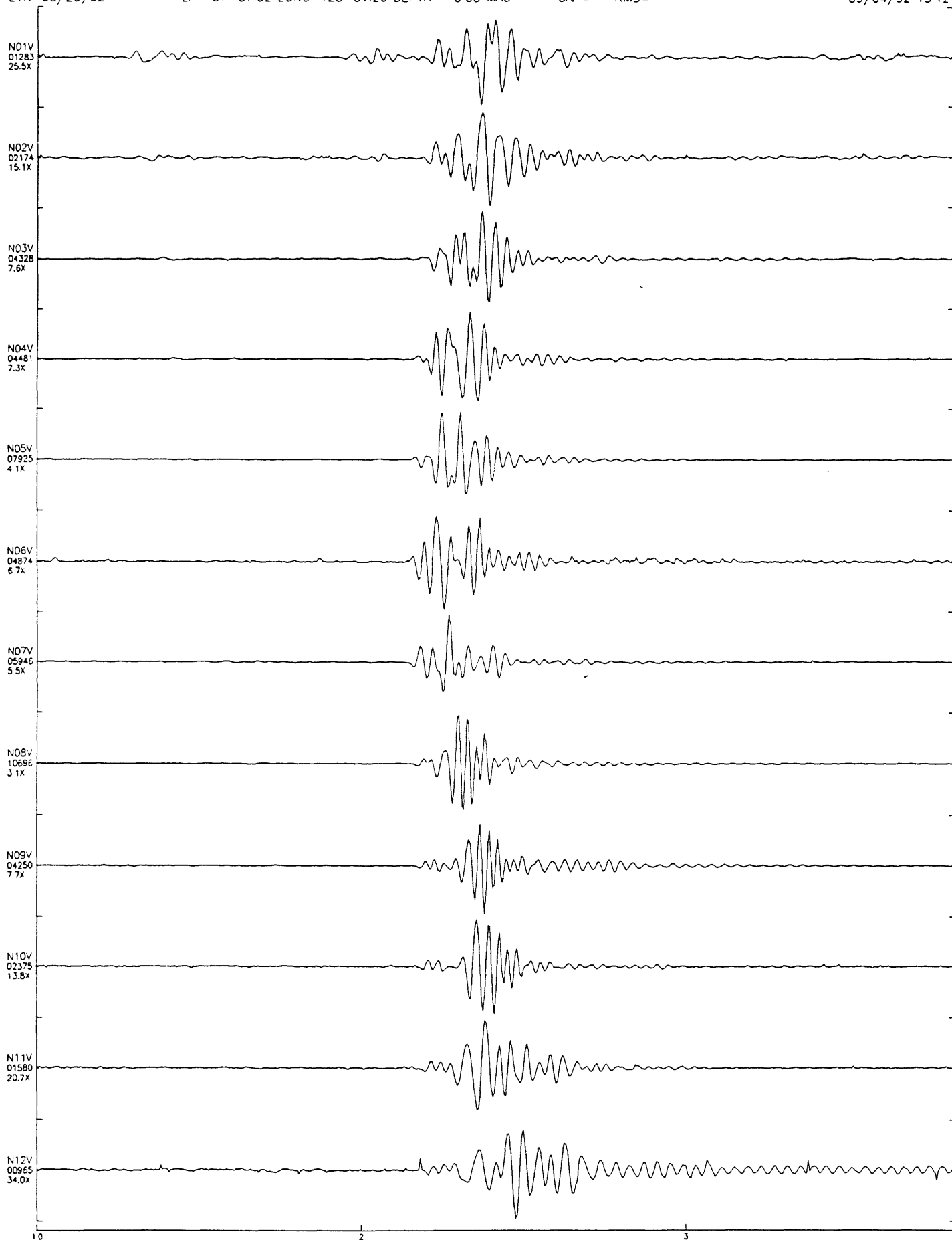
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EVN=08/20/92 LAT=37-07.92 LONG=123-01 20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/04/92 16:03



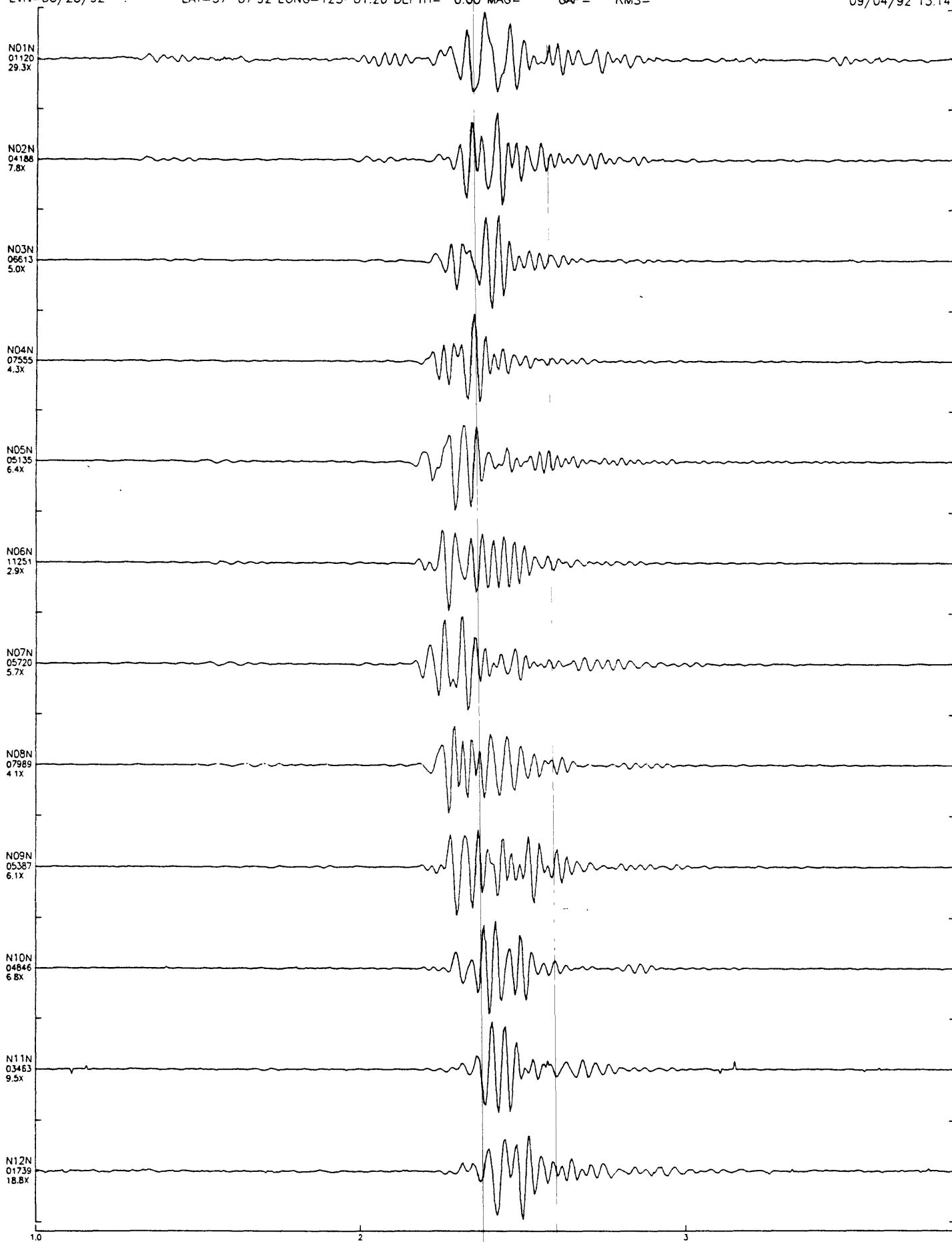
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Sheet 1
09/04/92 13 12



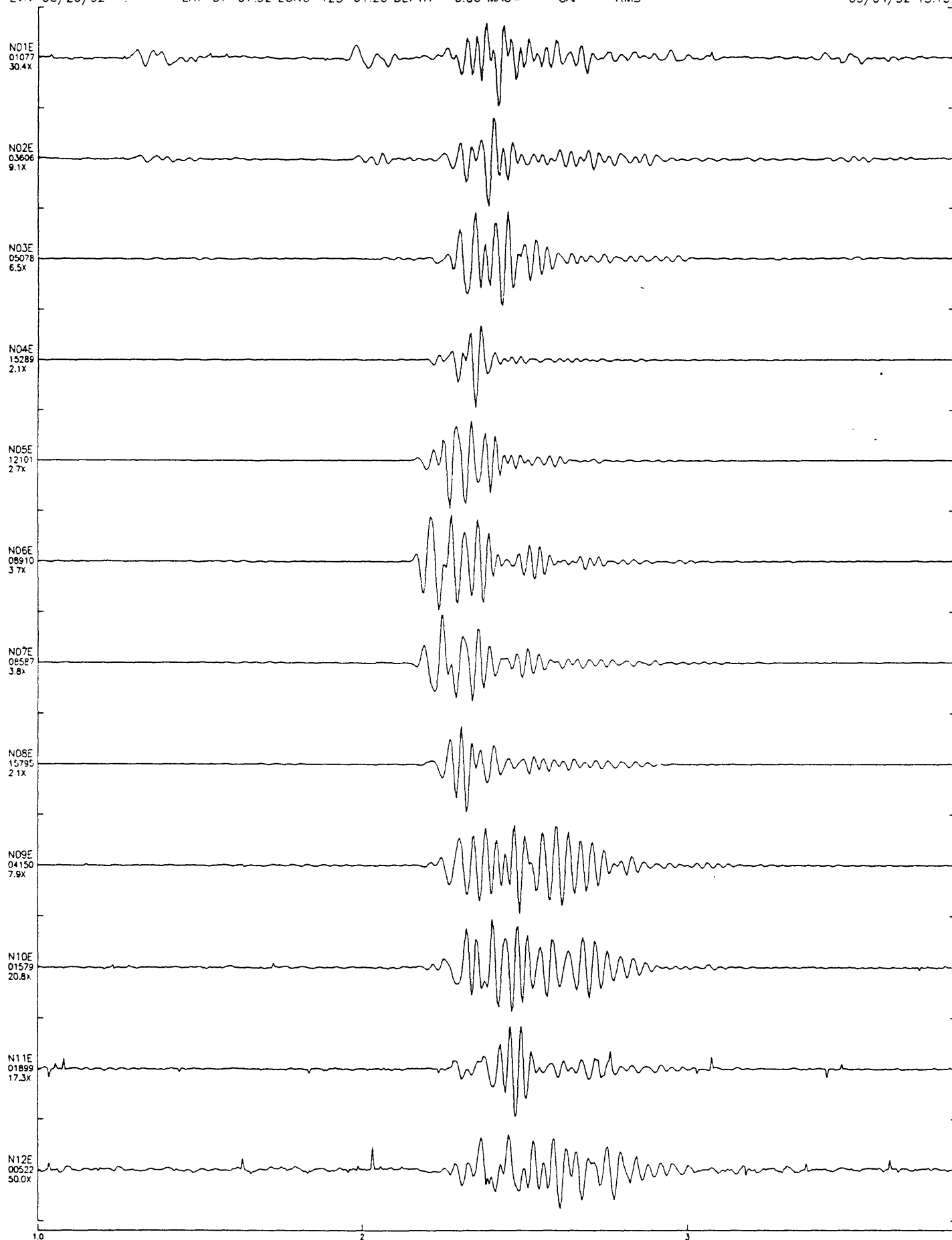
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Sheet 1
09/04/92 13.14



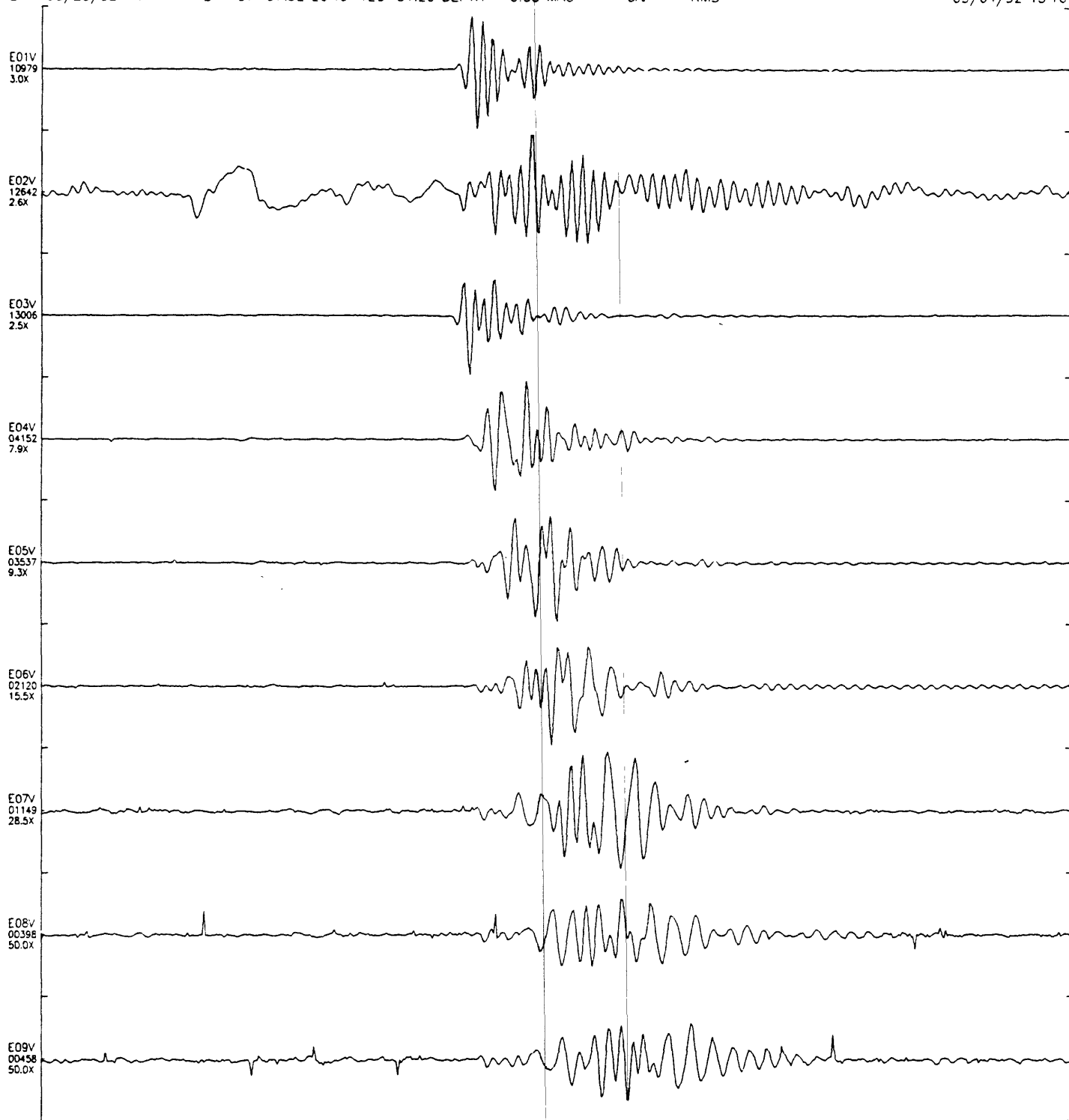
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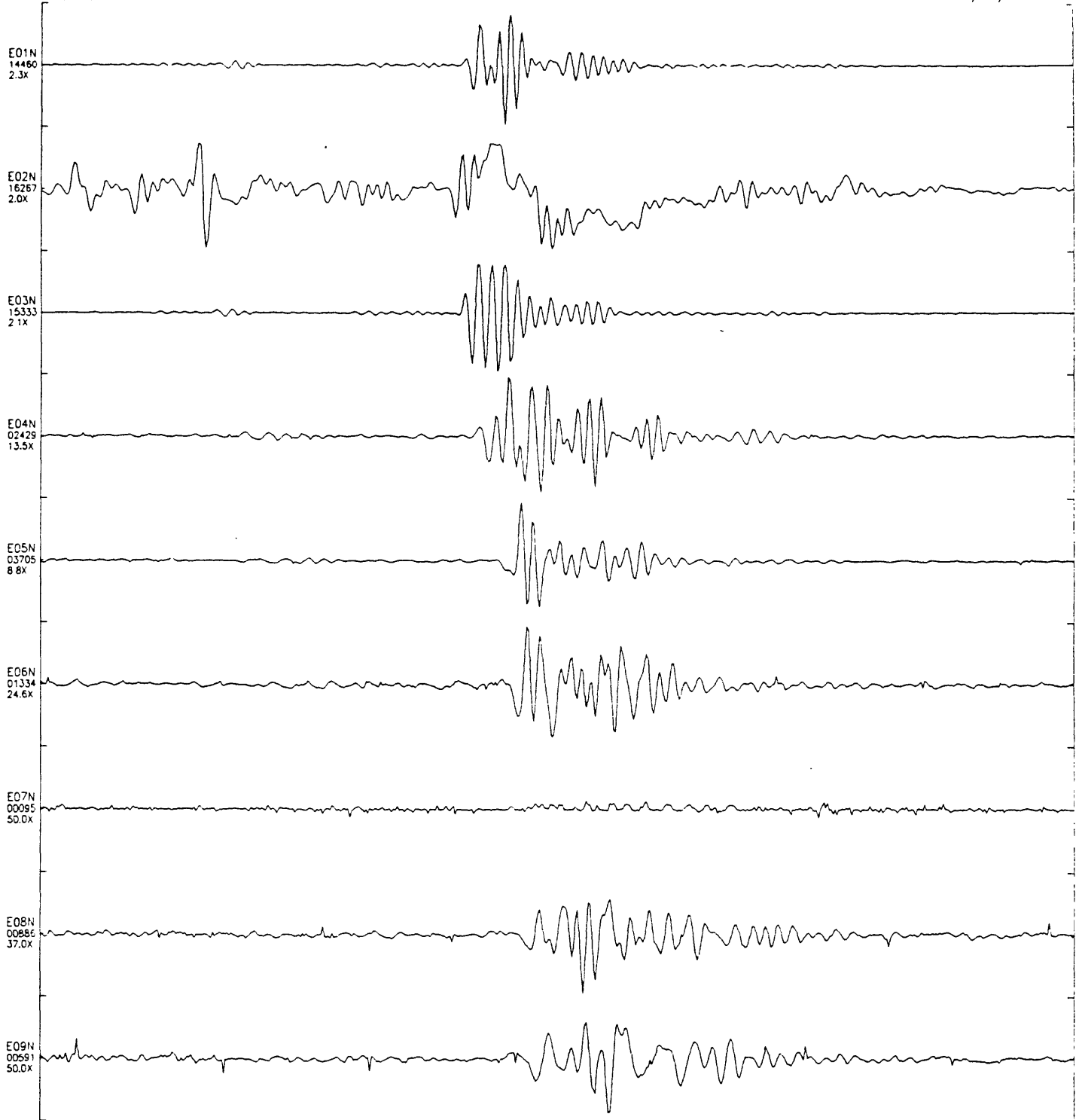
Sheet 1
09/04/92 13:15



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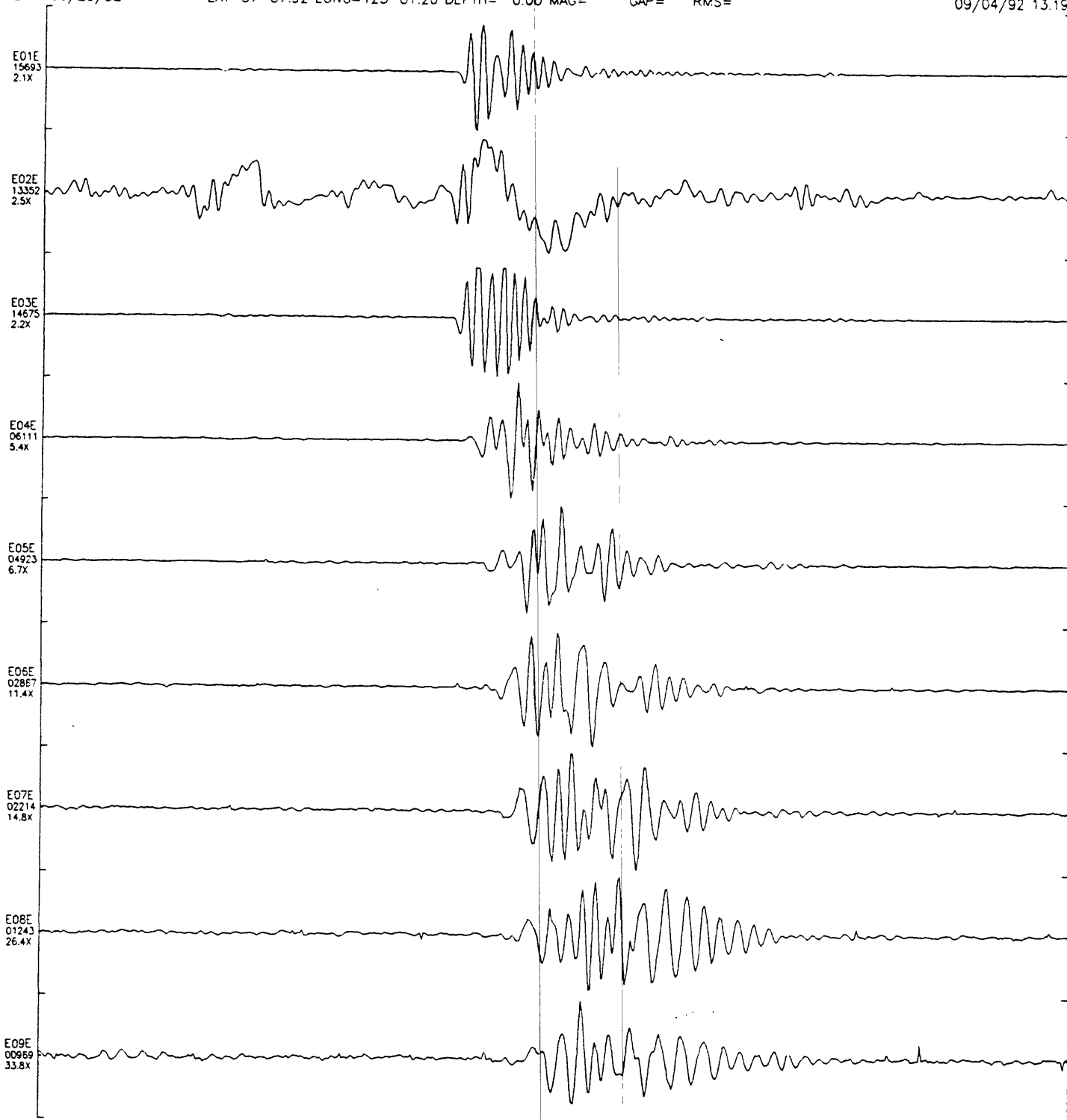
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09/04/92 13 16





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Sheet 1
09/04/92 13.19

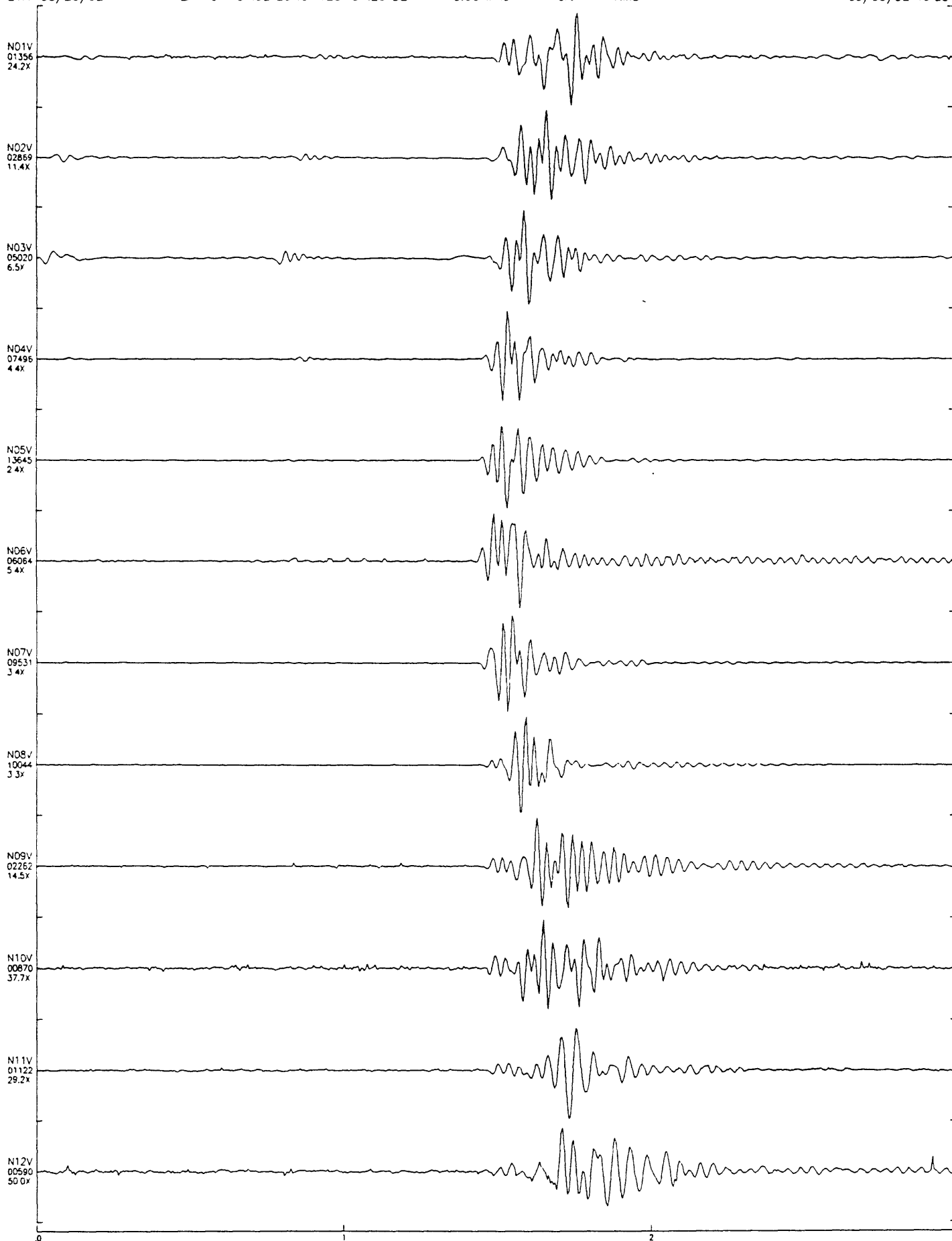


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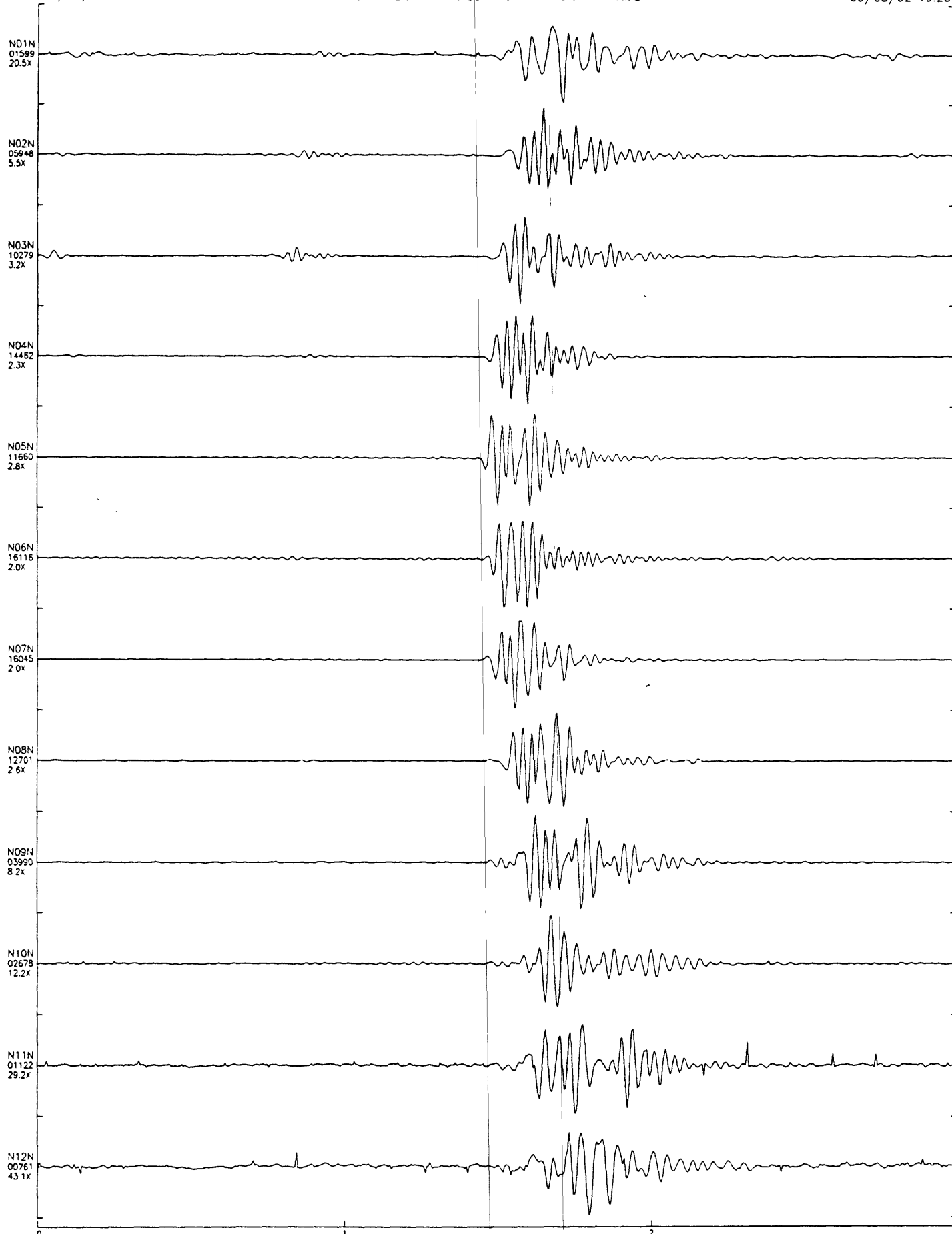
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09/03/92 19 22



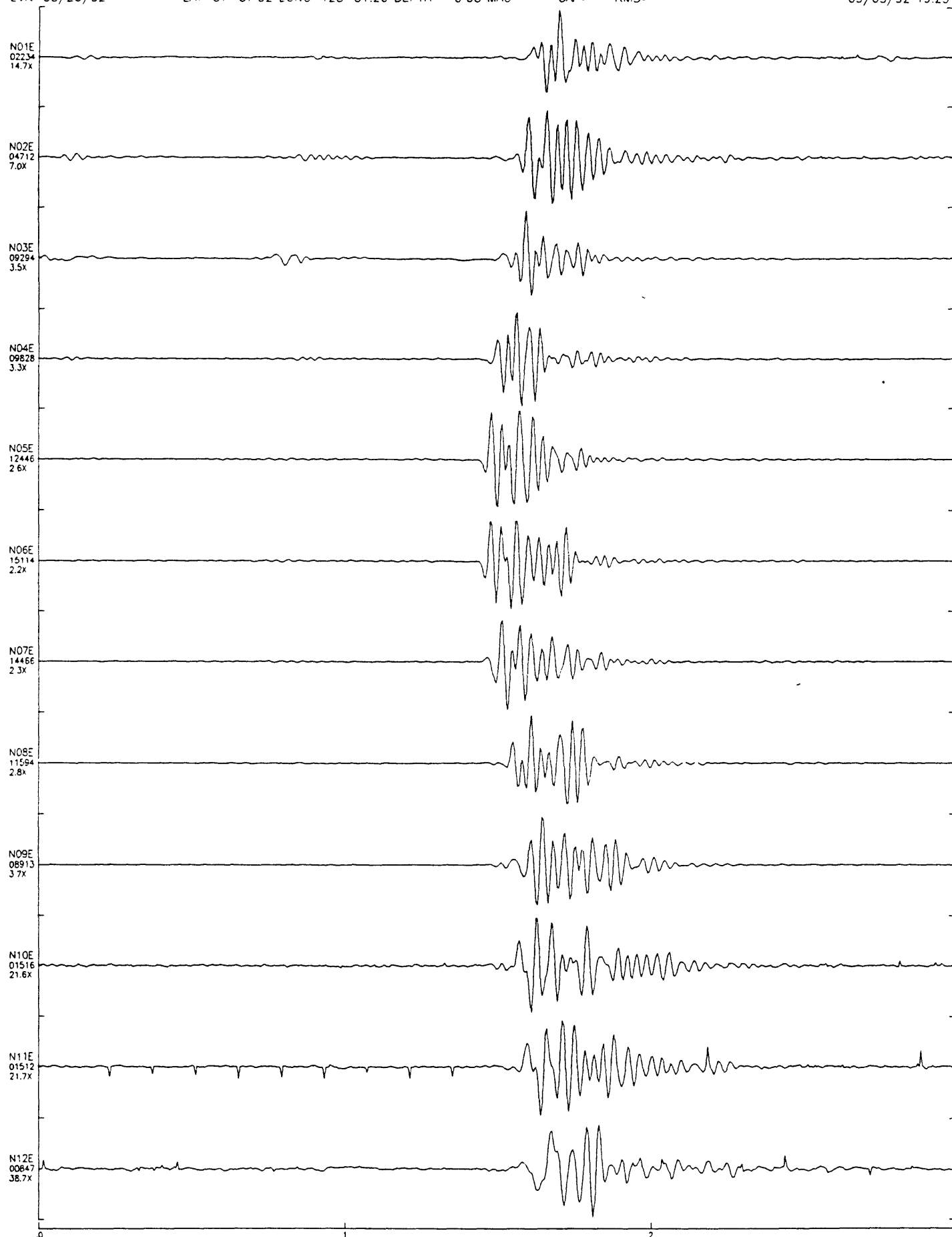
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09/03/92 19.23



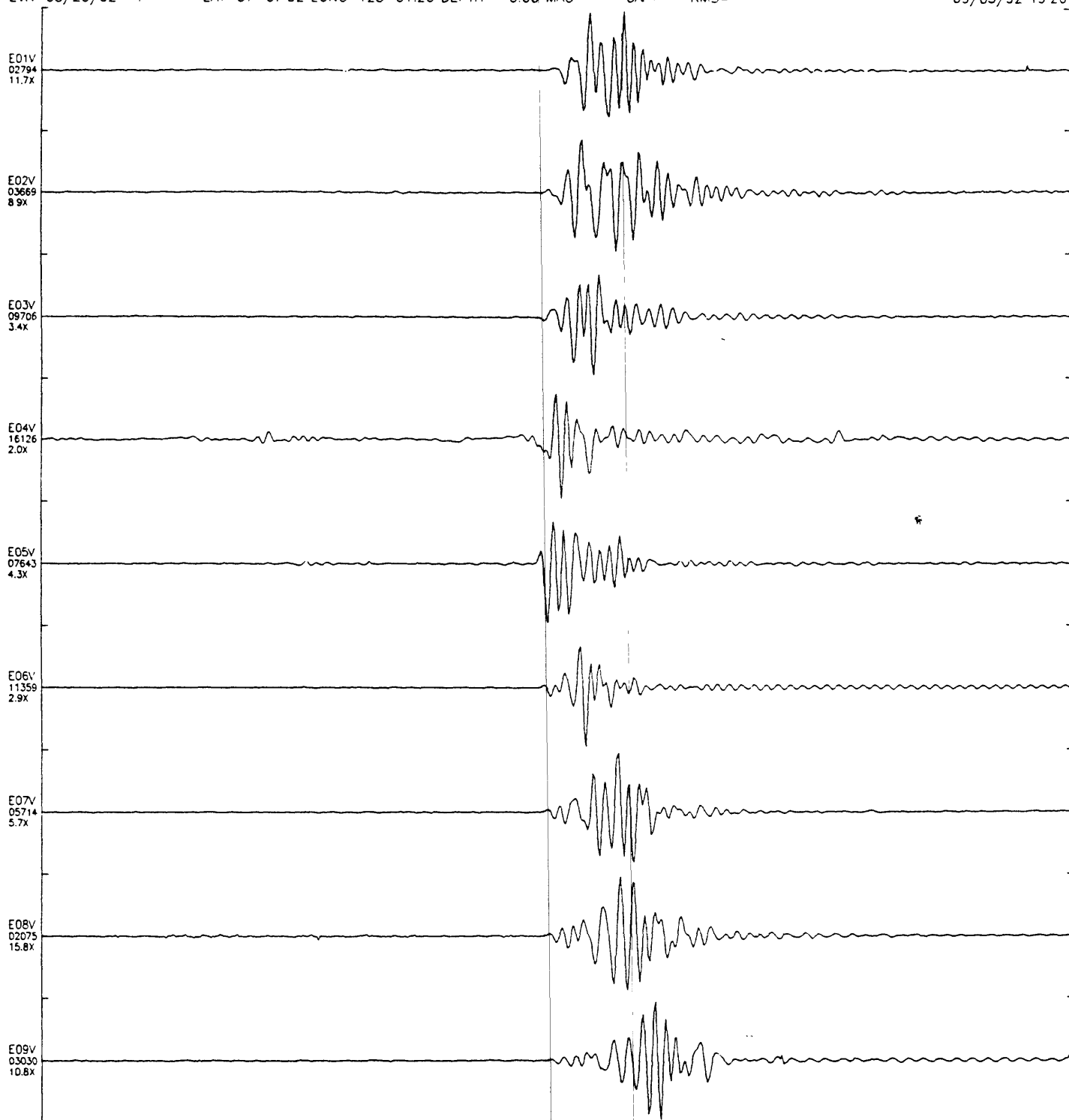
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09/03/92 19.25



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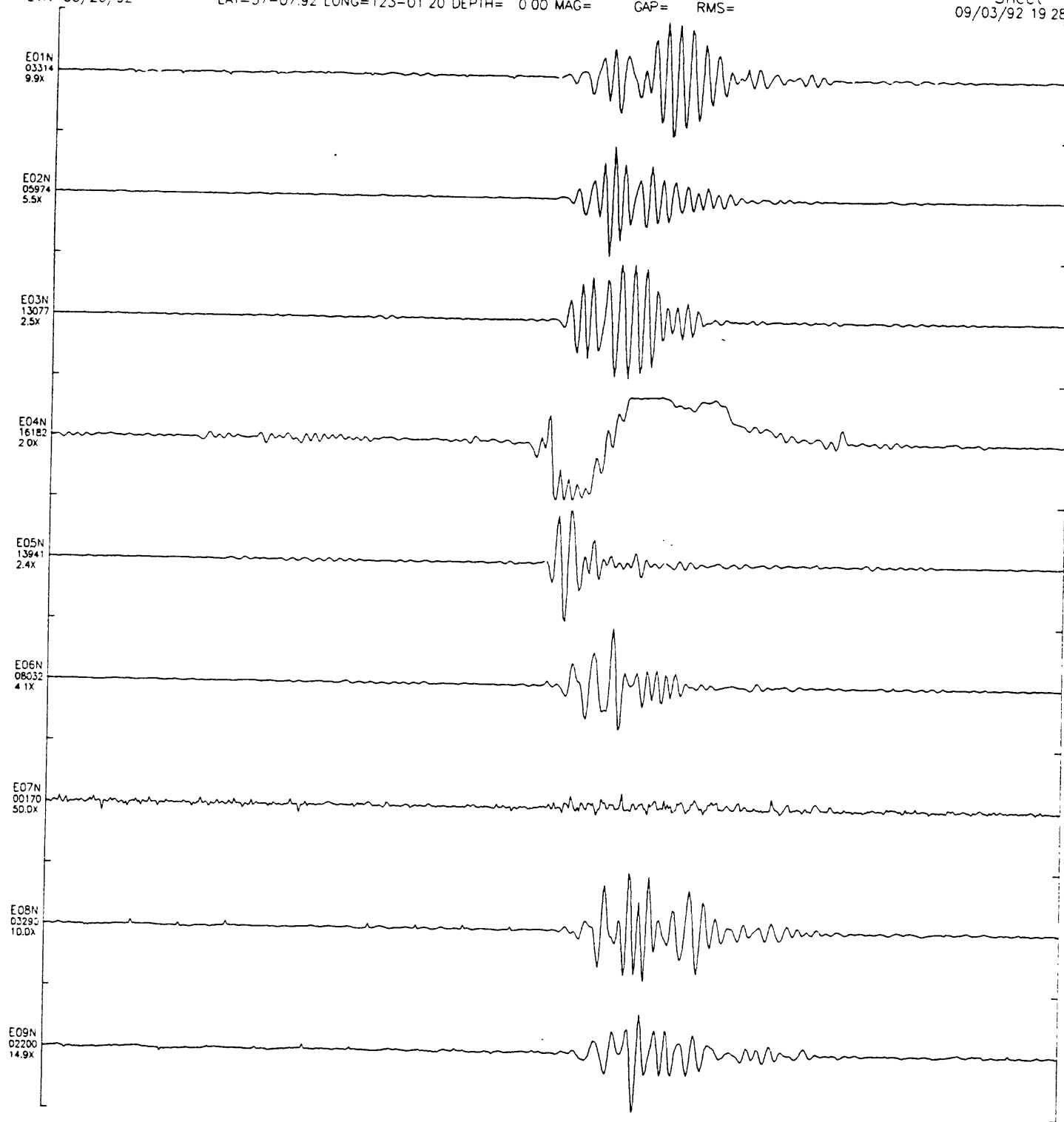
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09/03/92 19 26



0 1 2

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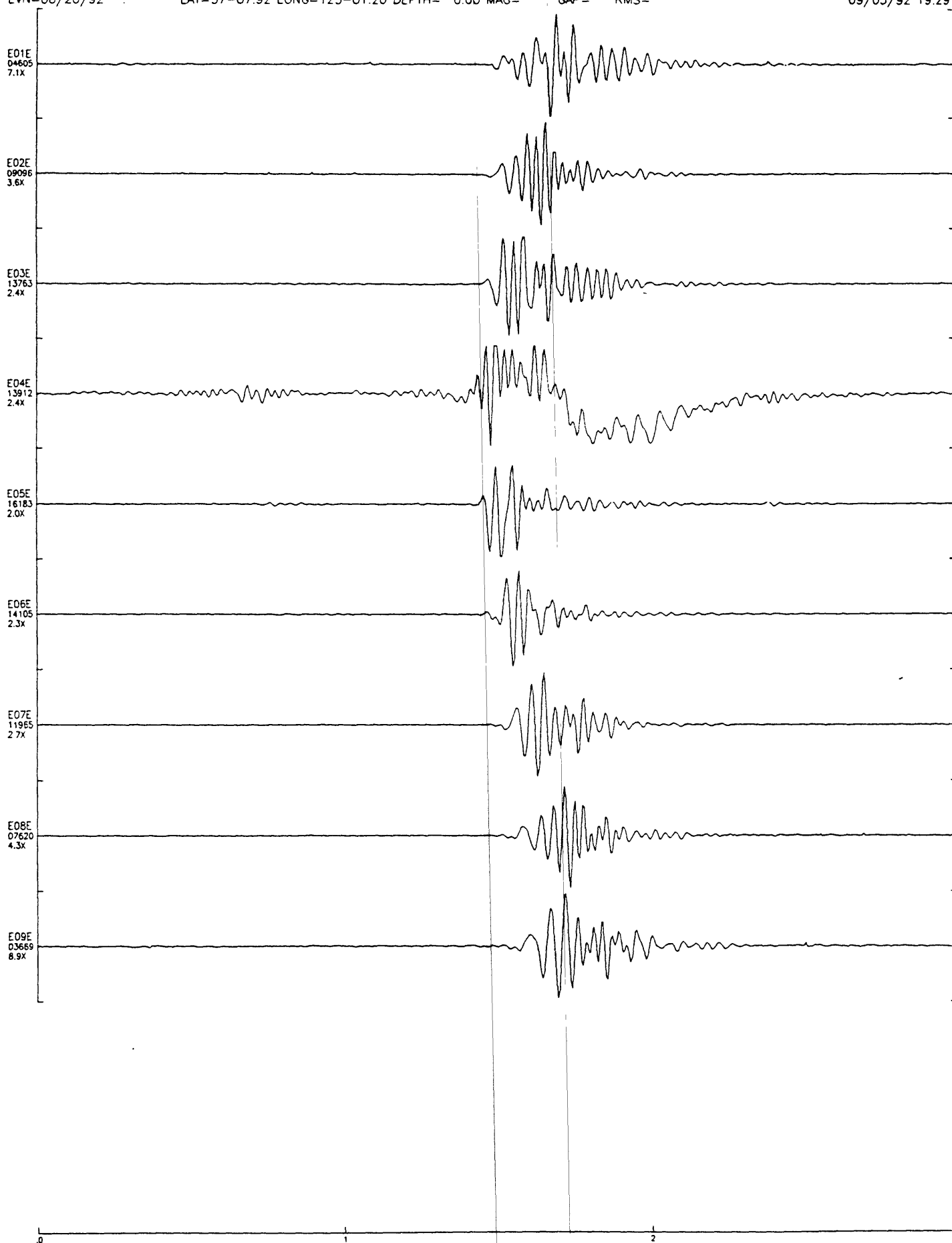
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09/03/92 19 28



0 1 2

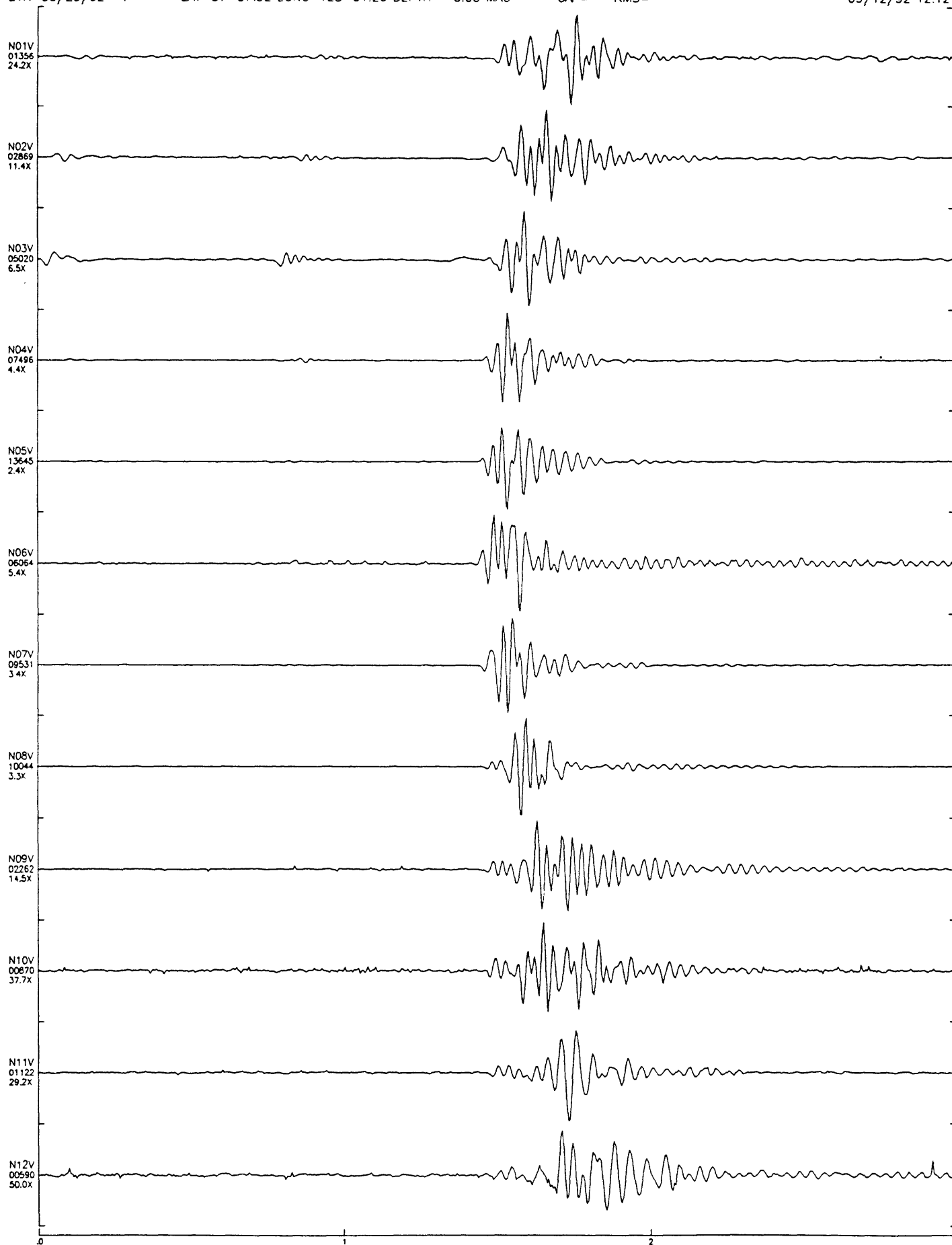
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09/03/92 19.29



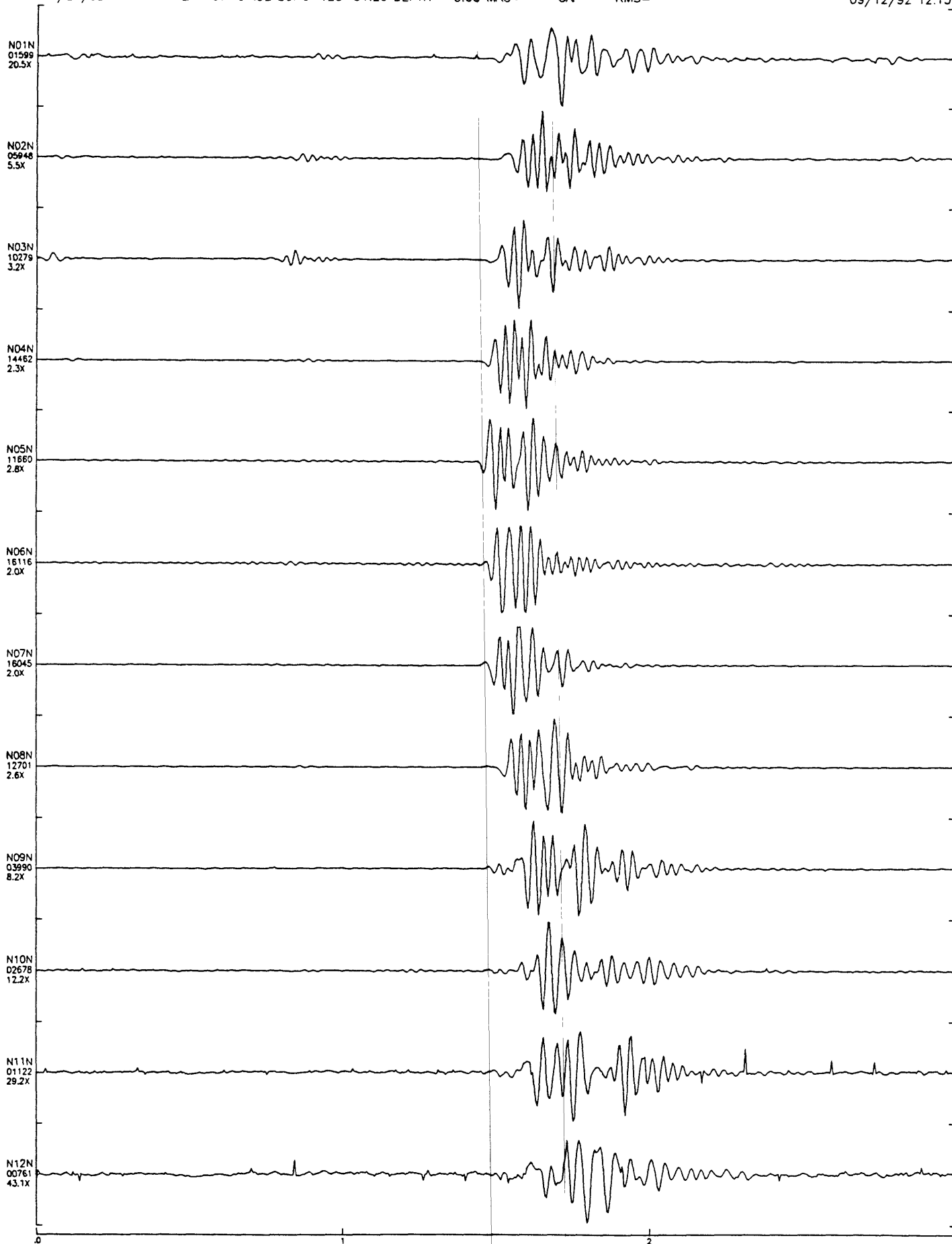
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Sheet 1
09/12/92 12.12



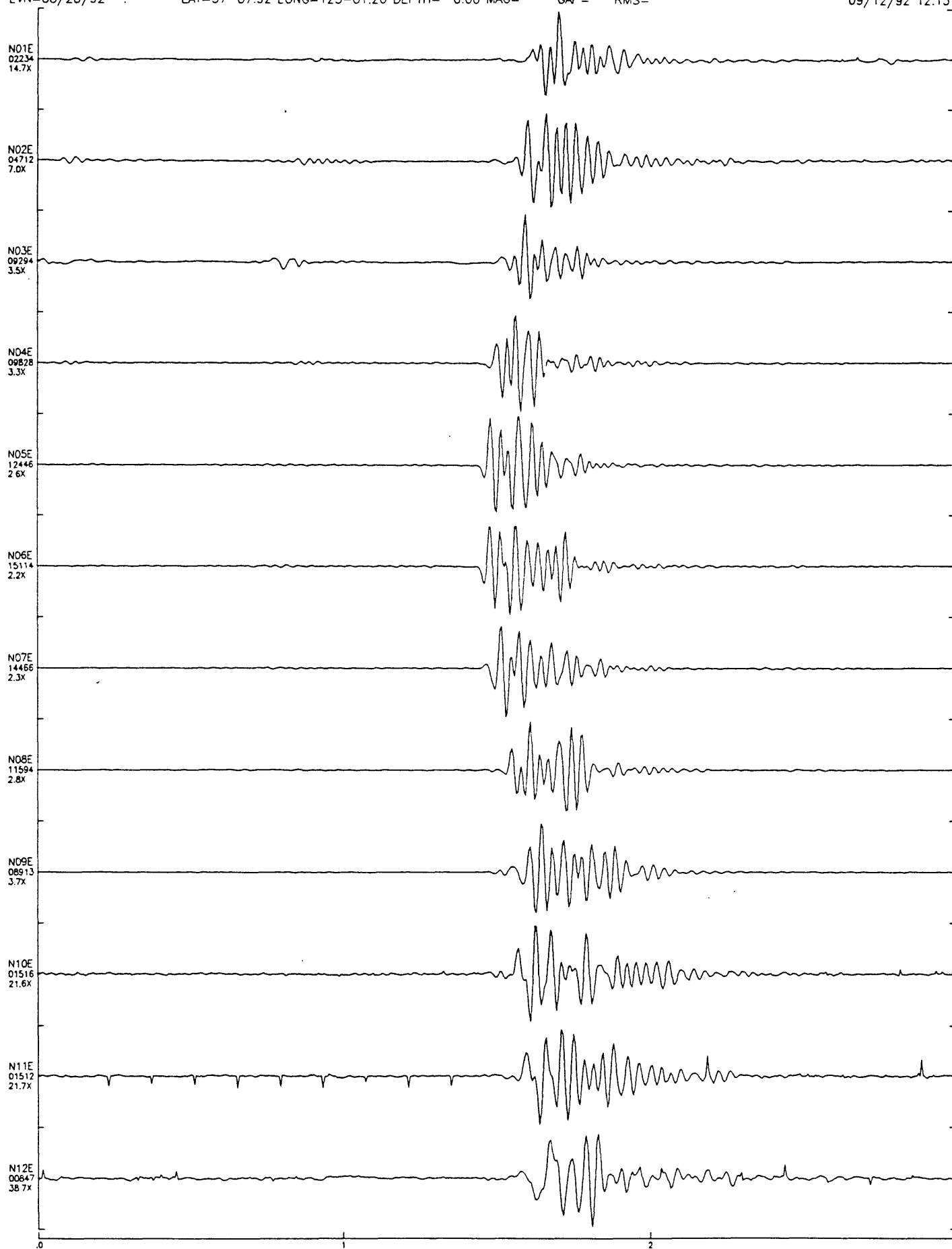
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09/12/92 12:13



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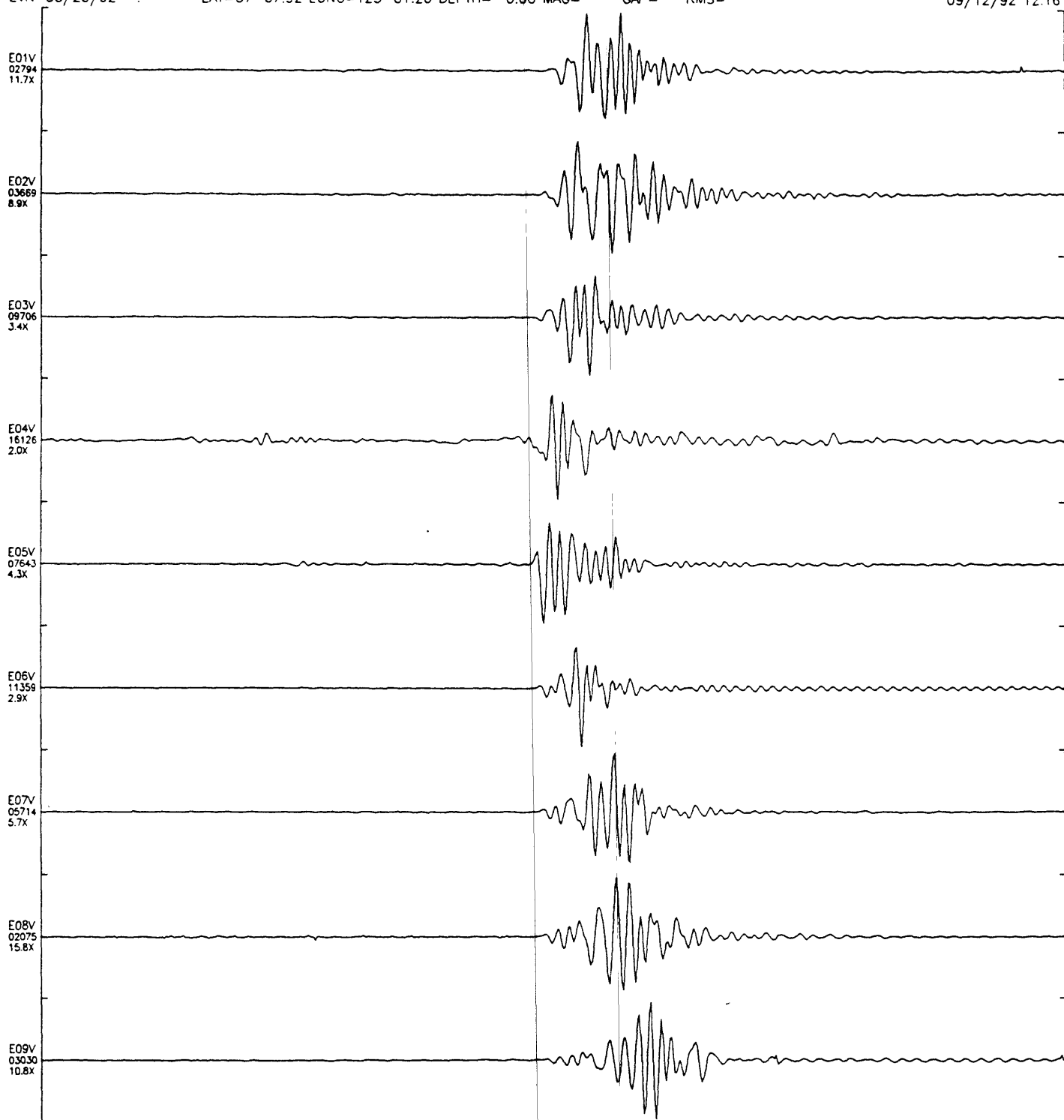
Sheet 1
09/12/92 12:15



140

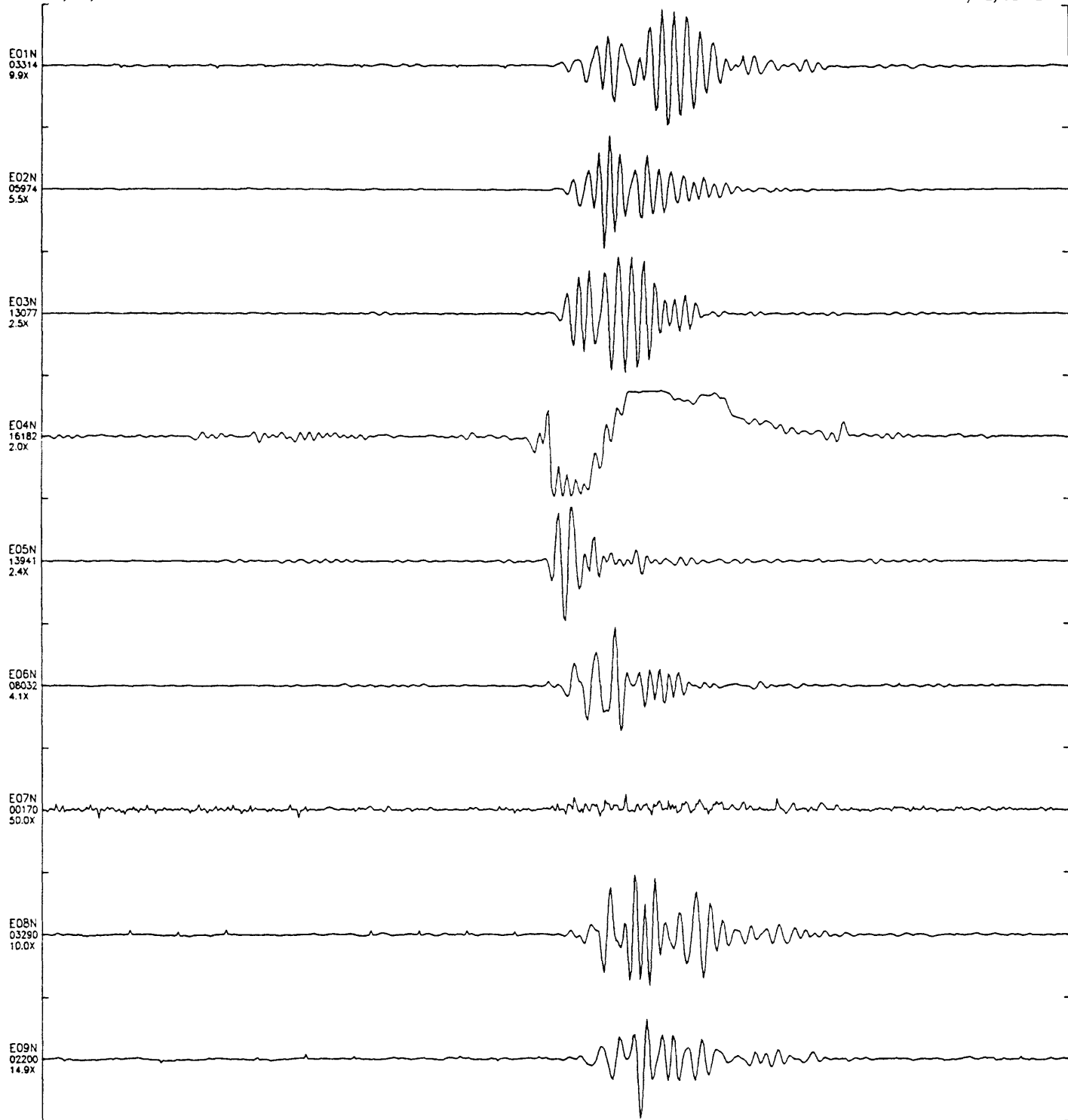
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09/12/92 12.16



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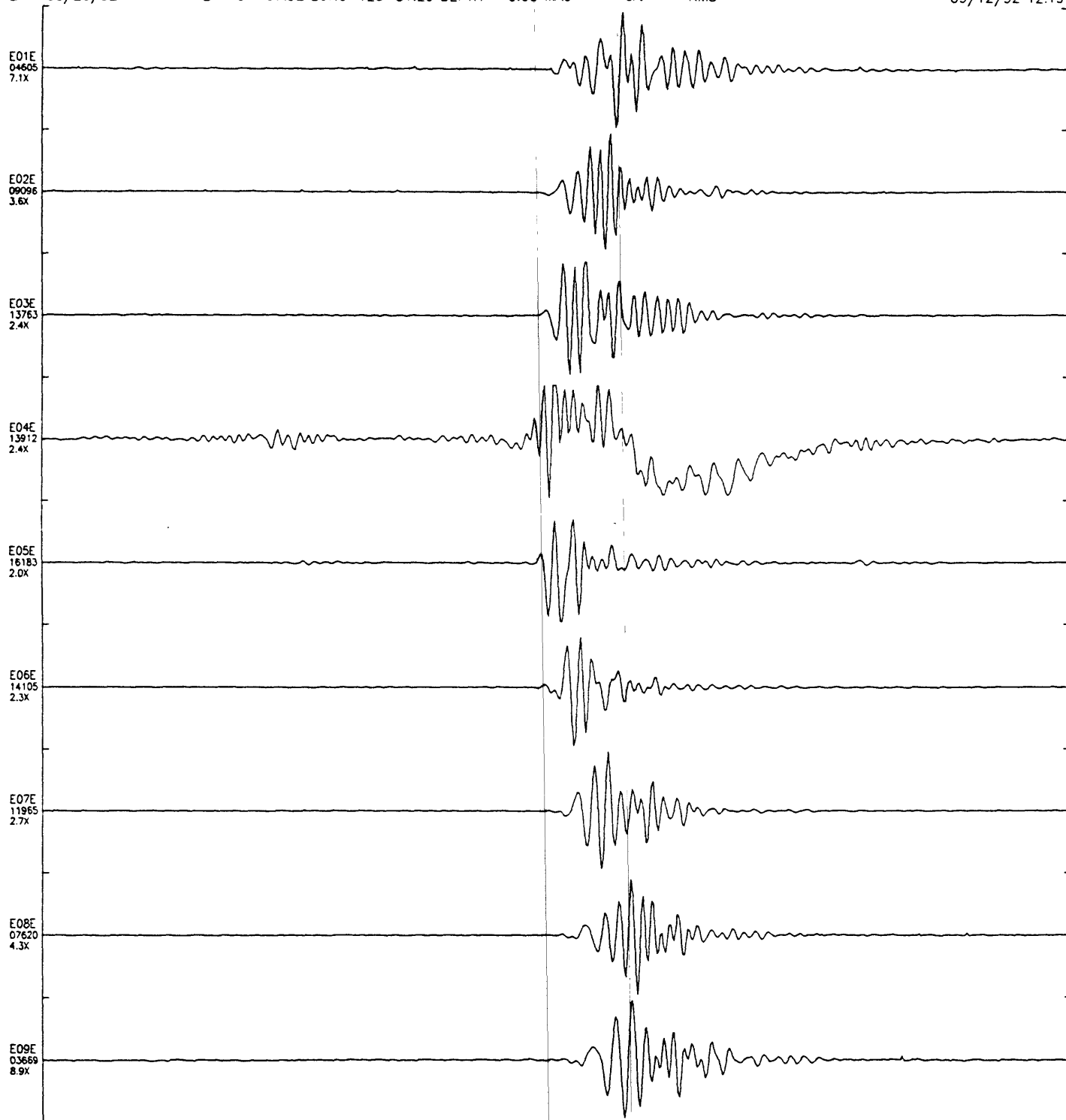
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09/12/92 12:17



0 1 2

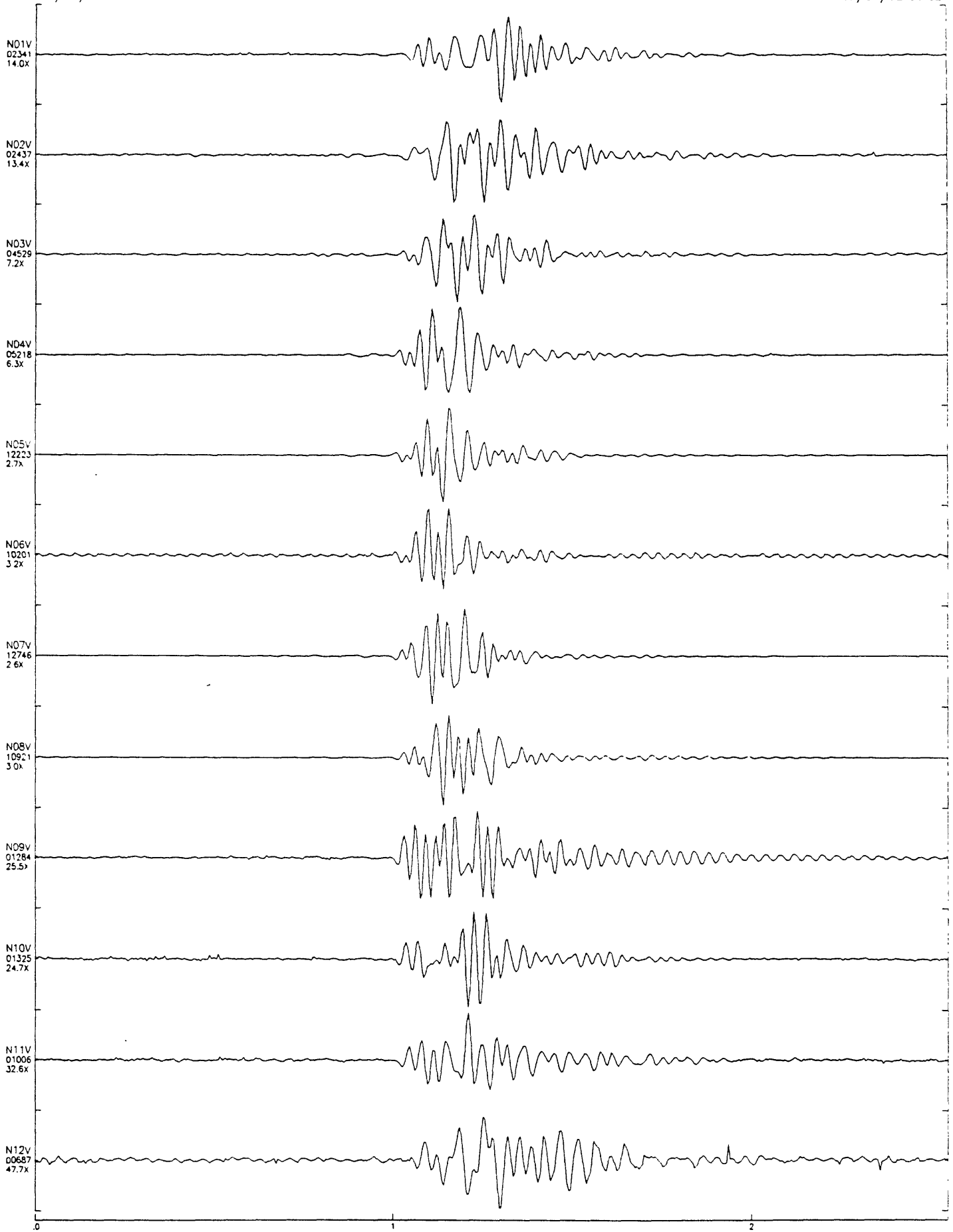
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Sheet 1
09/12/92 12:19



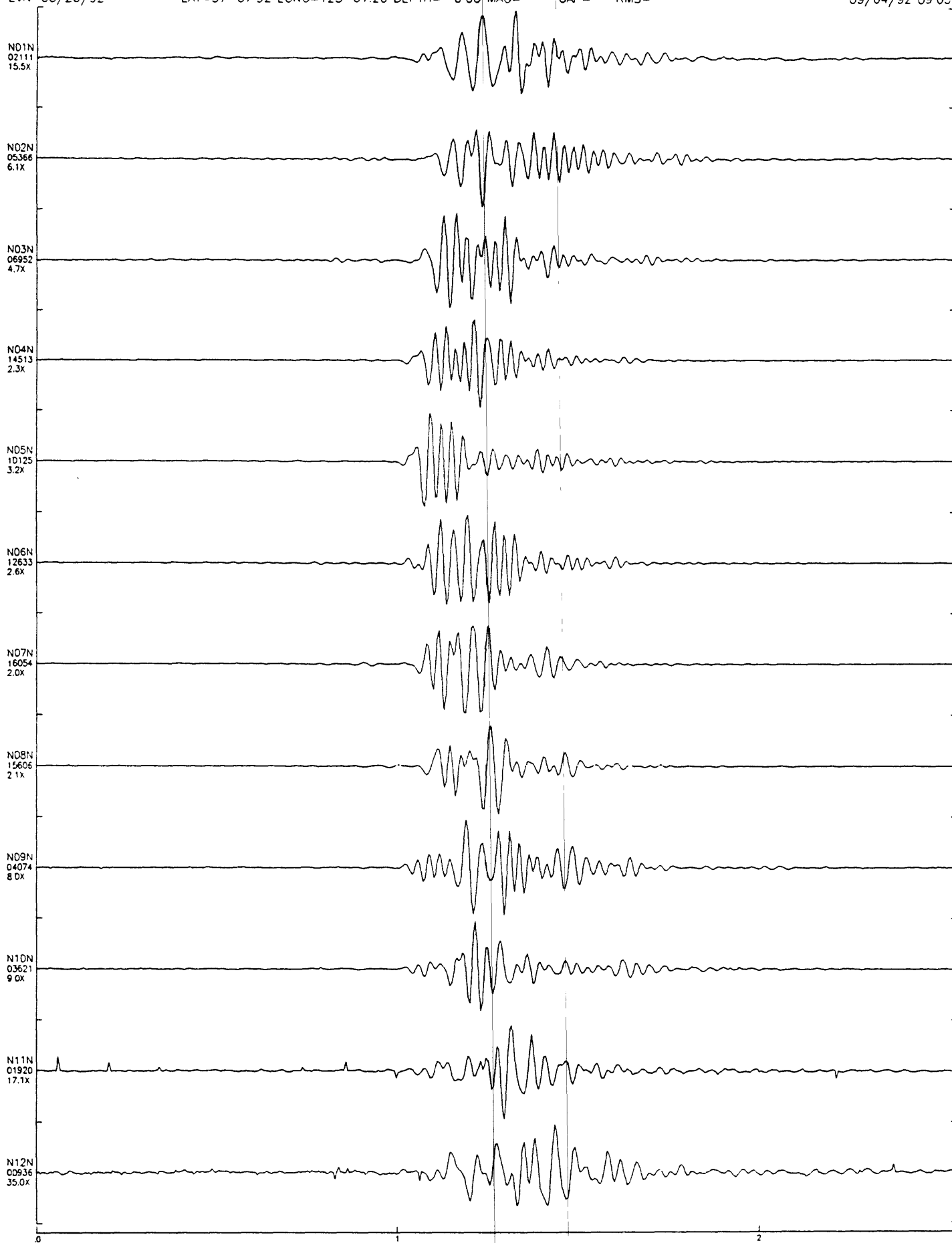
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Sheet 1
09/04/92 09:02



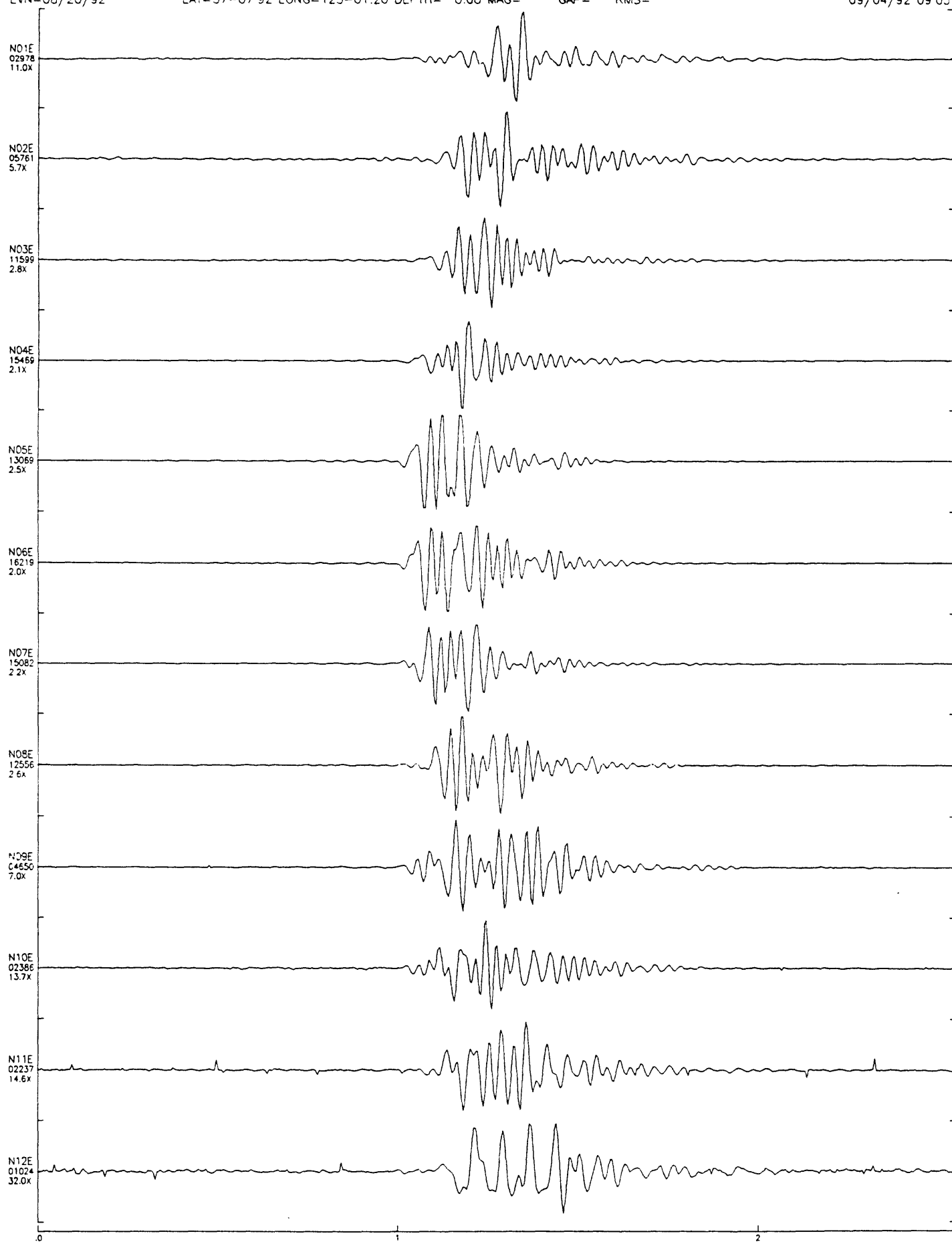
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EVN=08/20/92 LAT=37-07 92 LONG=123-01.20 DEPTH= 0 00 MAG= GAP= RMS=

Sheet 1
09/04/92 09 03



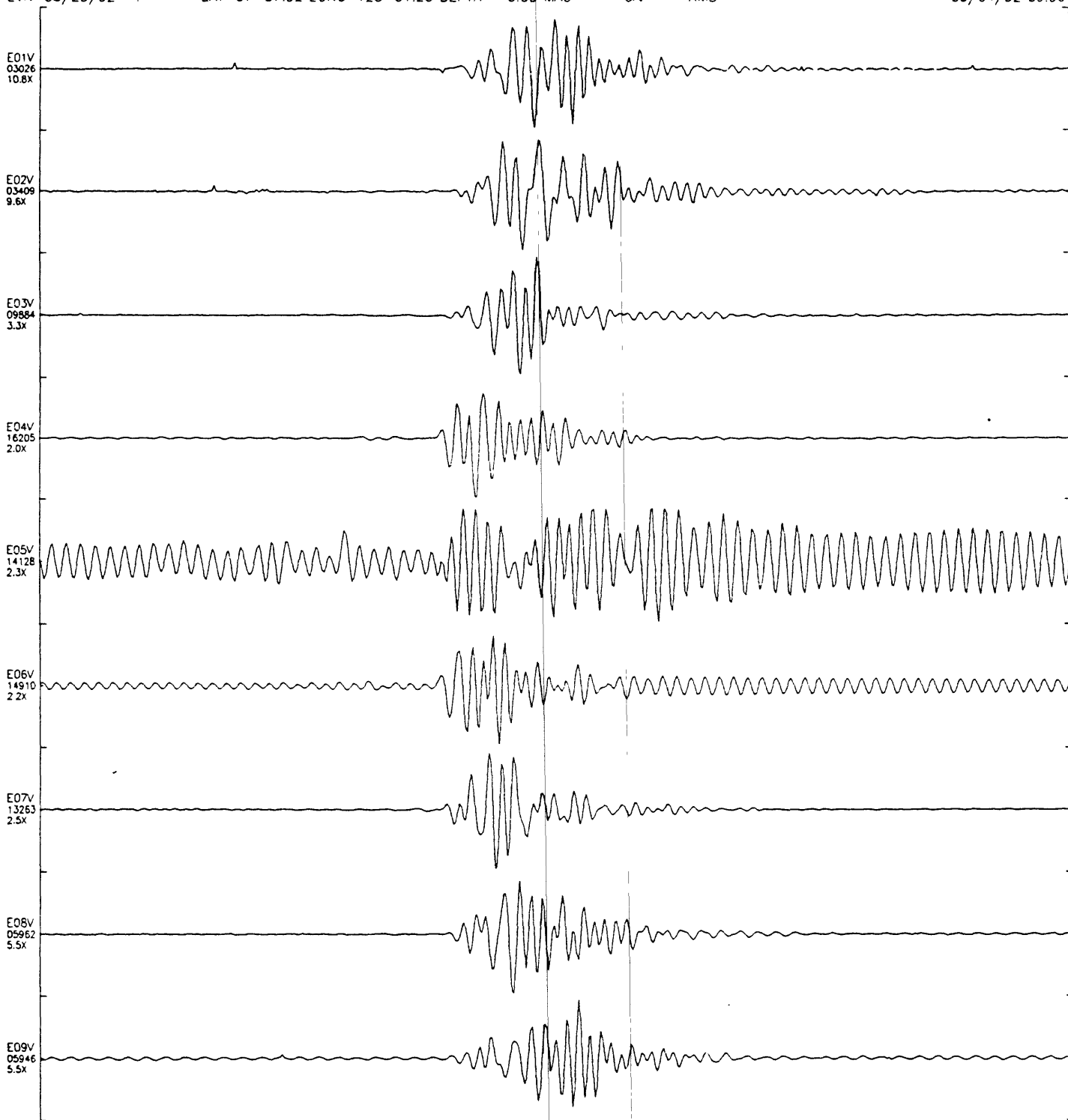
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Sheet 1
09/04/92 09 05



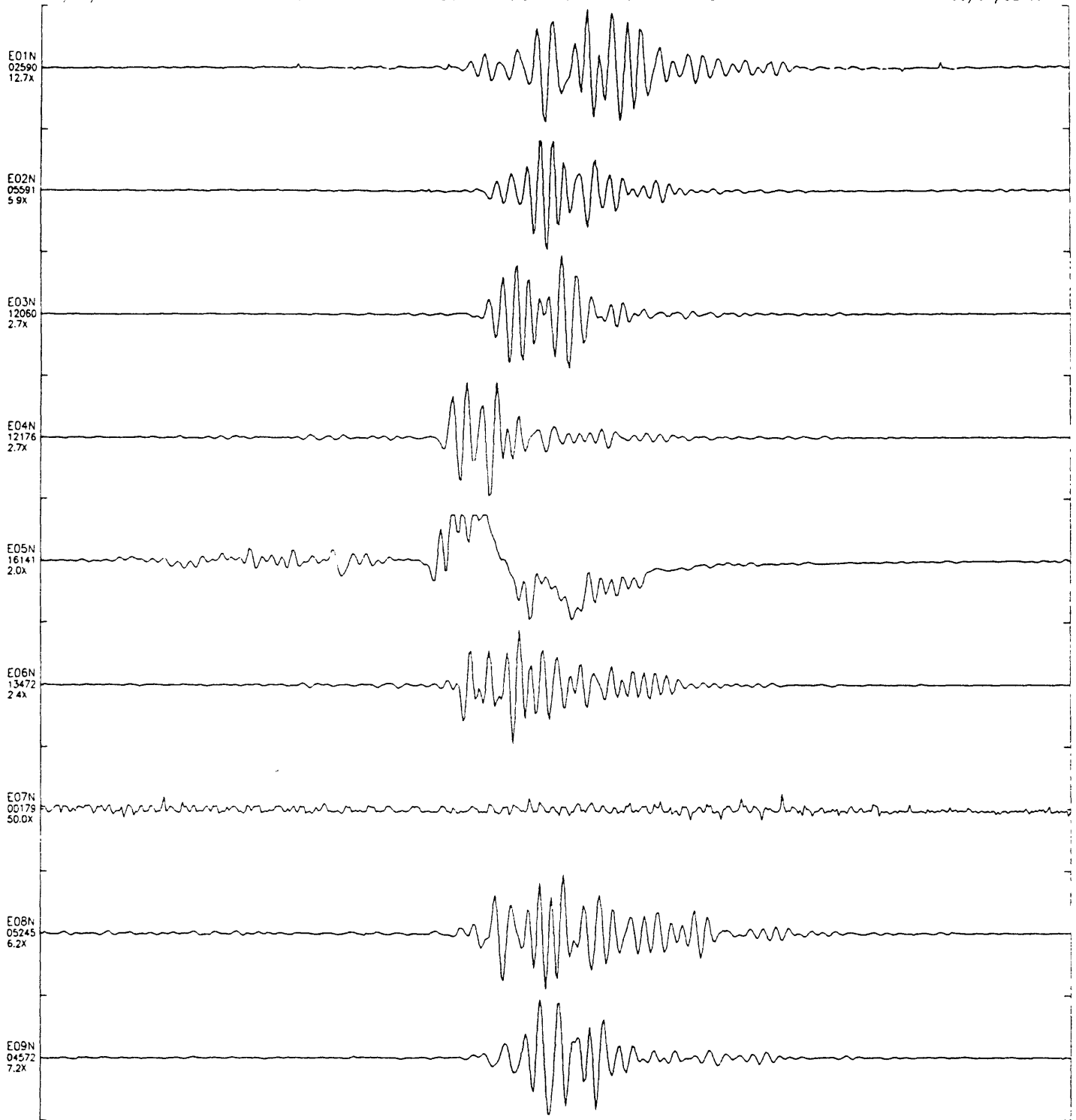
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Sheet 1
09/04/92 09:06



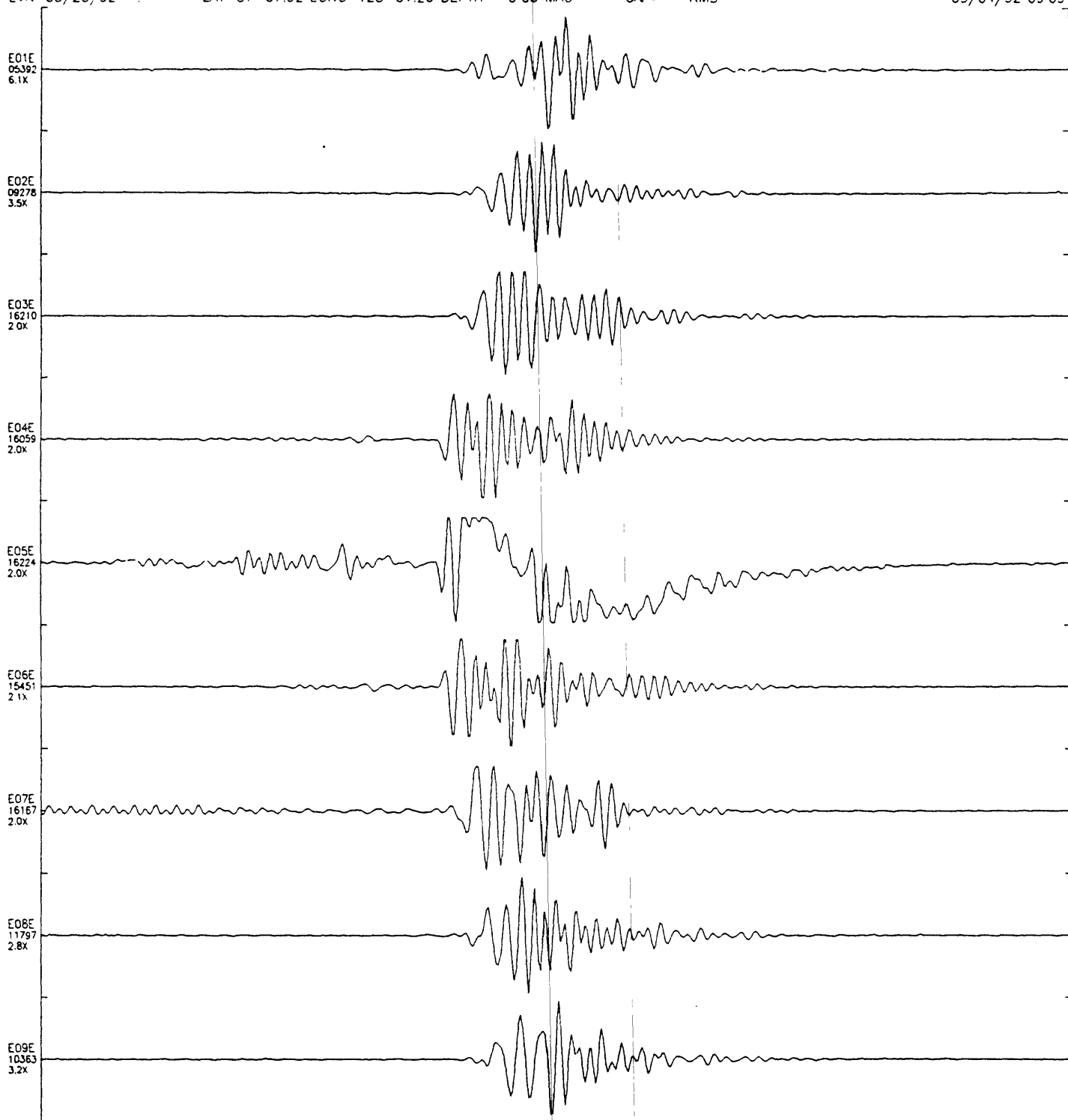
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09/04/92 09 07



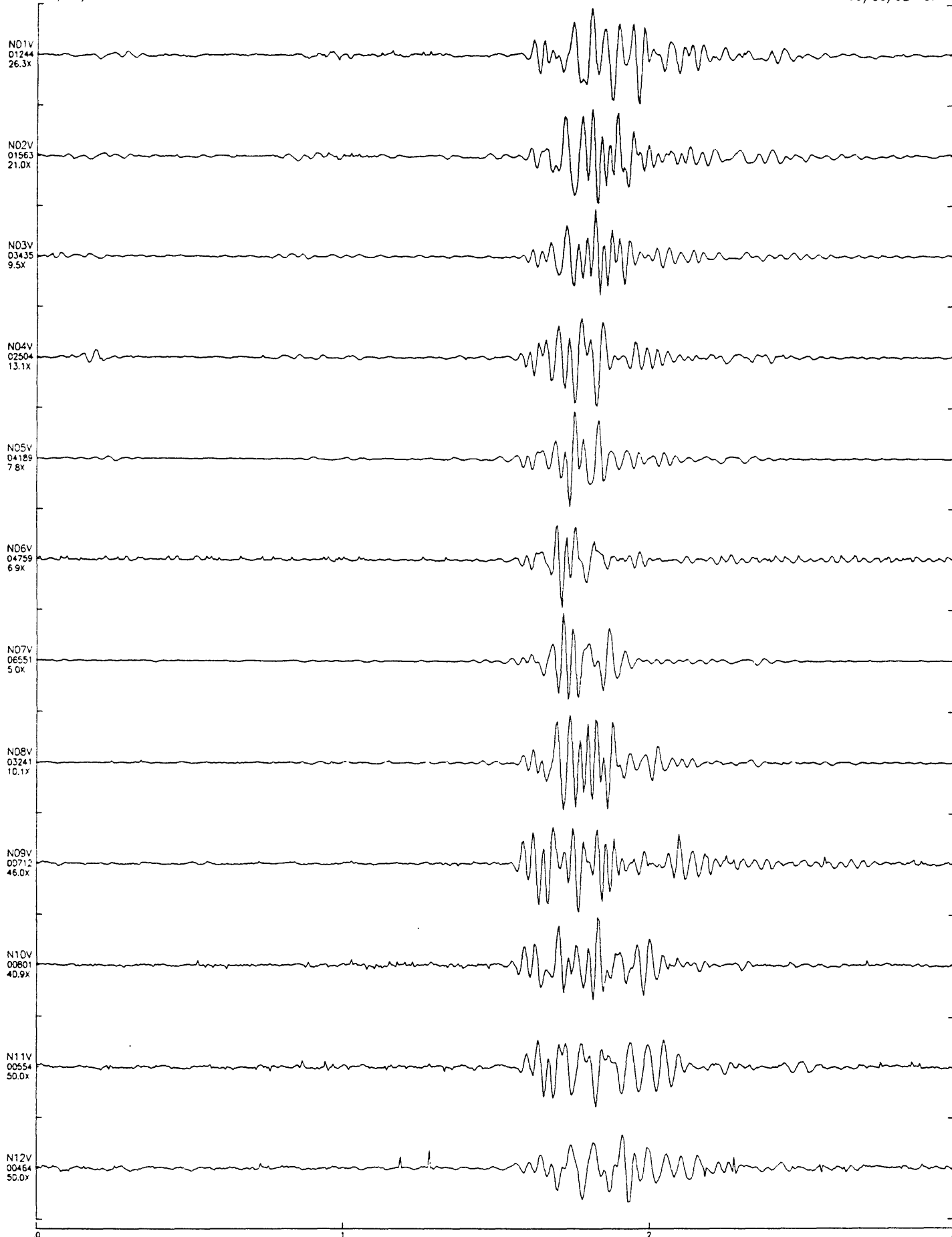
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Sheet 1
09/04/92 09 09



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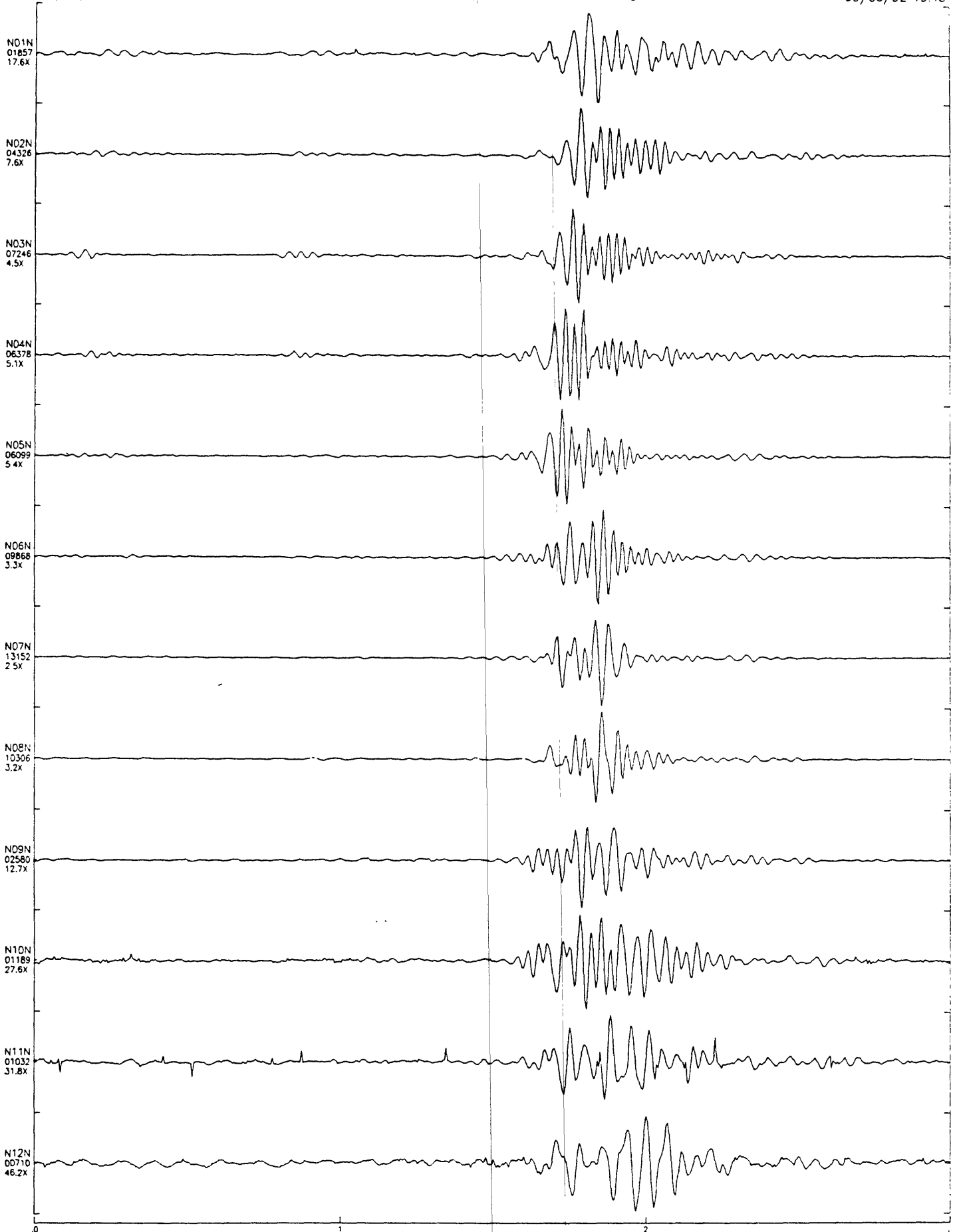
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09/03/92 19.47



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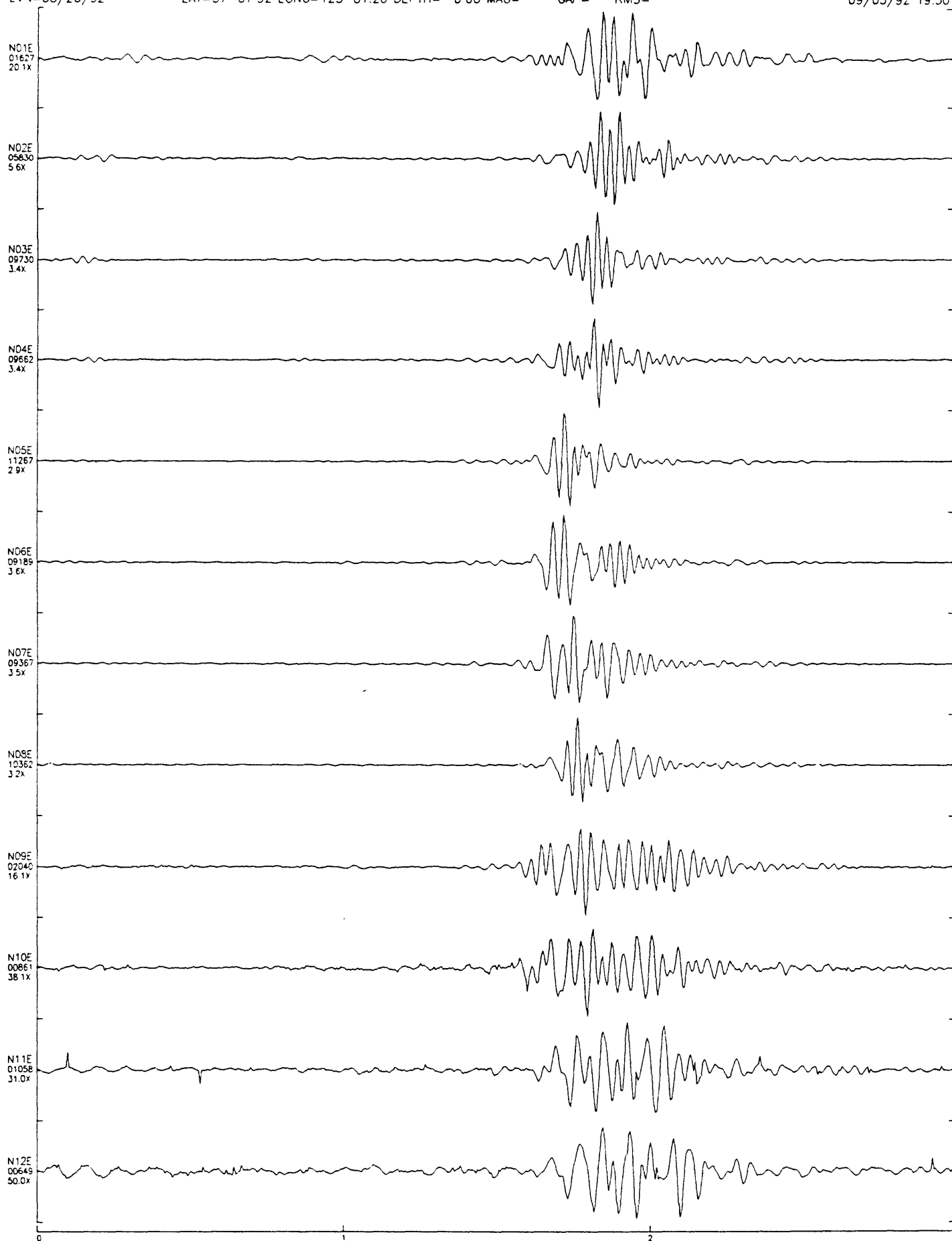
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Sheet 1
09/03/92 19.45



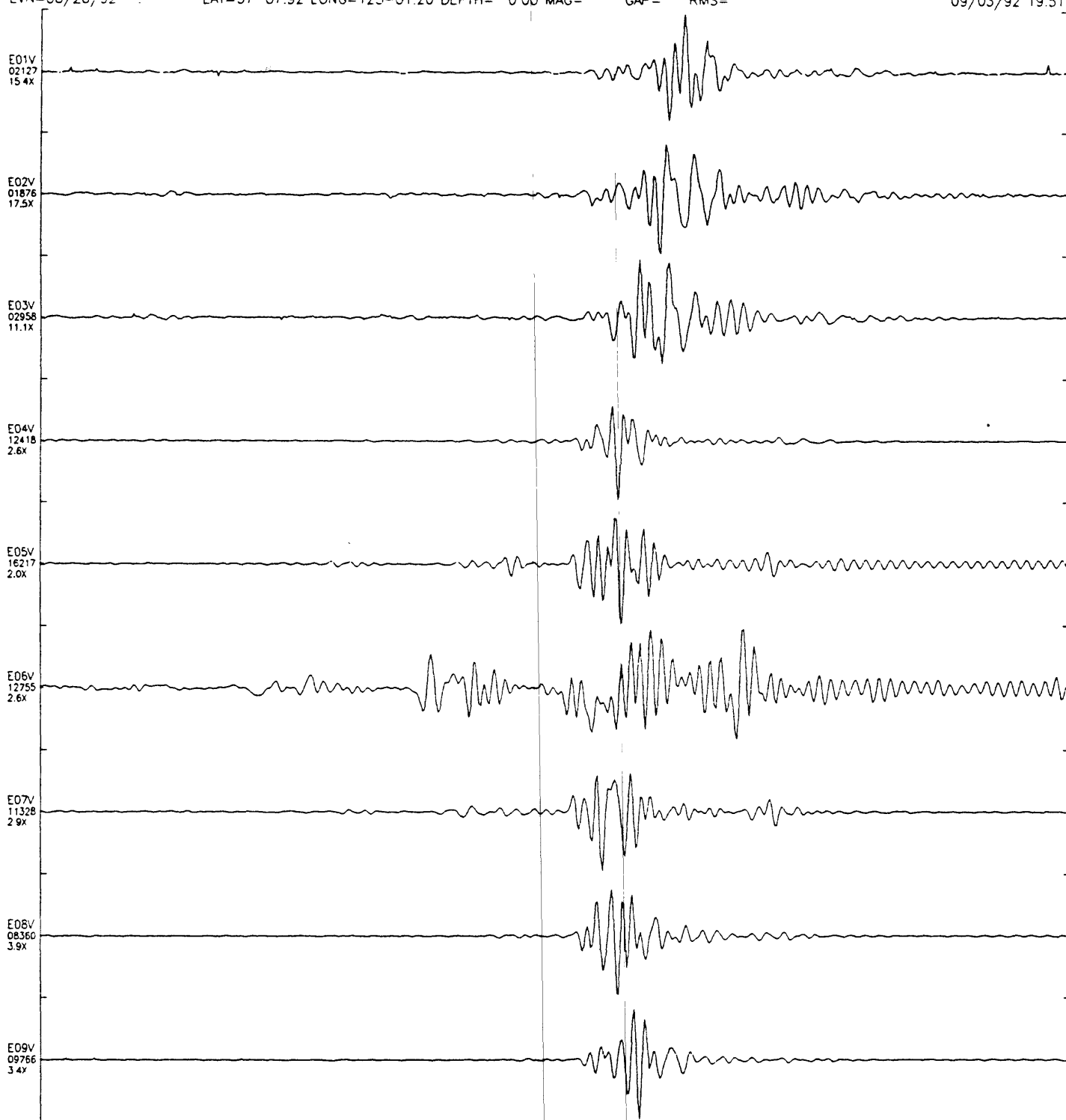
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Sheet 1
09/03/92 19:50



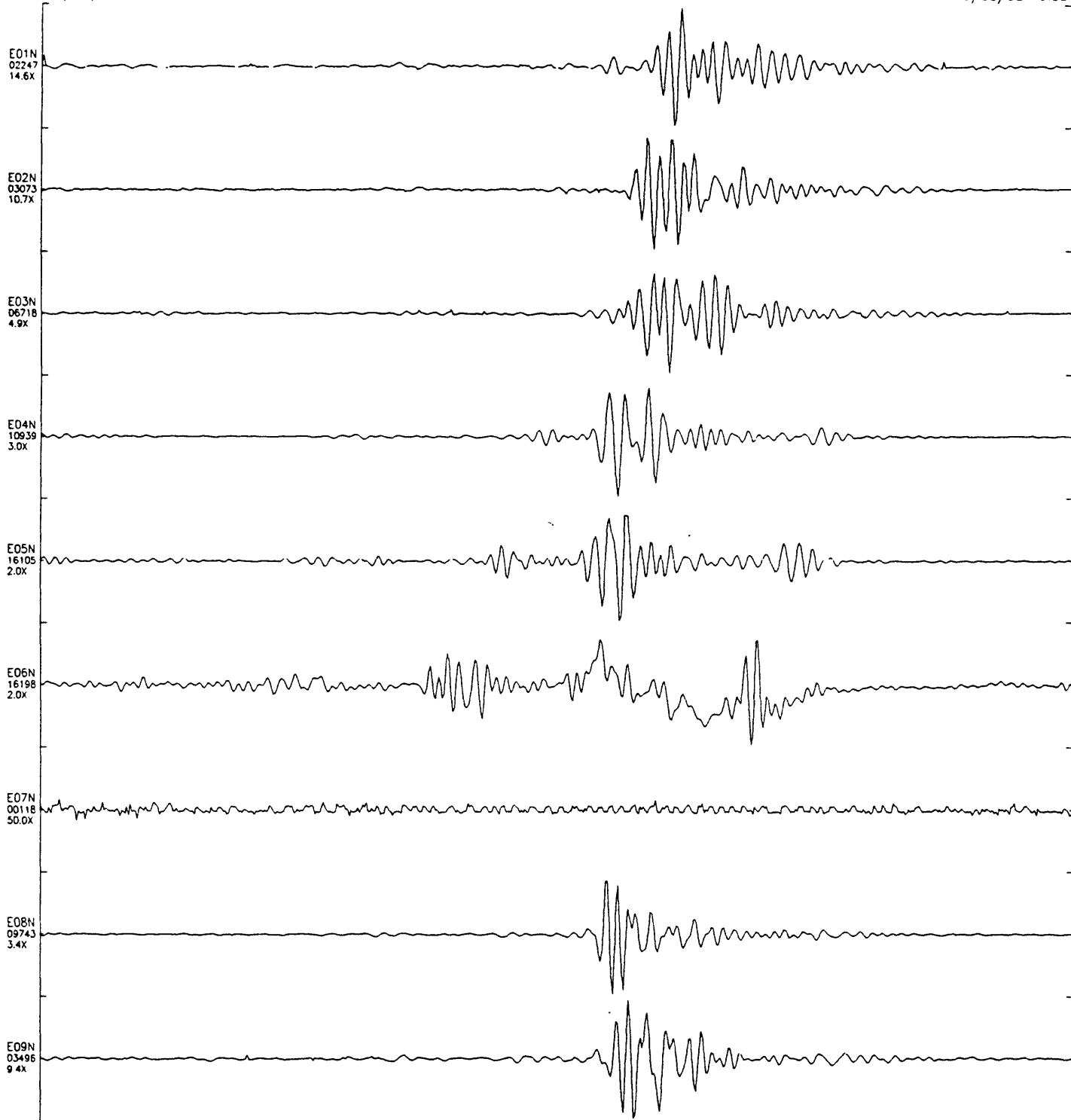
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09/03/92 19.51



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Sheet 1
09/03/92 19:52



0 1 2

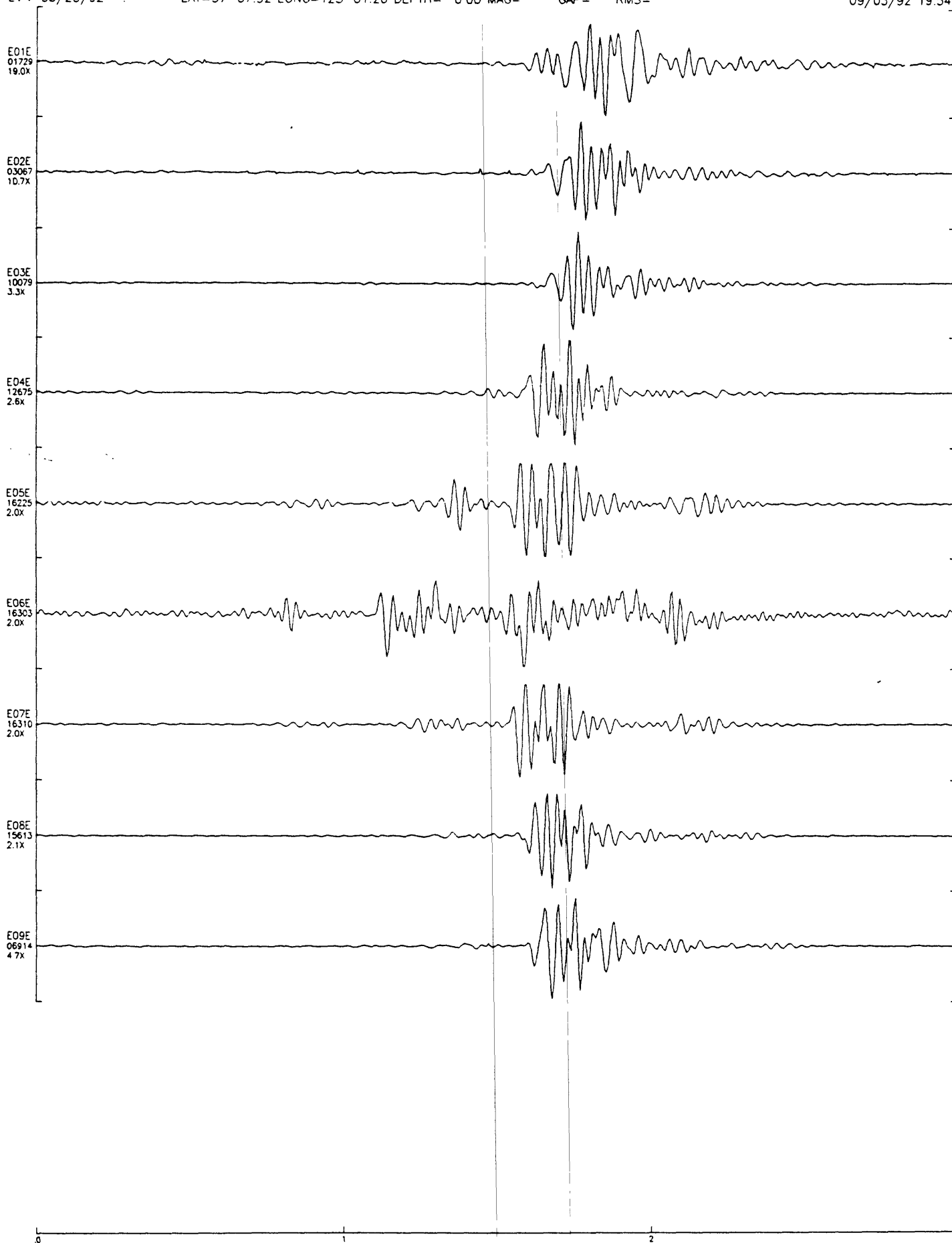
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EVN=08/20/92

LAT=37-07.92 LONG=123-01.20 DEPTH= 0 00 MAG=

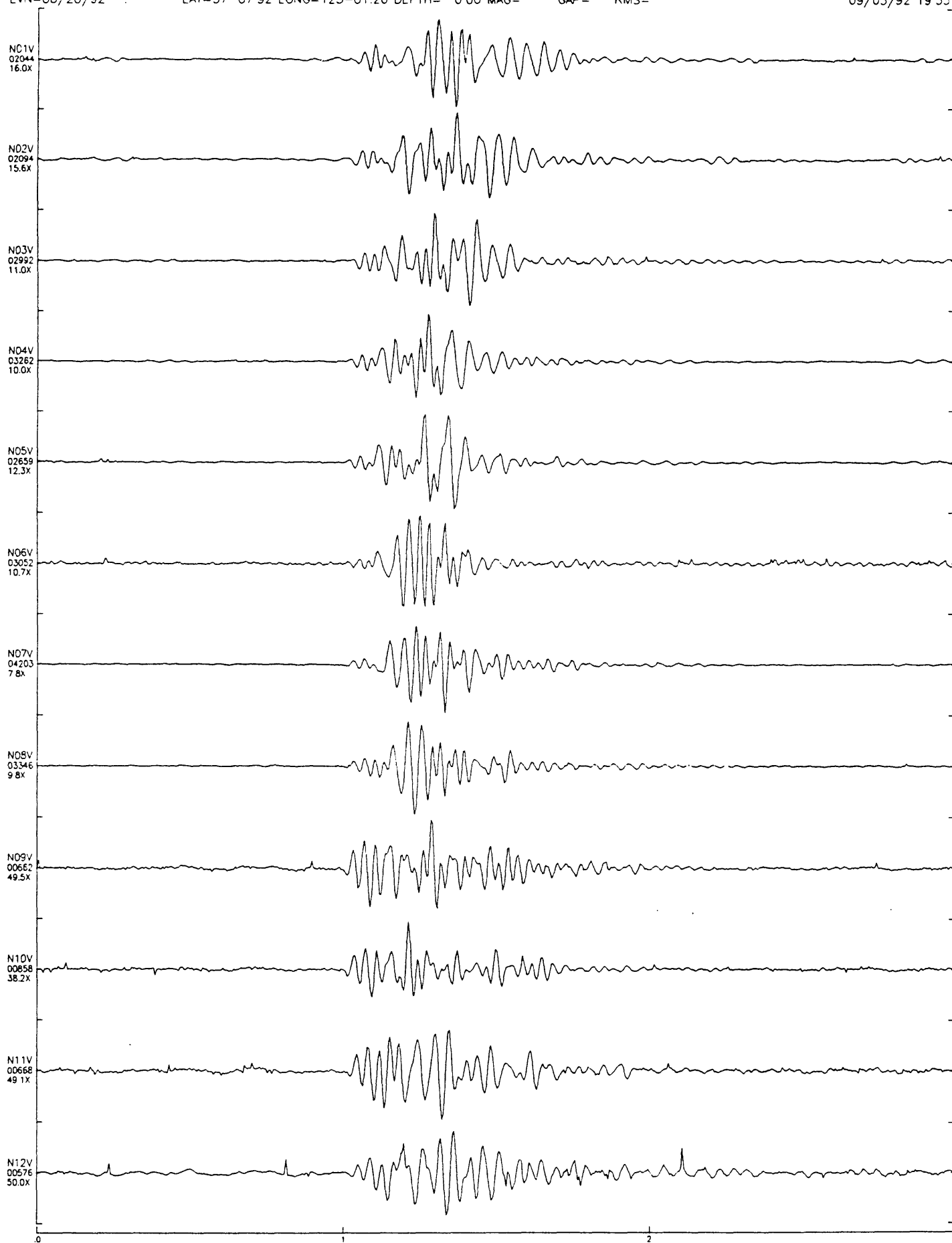
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Sheet 1
09/03/92 19:54



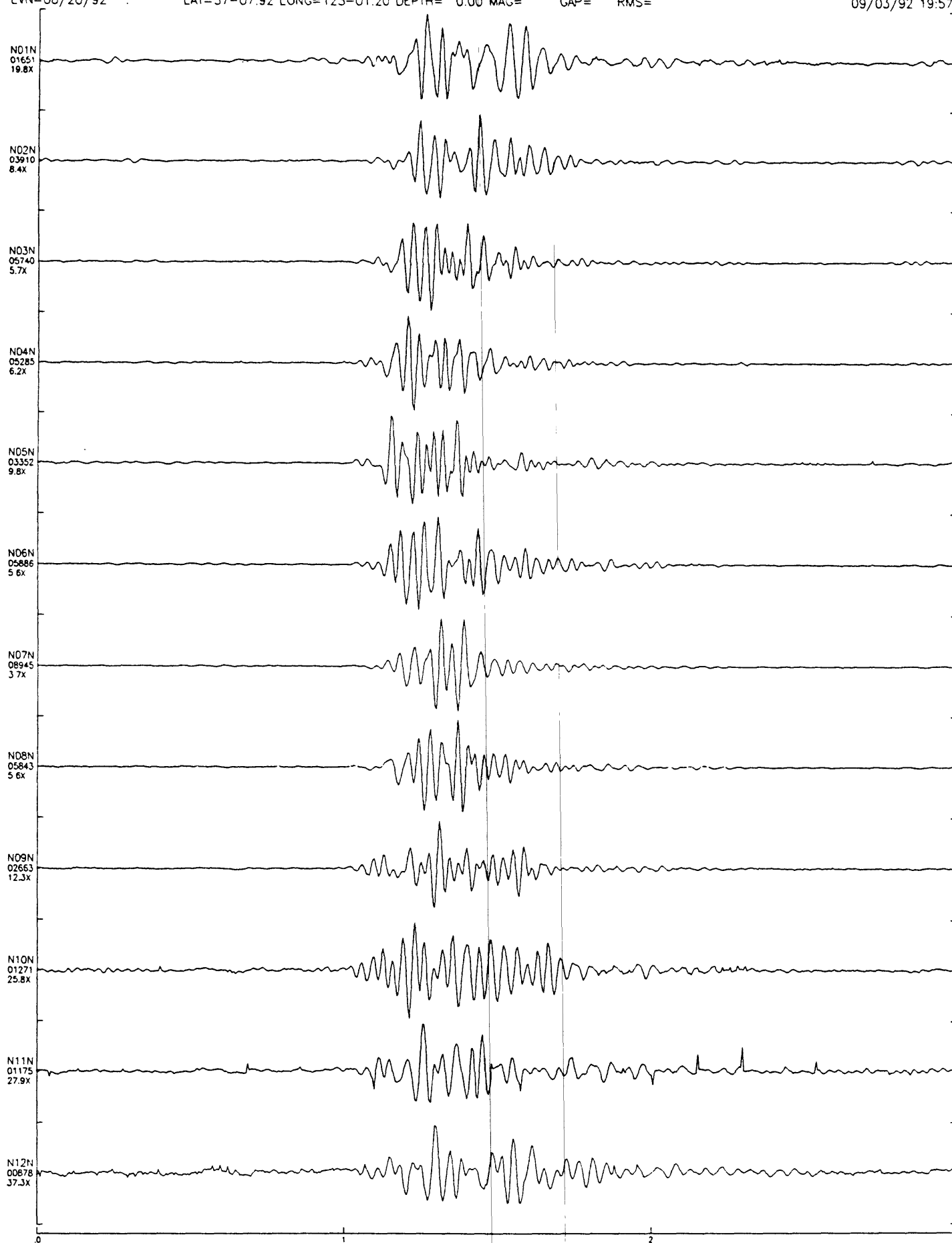
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09/03/92 19:55



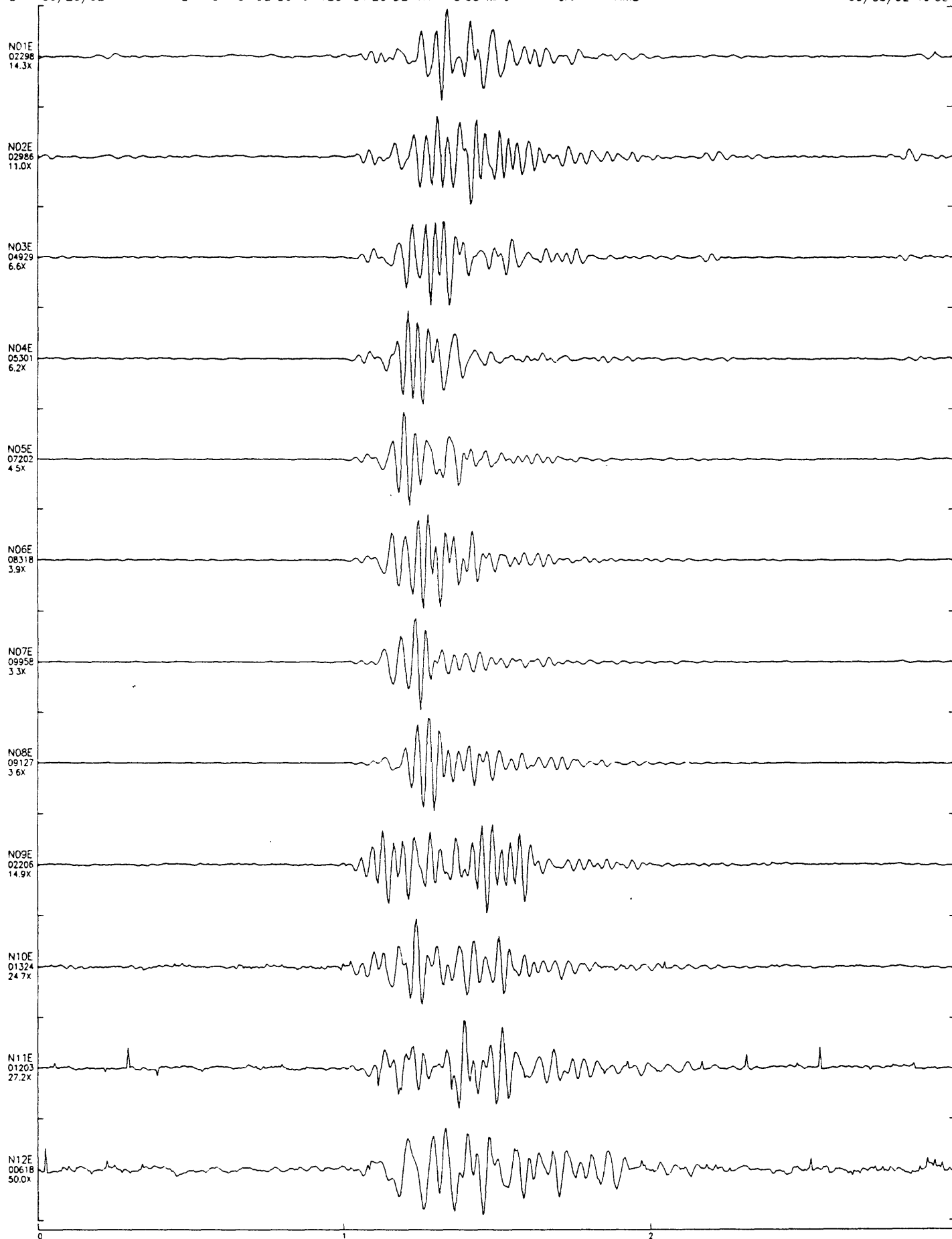
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Sheet 1
09/03/92 19:57



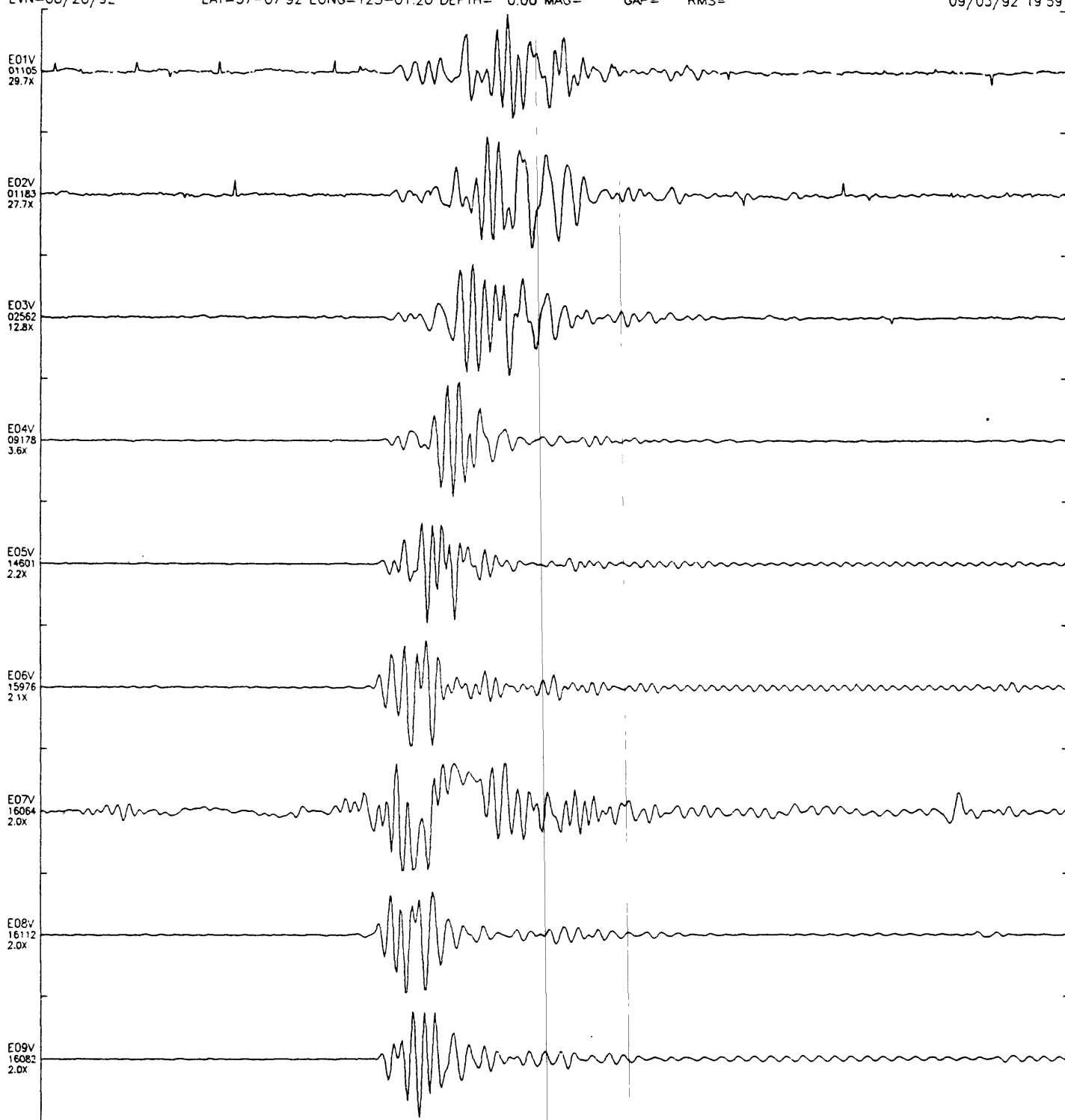
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Sheet 1
09/03/92 19 58



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Sheet 1
09/03/92 19 59

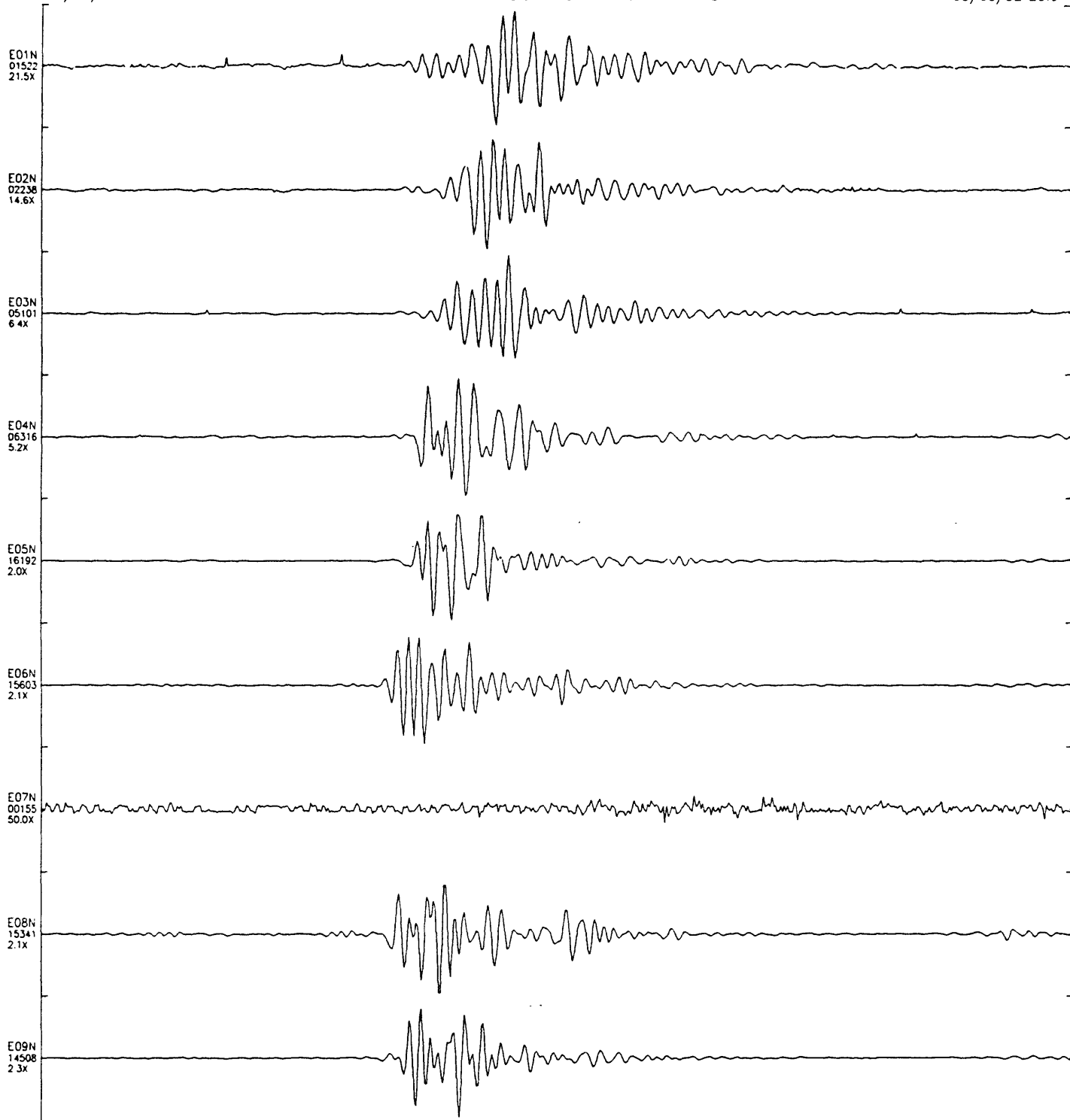


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159

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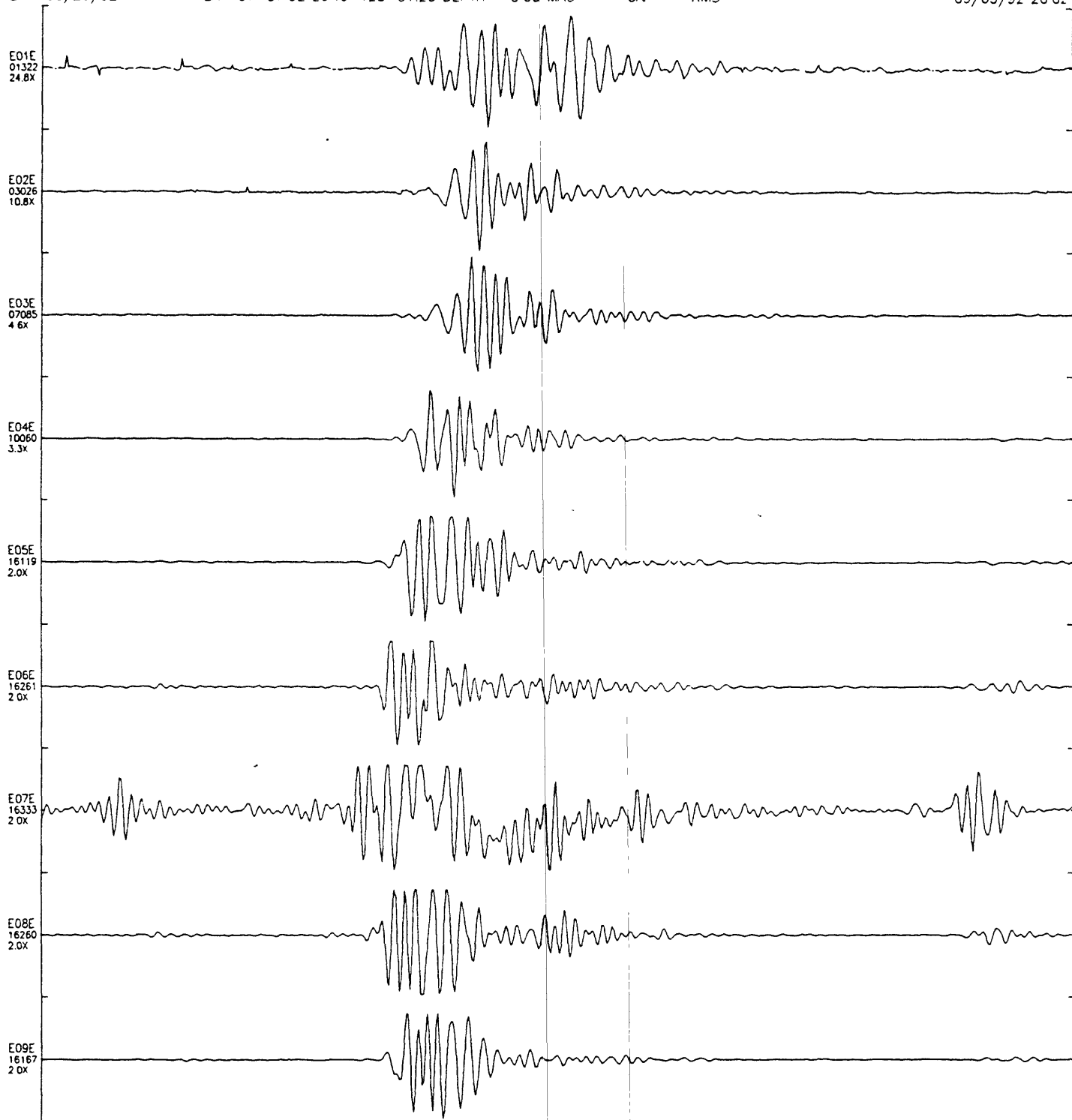
Sheet 1
09/03/92 20.01



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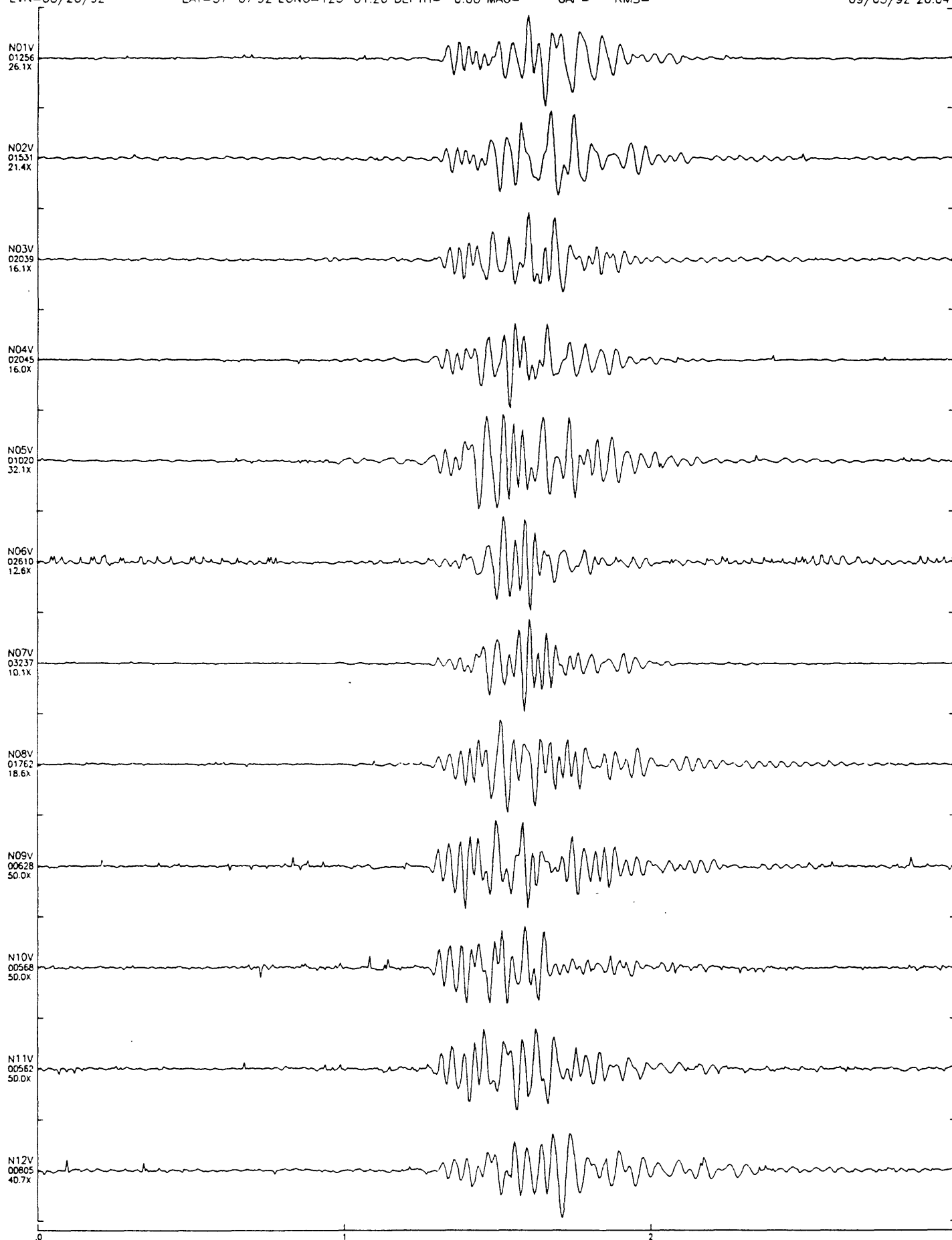
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09/03/92 20 02



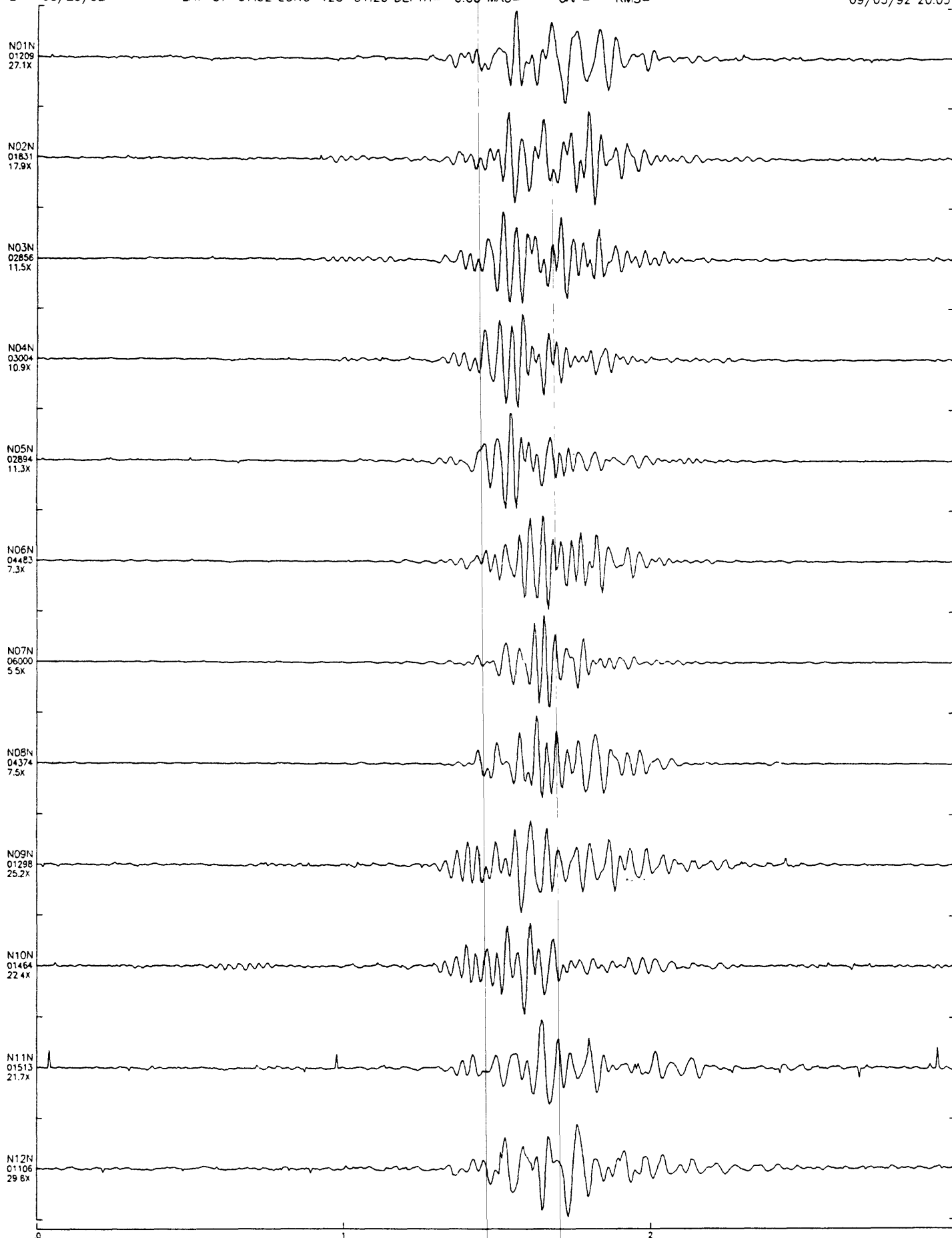
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09/03/92 20:04



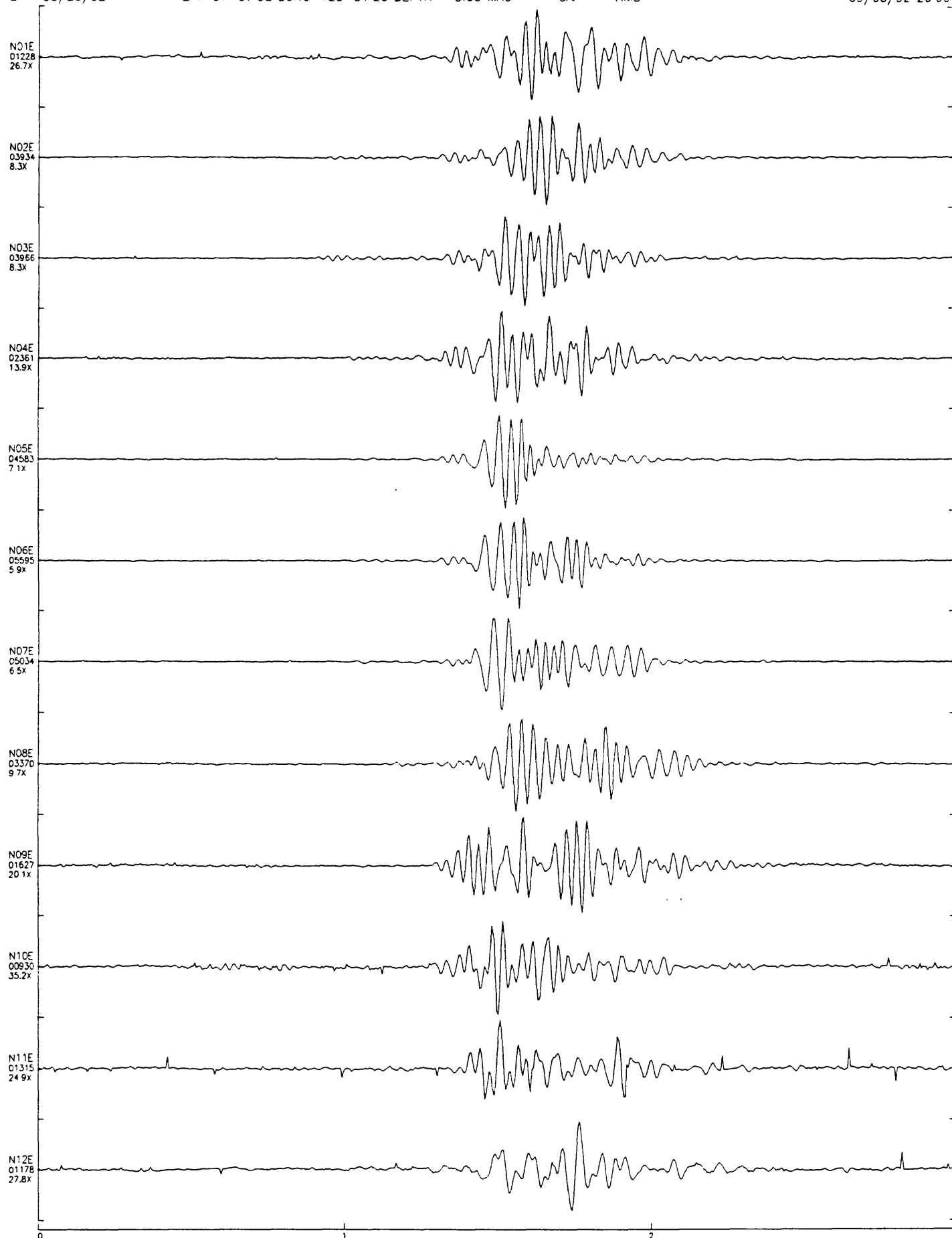
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Sheet 1
09/03/92 20.05



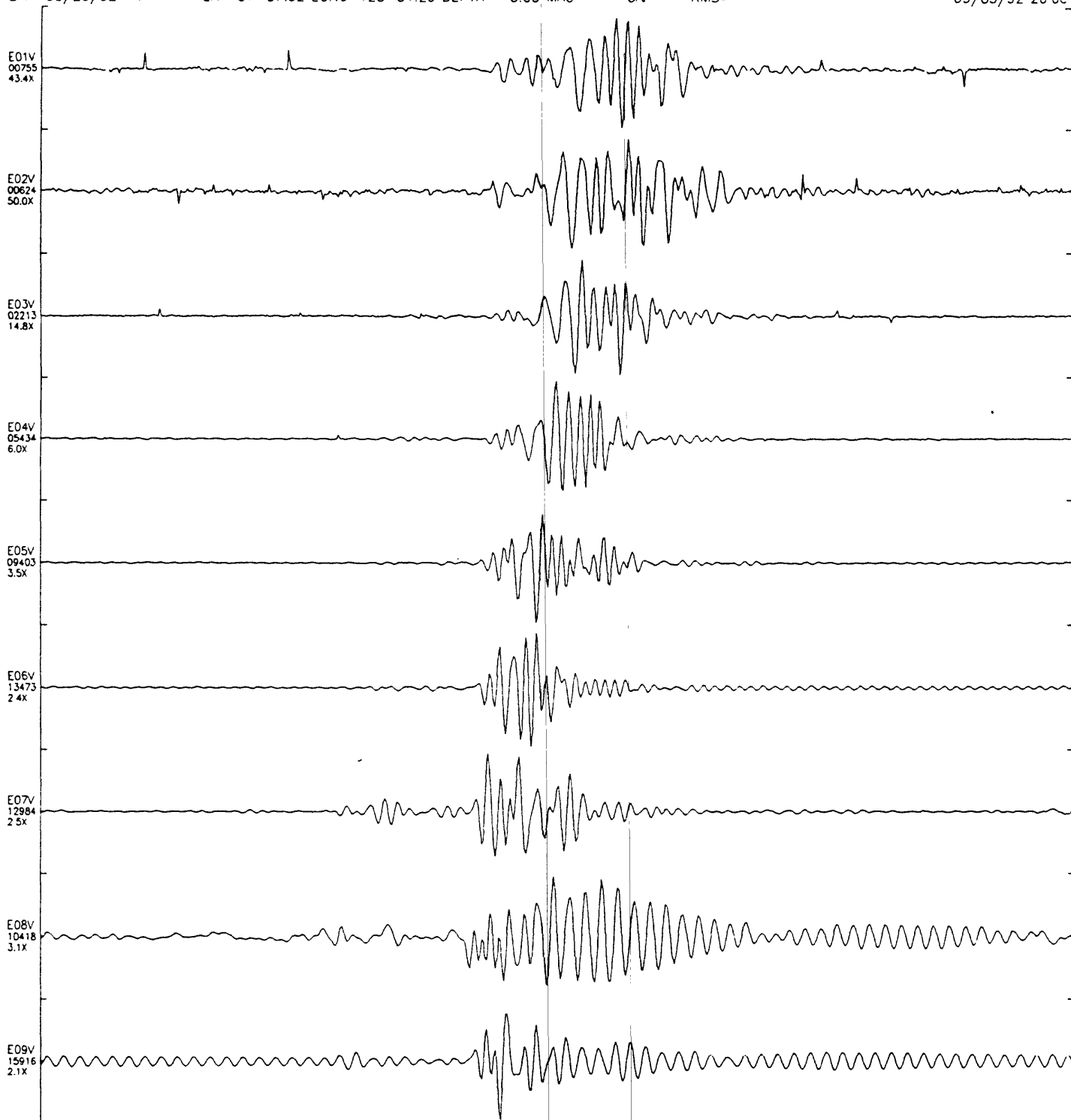
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Sheet 1
09/03/92 20:06



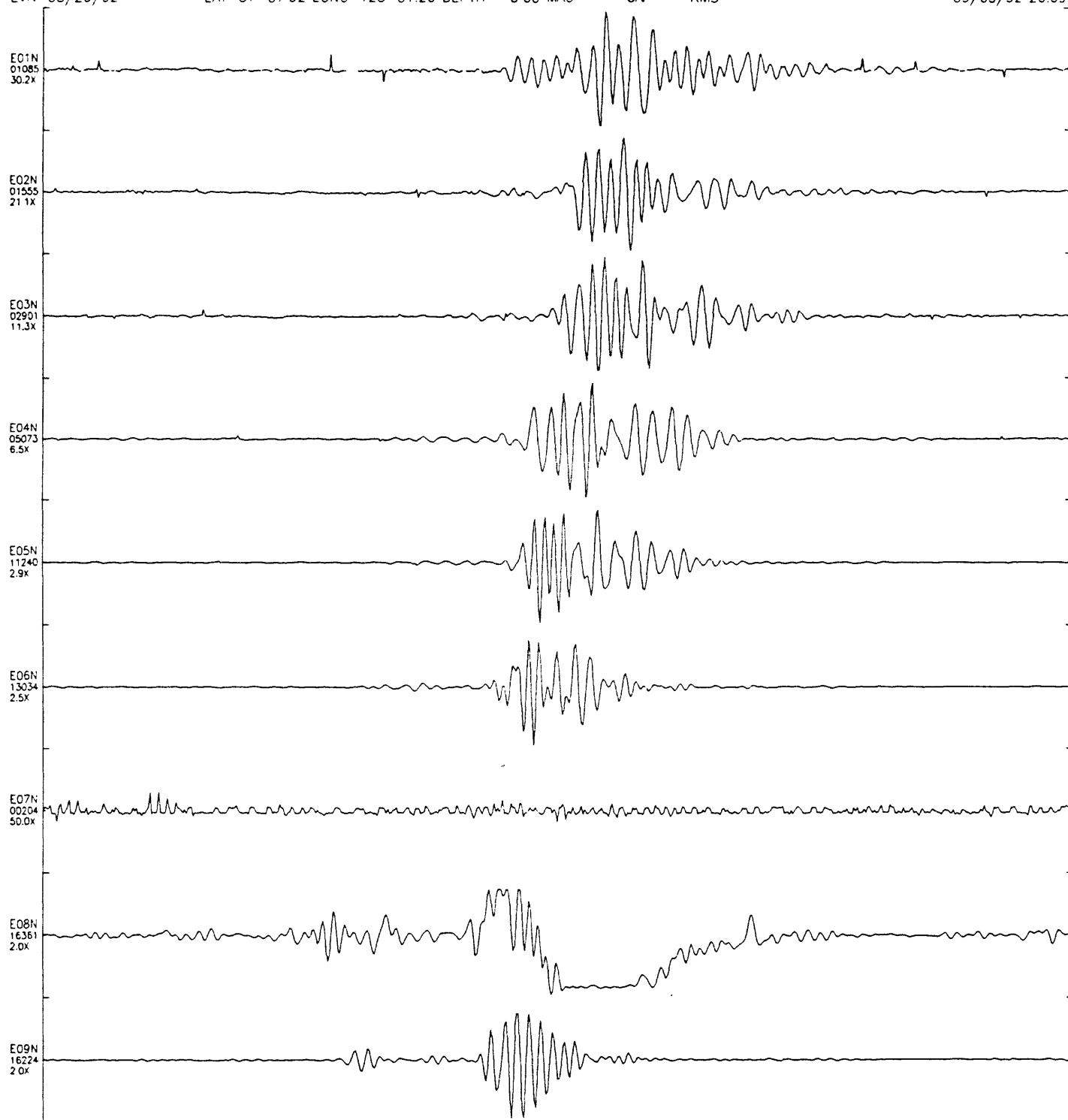
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Sheet 1
09/03/92 20 08



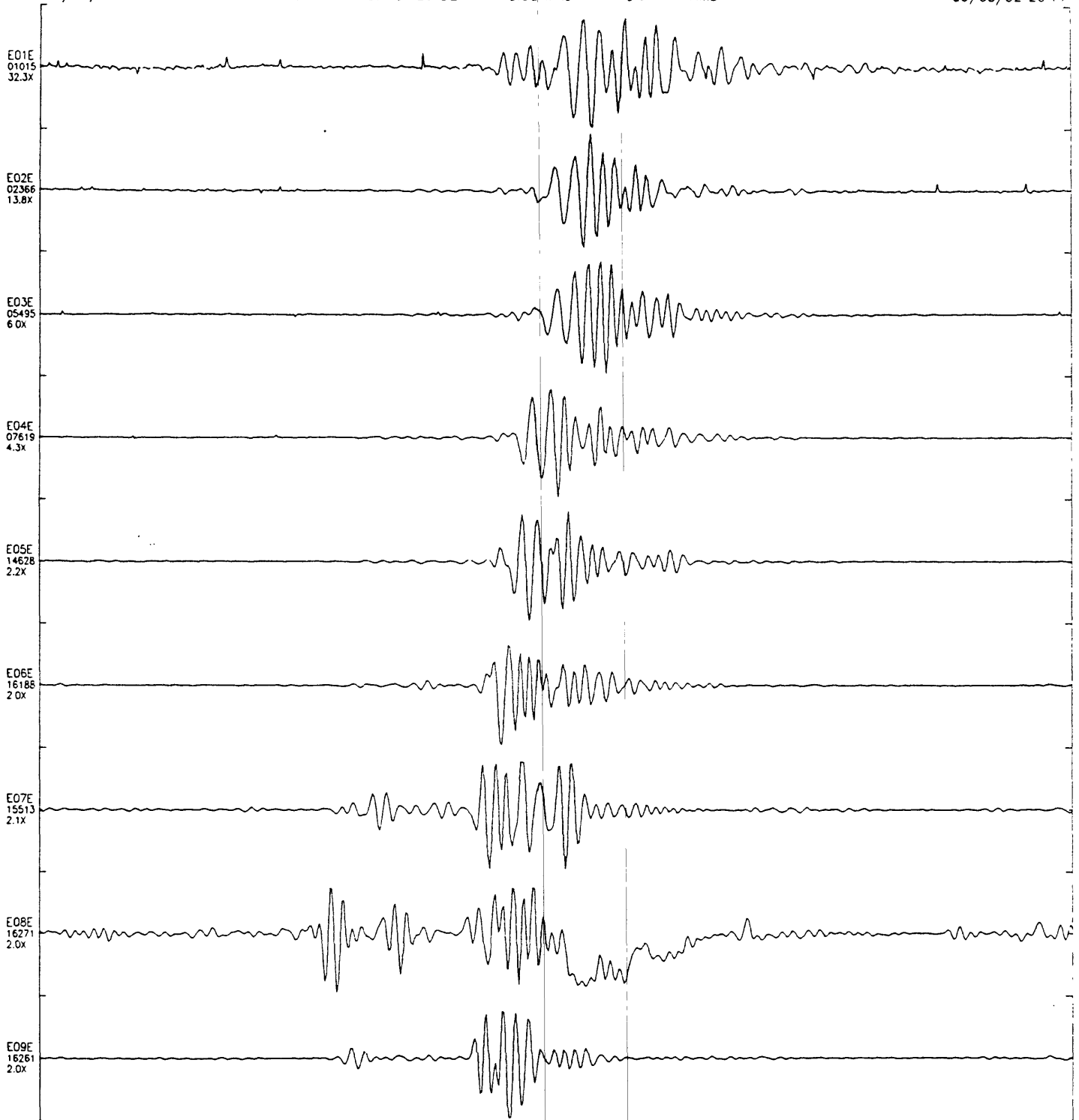
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Sheet 1
09/03/92 20:09



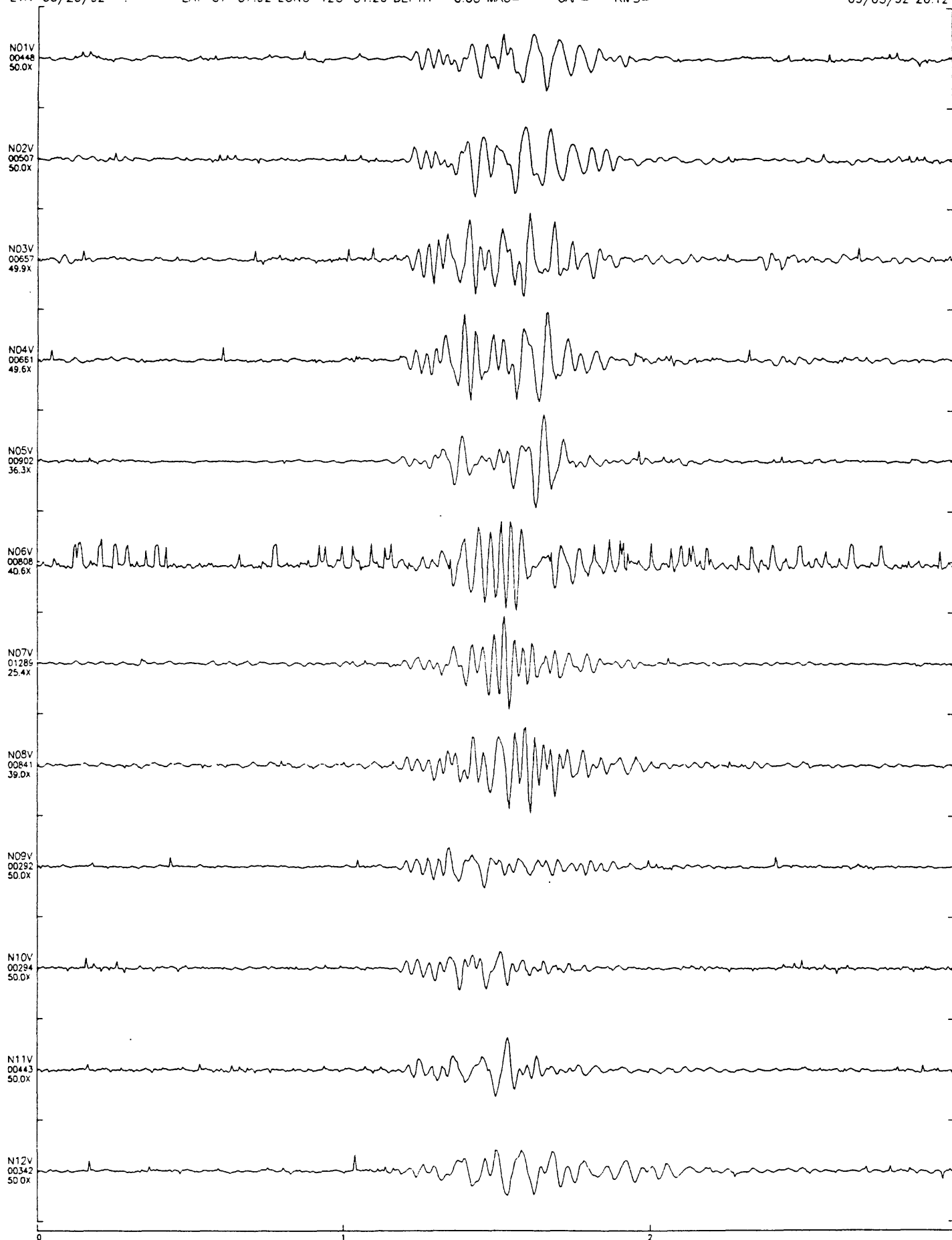
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Sheet 1
09/03/92 20 11



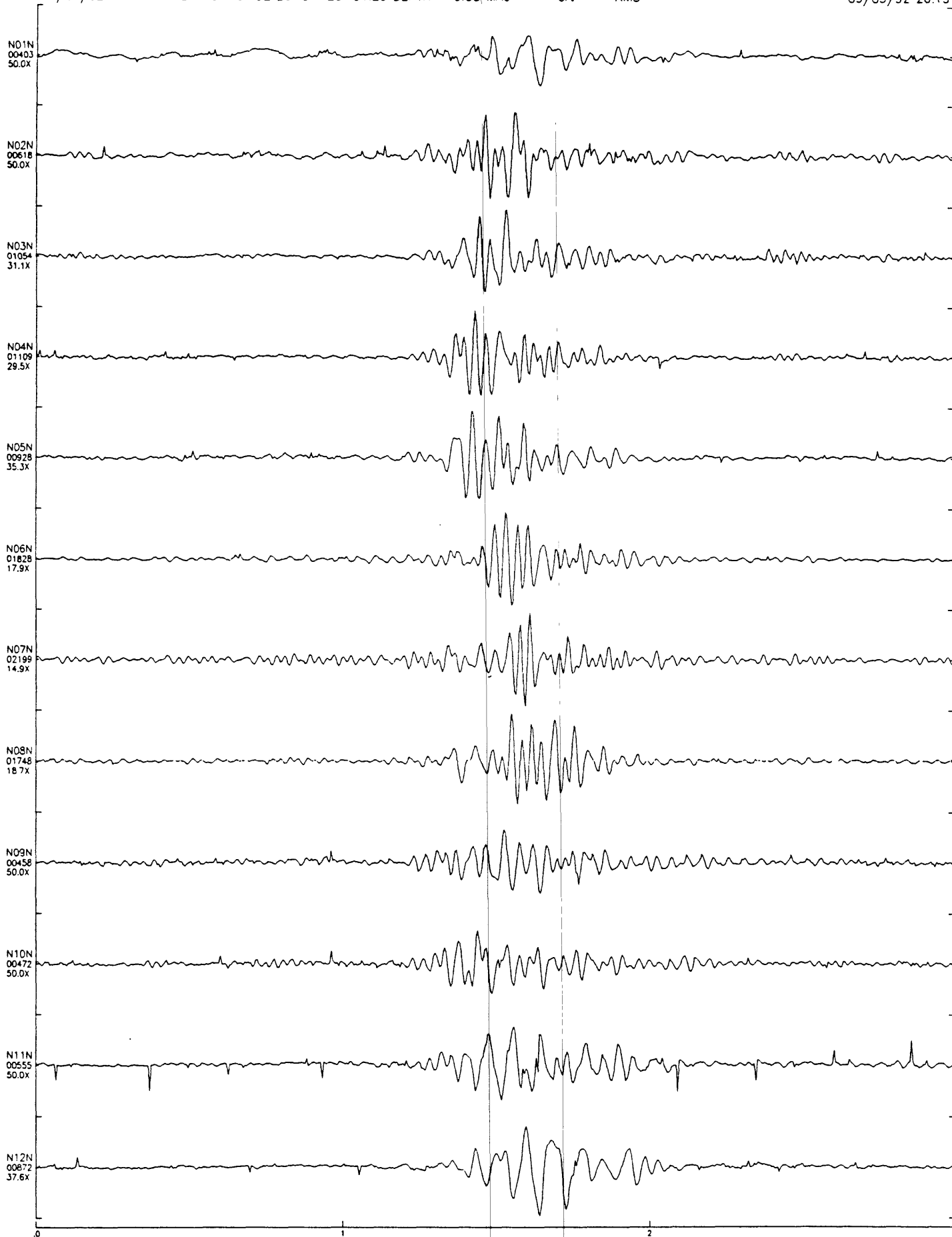
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Sheet 1
09/03/92 20:12



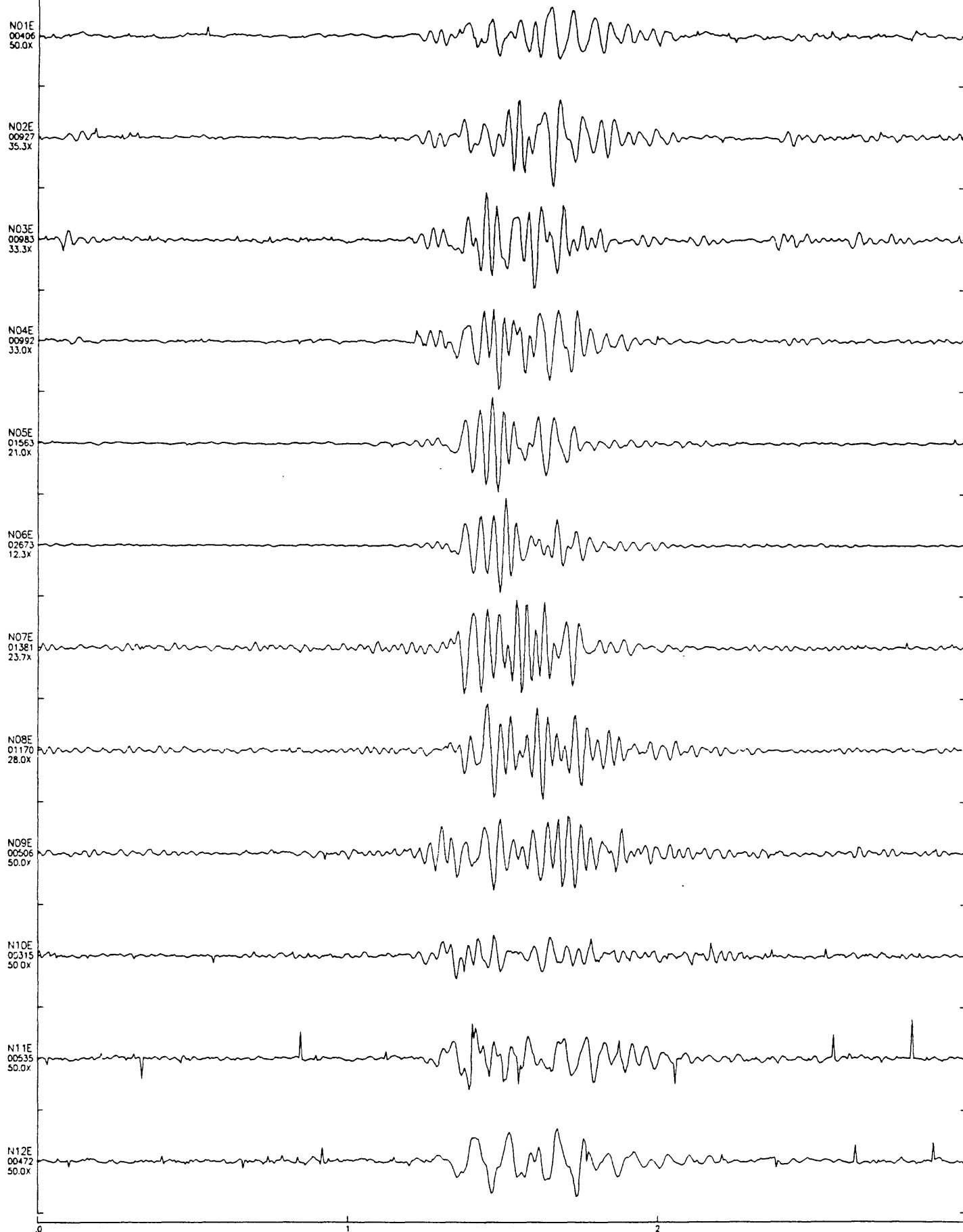
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IST=08/21/92 00:12 02.907 SPS=200.321 DEC=1 D:\92082107.CT1
EVN=08/20/92 LAT=37-07.92 LONG=123-01.20 DEPTH= 0 00 MAG= GAP= RMS=

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09/03/92 20 15



170

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EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/03/92 20.16

E01V
00284
50.0x

E02V
00249
50.0x

E03V
00604
50.0x

E04V
00209
16.1x

E05V
04378
7.5x

E06V
07224
4.5x

E07V
10959
3.0x

E08V
11642
2.8x

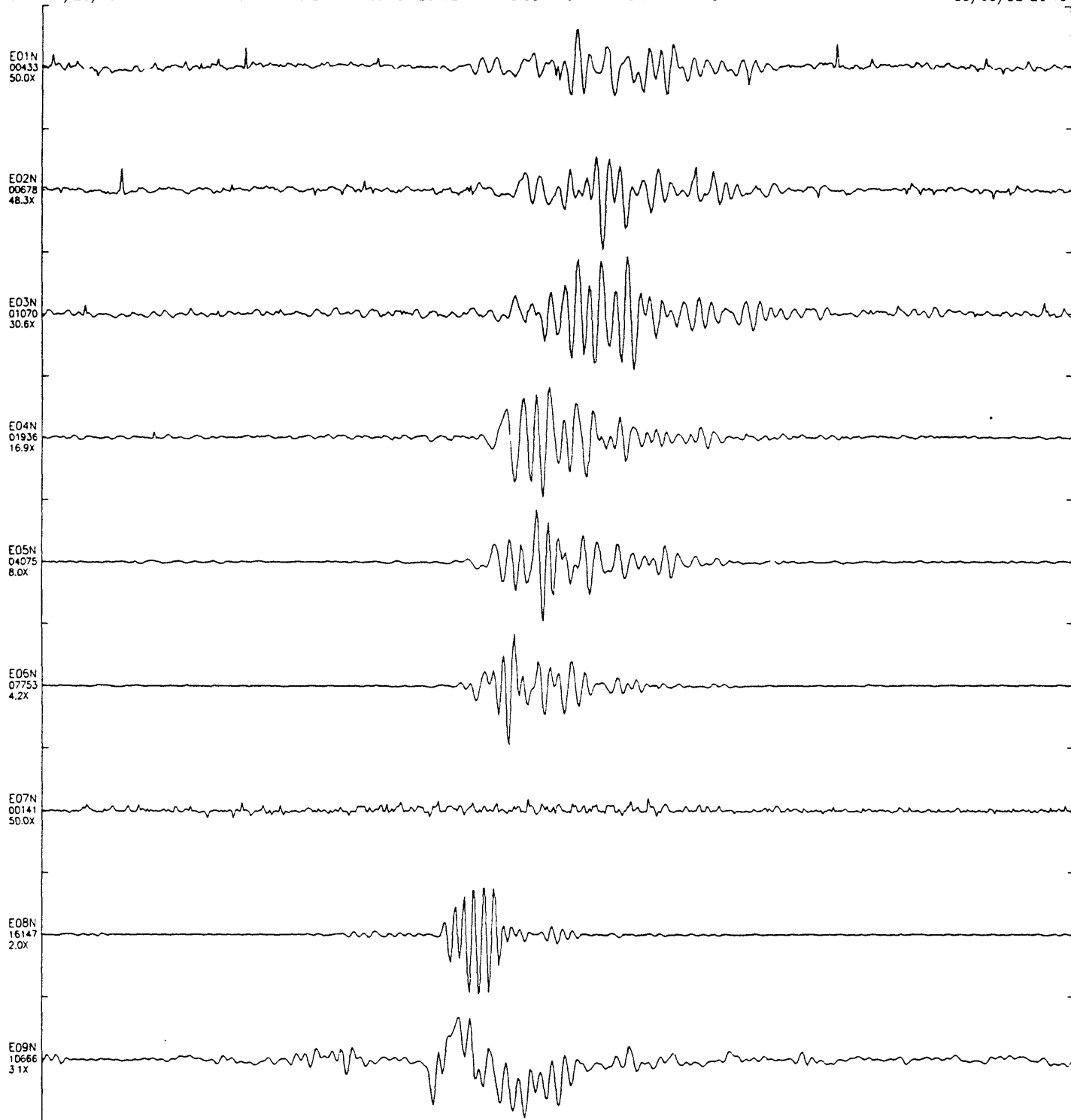
E09V
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0 1 2

171

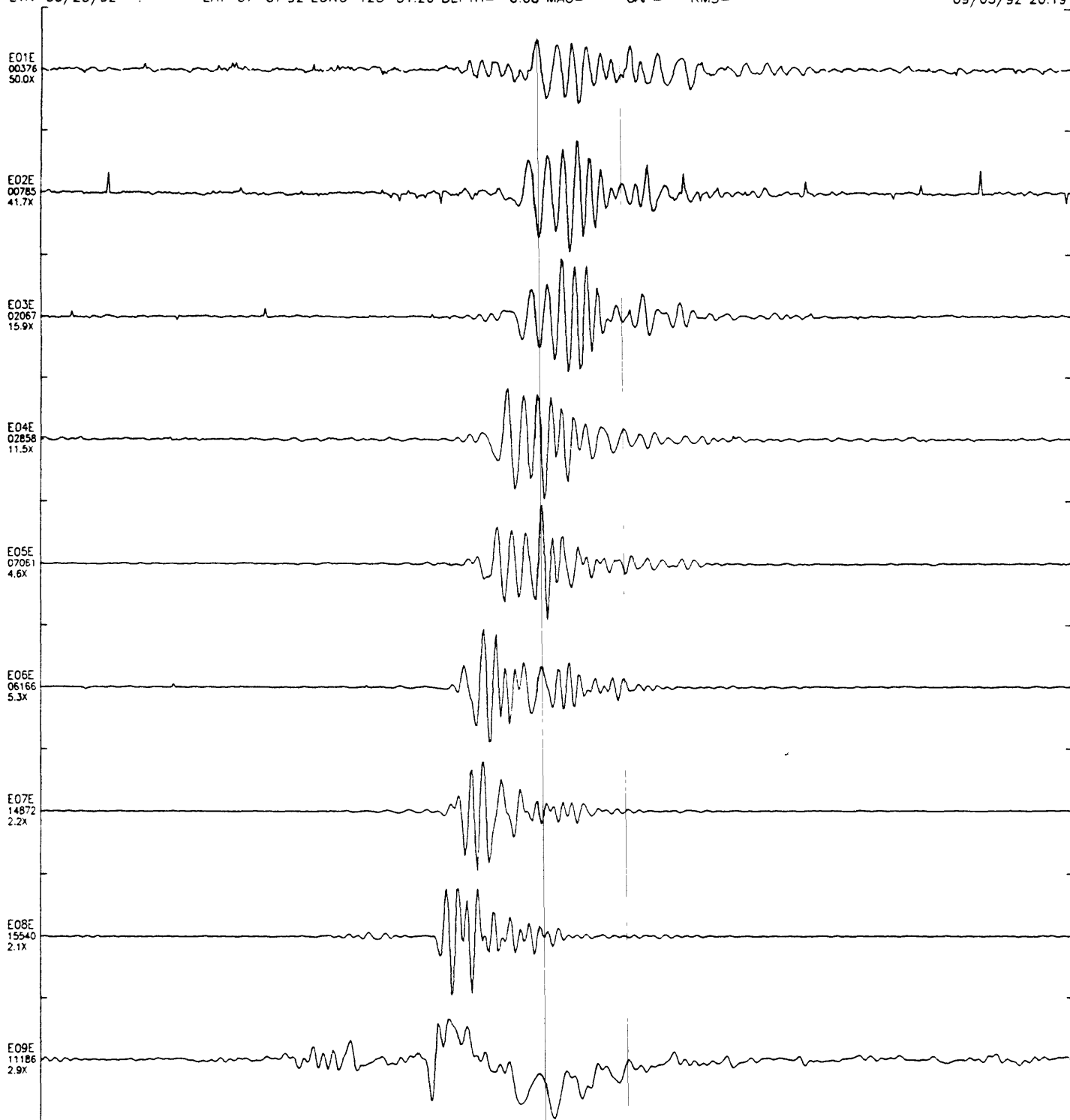
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Sheet 1
09/03/92 20 18



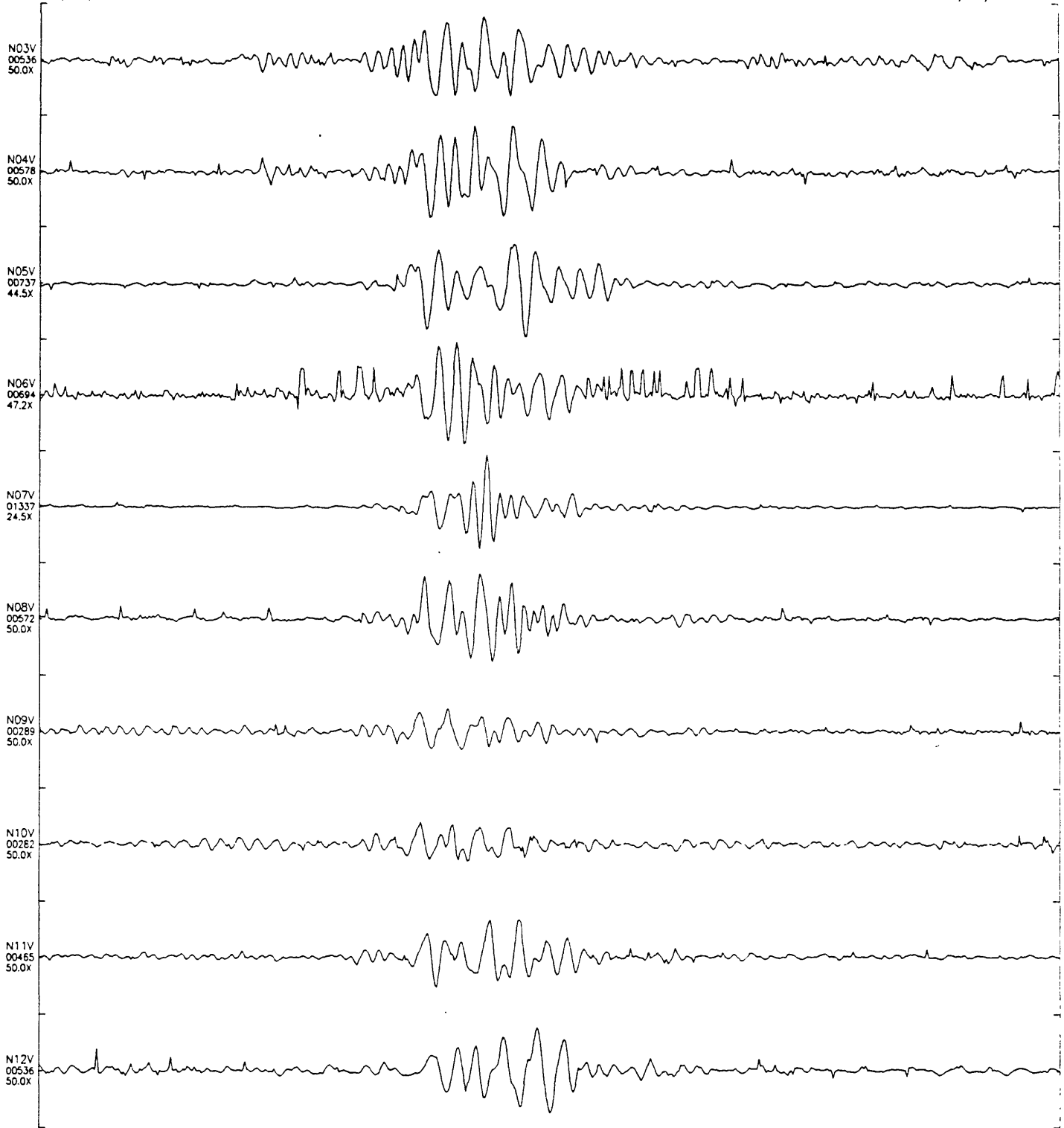
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Sheet 1
09/03/92 20.19



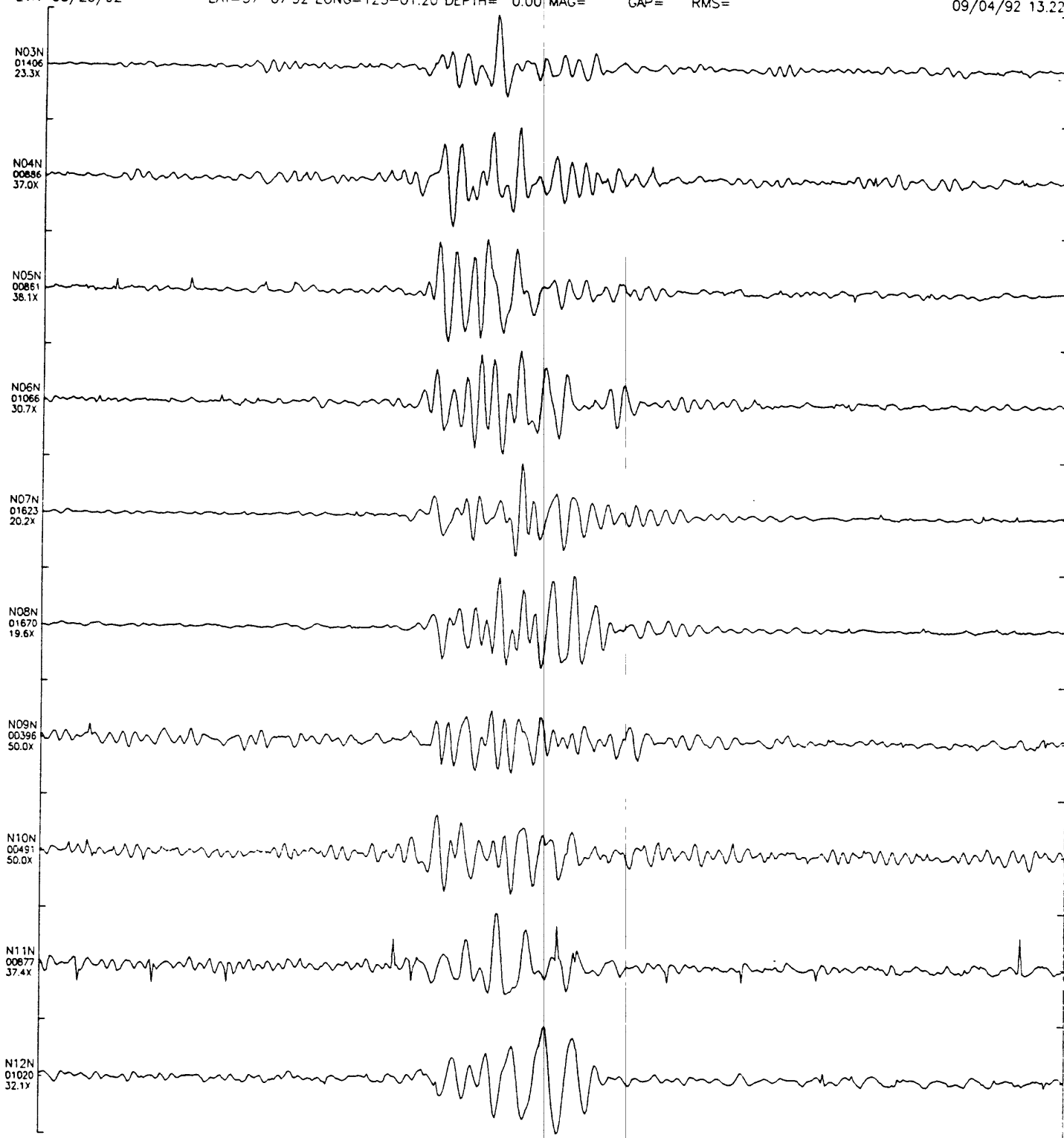
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Sheet 1
09/04/92 13.21



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Sheet 1
09/04/92 13.22

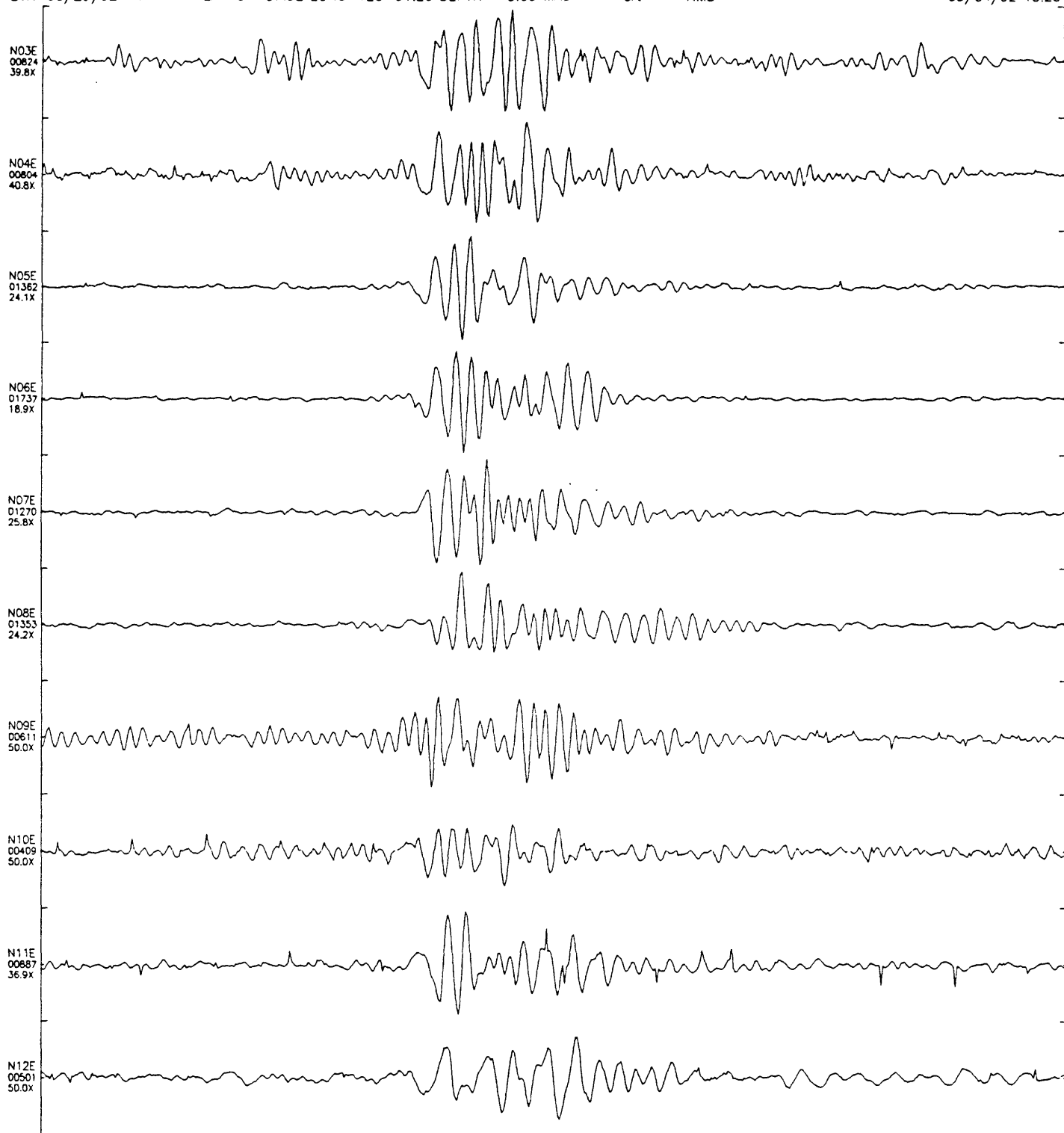


10 2 3

175

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EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

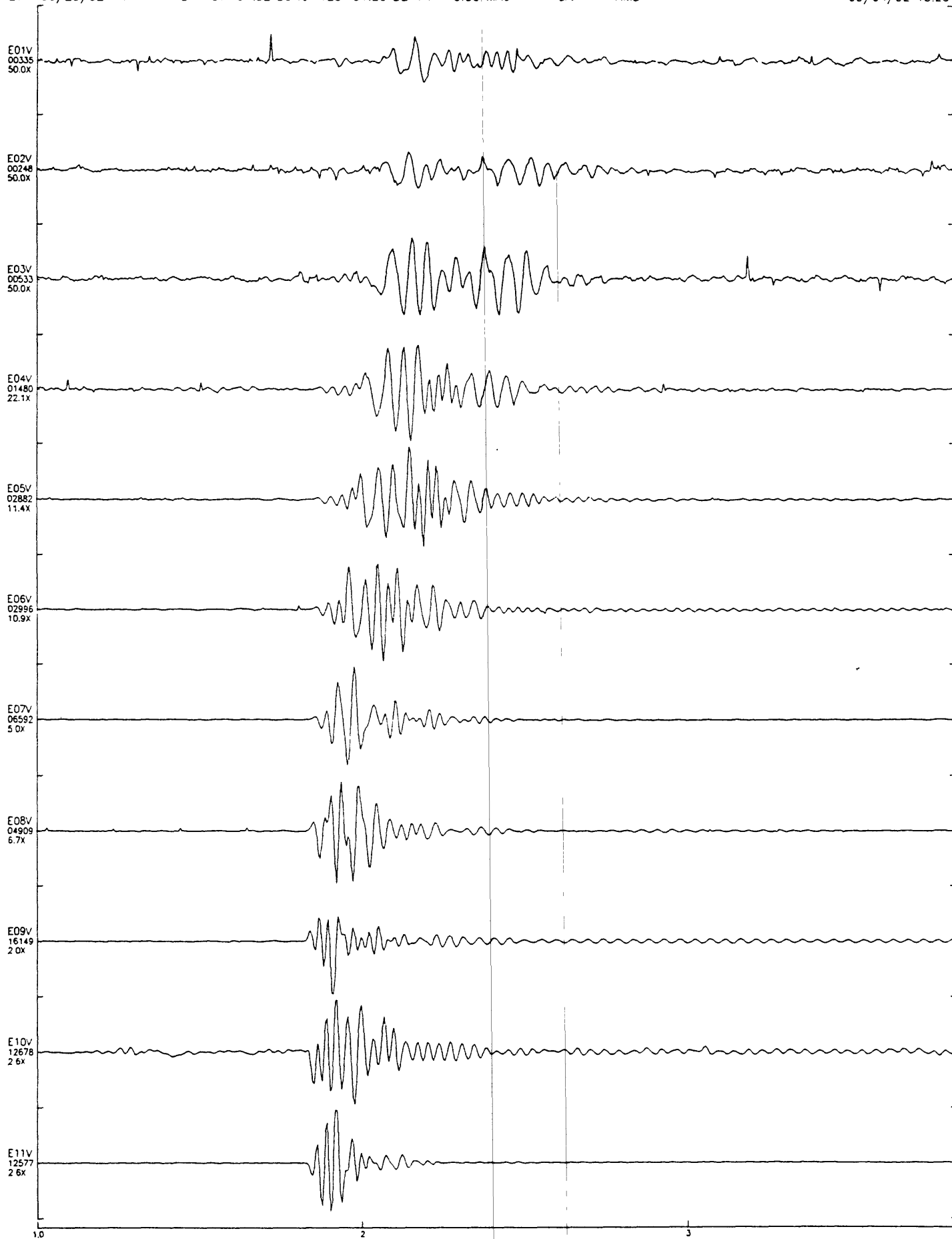
Sheet 1
09/04/92 13.23



IST=08/21/92 00:15 01.908 SPS=200.321 DEC=1 D.\92082108.CT1
EVN=08/20/92 LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG=

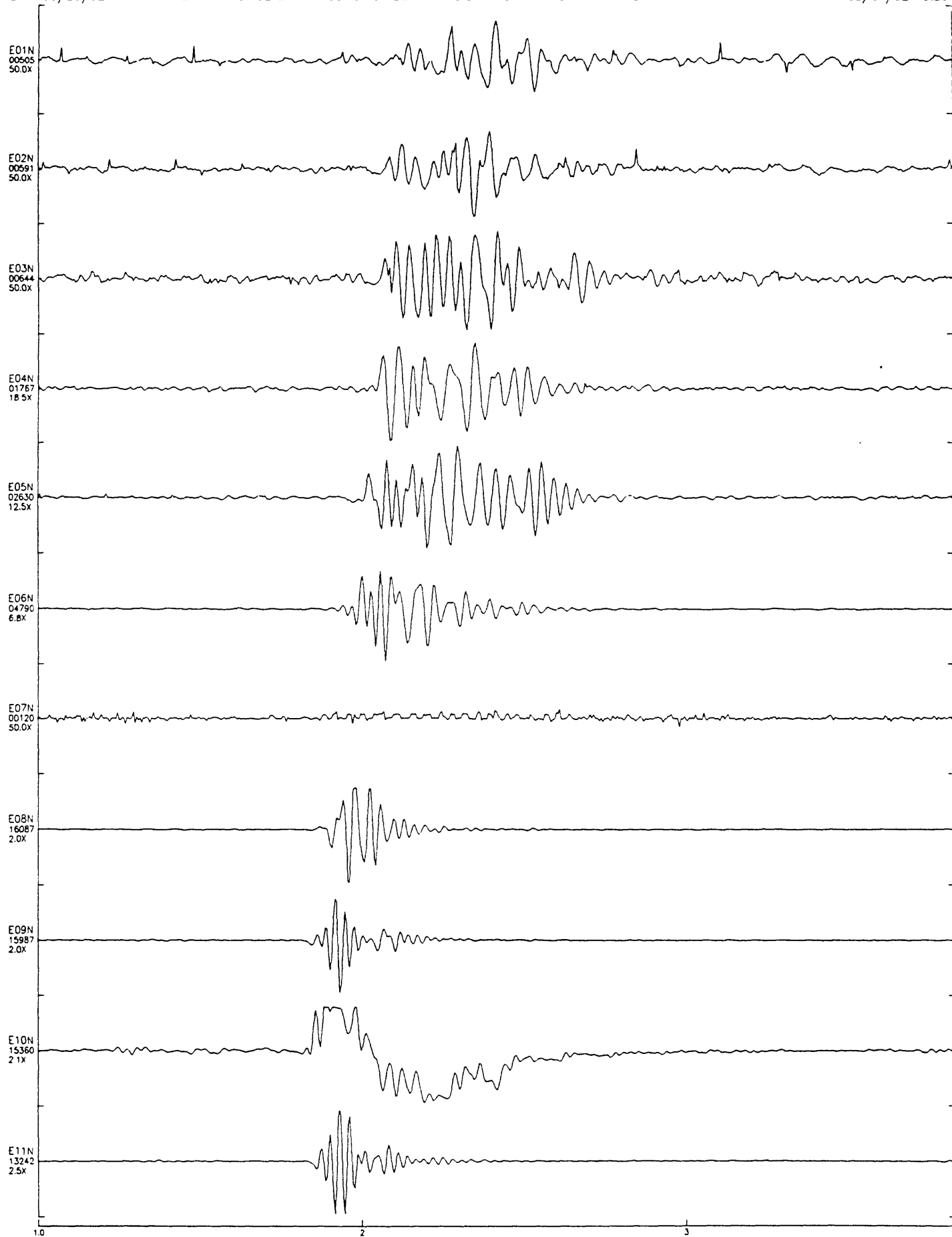
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Sheet 1
09/04/92 13.25



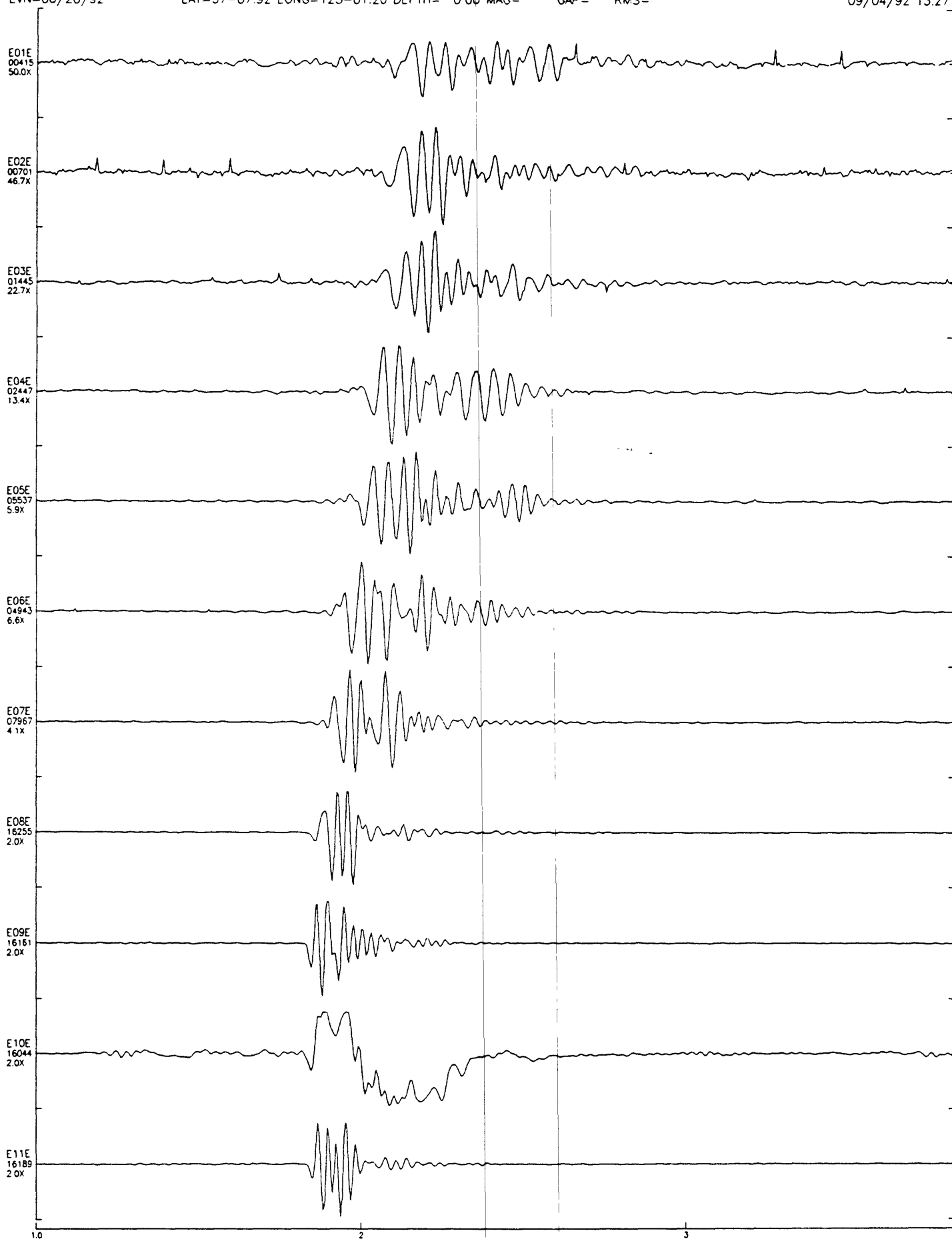
IST=08/21/92 00:15 01.908 SPS=200.321 DEC=1 D:\92082108.CT1
EVN=08/20/92 LAT=37-07 92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/04/92 13.26



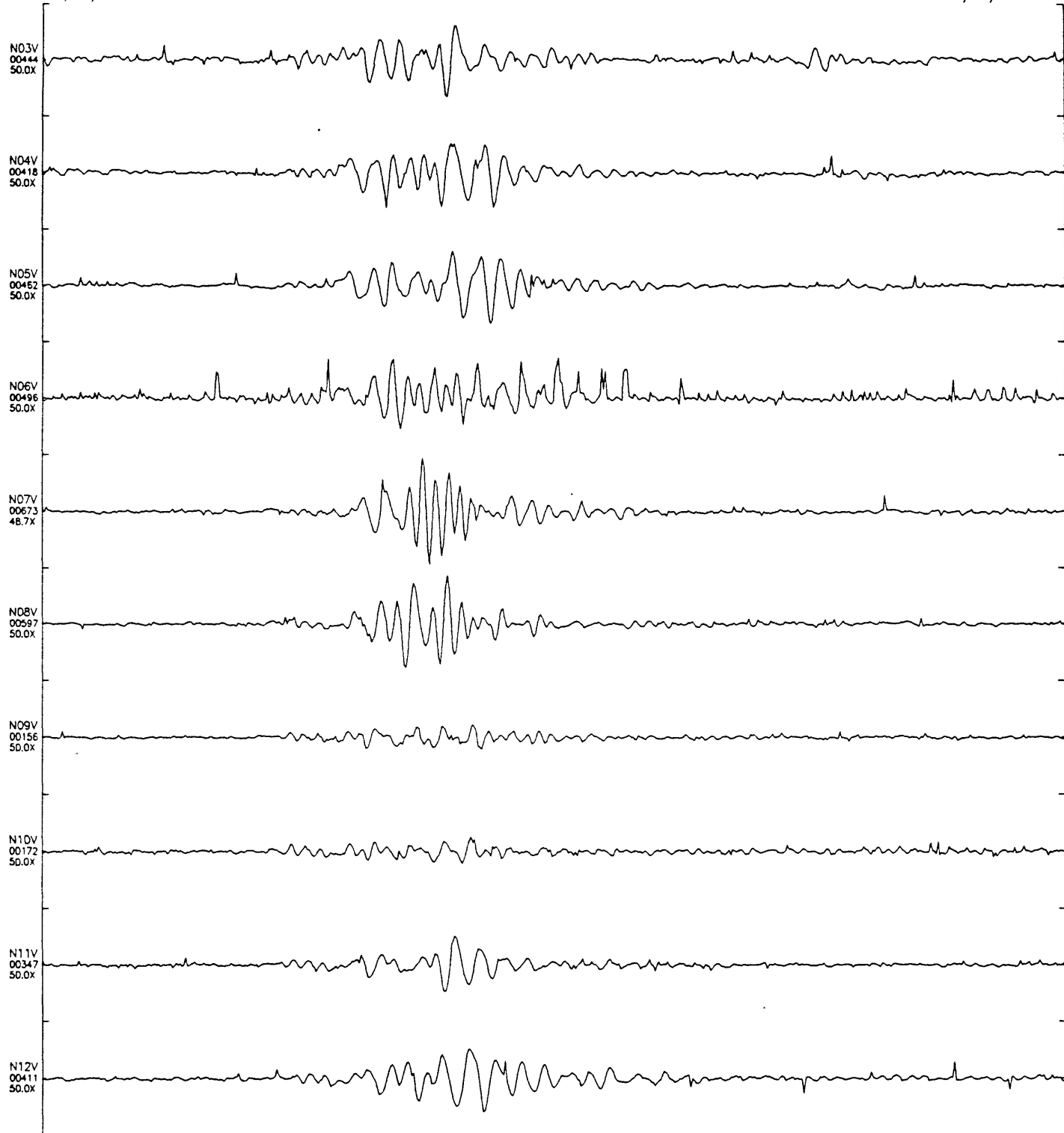
IST=08/21/92 00:15 01.908 SPS=200.321 DEC=1 D.\92082108.CT1
EVN=08/20/92 LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/04/92 13.27



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Sheet 1
09/08/92 14:03



1.0

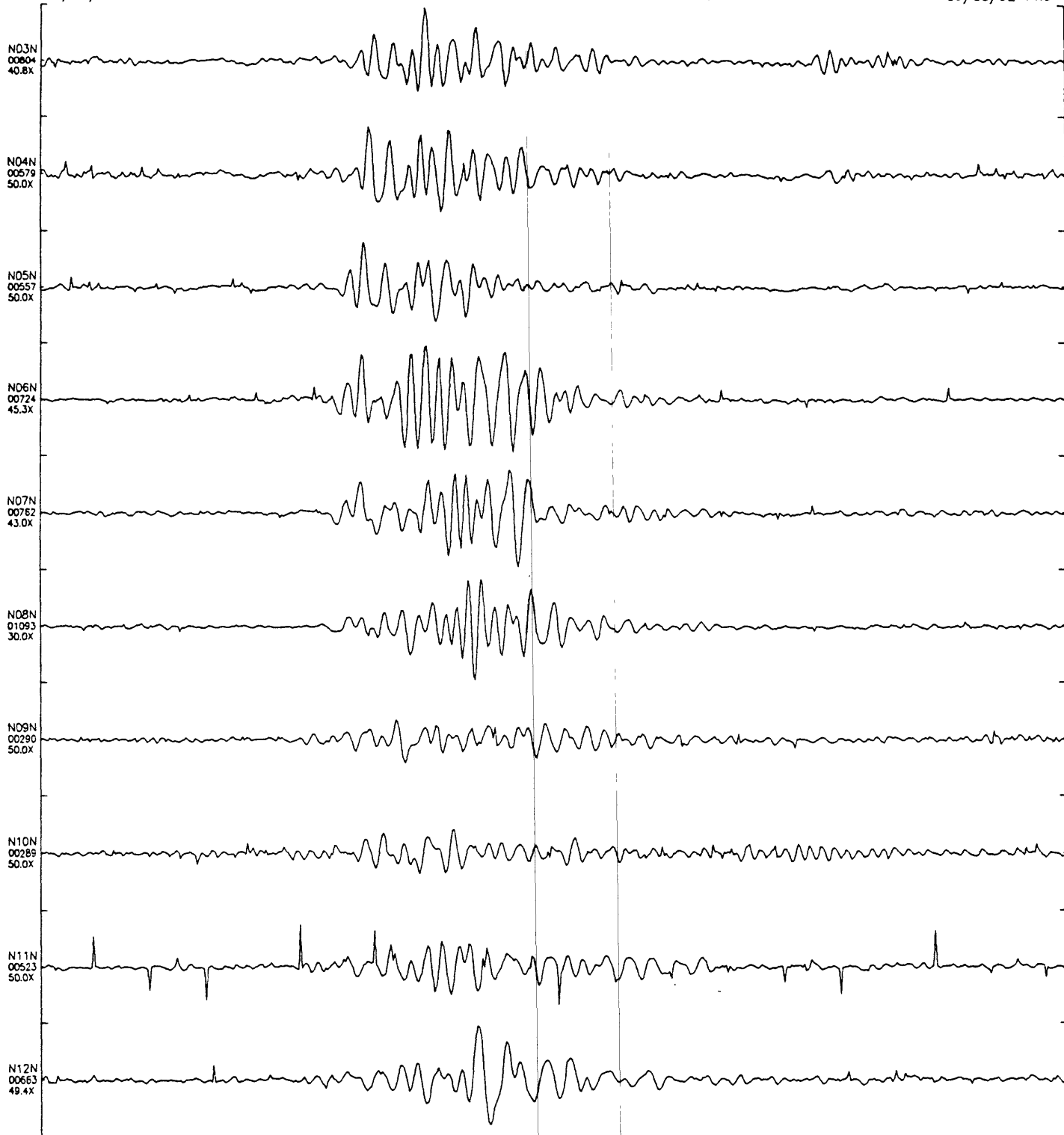
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180

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Sheet 1
09/08/92 14:04

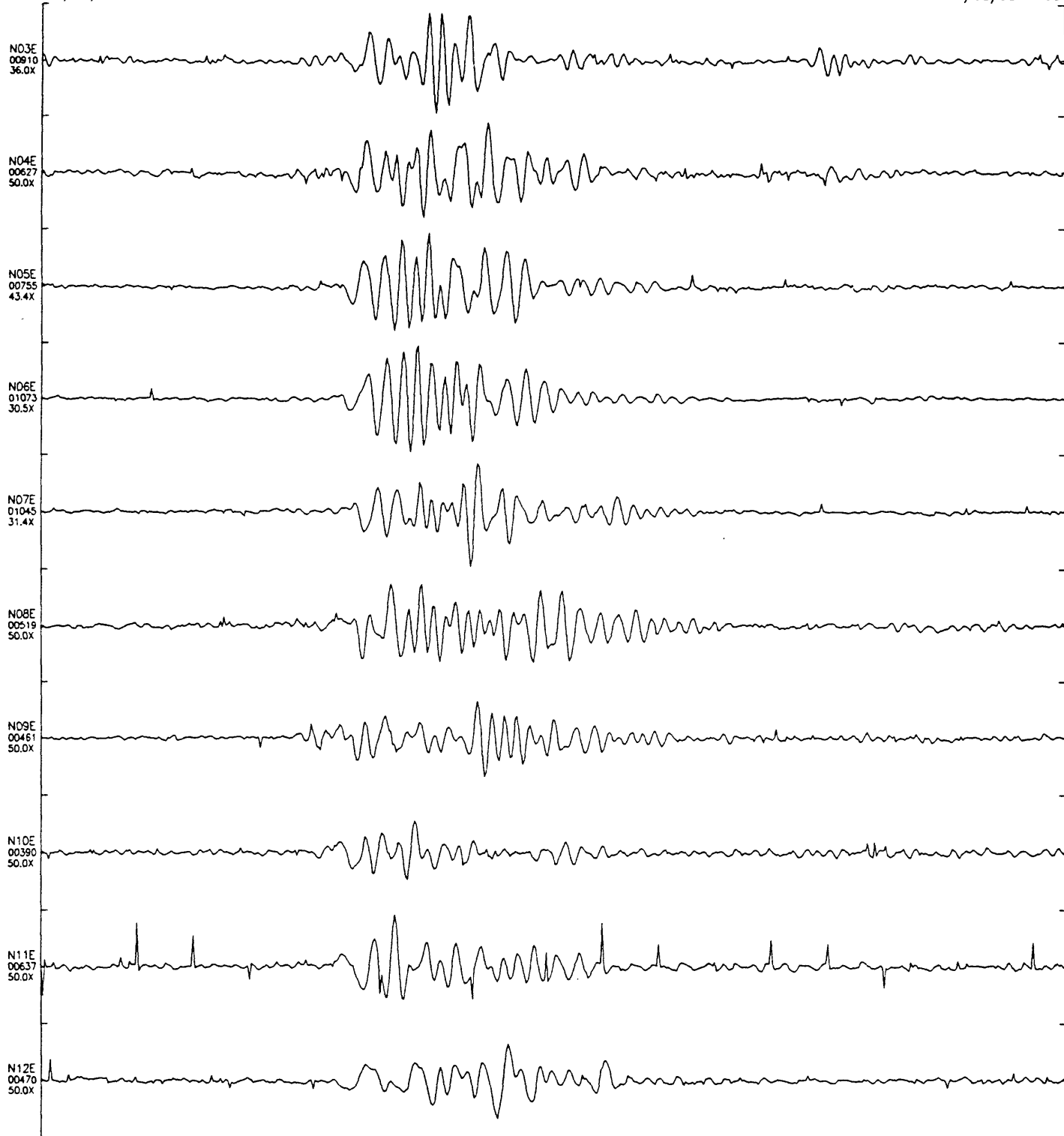


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Sheet 1
09/08/92 14:05



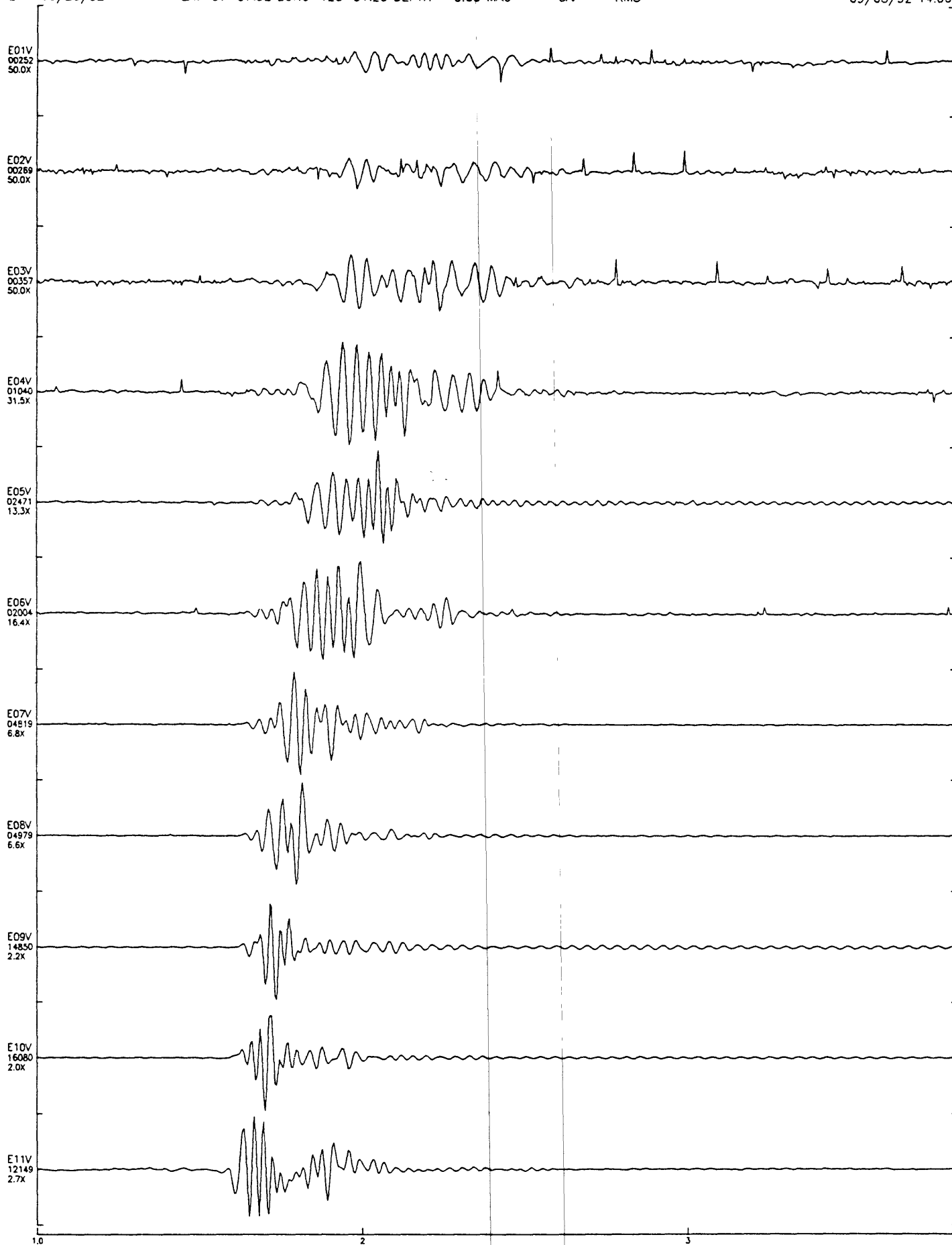
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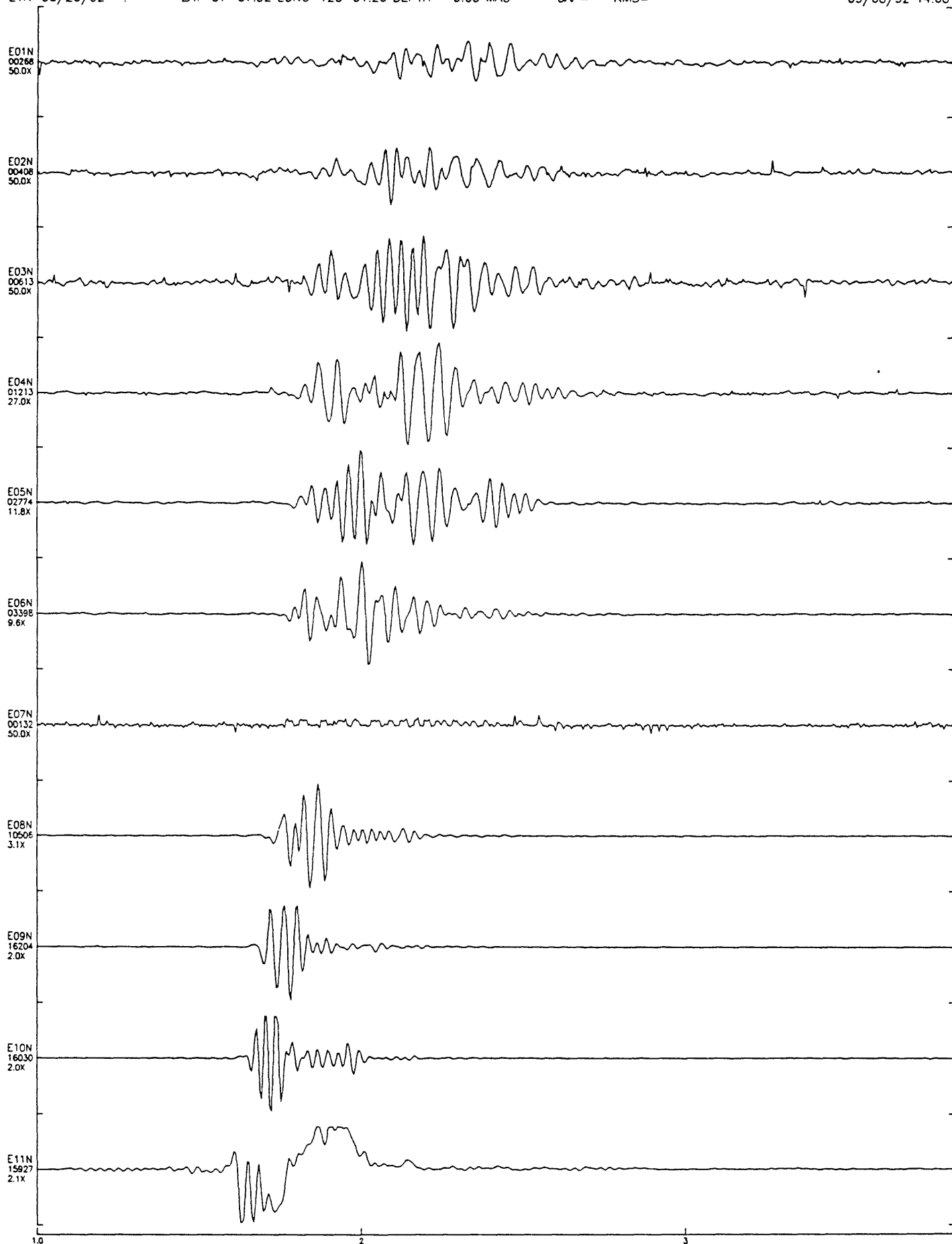
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EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/08/92 14:06



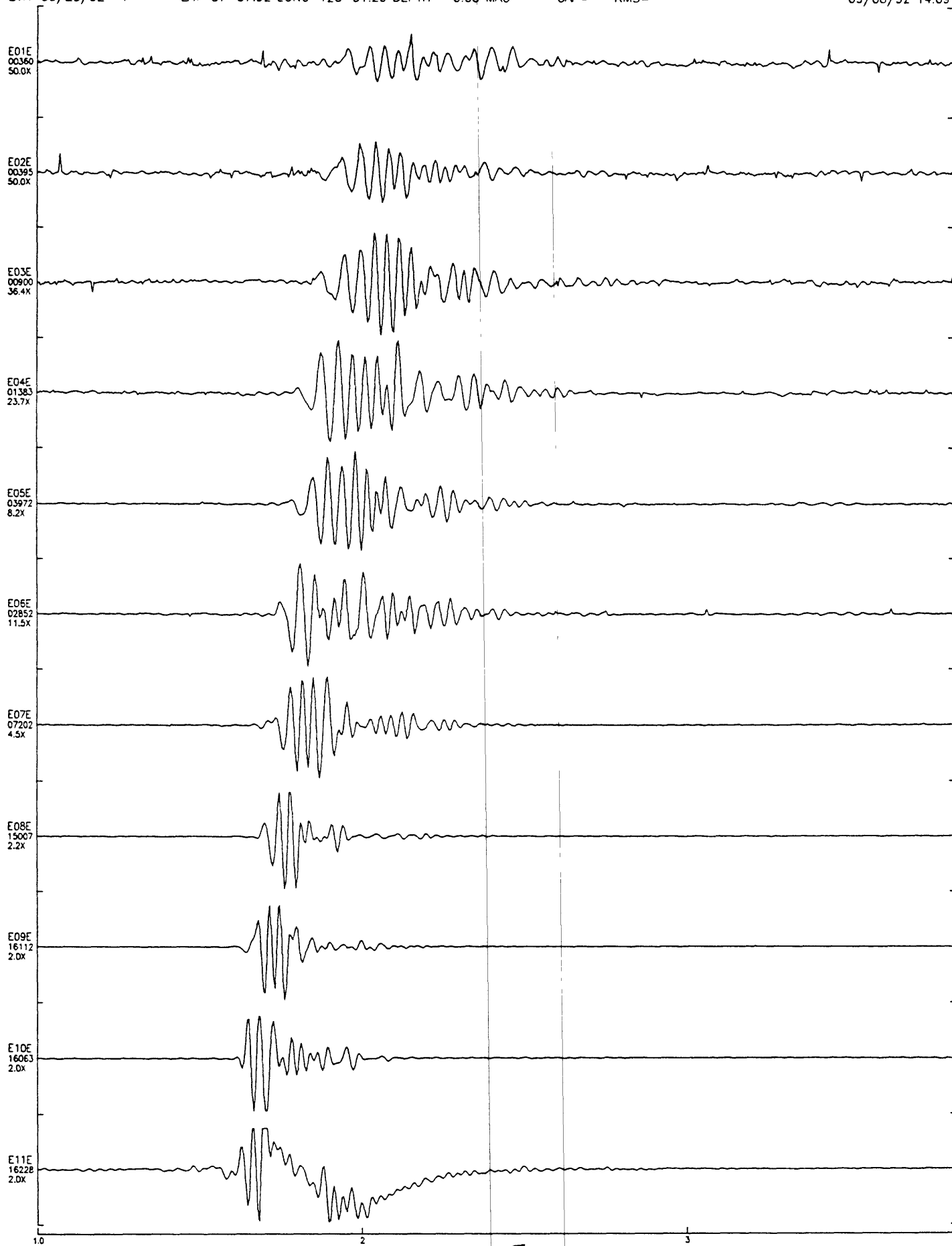
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Sheet 1
09/08/92 14:08



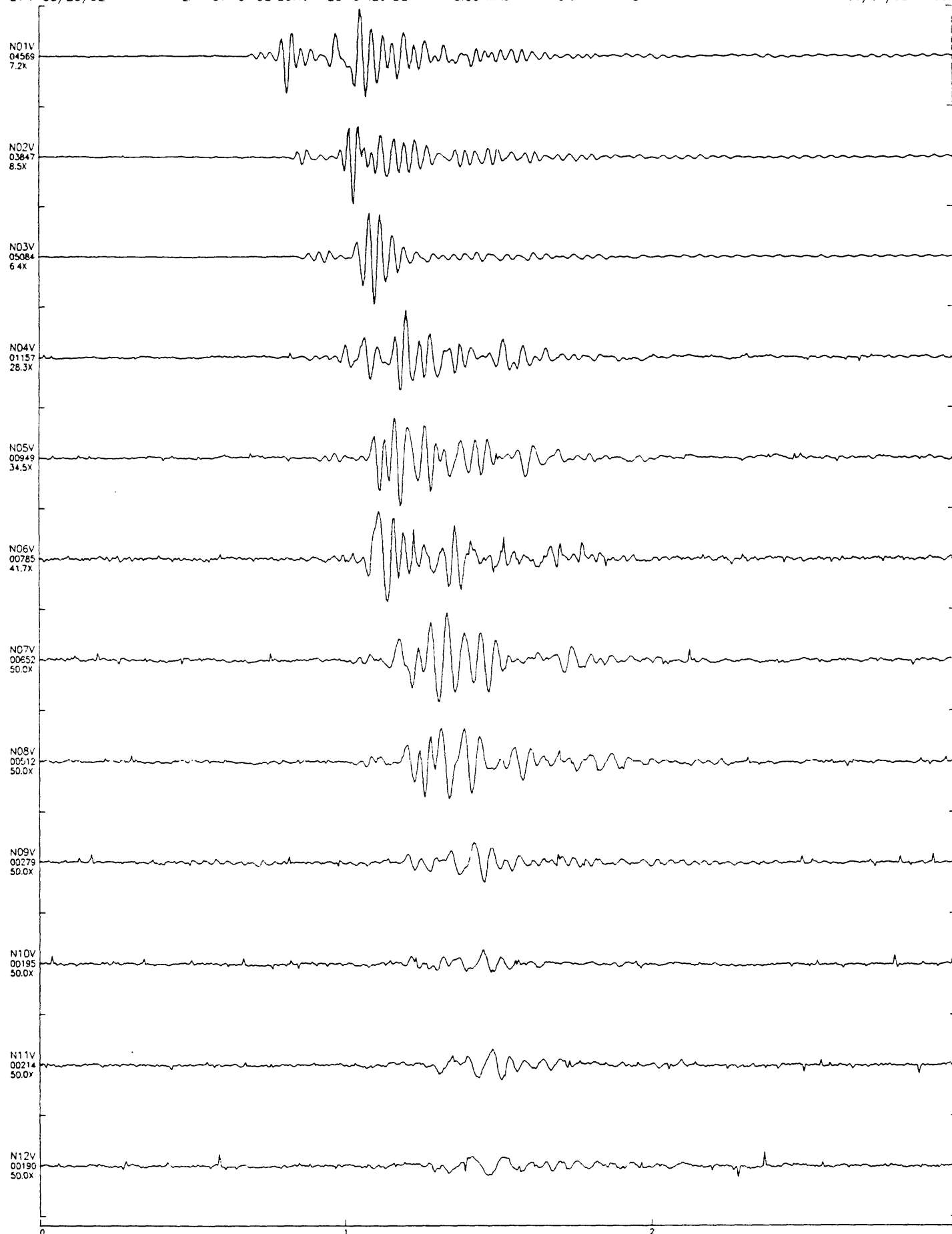
IST=08/21/92 00:17 18.649 SPS=200.321 DEC=1 D:\92082109.CT1
EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/08/92 14:09



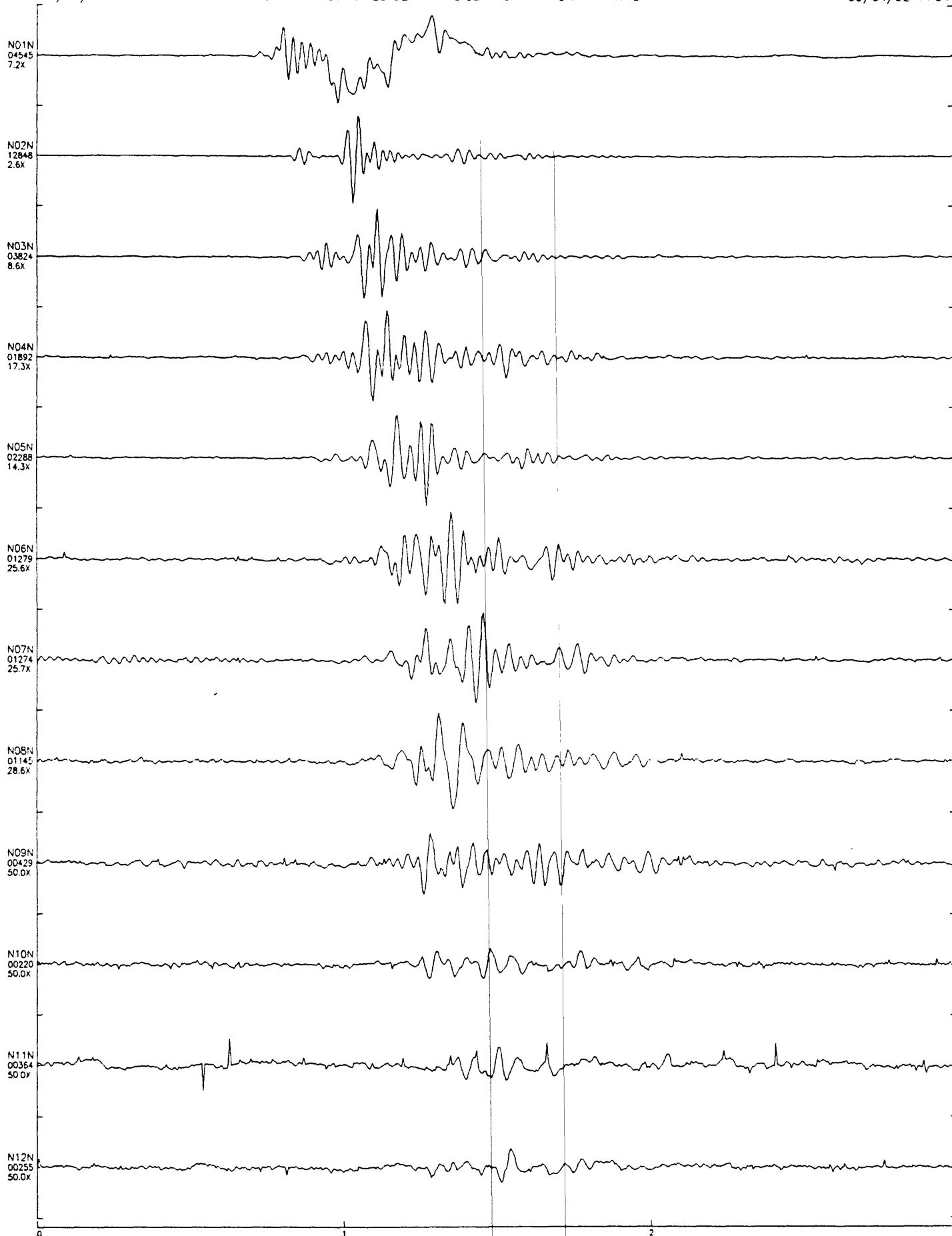
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Sheet 1
09/04/92 14.53



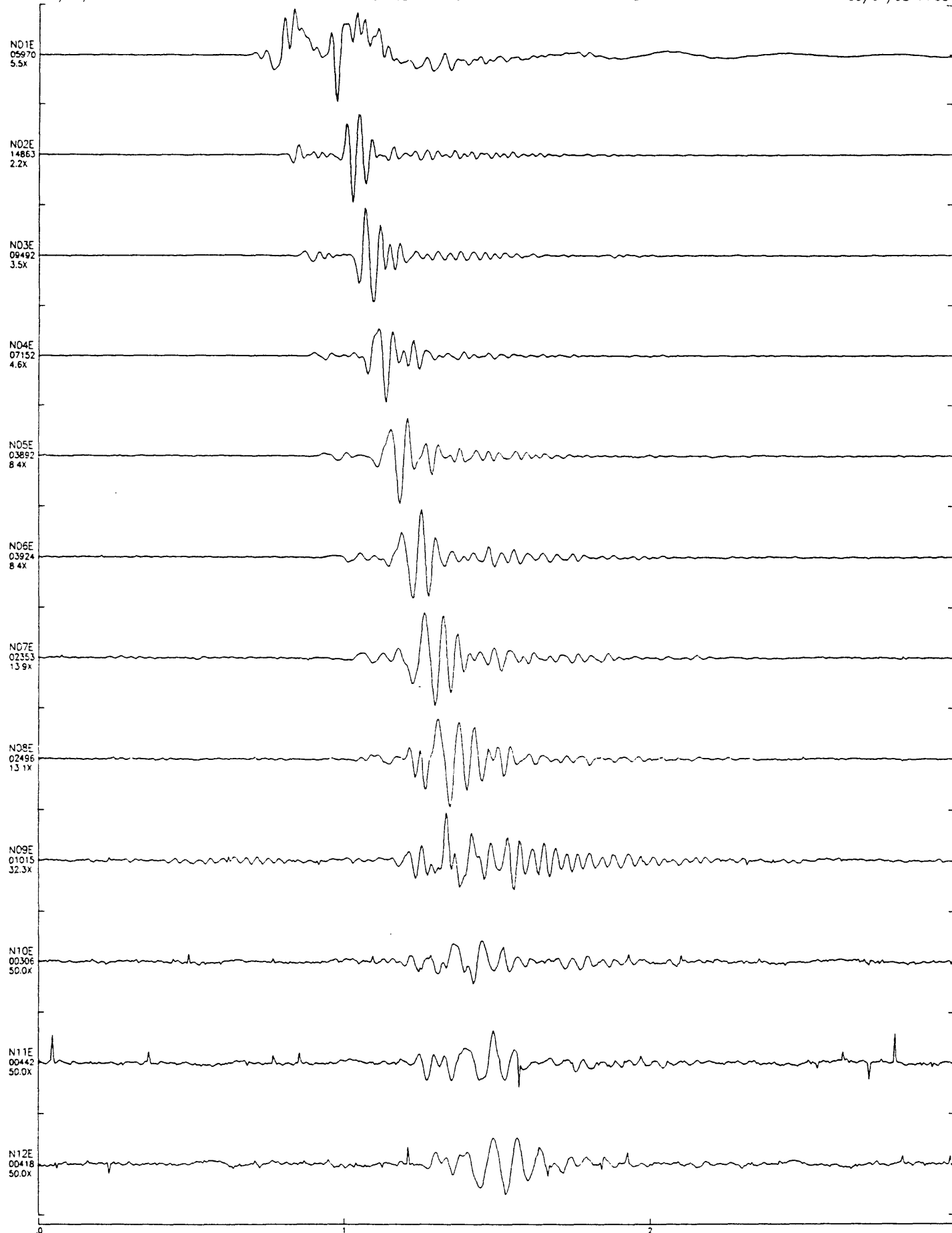
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EVN=08/20/92 LAT=37-07 92 LONG=123-01 20 DEPTH= 0 00 MAG= GAP= RMS=

Sheet 1
09/04/92 14 54



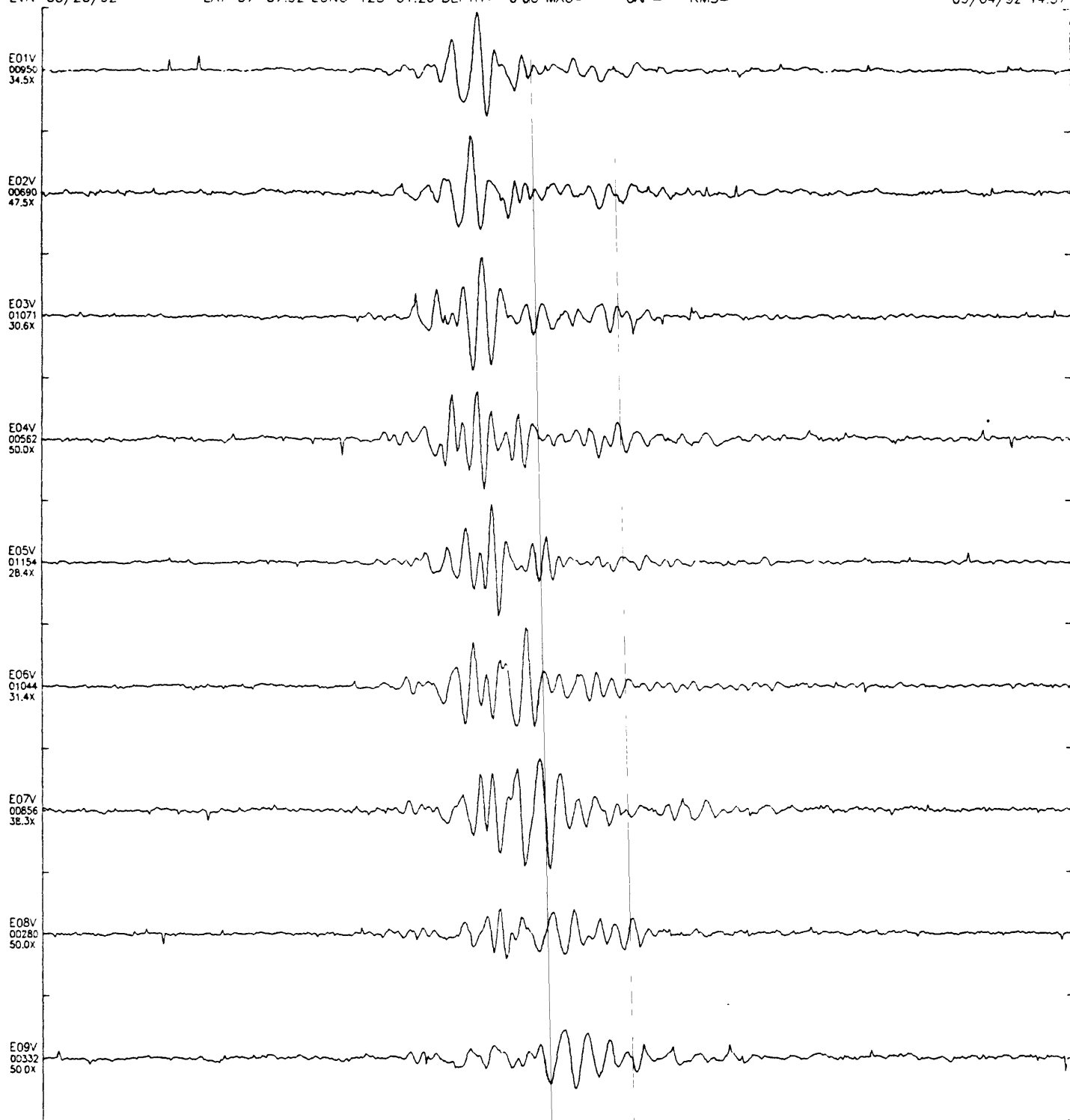
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Sheet 1
09/04/92 14 55



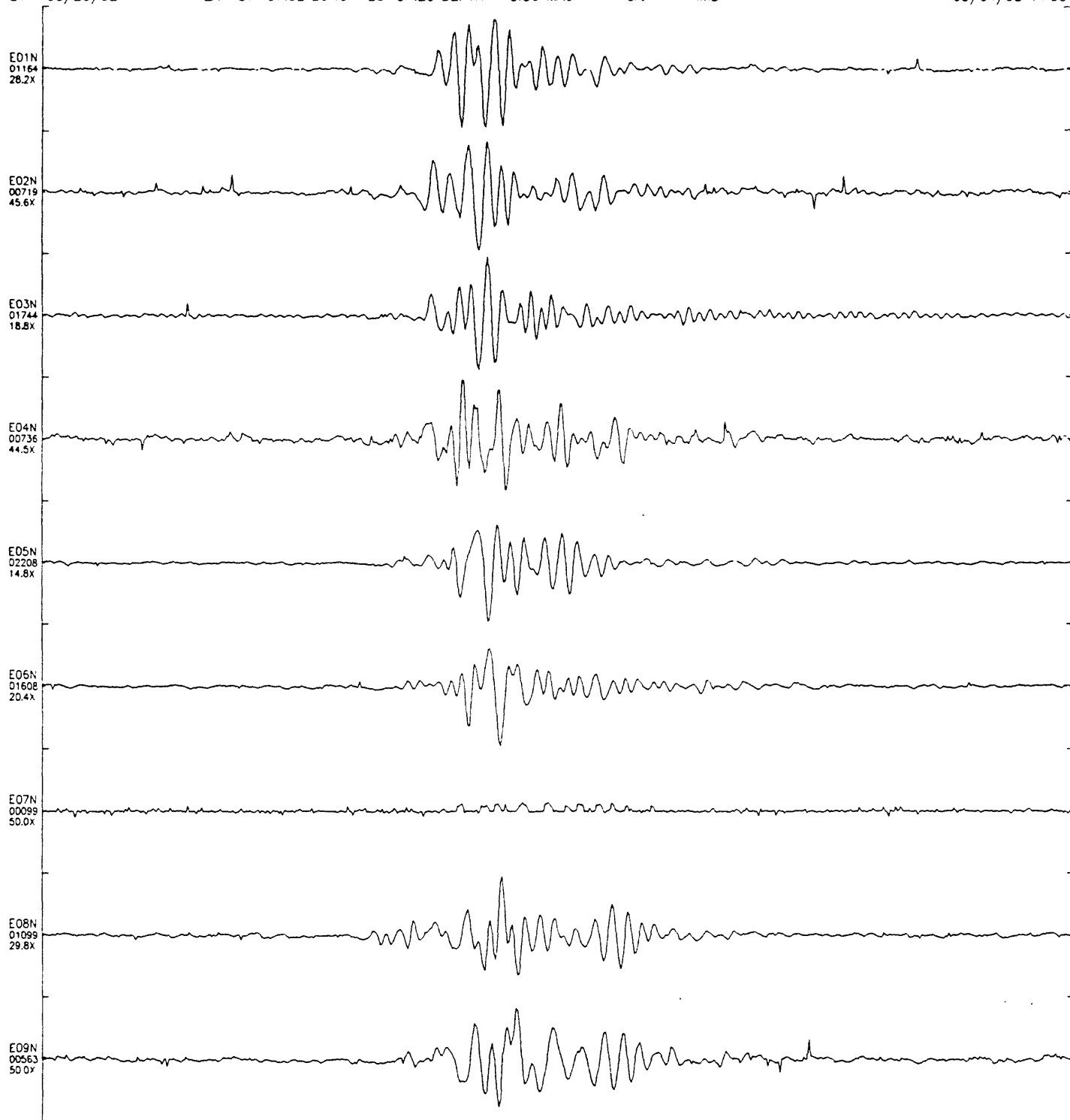
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09/04/92 14:57



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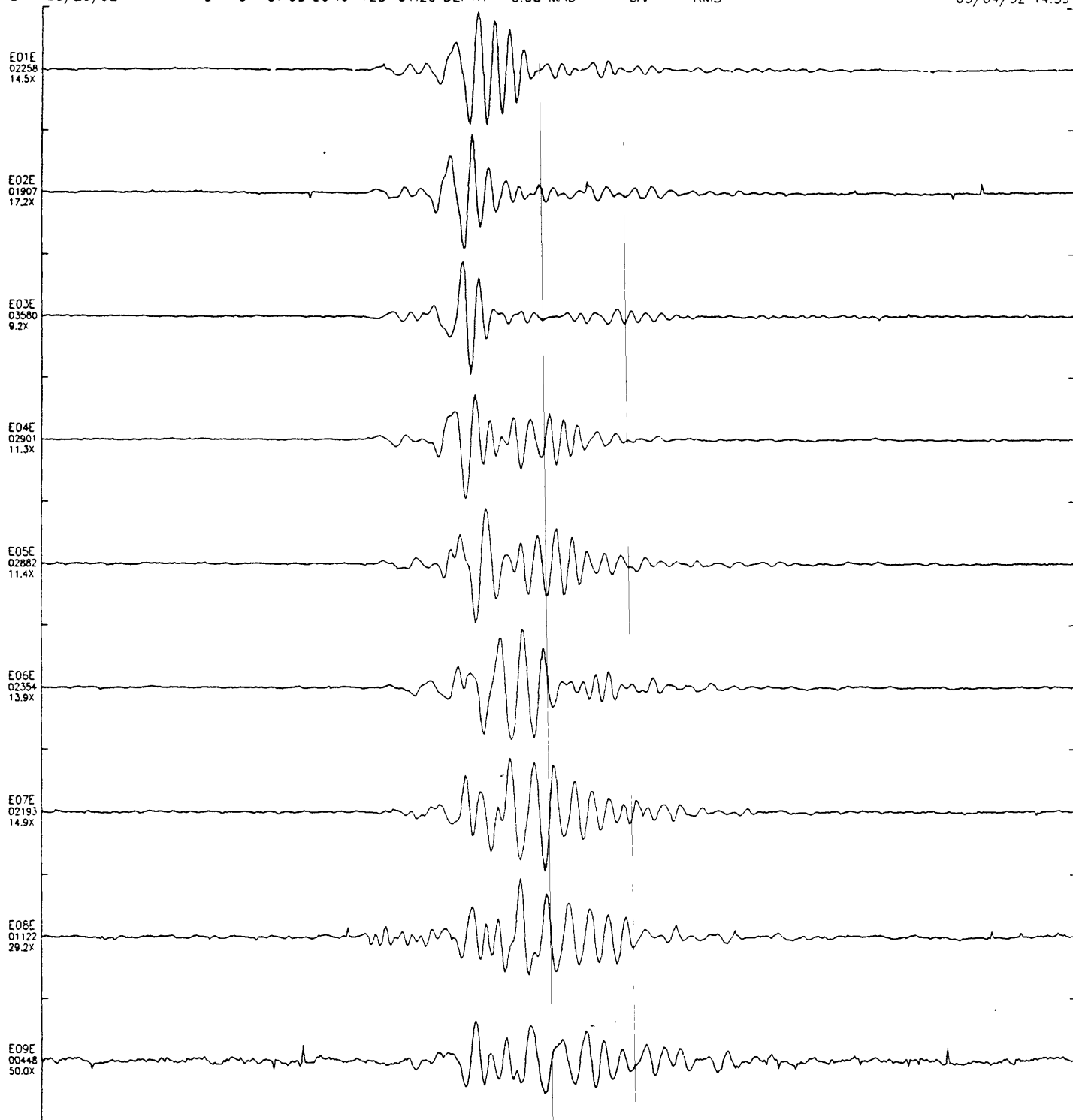
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09/04/92 14 58



0 1 2

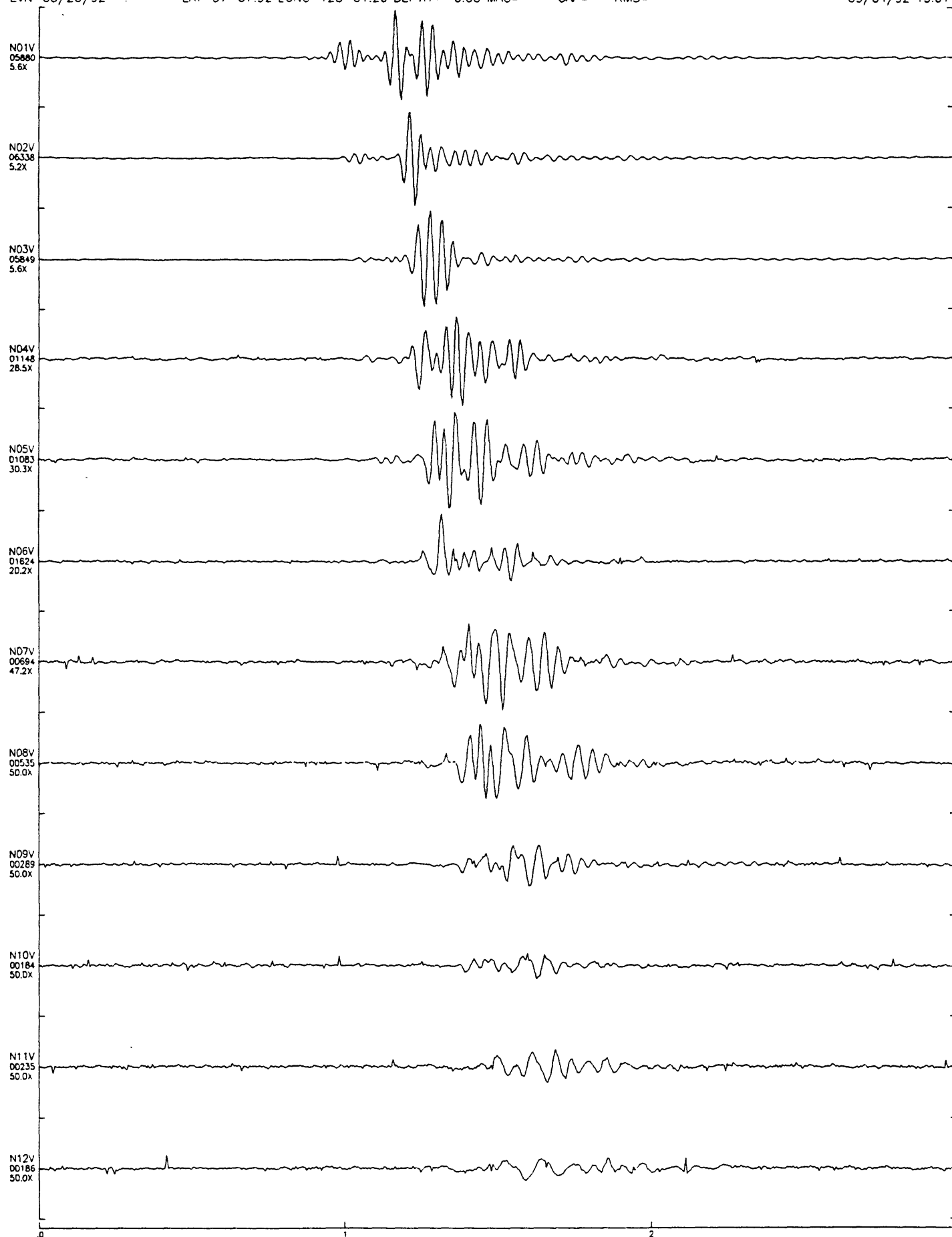
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Sheet 1
09/04/92 14:59



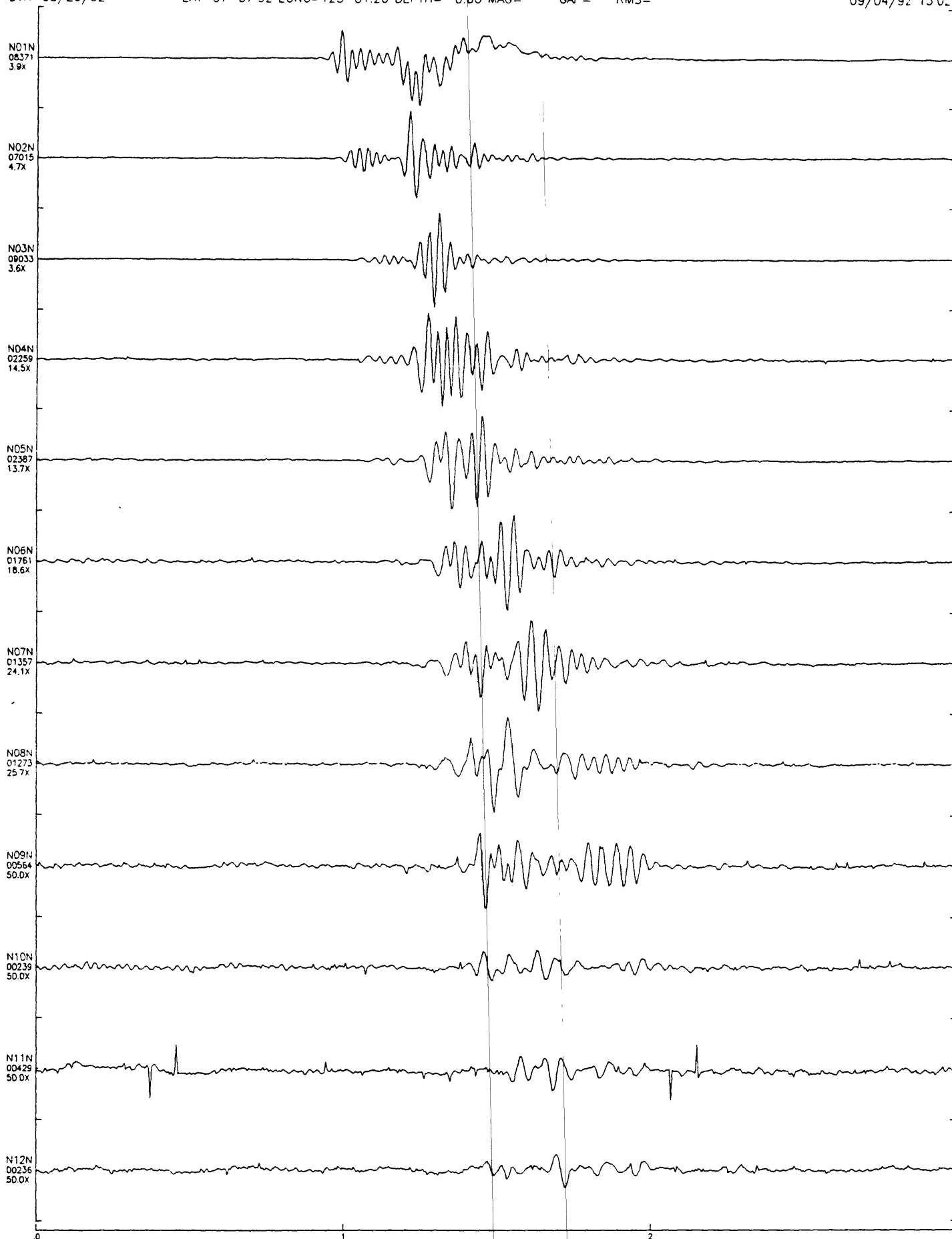
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Sheet 1
09/04/92 15:01



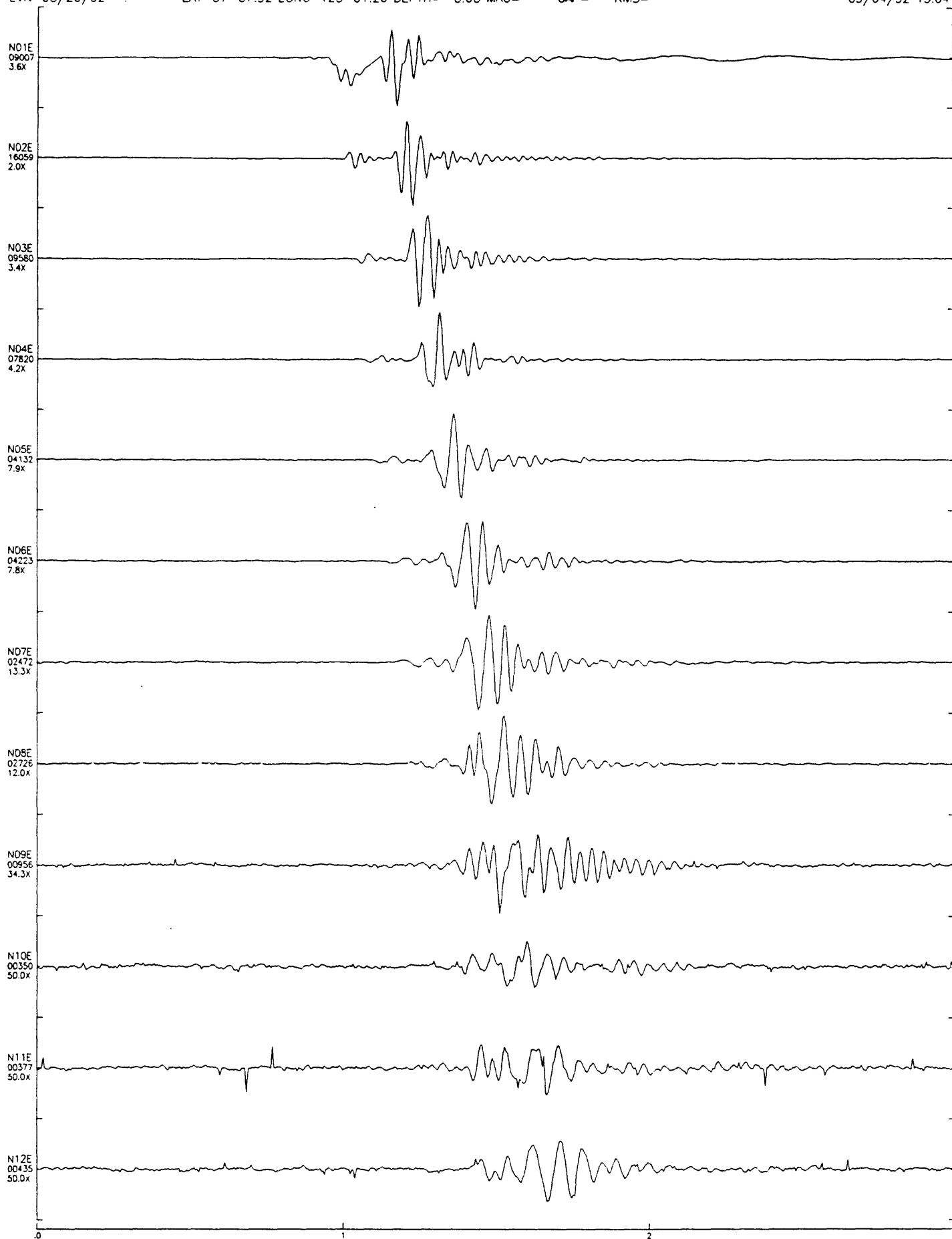
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EVN=08/20/92 LAT=37-07 92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

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09/04/92 15 02



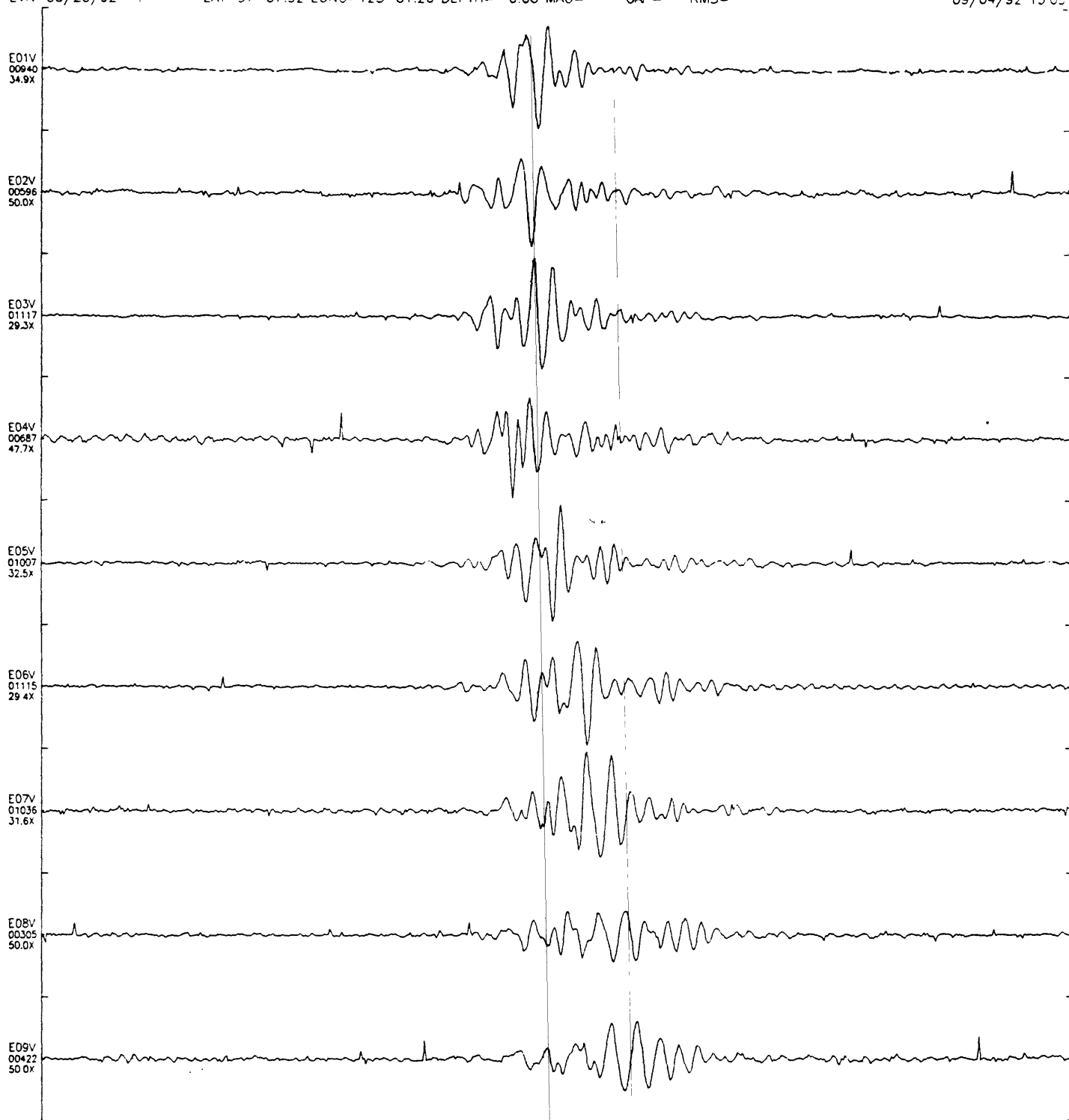
IST=08/20/92 20:28 07.270 SPS=200.321 DEC=1 D:\92082003.CT2
EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/04/92 15:04



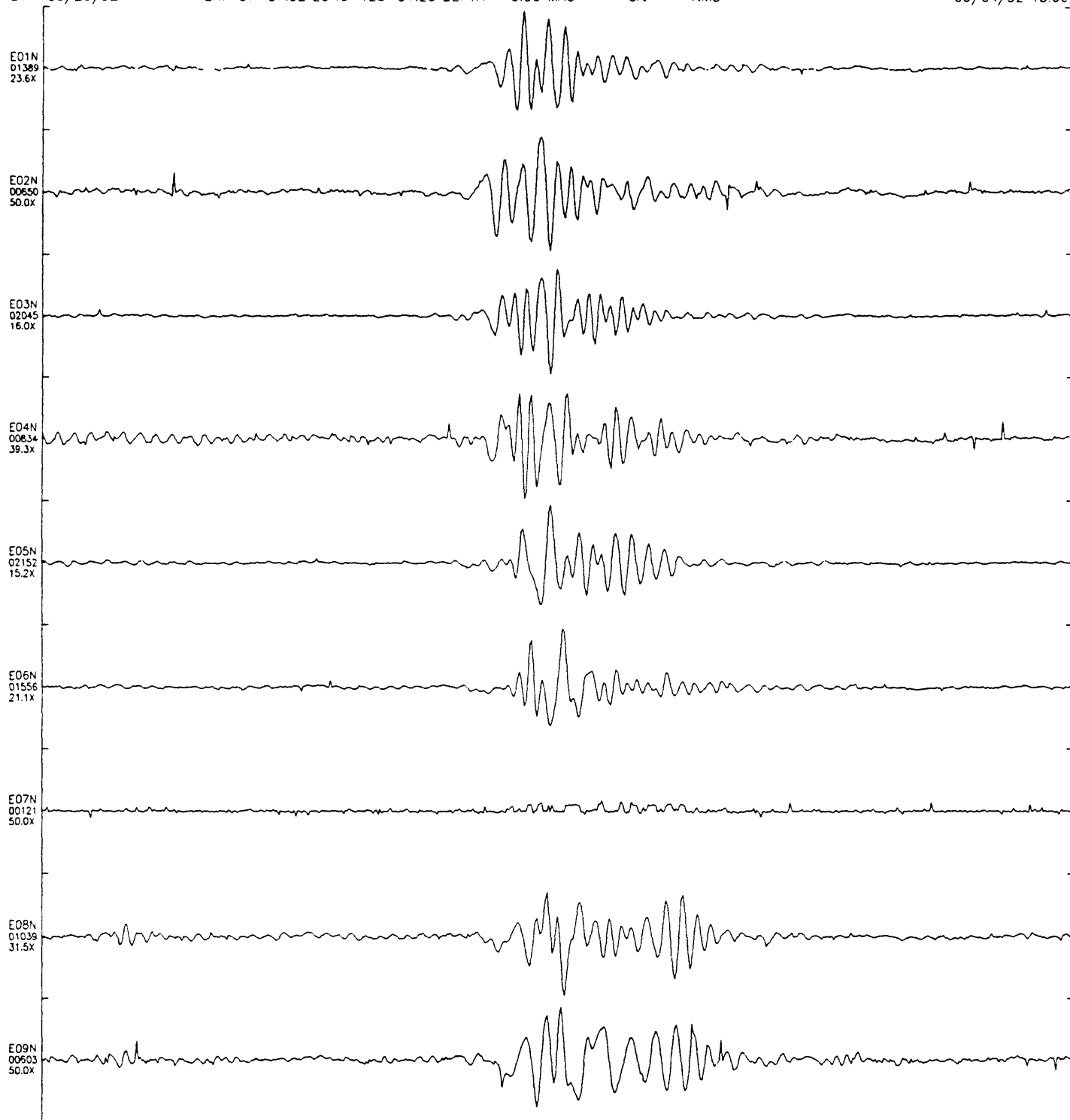
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Sheet 1
09/04/92 15 05



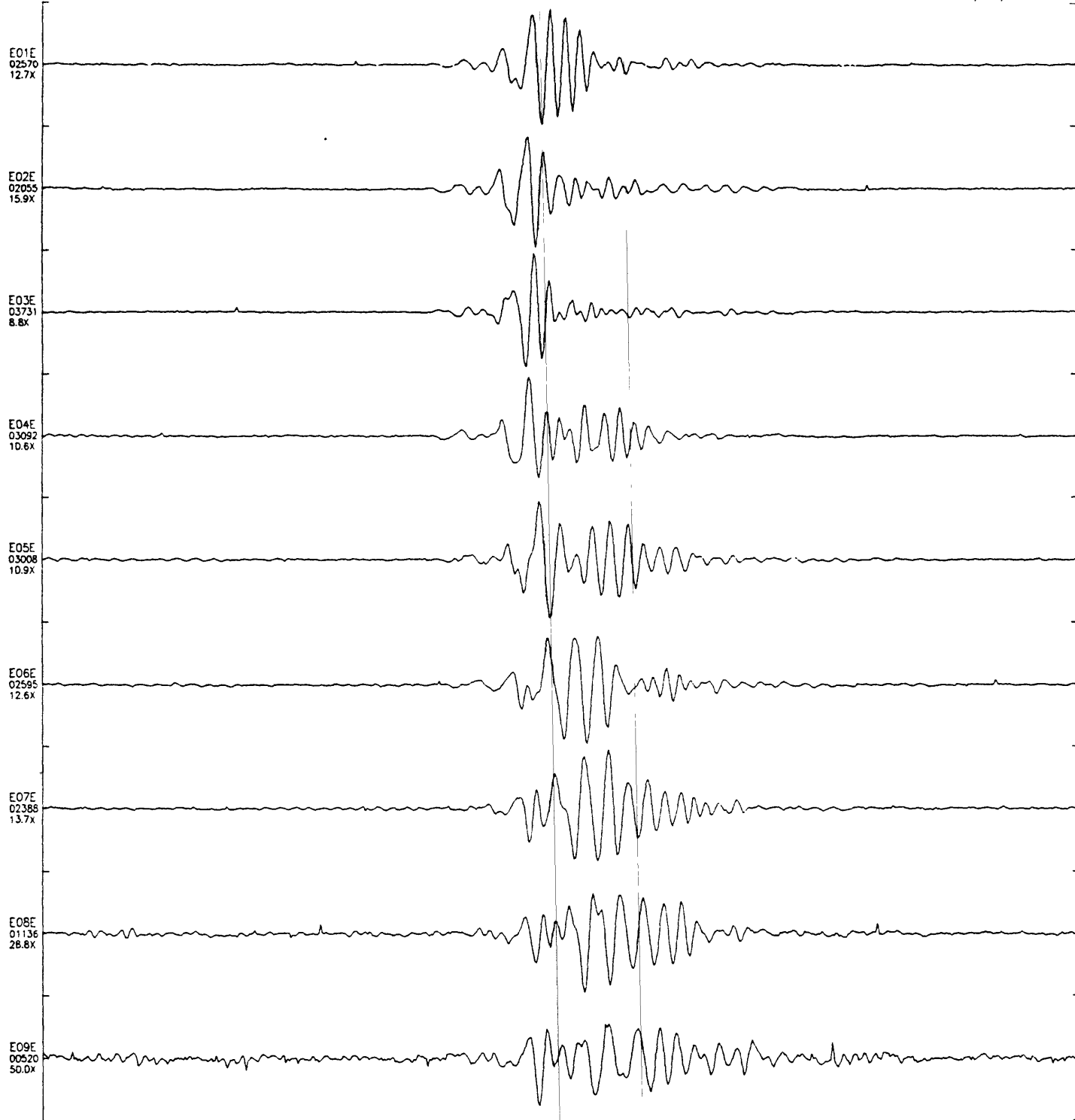
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EVN=08/20/92 LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/04/92 15:06



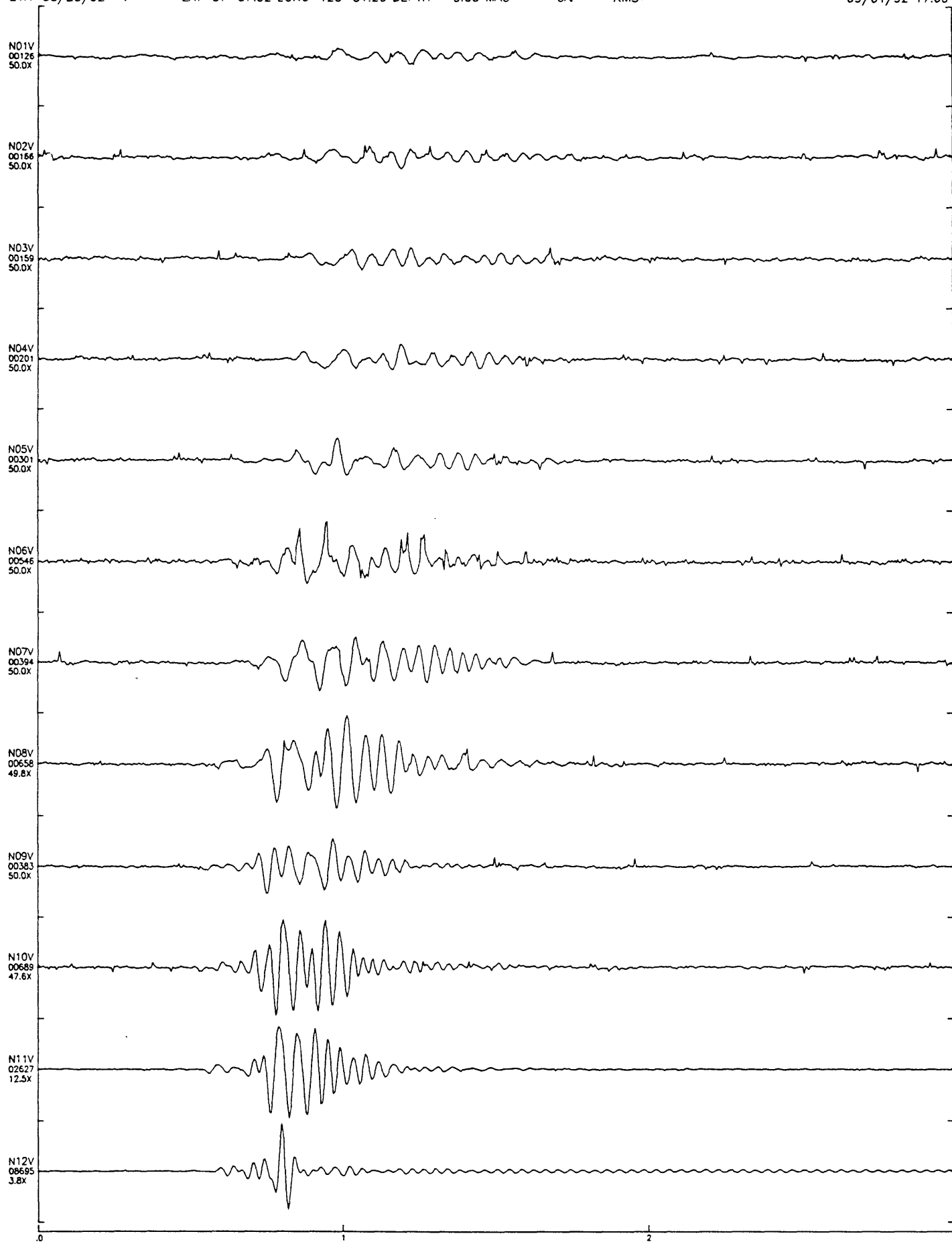
IST=08/20/92 20:28 07.270 SPS=200.321 DEC=1 D.\92082003.CT2
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Sheet 1
09/04/92 15:05



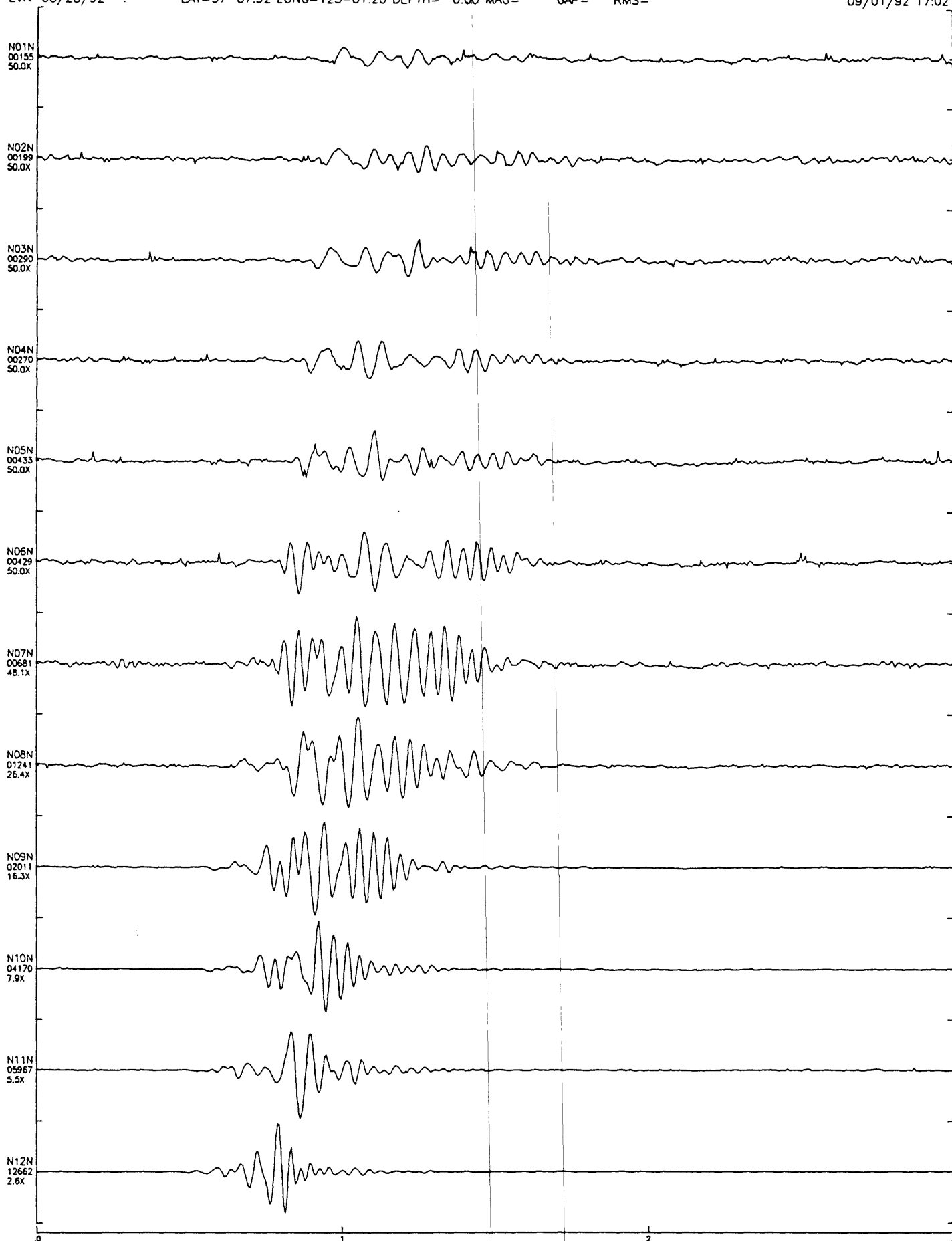
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Sheet 1
09/01/92 17:00



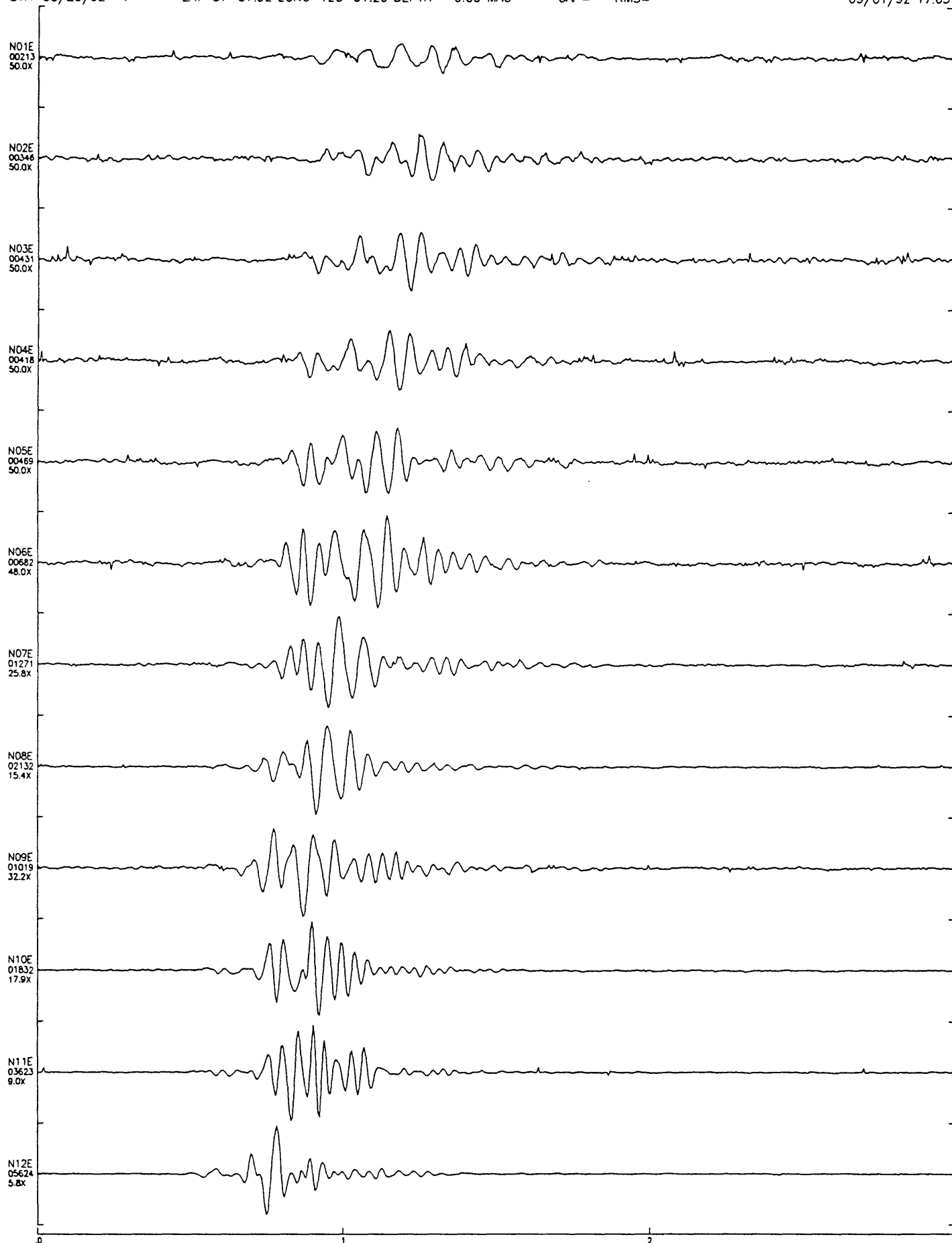
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Sheet 1
09/01/92 17:02



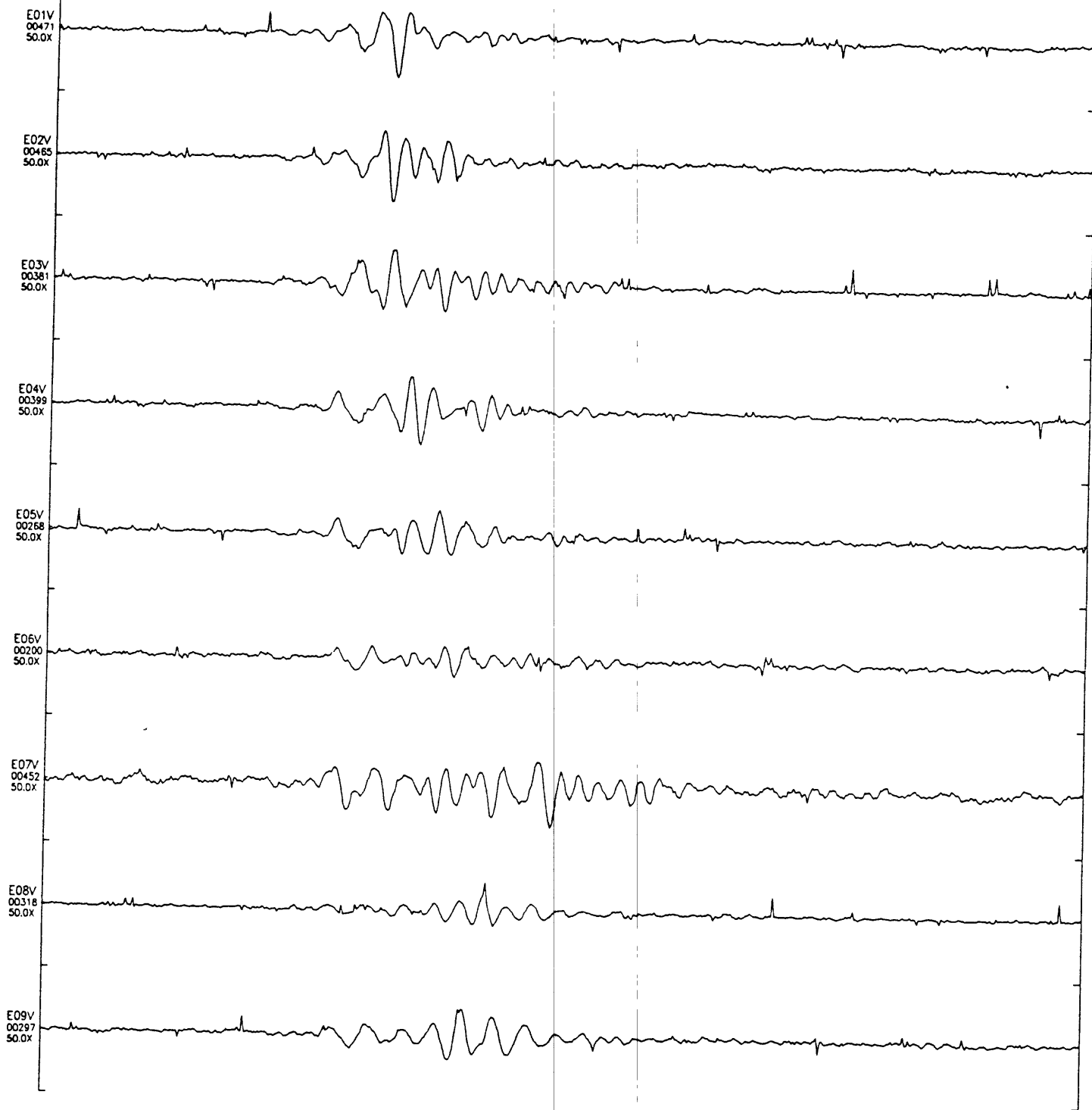
IST=08/20/92 21:15 02.496 SPS=200.321 DEC=1 D:\92082008.CT1
EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/01/92 17:03



IST=08/20/92 21:15 02.496 SPS=200.321 DEC=1 D:\92082008.CT1
EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

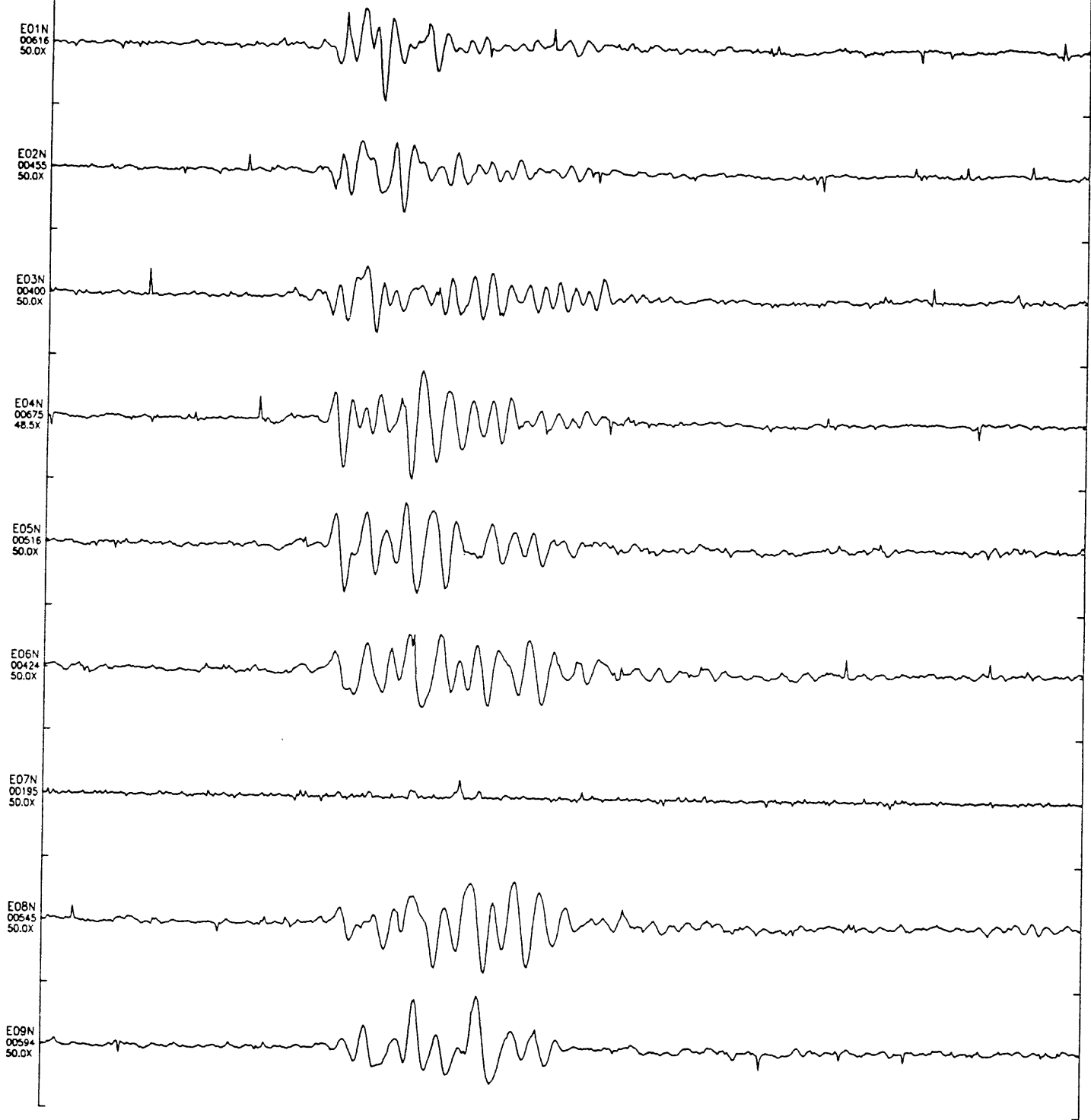
Sheet 1
09/01/92 17:04



IST=08/20/92 21:15 02.496 SPS=200.321 DEC=1 D:\92082008.CT1
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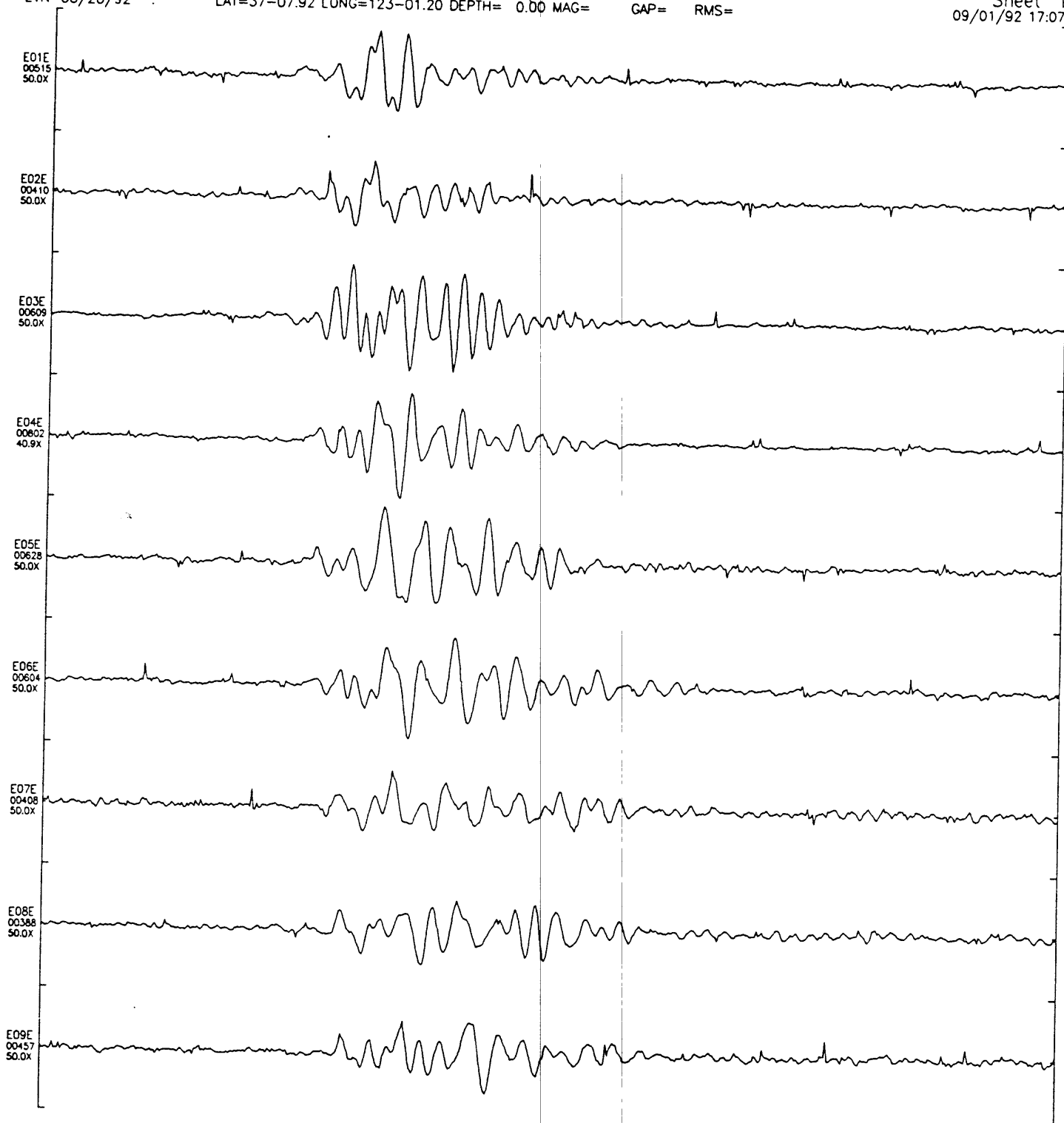
GAP= RMS=

Sheet 1
09/01/92 17:06



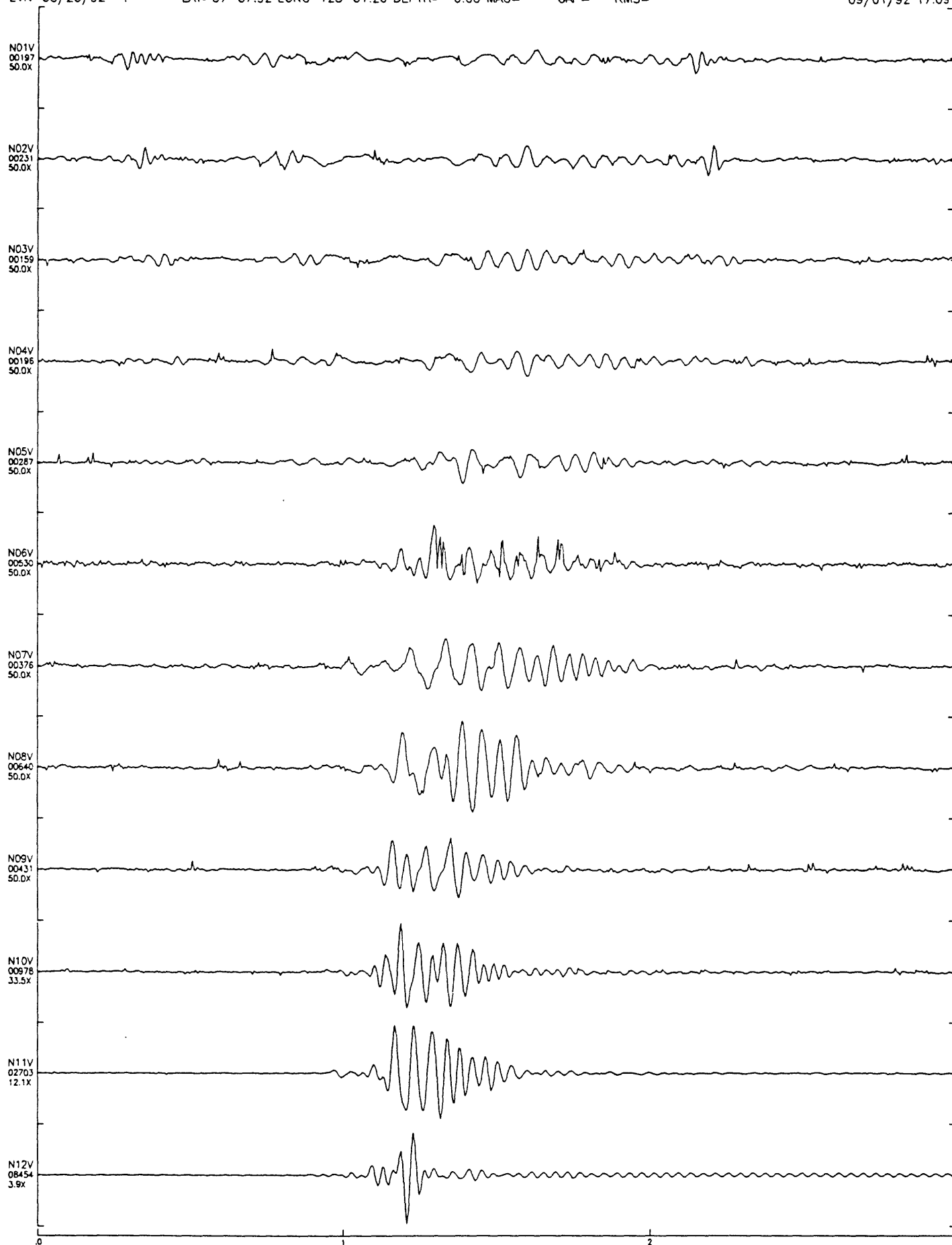
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Sheet 1
09/01/92 17:07



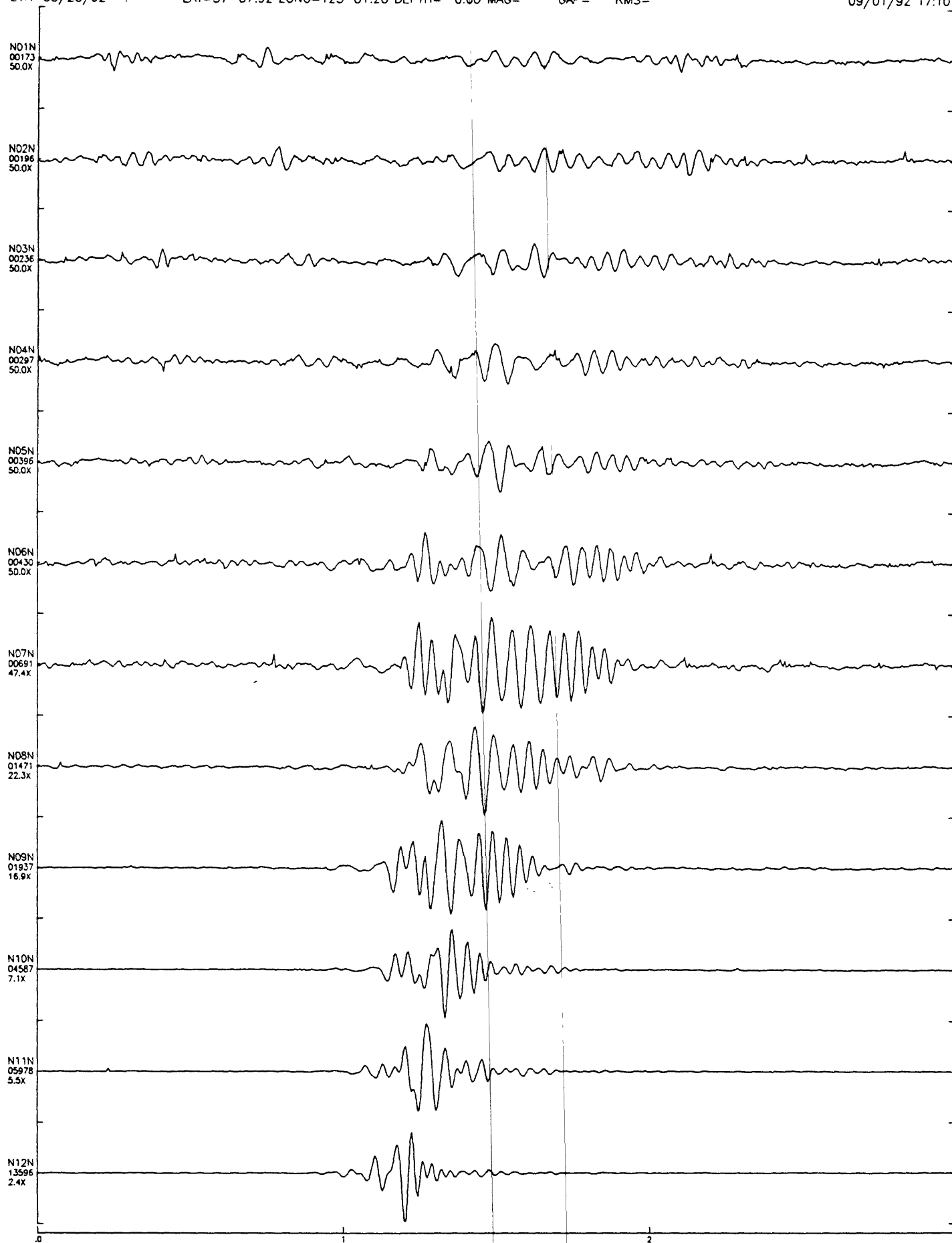
IST=08/20/92 21:15 12.720 SPS=200.321 DEC=1 D:\92082008.CT2
EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

Sheet 1
09/01/92 17:09



IST=08/20/92 21:15 12.720 SPS=200.321 DEC=1 D:\92082008.CT2
EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

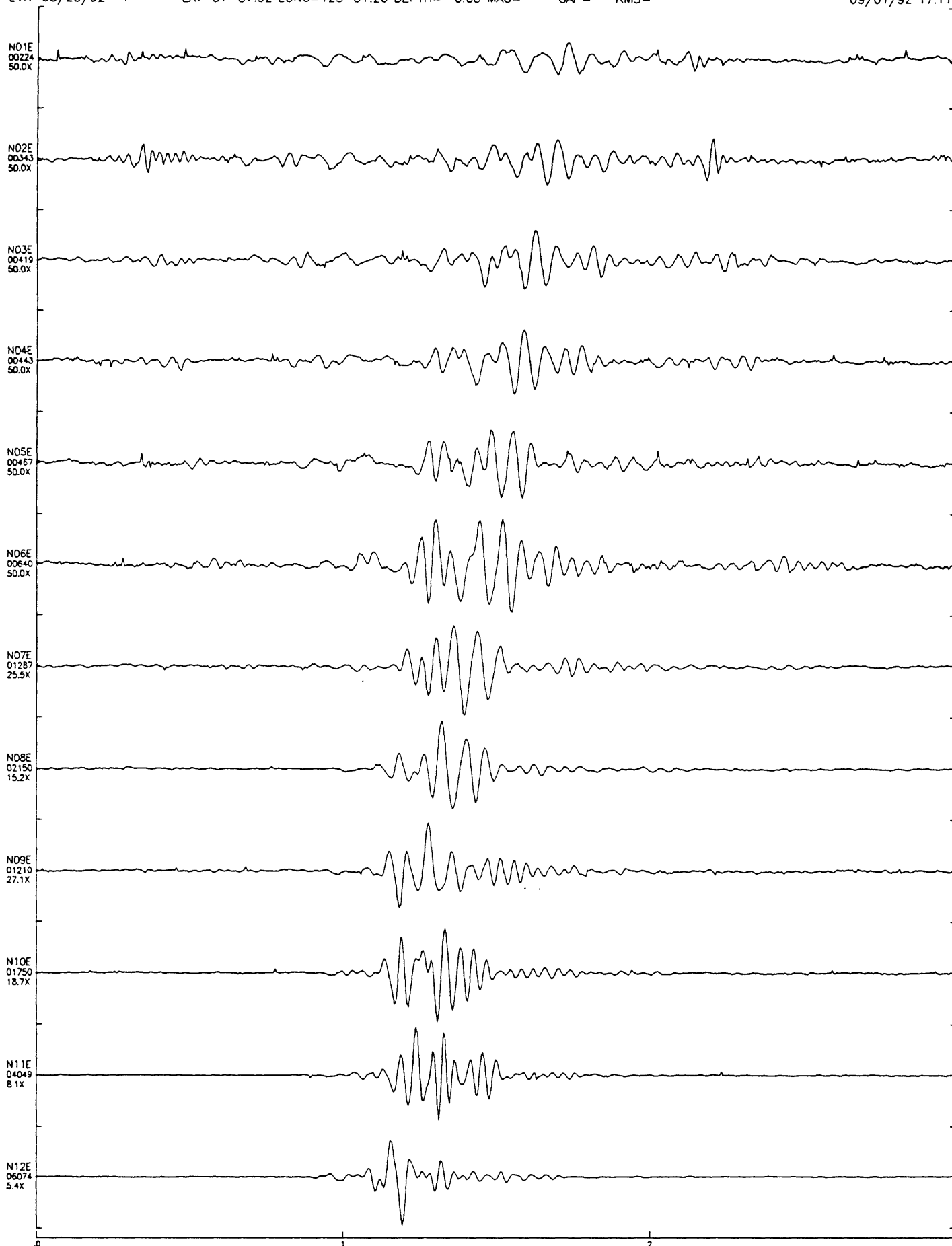
Sheet 1
09/01/92 17:10



205

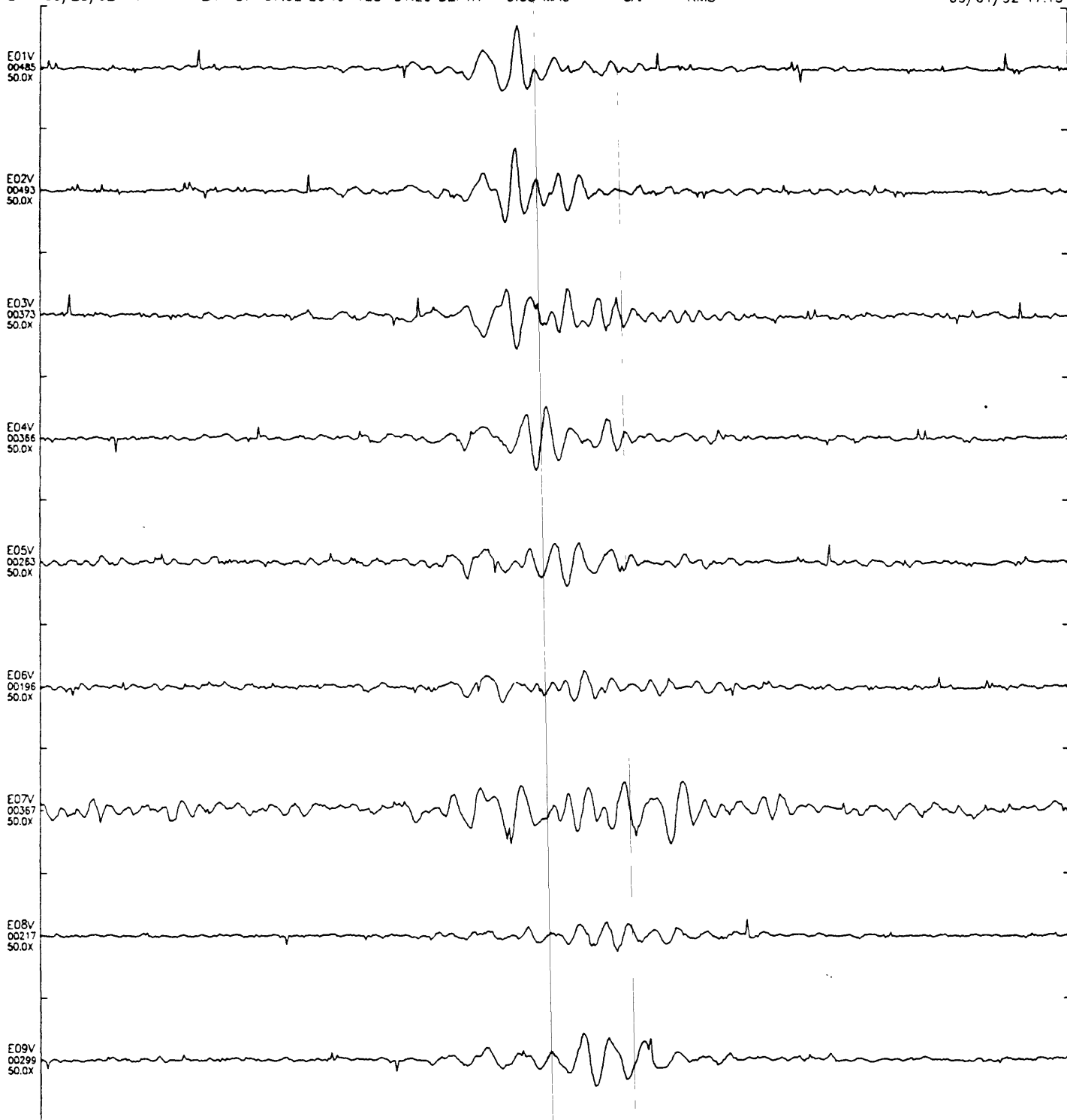
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Sheet 1
09/01/92 17:11



IST=08/20/92 21:15 12.720 SPS=200.321 DEC=1 D:\92082008.CT2
EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

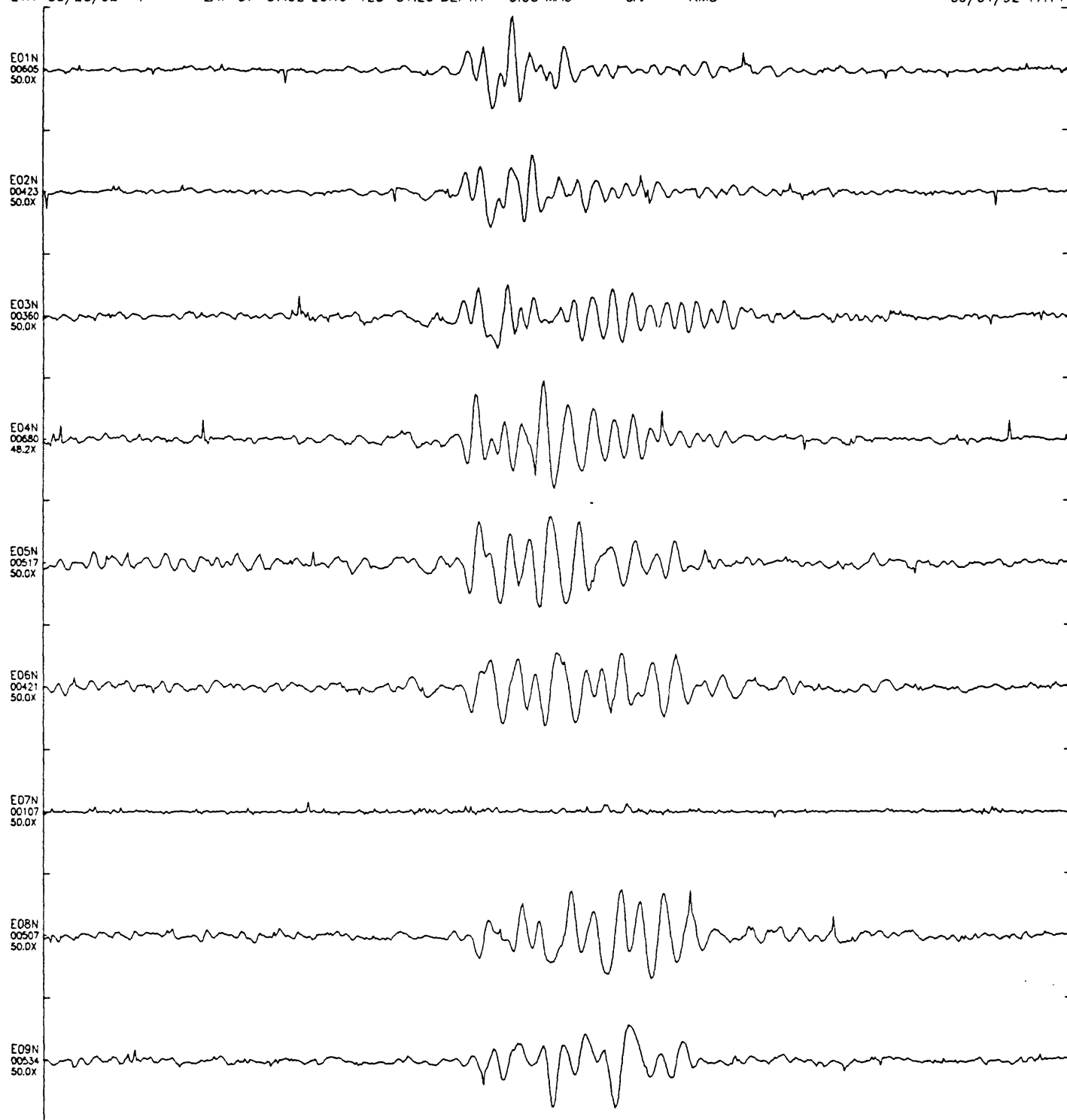
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09/01/92 17:13



0 1 2

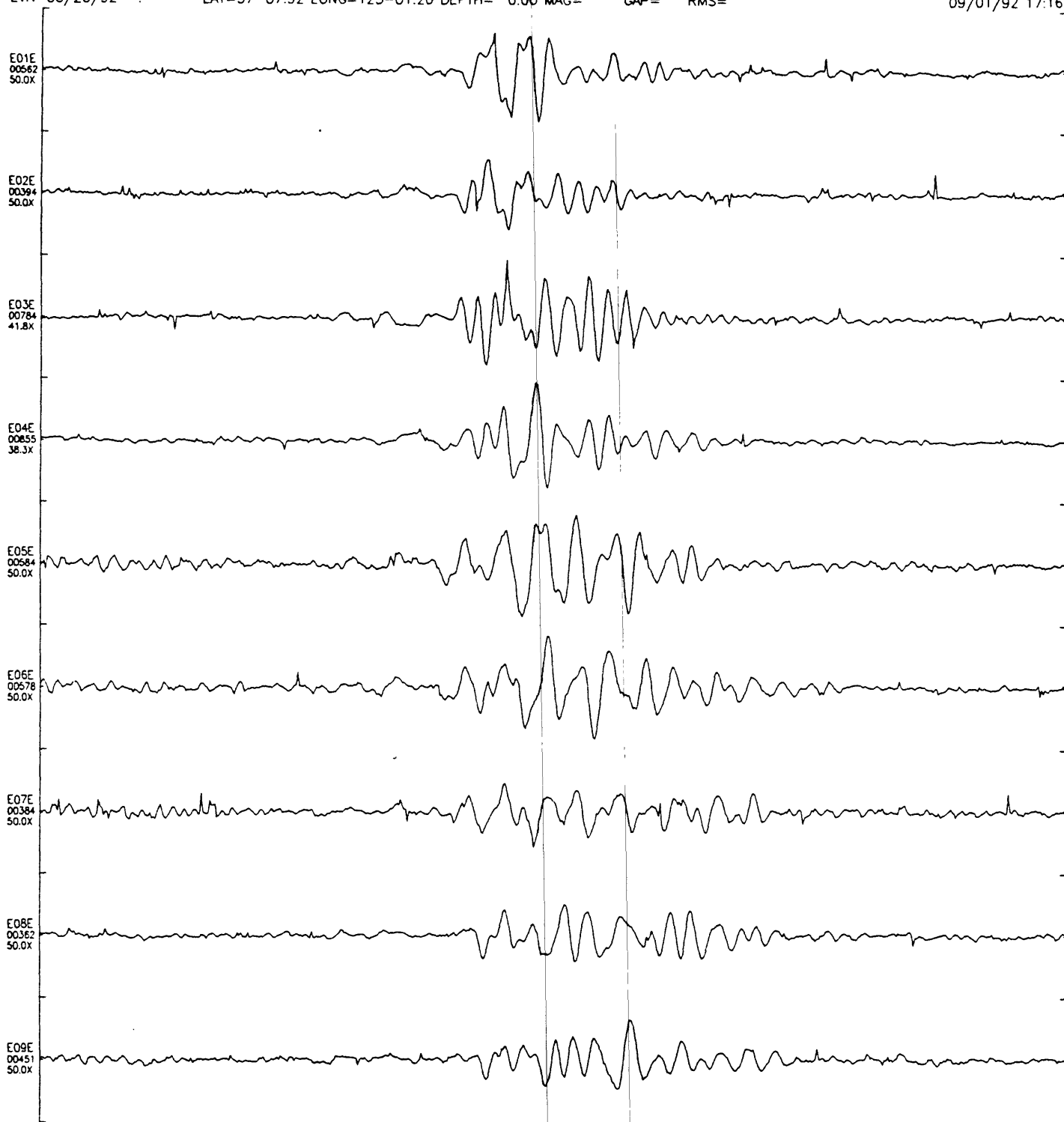
IST=08/20/92 21:15 12.720 SPS=200.321 DEC=1 D:\92082008.CT2
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Sheet 1
09/01/92 17:14



IST=08/20/92 21:15 12.720 SPS=200.321 DEC=1 D:\92082008.CT2
EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

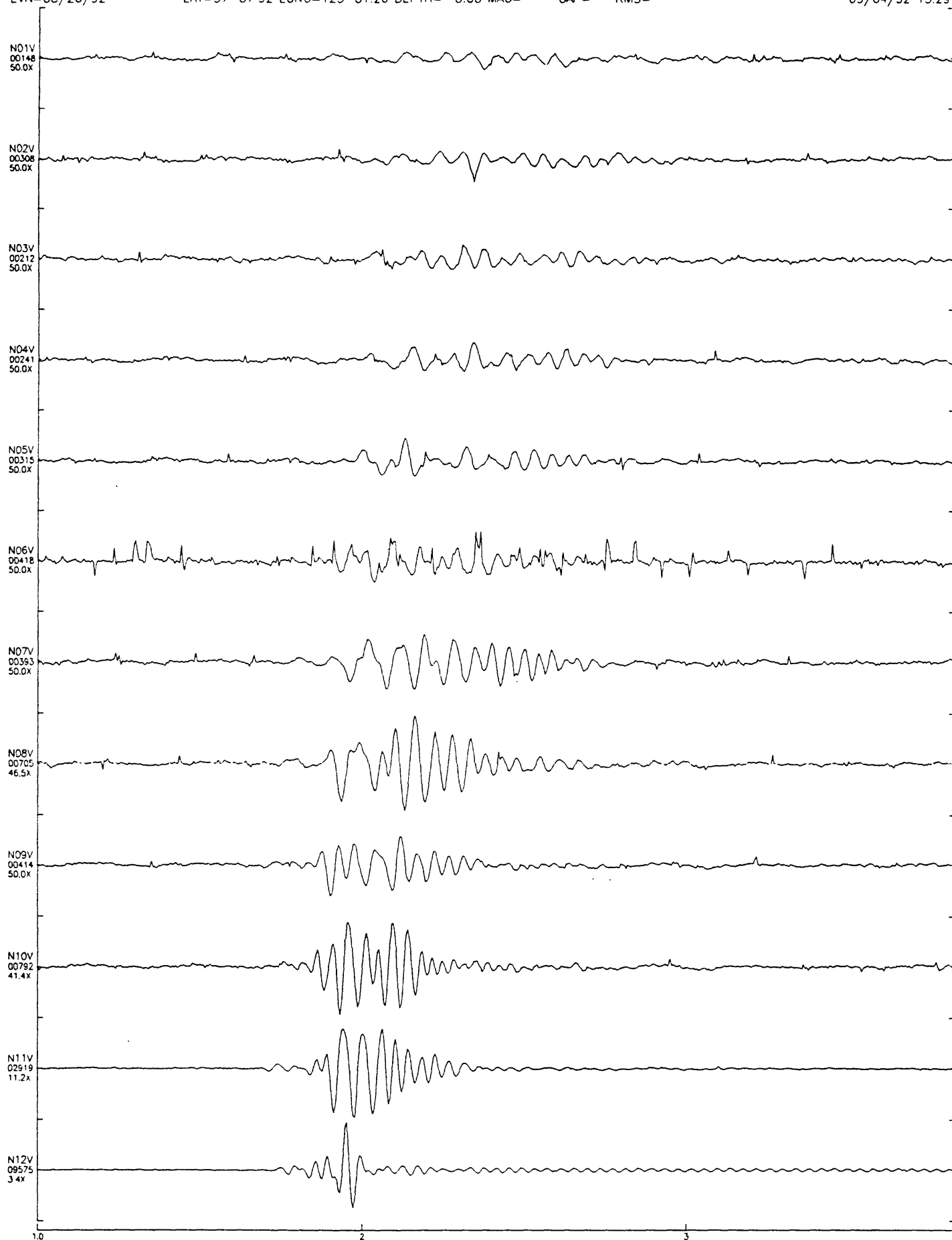
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09/01/92 17:16



0 1 2

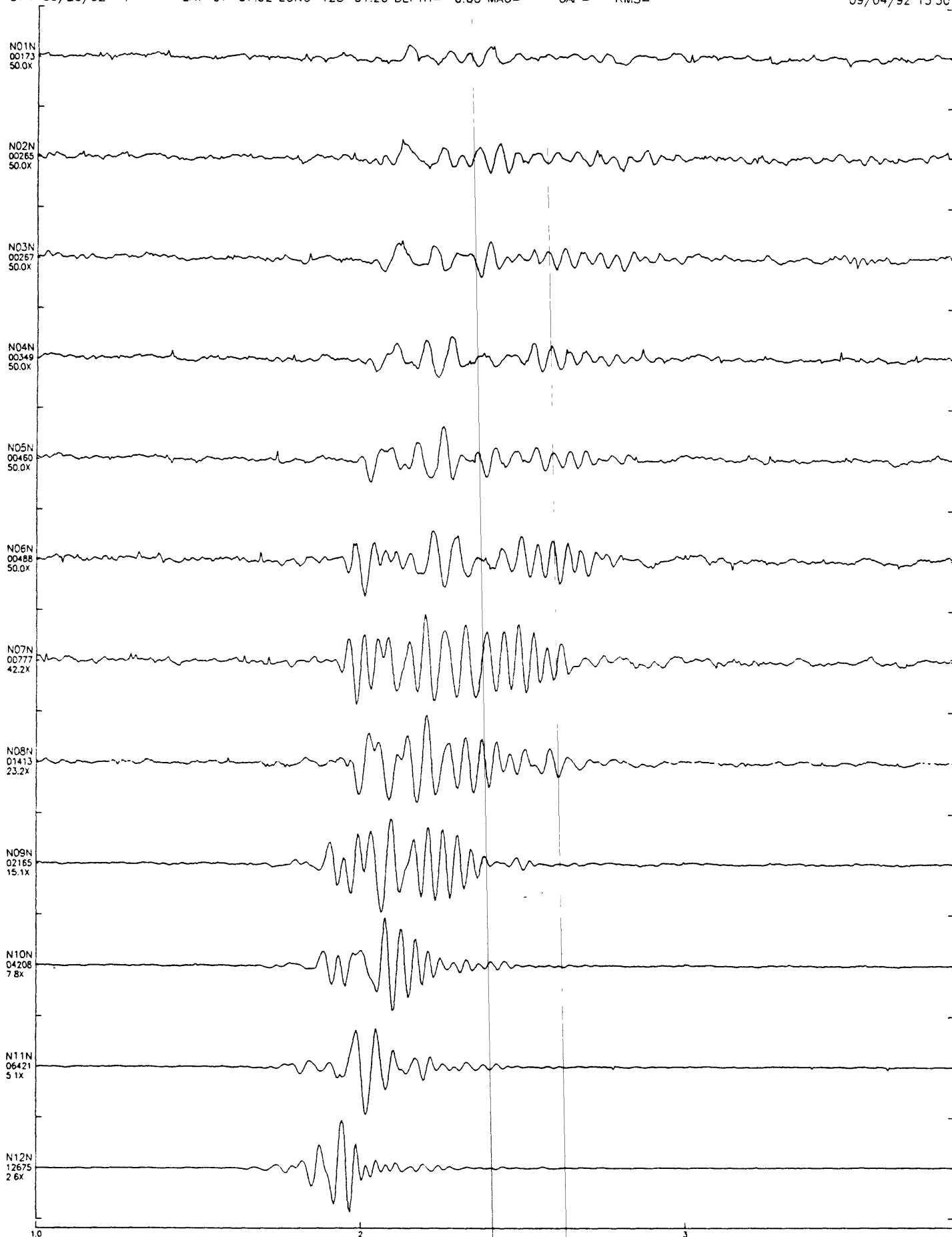
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Sheet 1
09/04/92 13:29



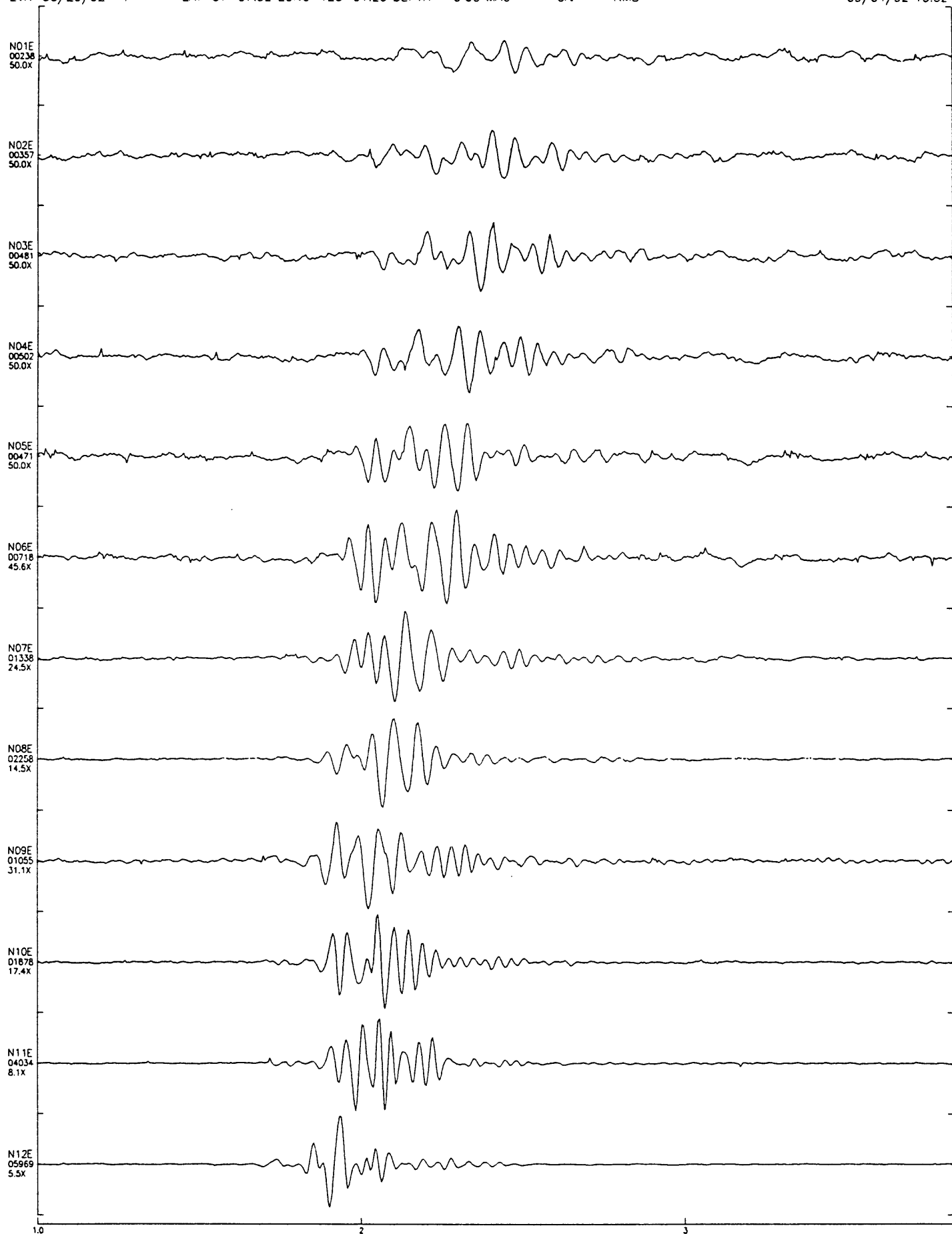
IST=08/20/92 21:23 54.121 SPS=200.321 DEC=1 D.\9208200C.CT1
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Sheet 1
09/04/92 13 30



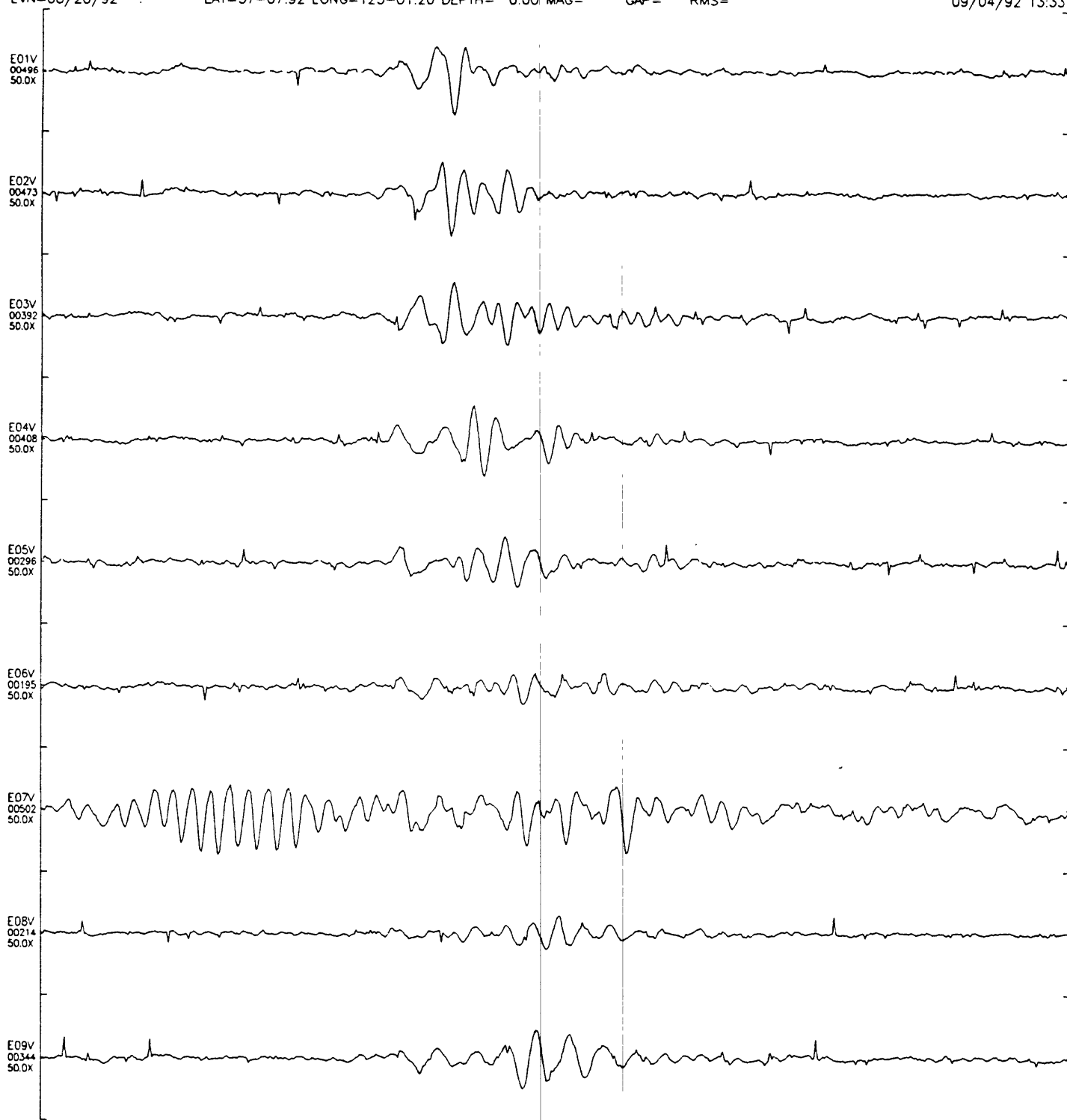
IST=08/20/92 21:23 54.121 SPS=200.321 DEC=1 D:\9208200C.CT1
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Sheet 1
09/04/92 13:32



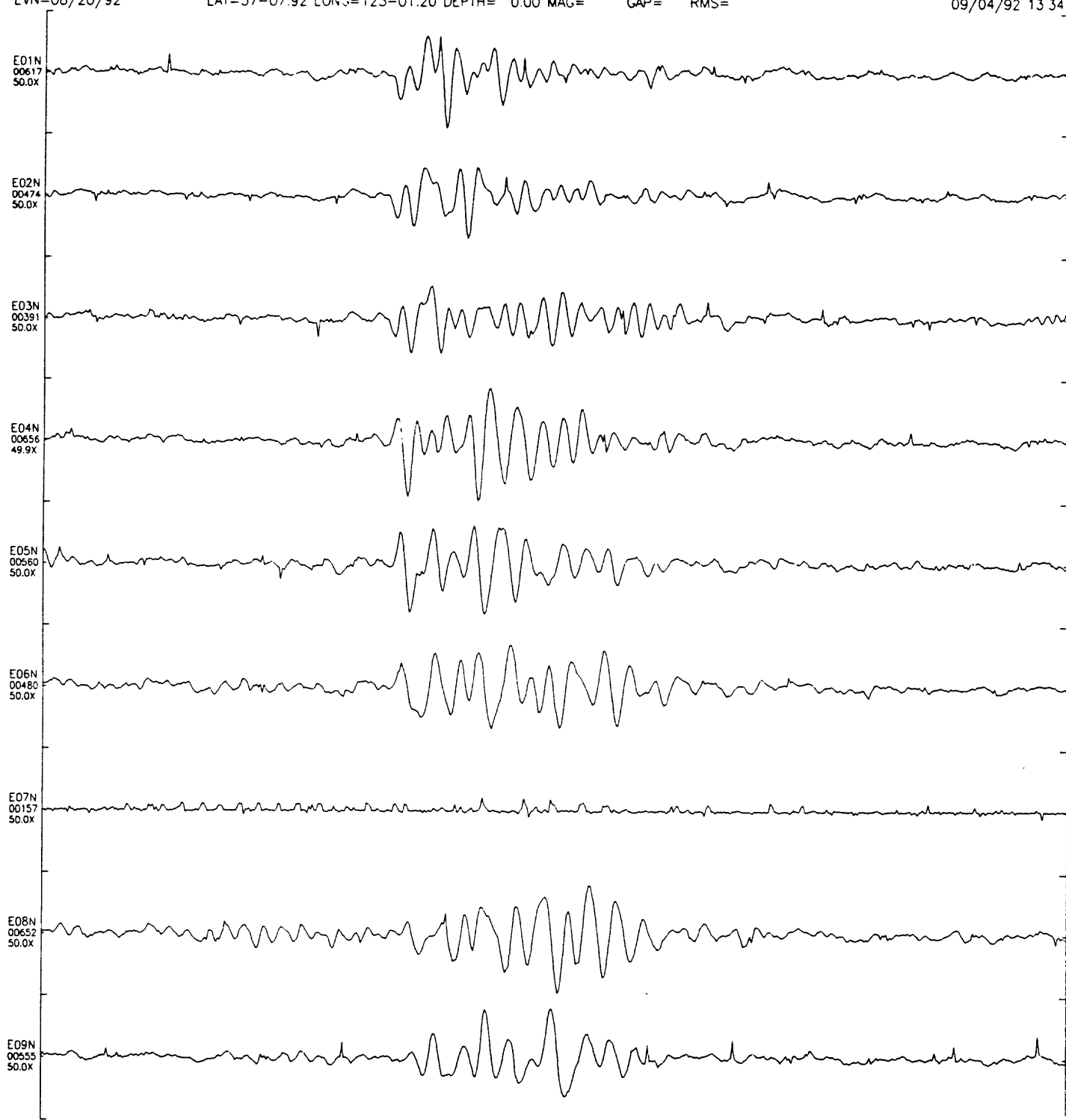
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Sheet 1
09/04/92 13:33



IST=08/20/92 21:23 54.121 SPS=200.321 DEC=1 D:\9208200C.CT1
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Sheet 1
09/04/92 13 34



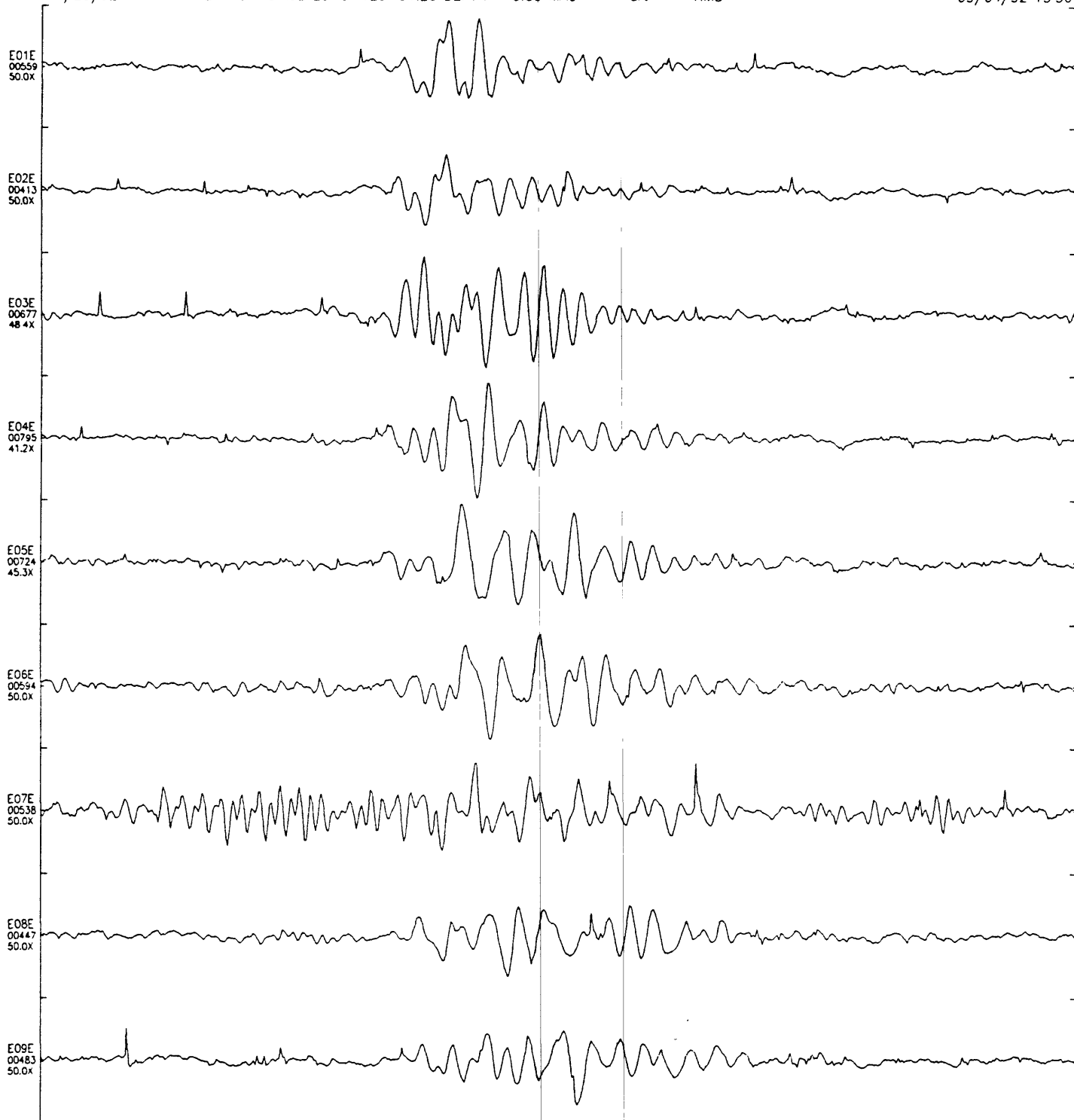
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Sheet 1
09/04/92 13 36

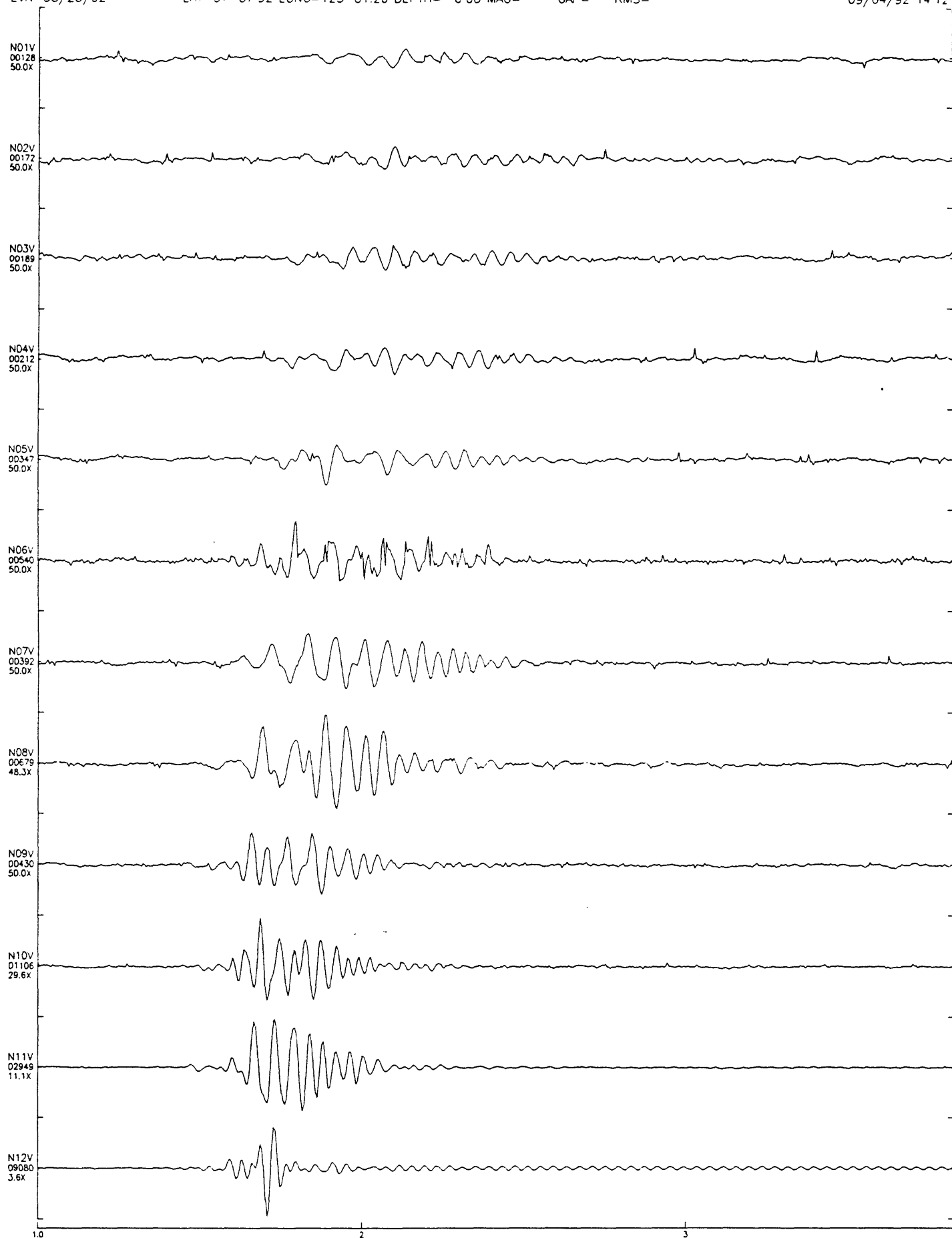


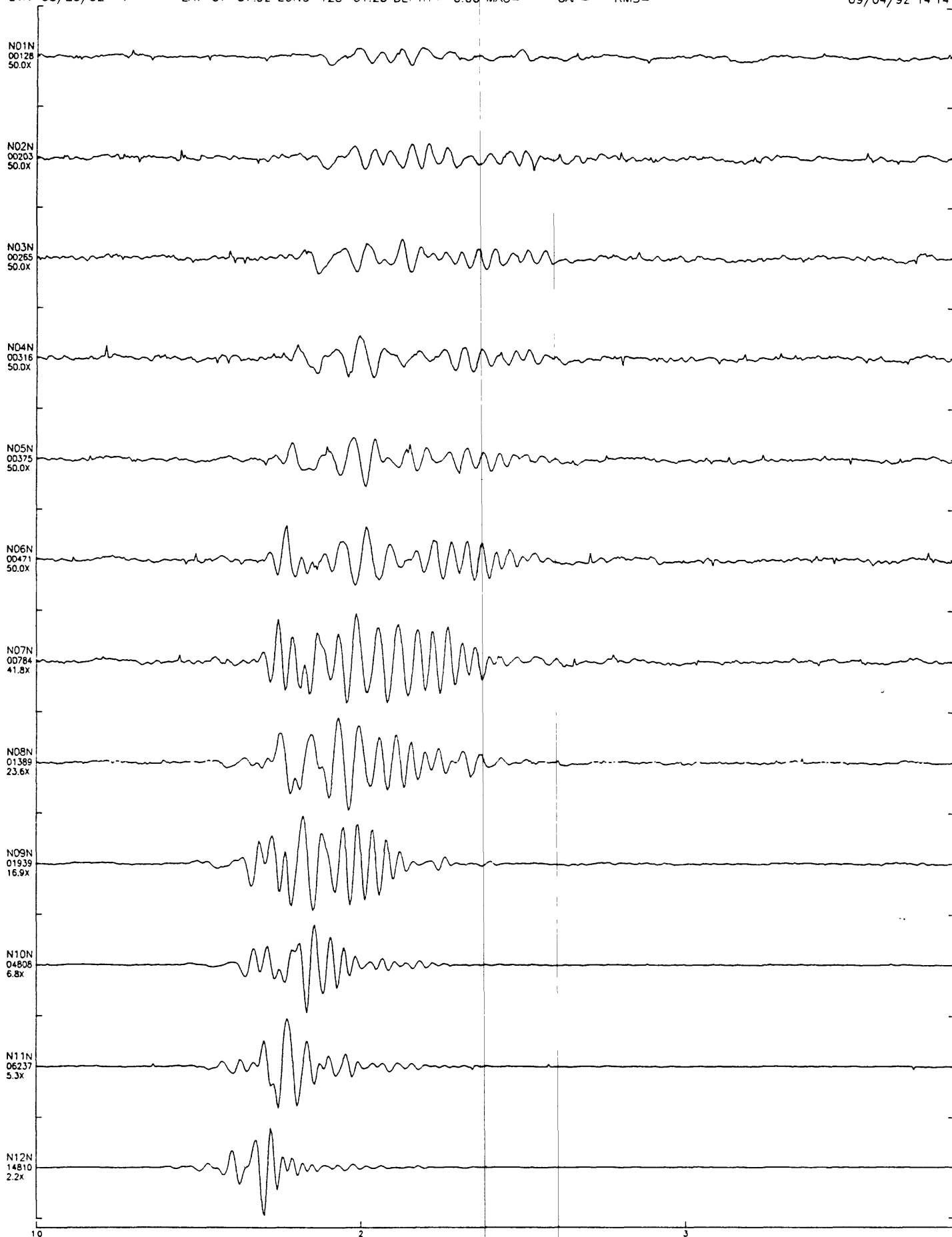
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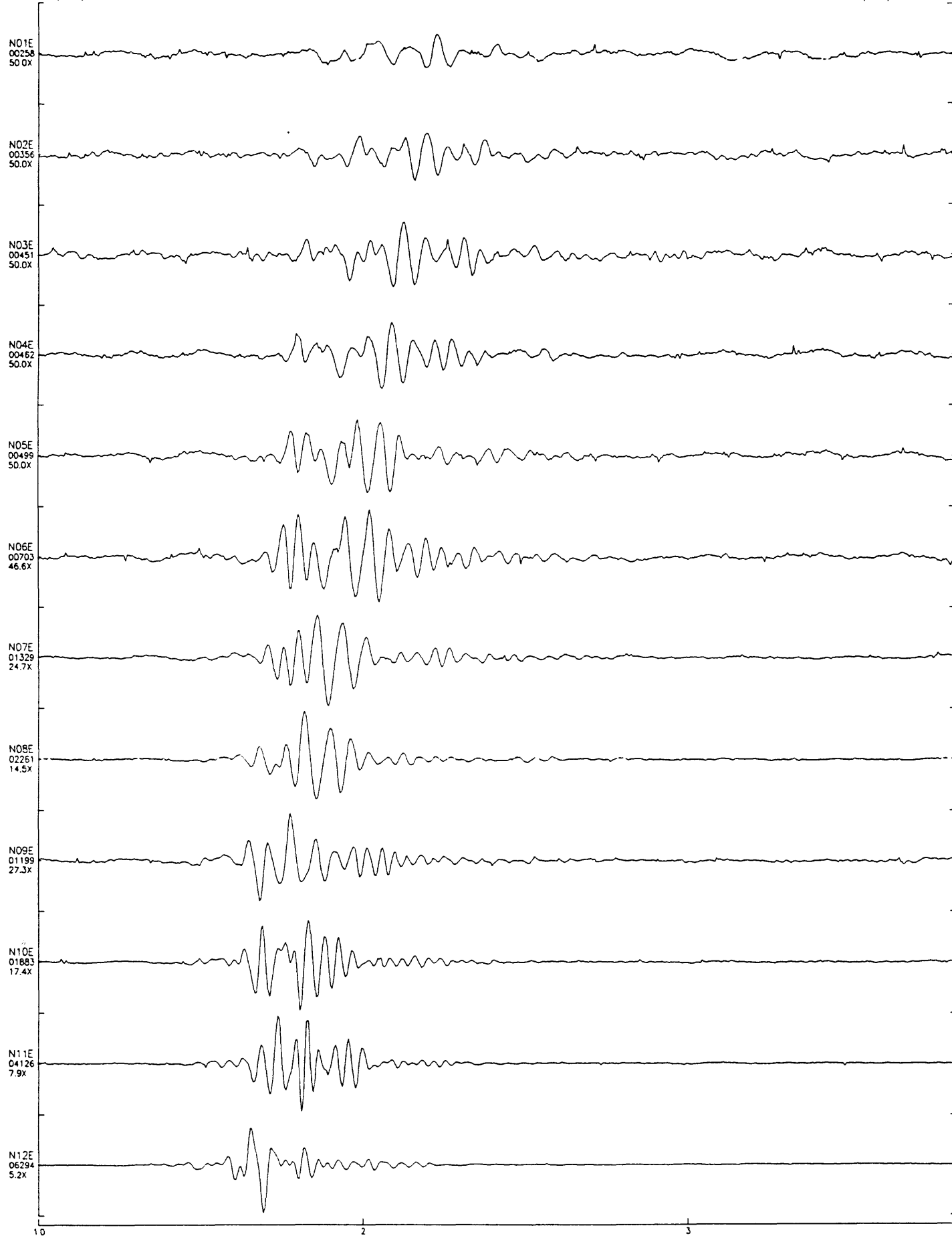
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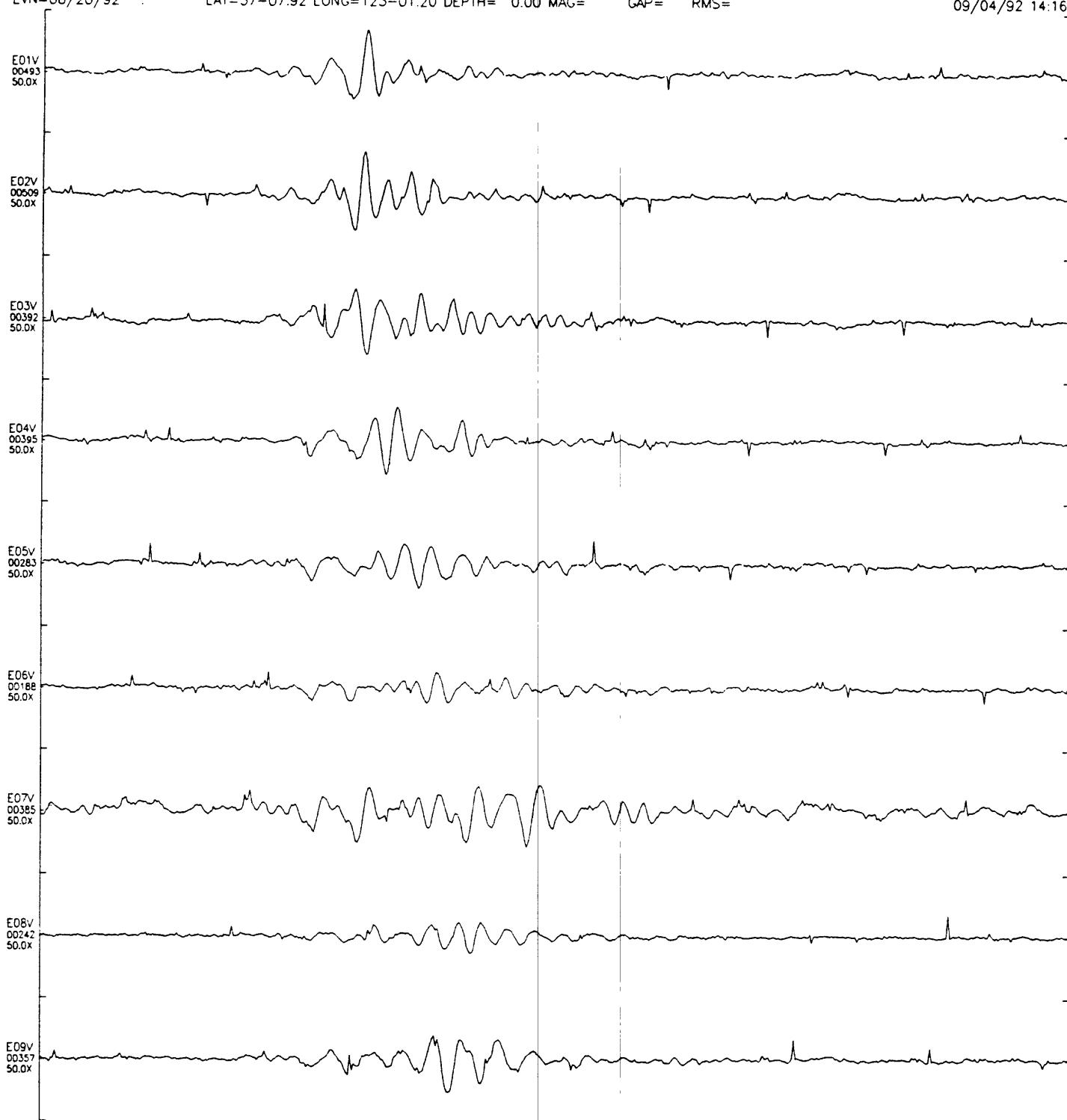




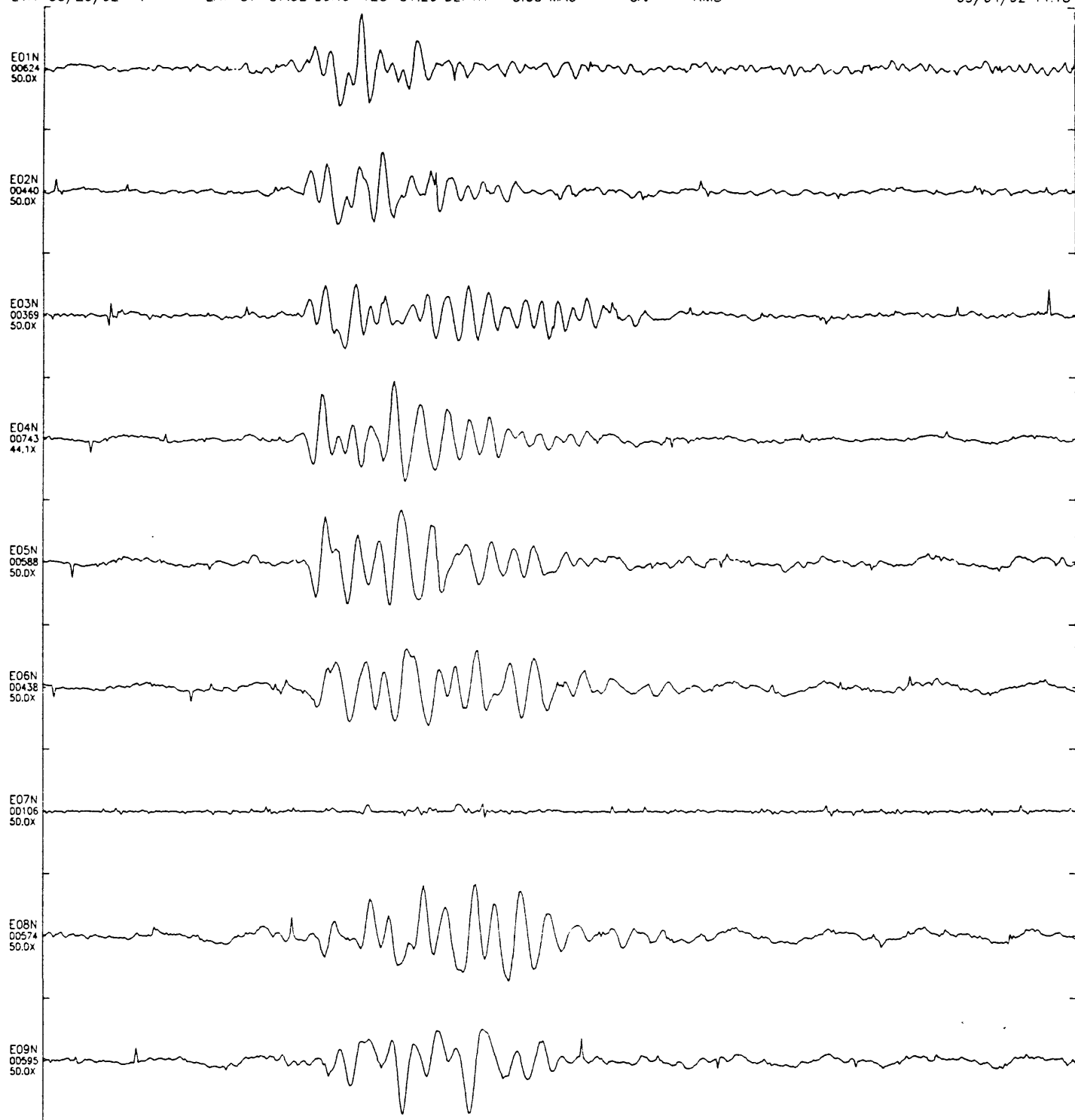


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Sheet 1
09/04/92 14:16



1.0 2 3



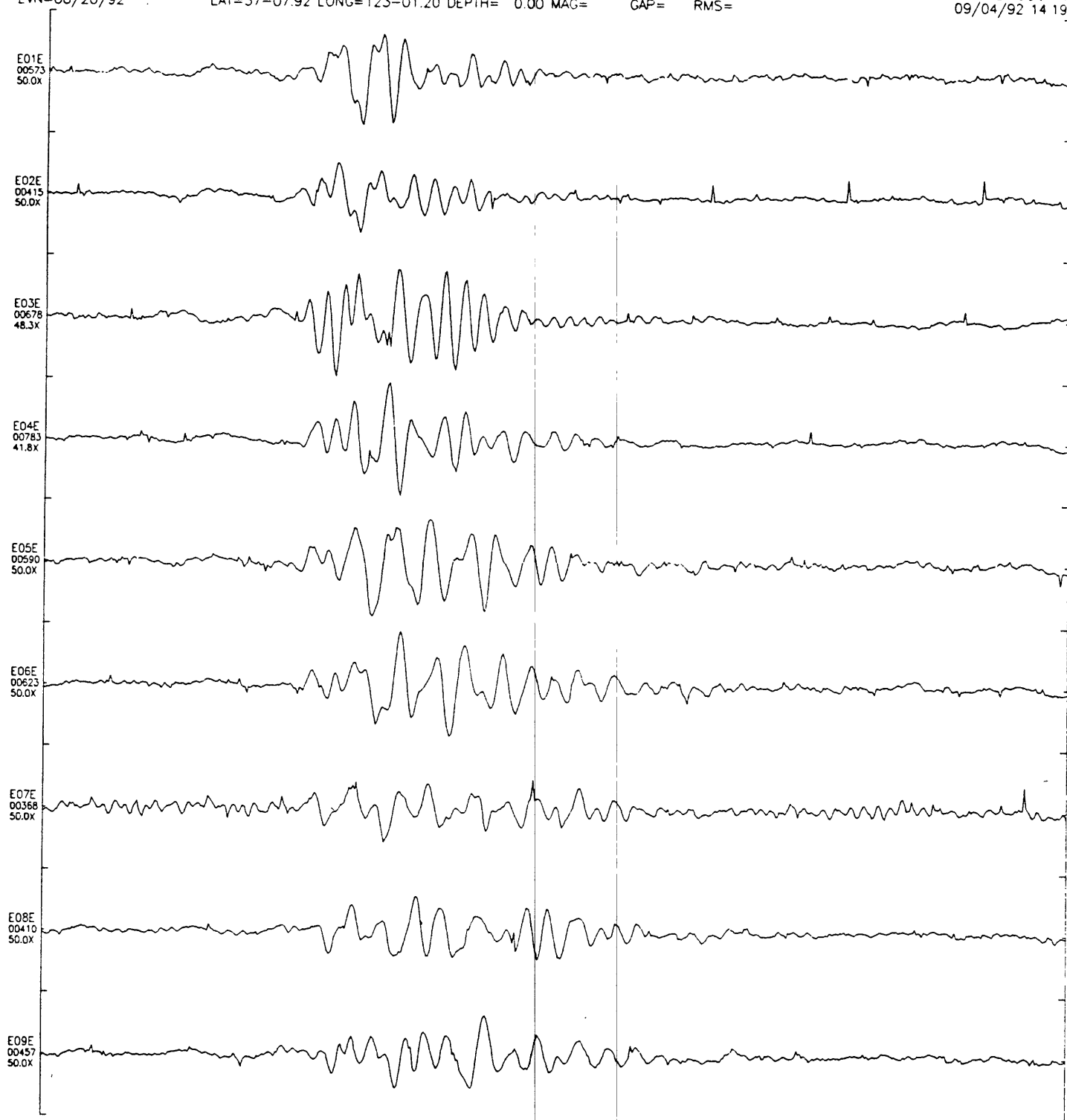
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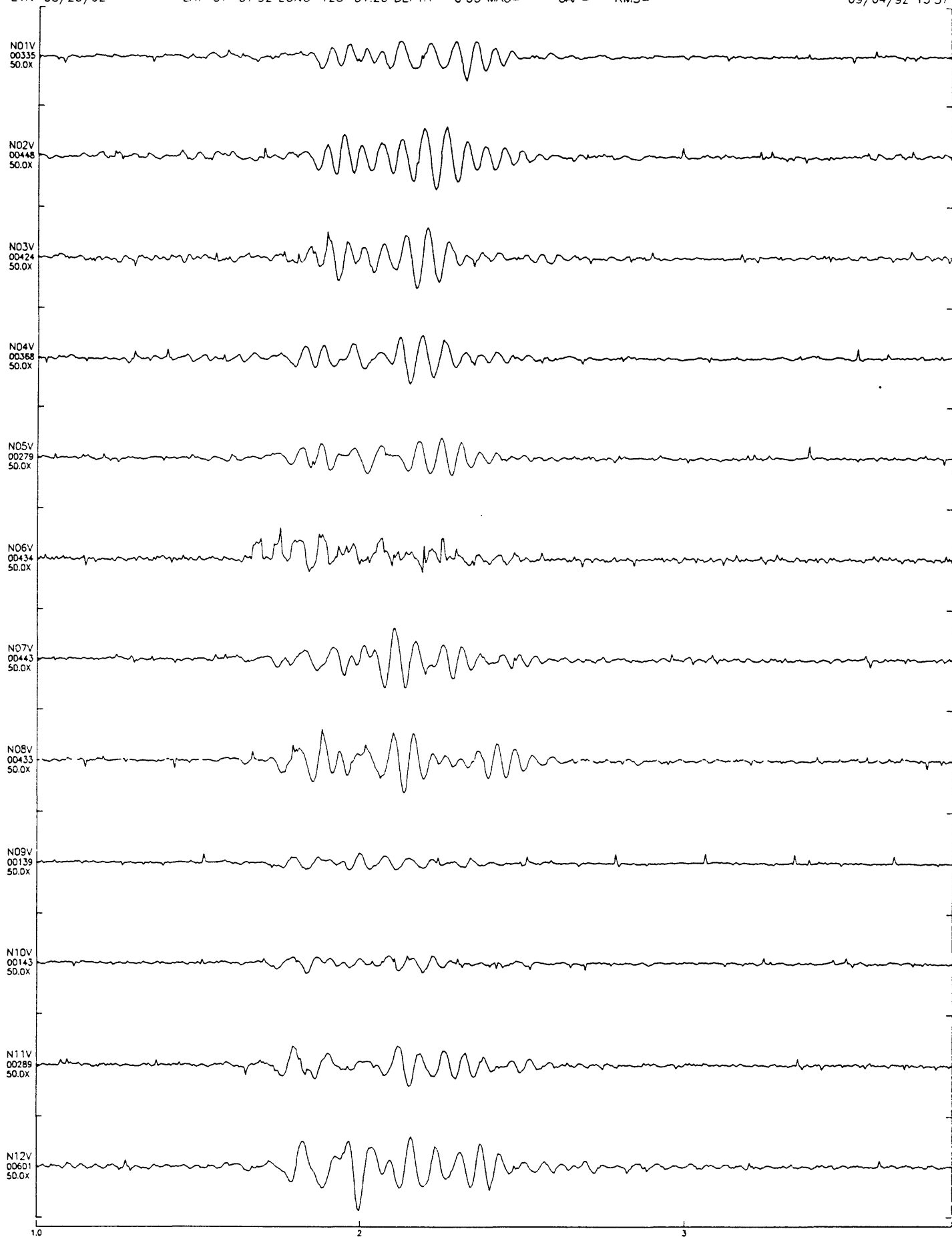
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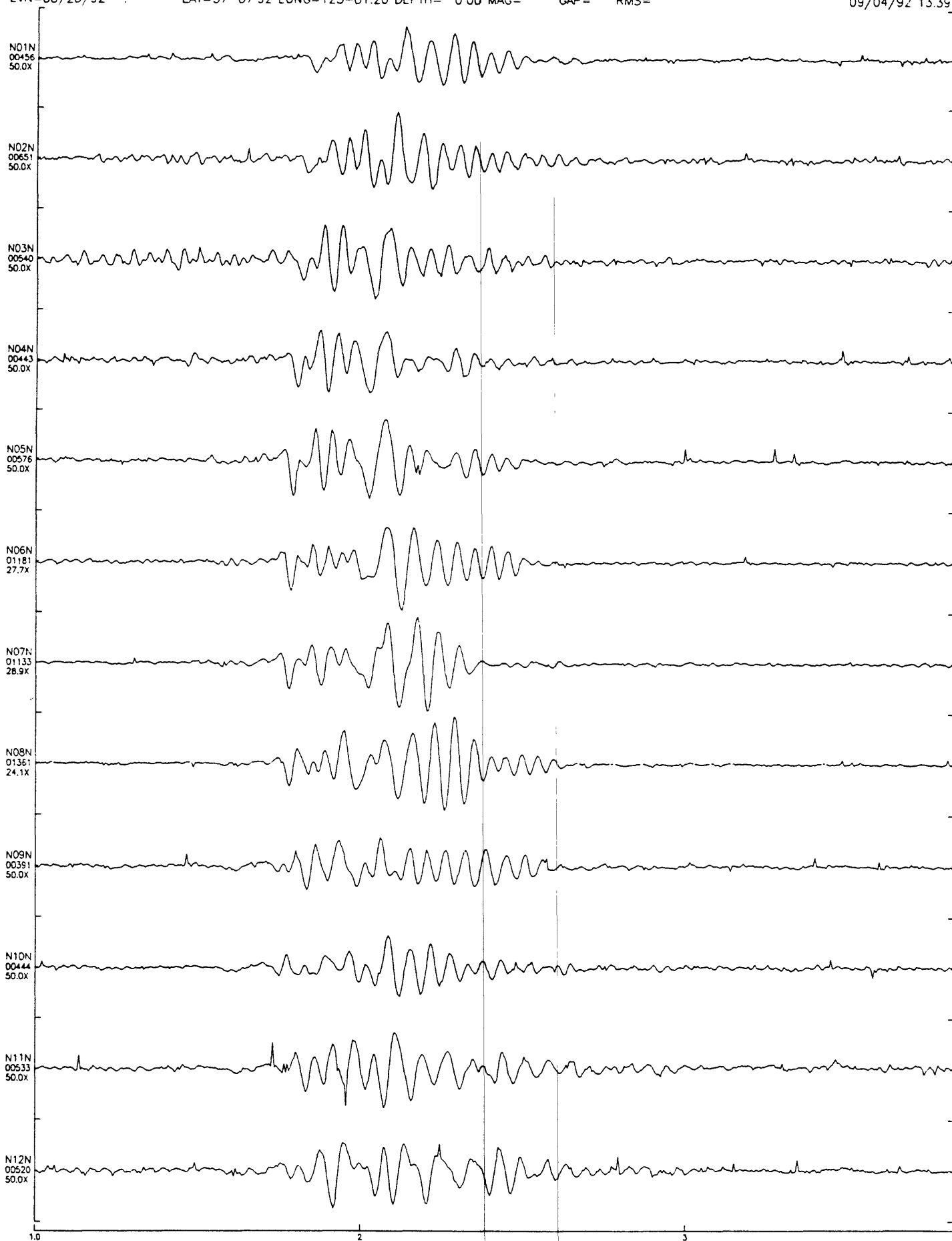
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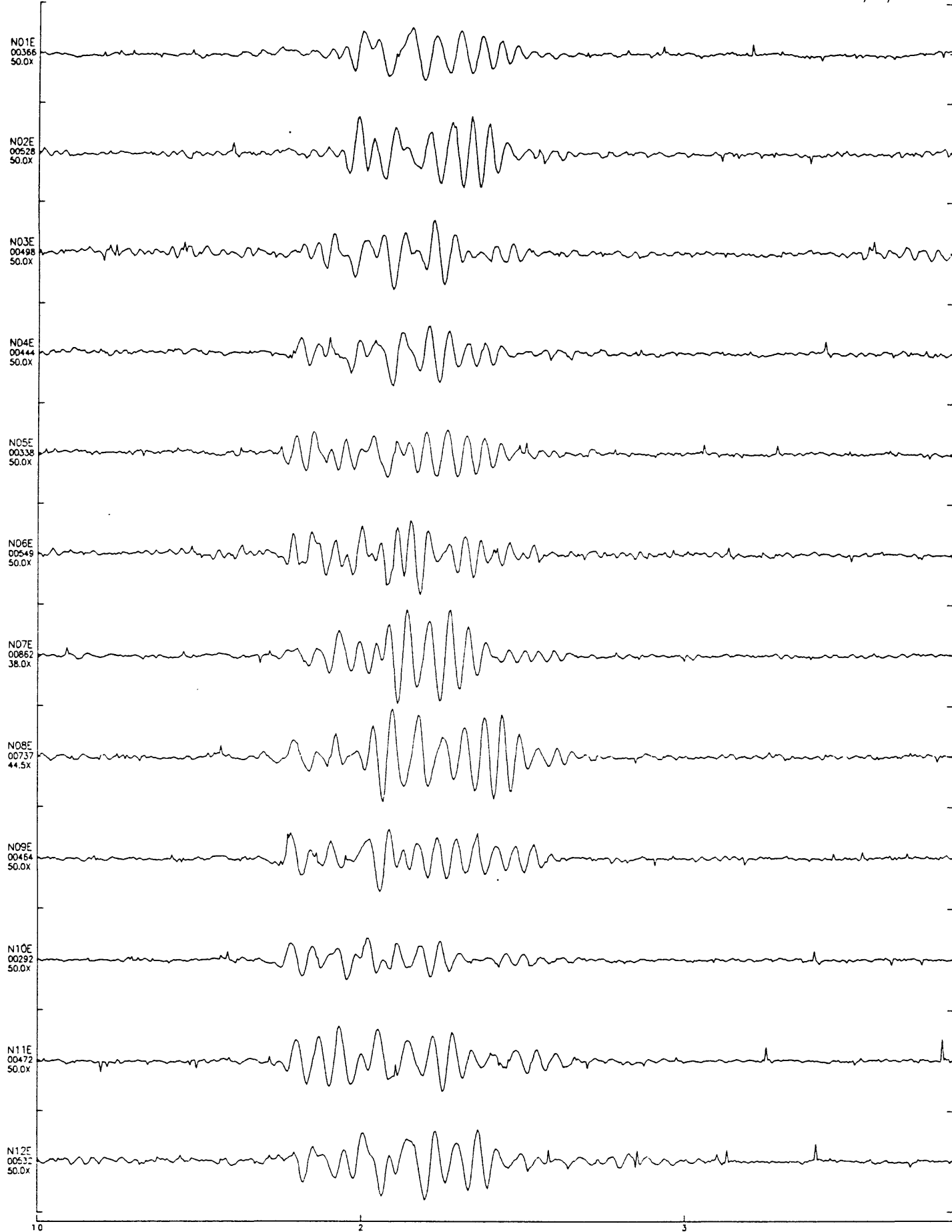
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EVN=08/20/92 : LAT=37-07.92 LONG=123-01.20 DEPTH= 0.00 MAG= GAP= RMS=

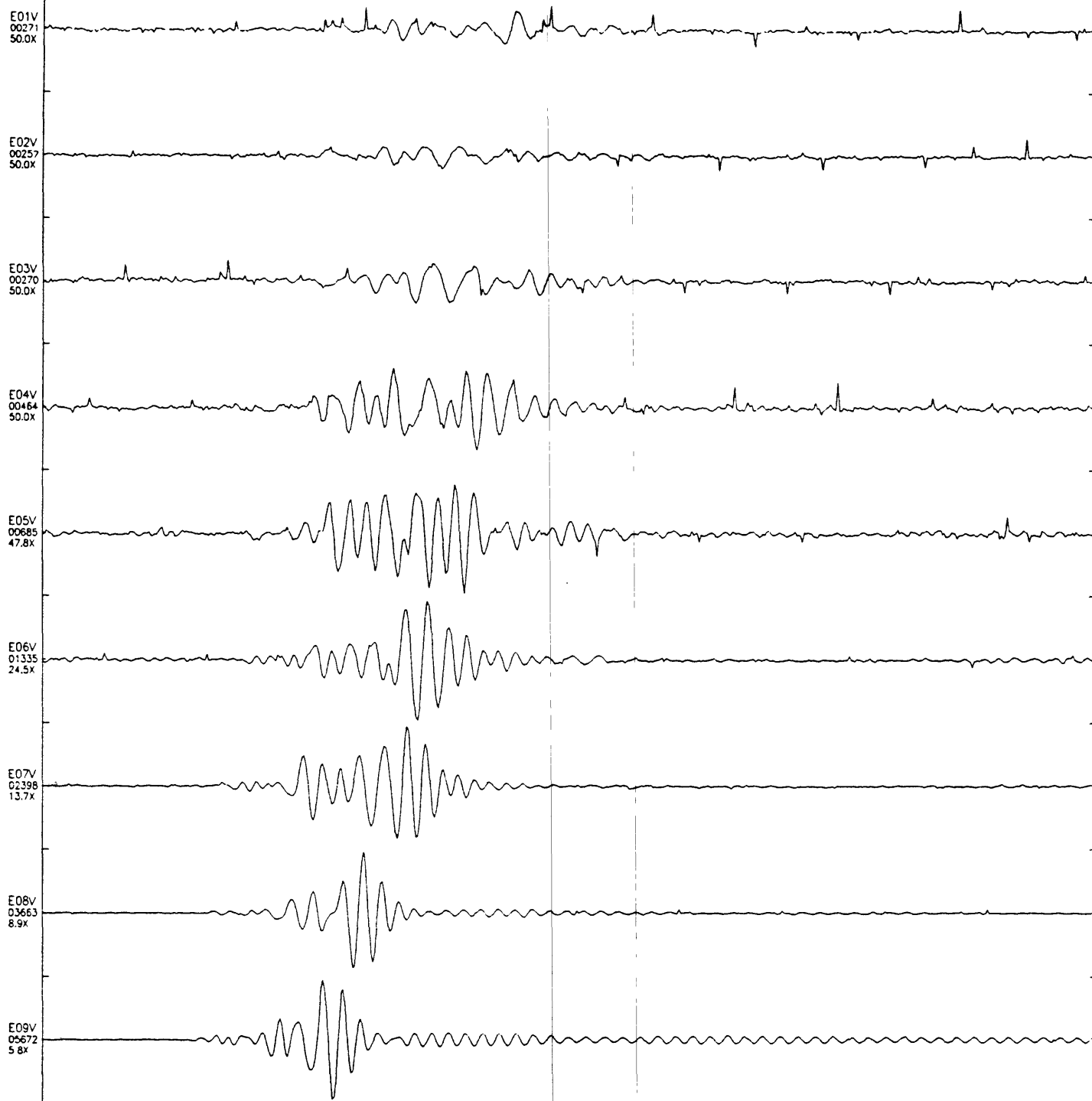
Sheet 1
09/04/92 14 19





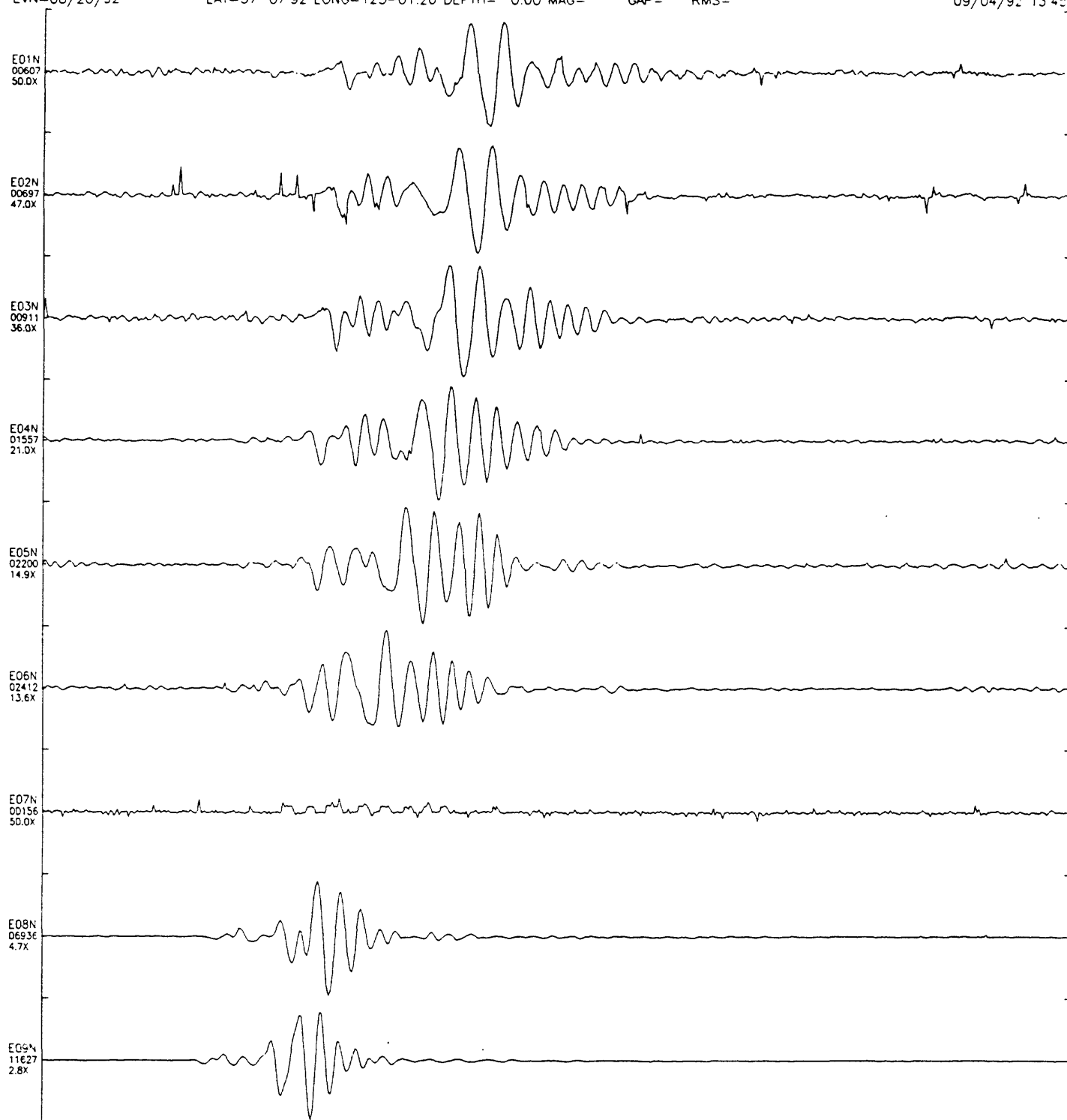






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Sheet 1
09/04/92 13 45



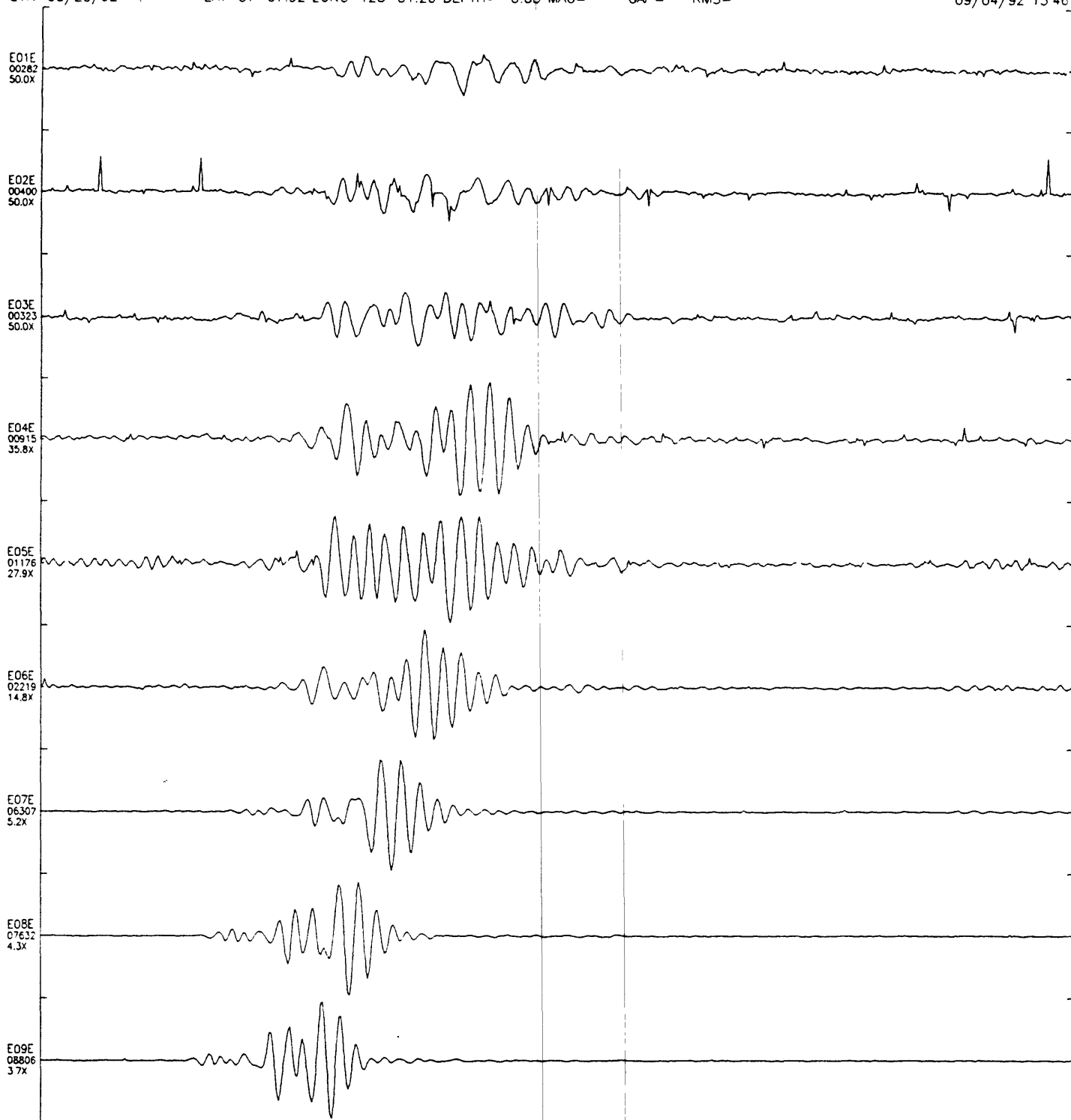
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IST=08/20/92 22:09 00.677 SPS=200.321 DEC=1 D:\9208200H.CT1
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Sheet 1
09/04/92 13:46



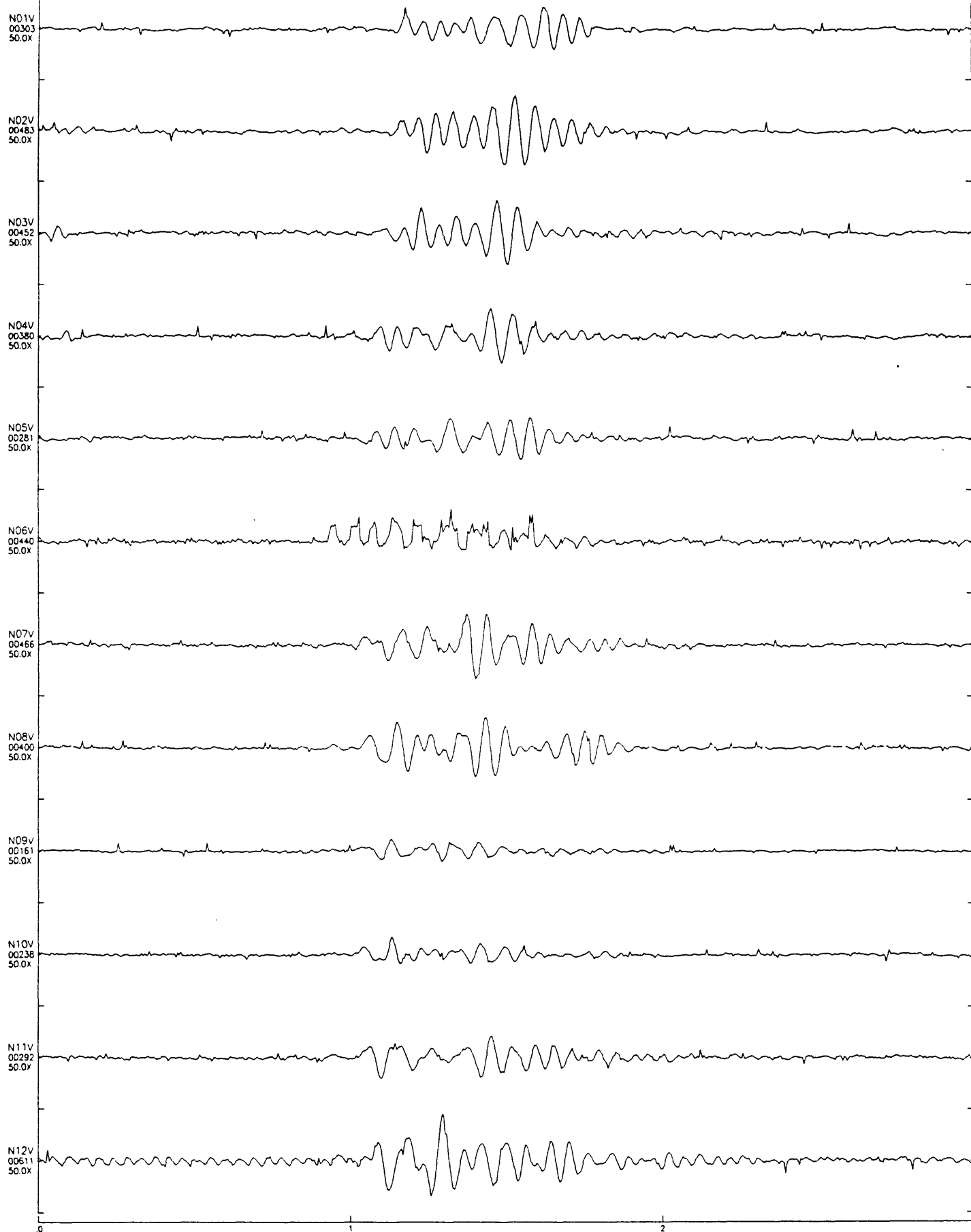
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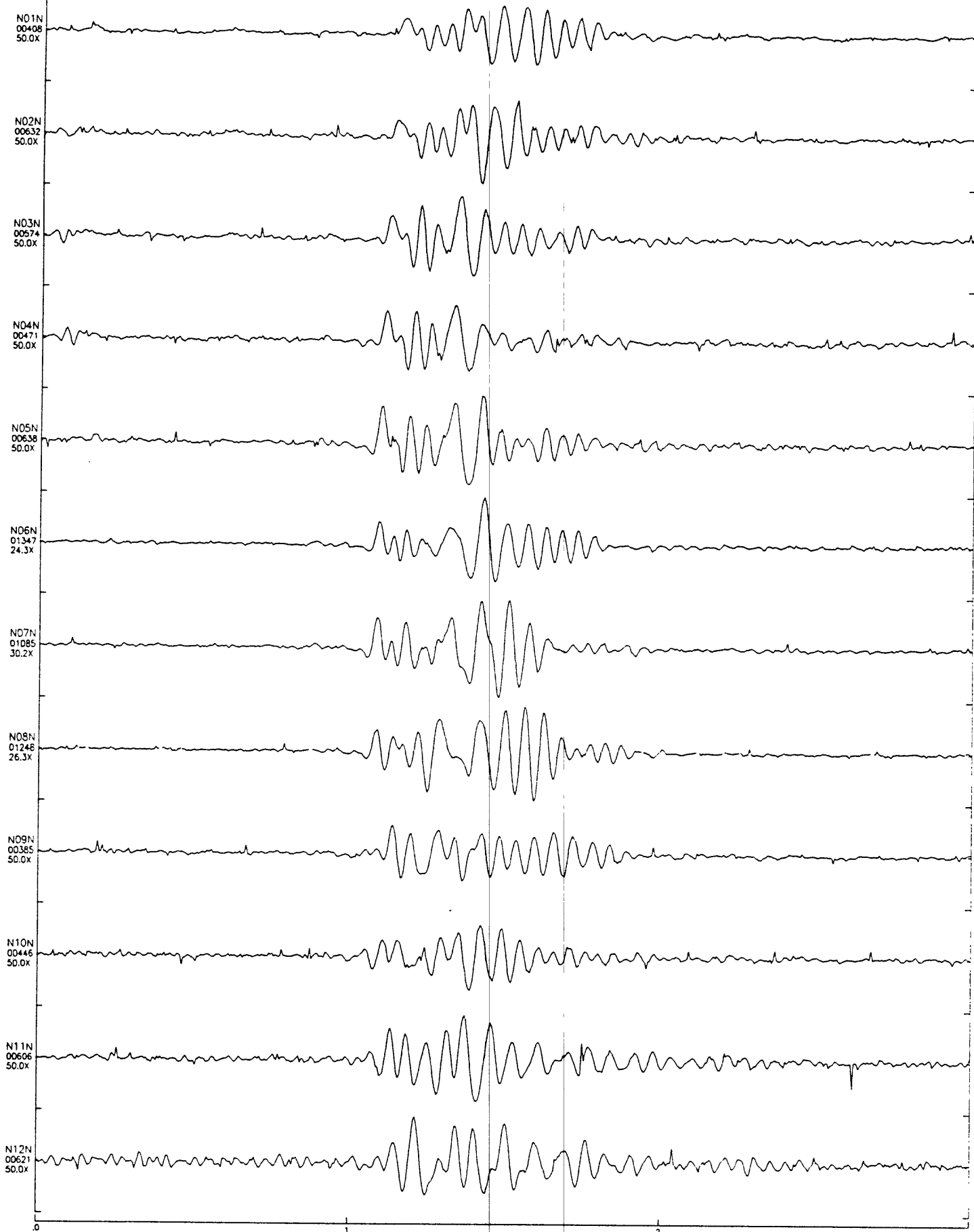
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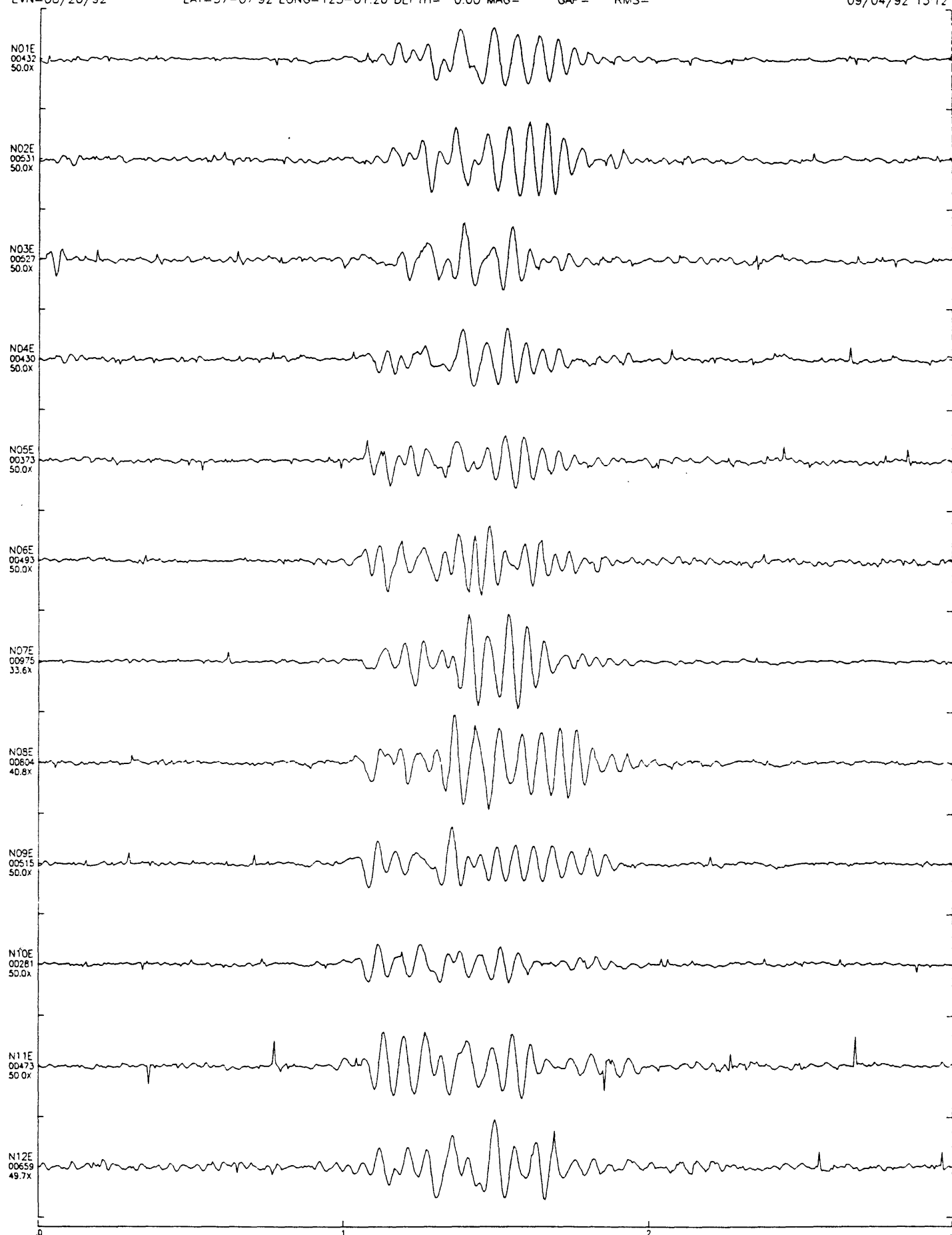
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09/04/92 15 09



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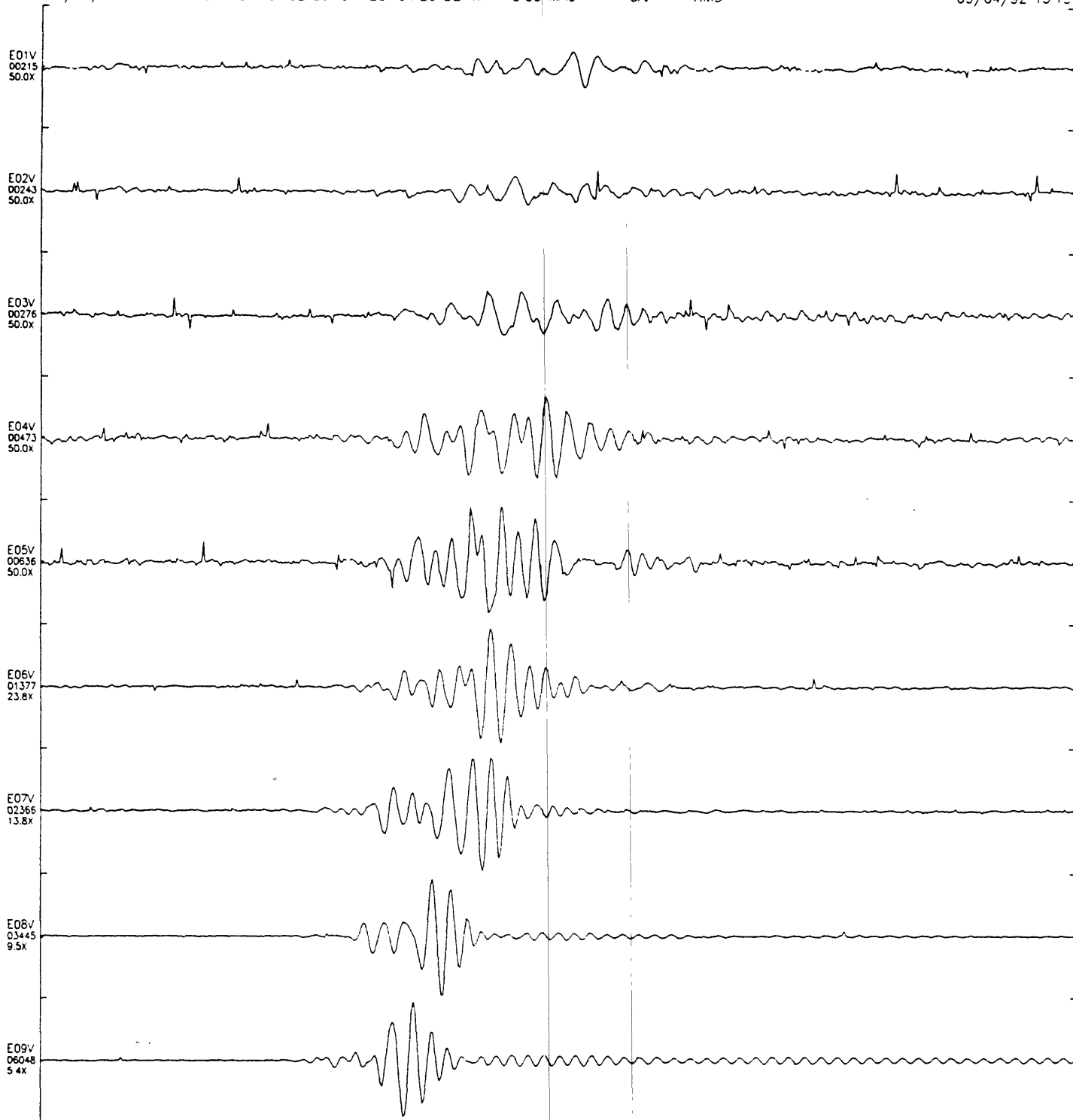
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09/04/92 15 11





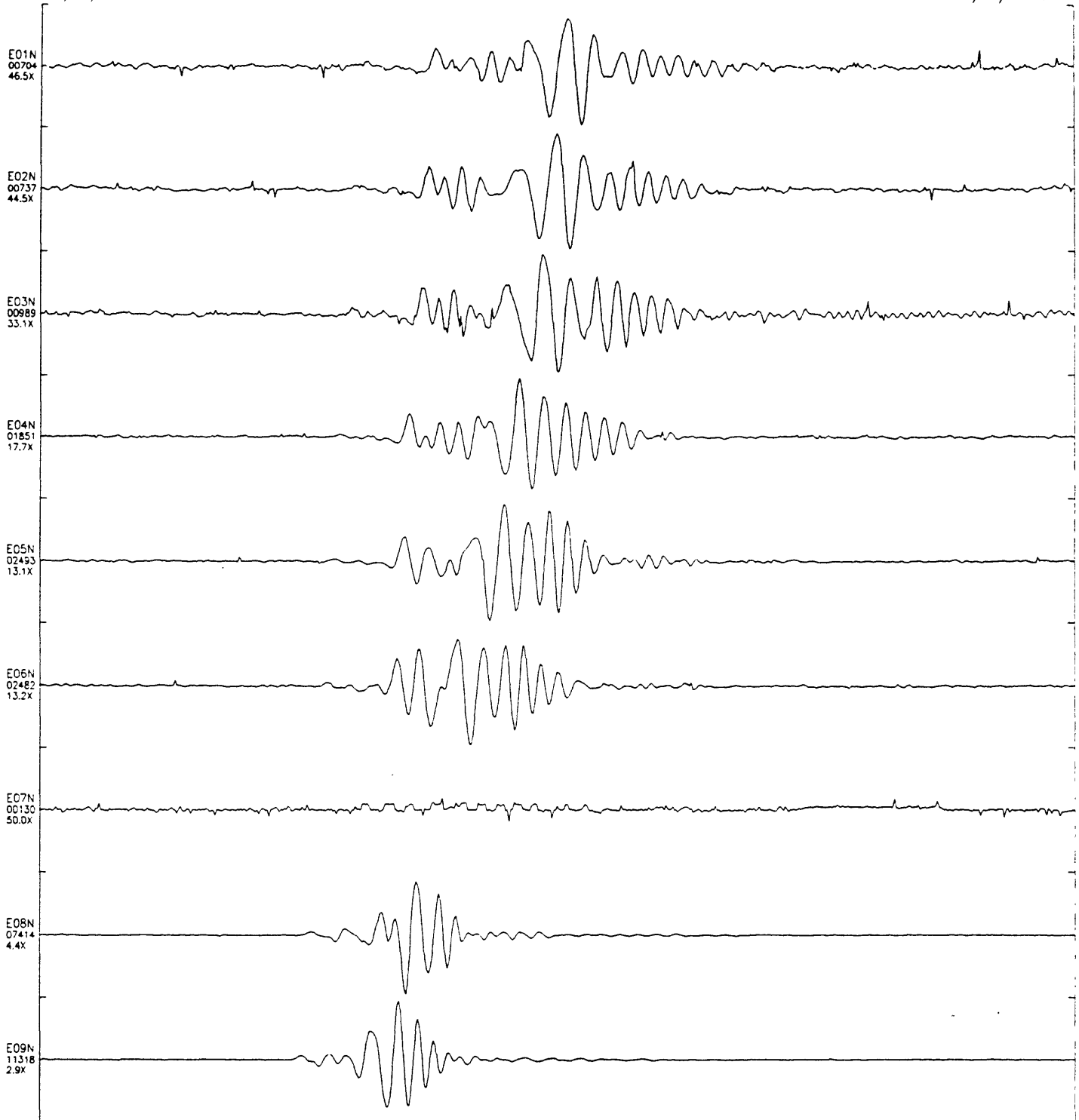
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Sheet 1
09/04/92 15 13



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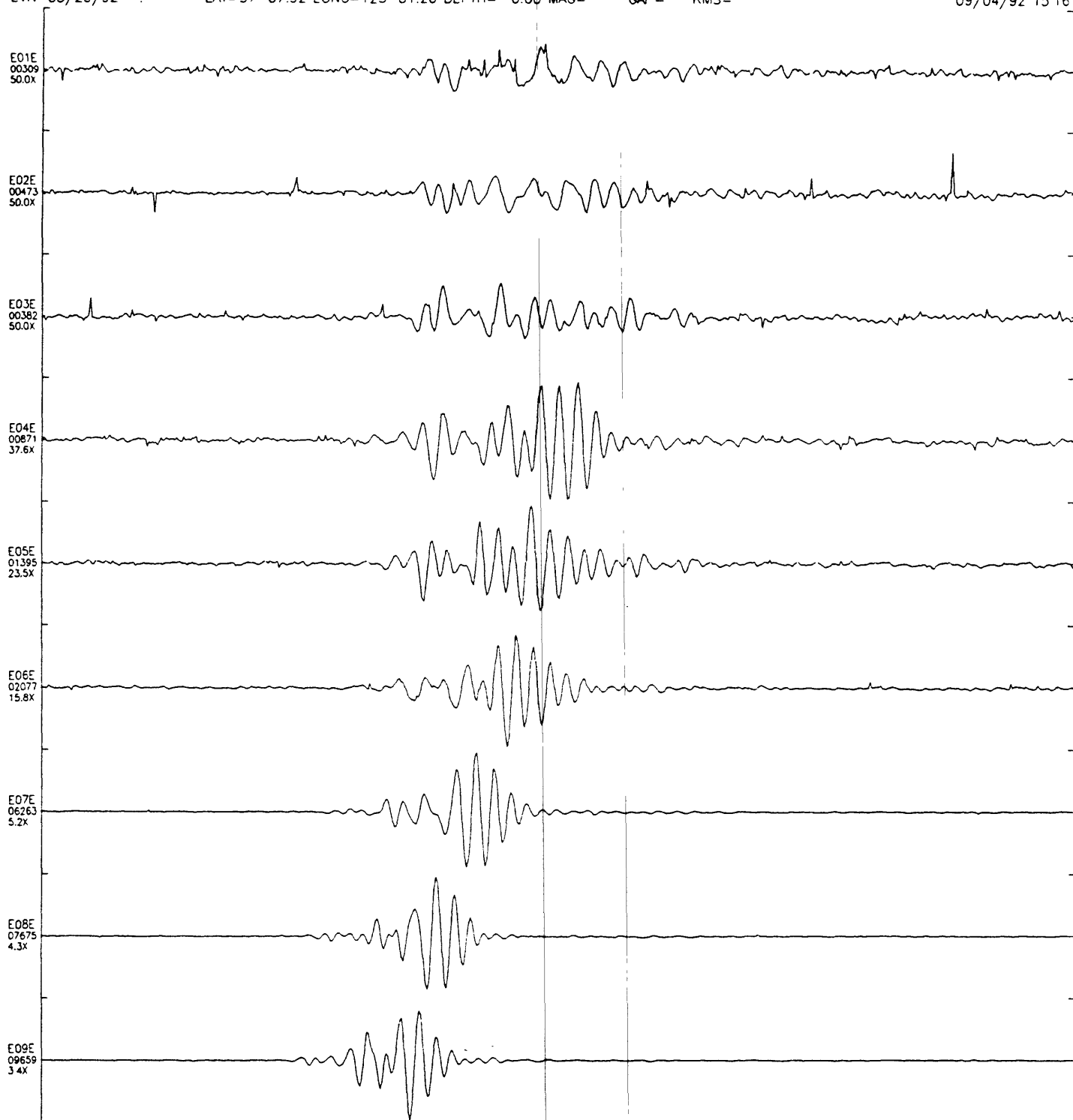
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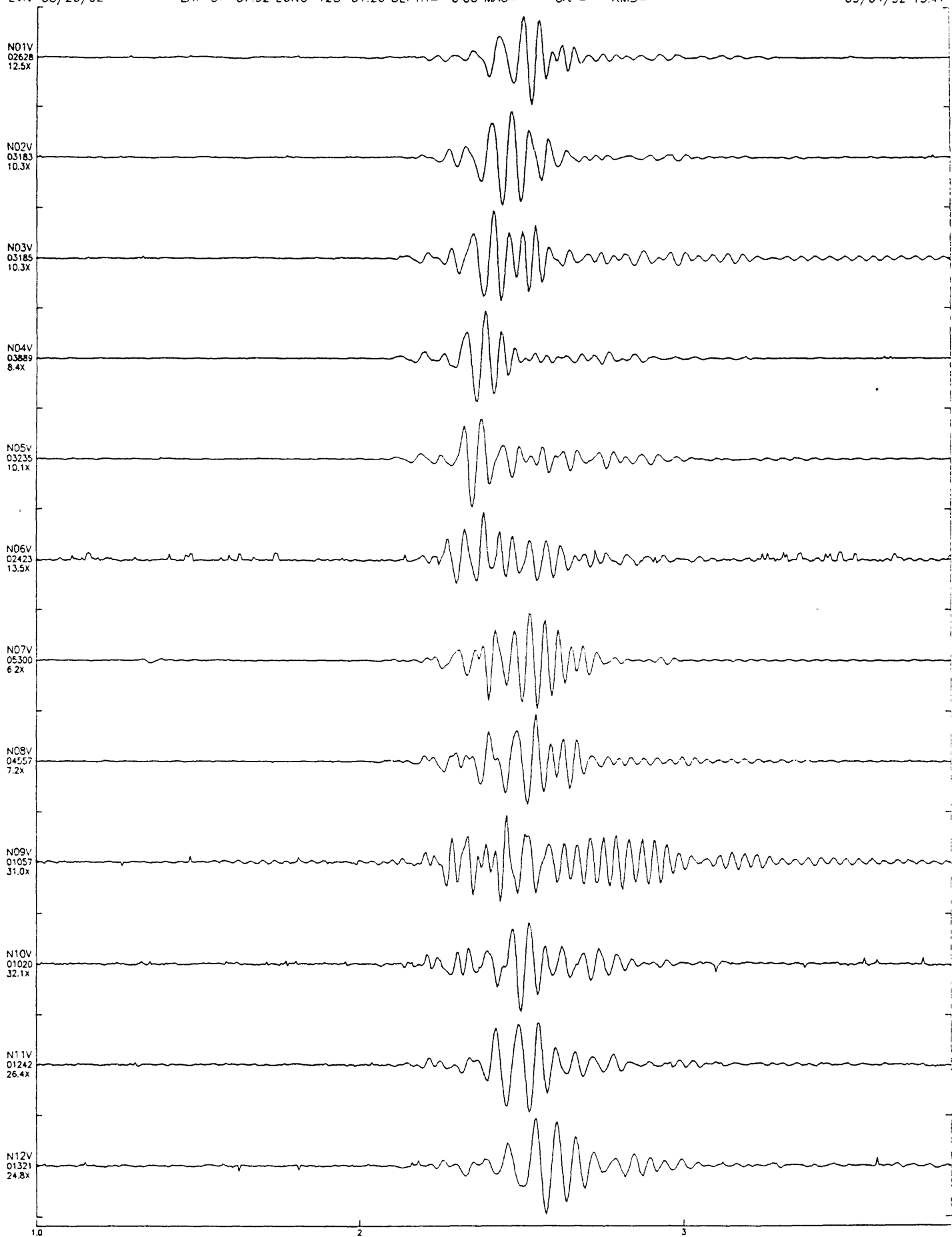
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09/04/92 15 16



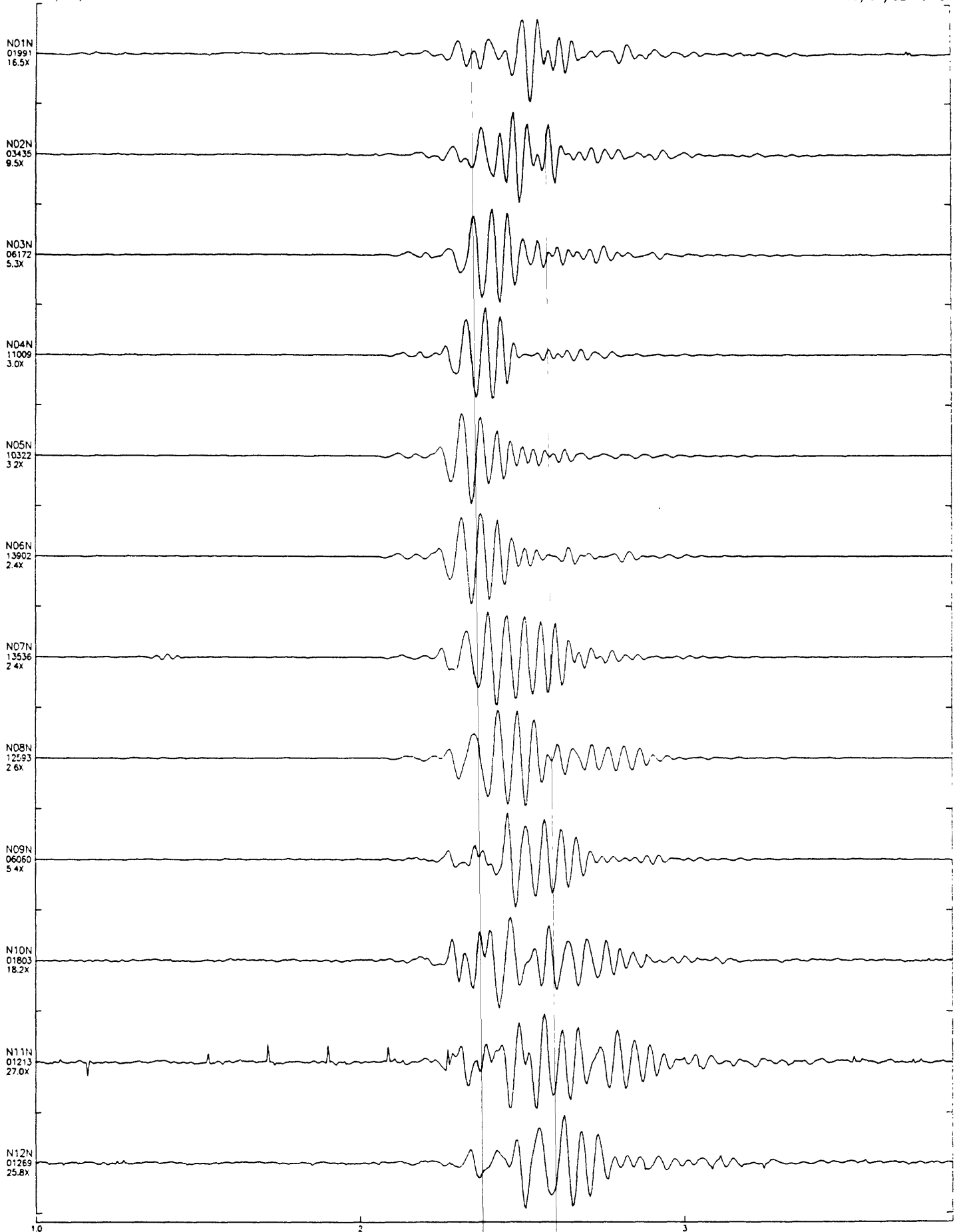
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09/04/92 13.47



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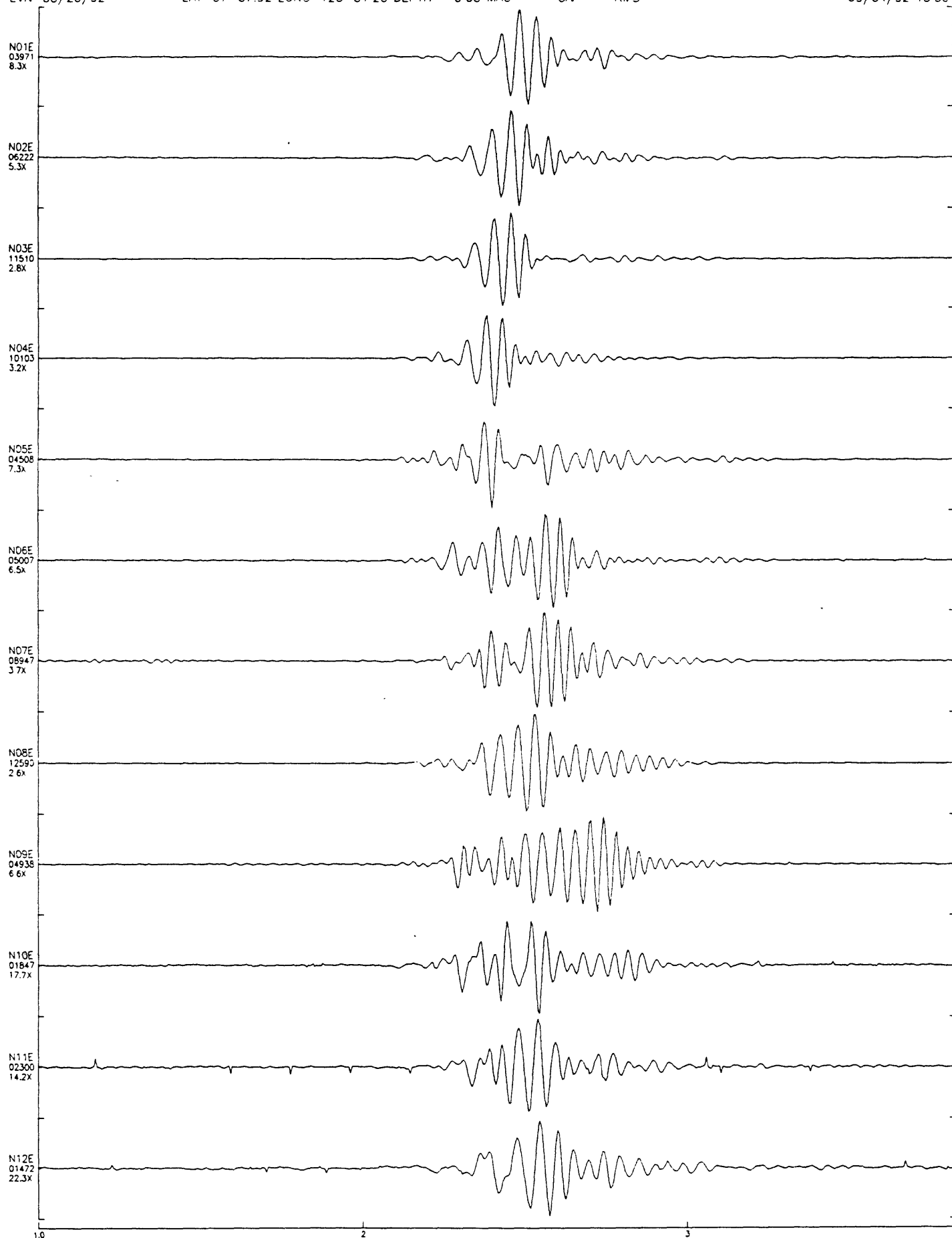
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09/04/92 13 49



235

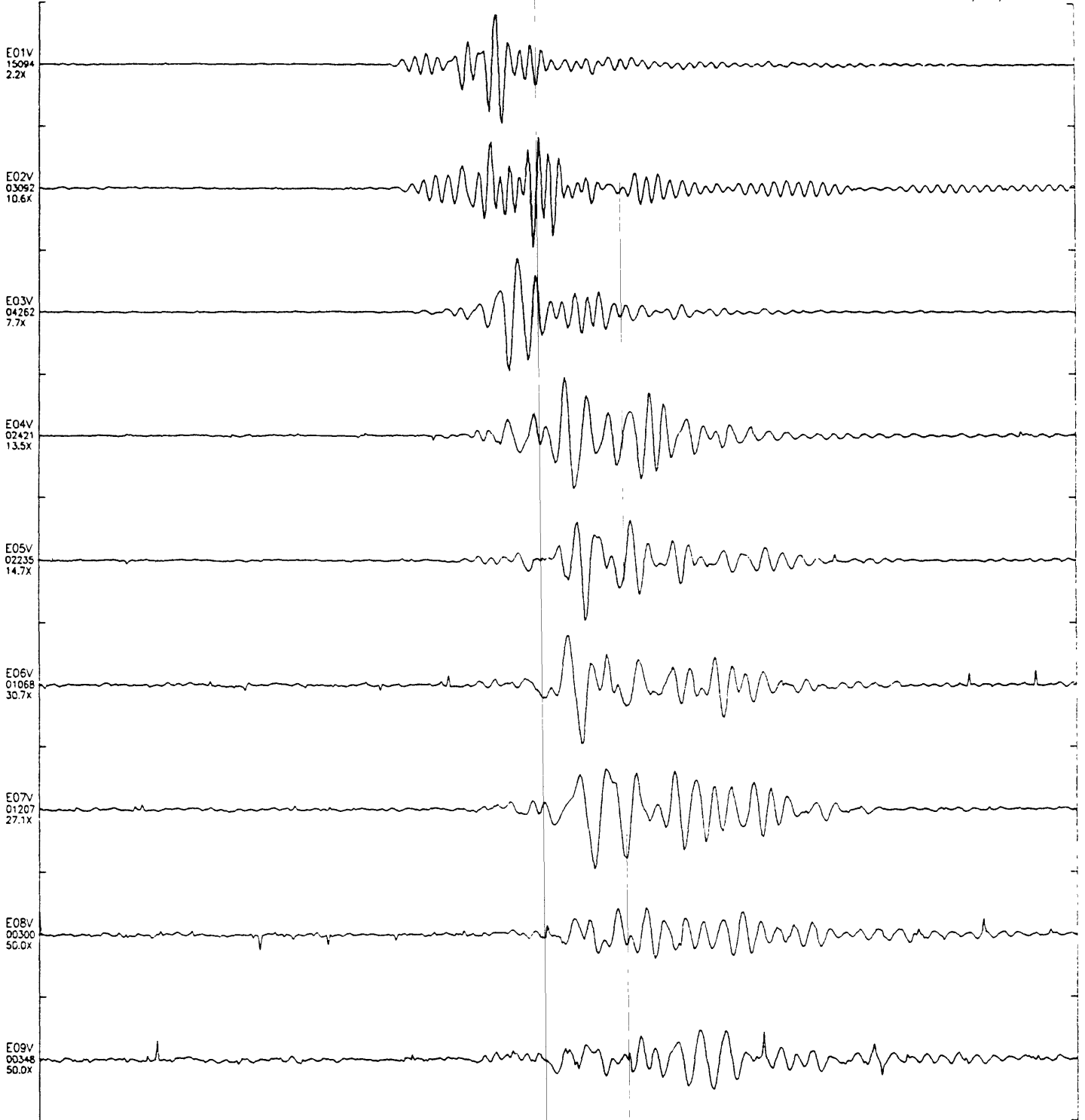
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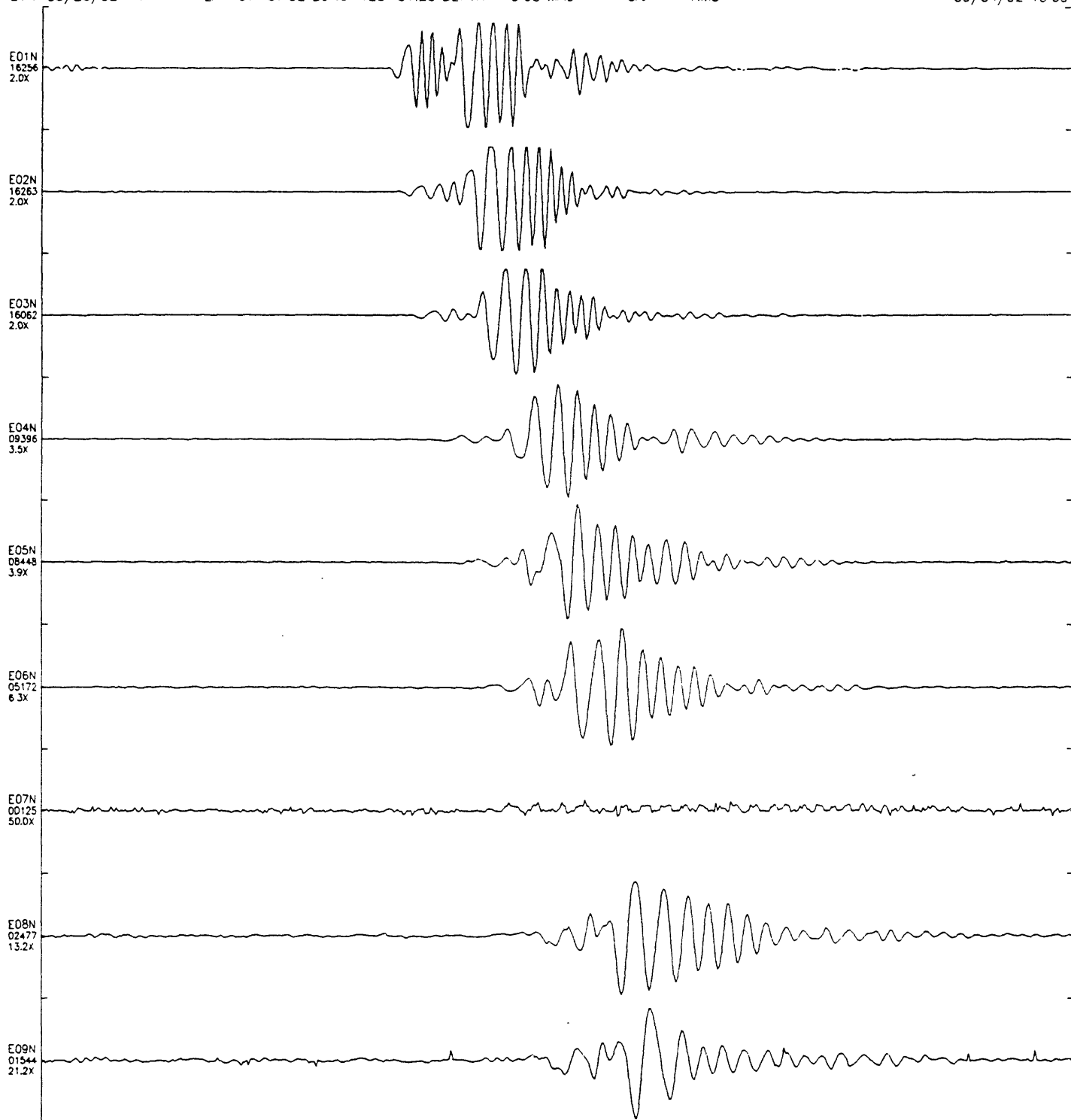
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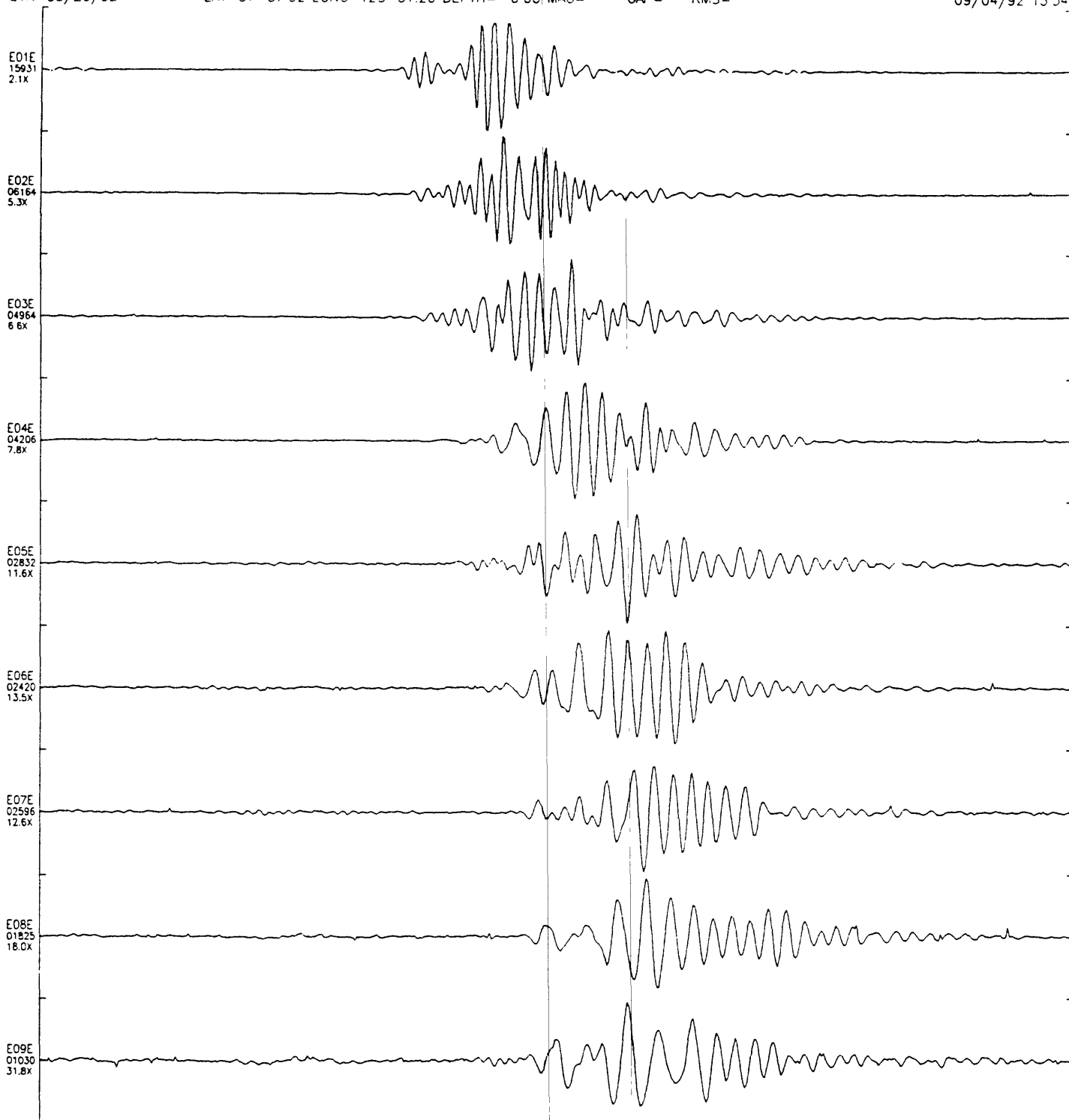
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09/04/92 13:54



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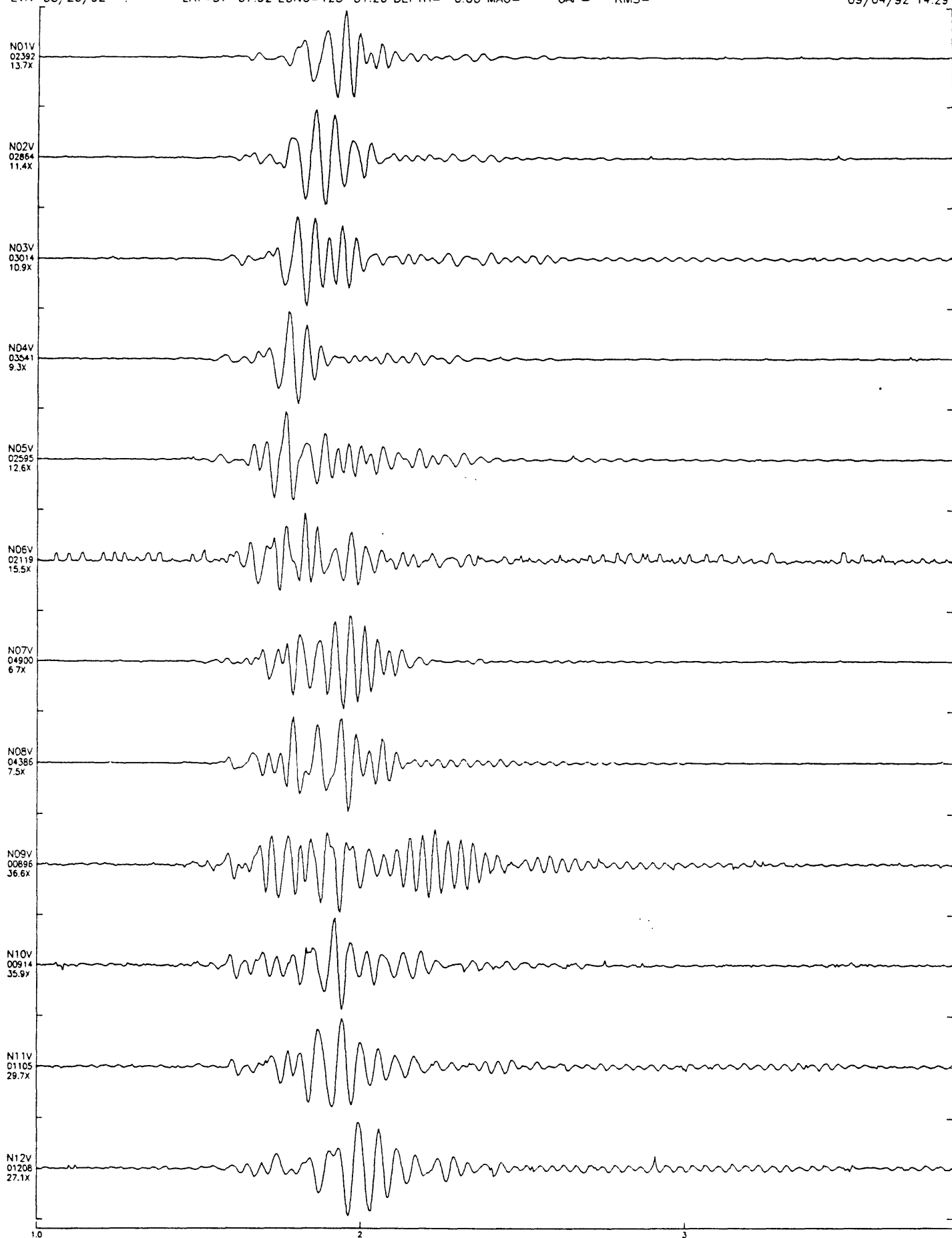
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239

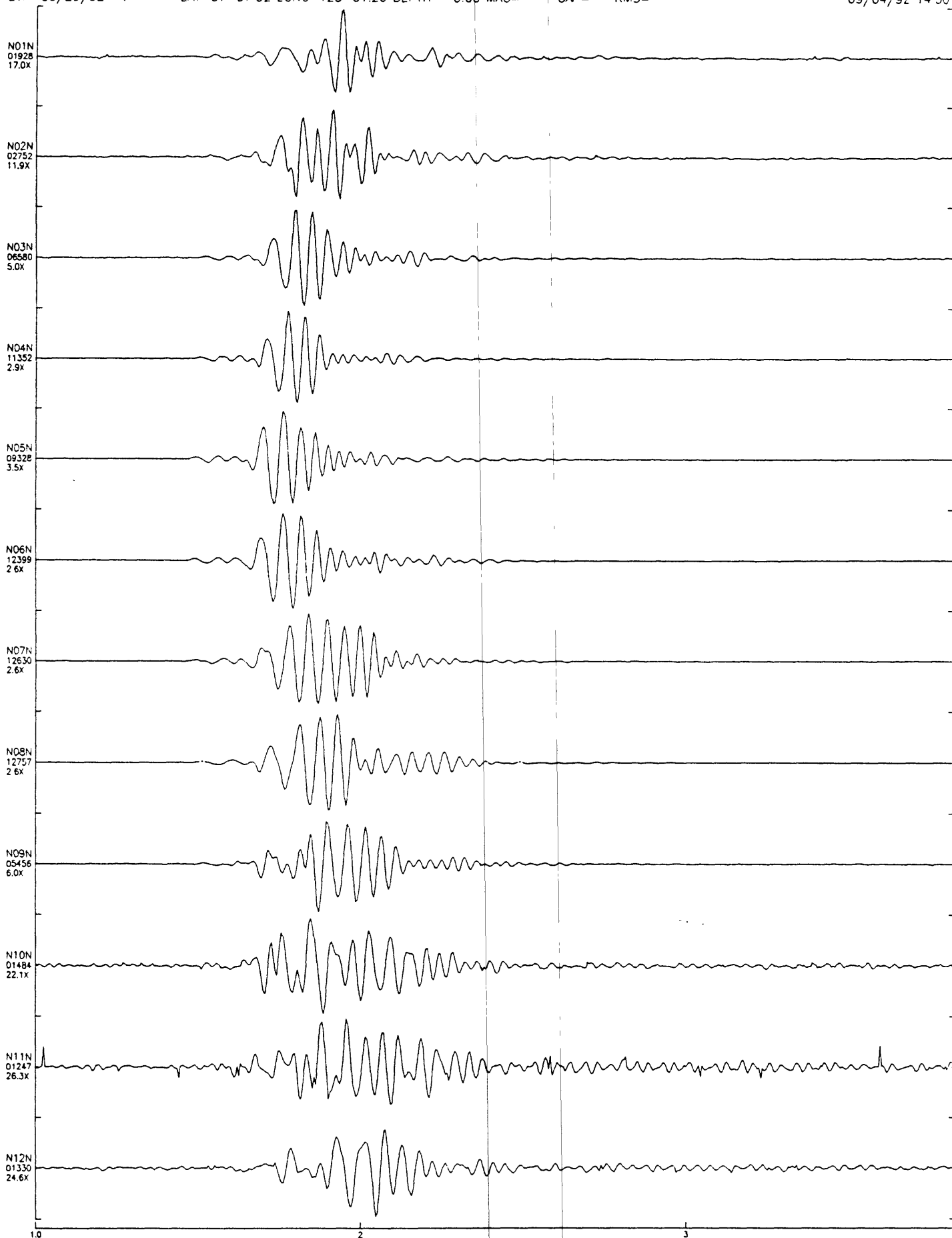
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Sheet 1
09/04/92 14.29



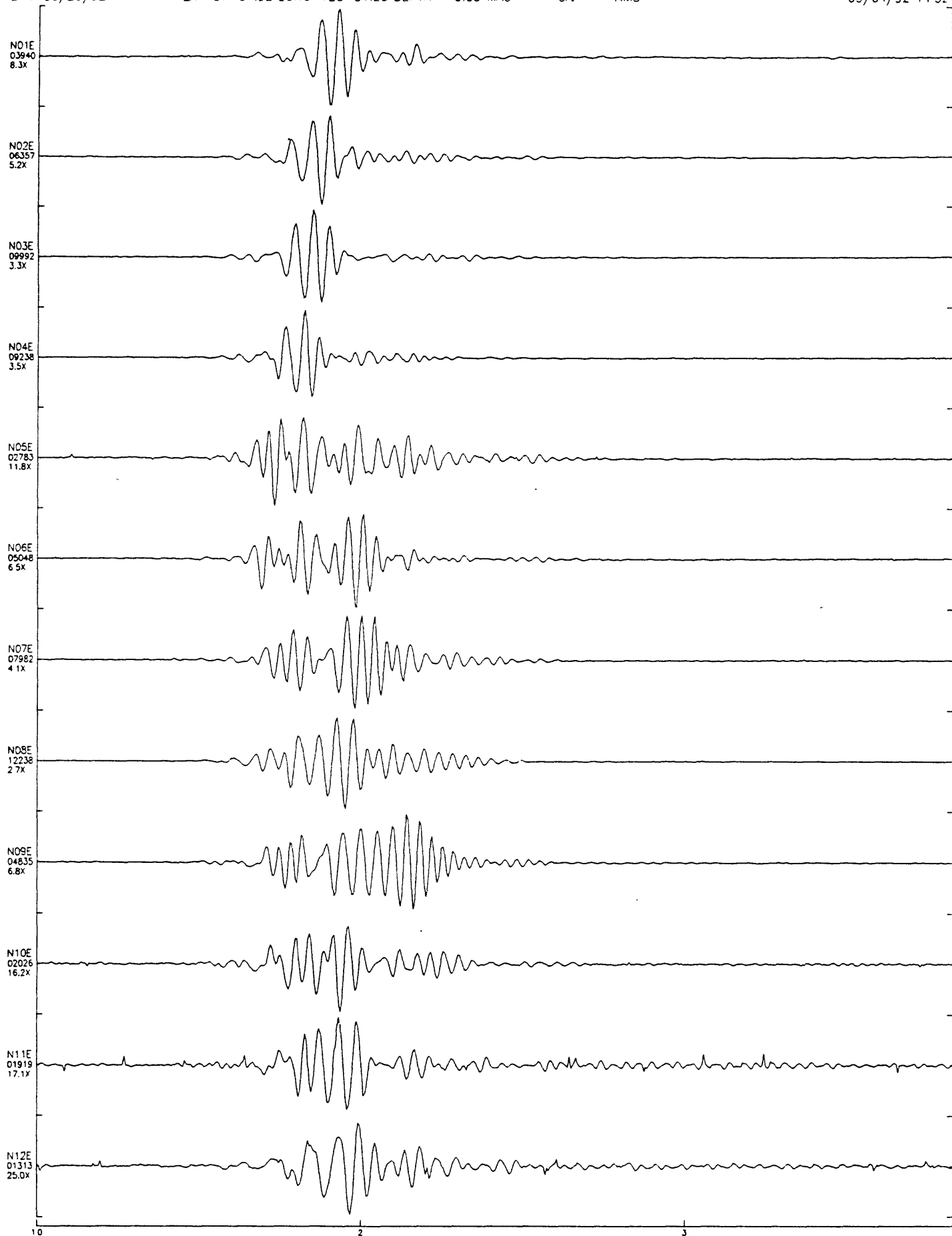
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Sheet 1
09/04/92 14 30



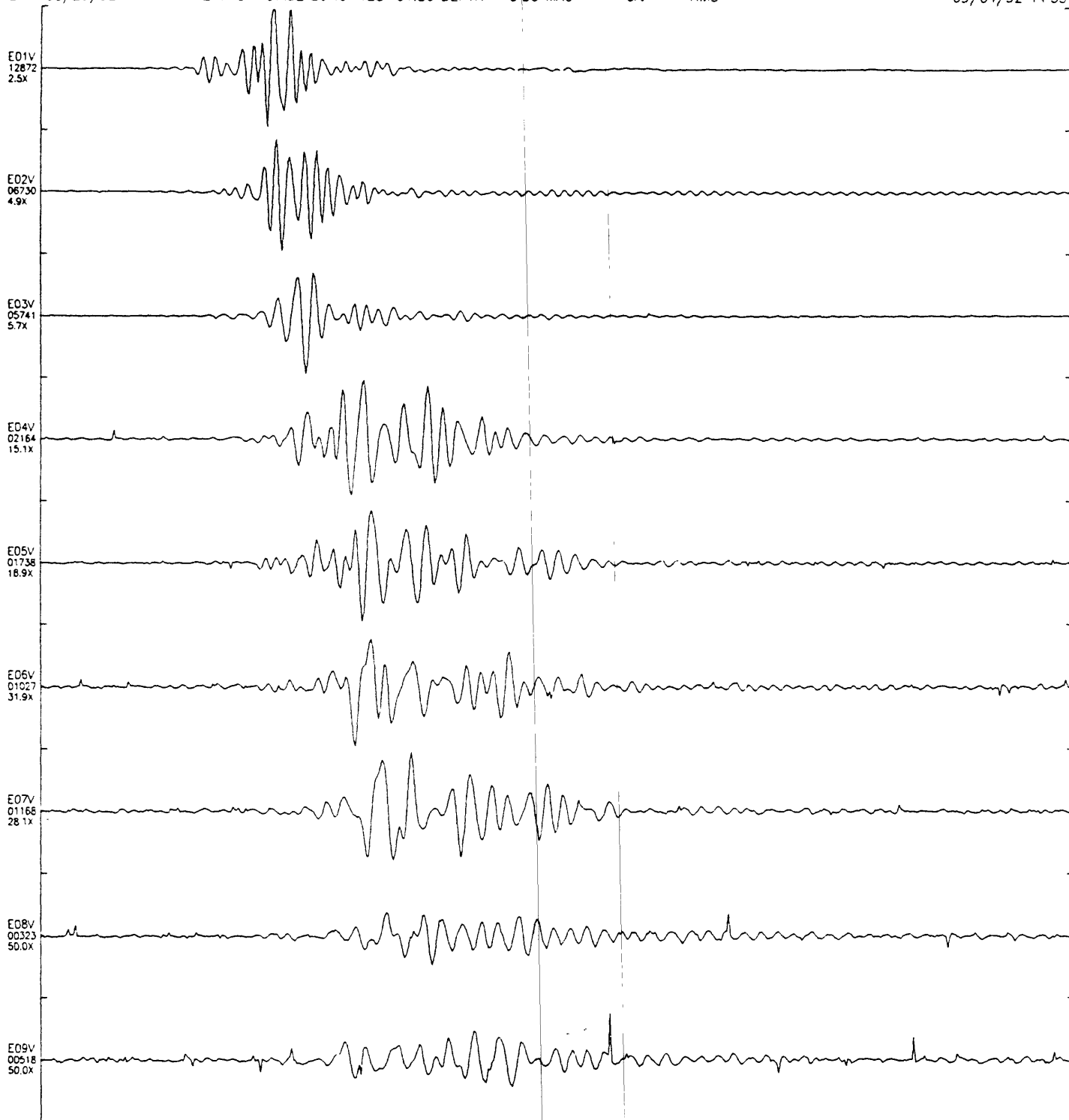
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09/04/92 14 32



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Sheet 1
09/04/92 14 33



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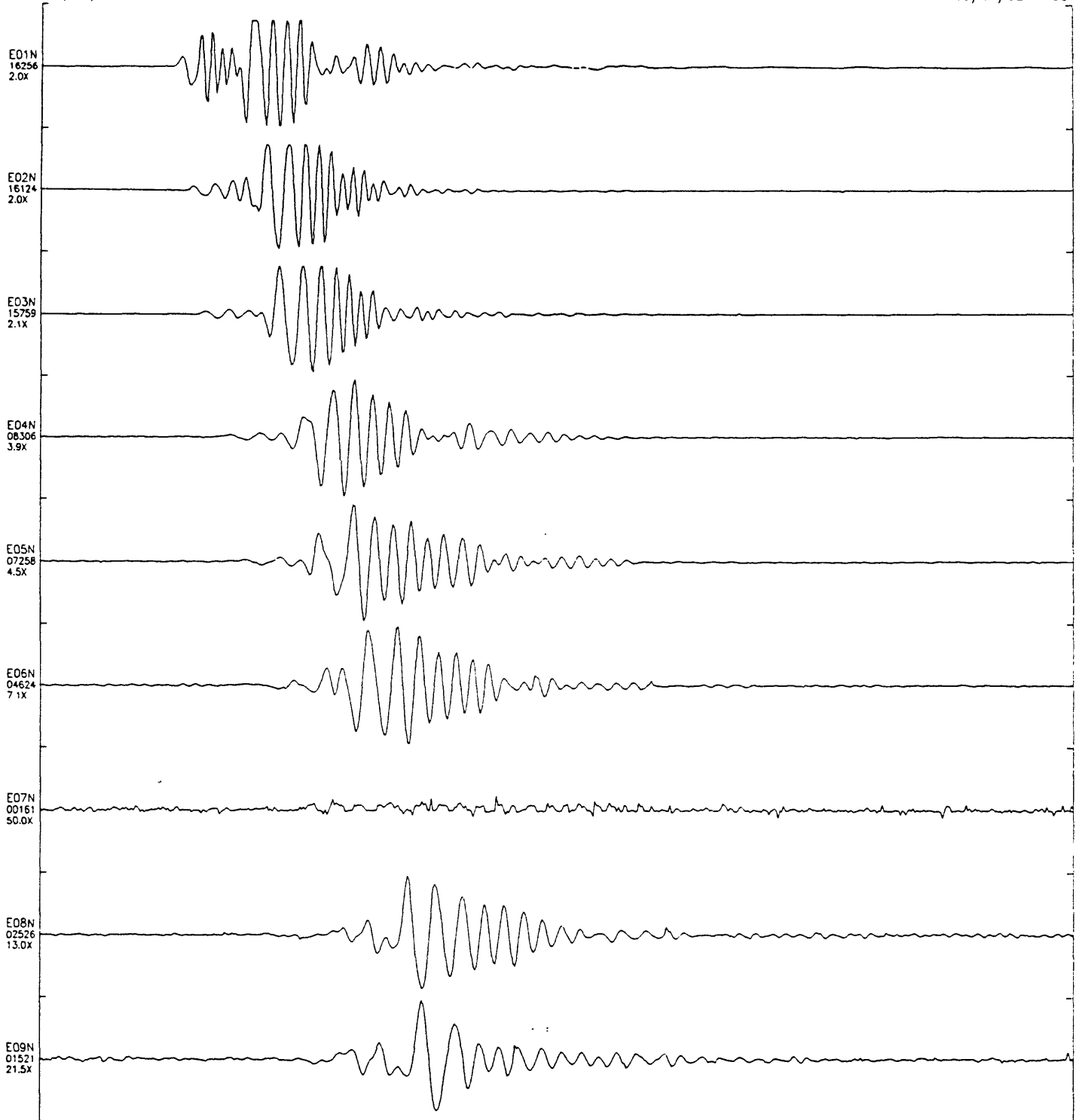
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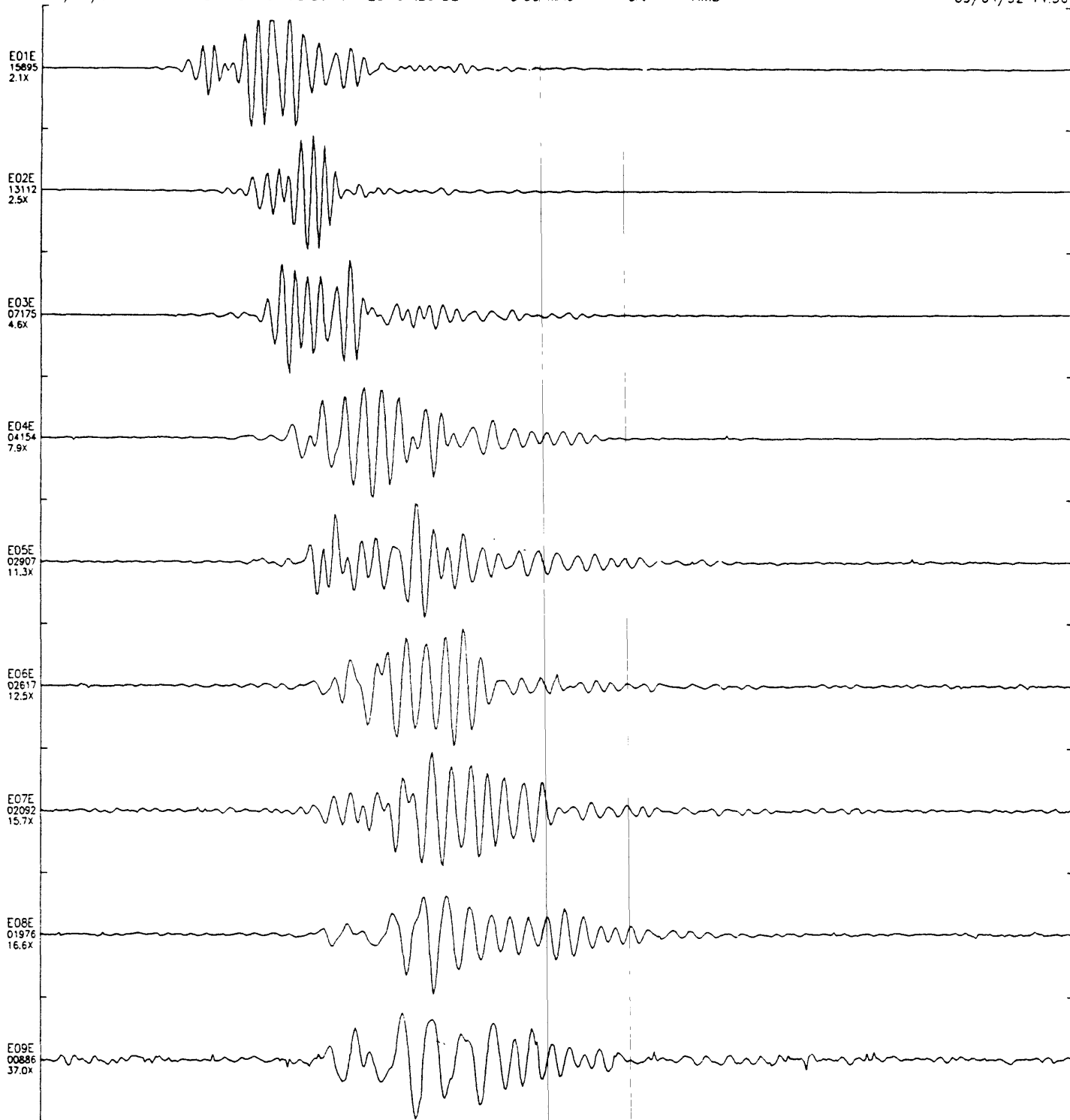
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09/04/92 14:36



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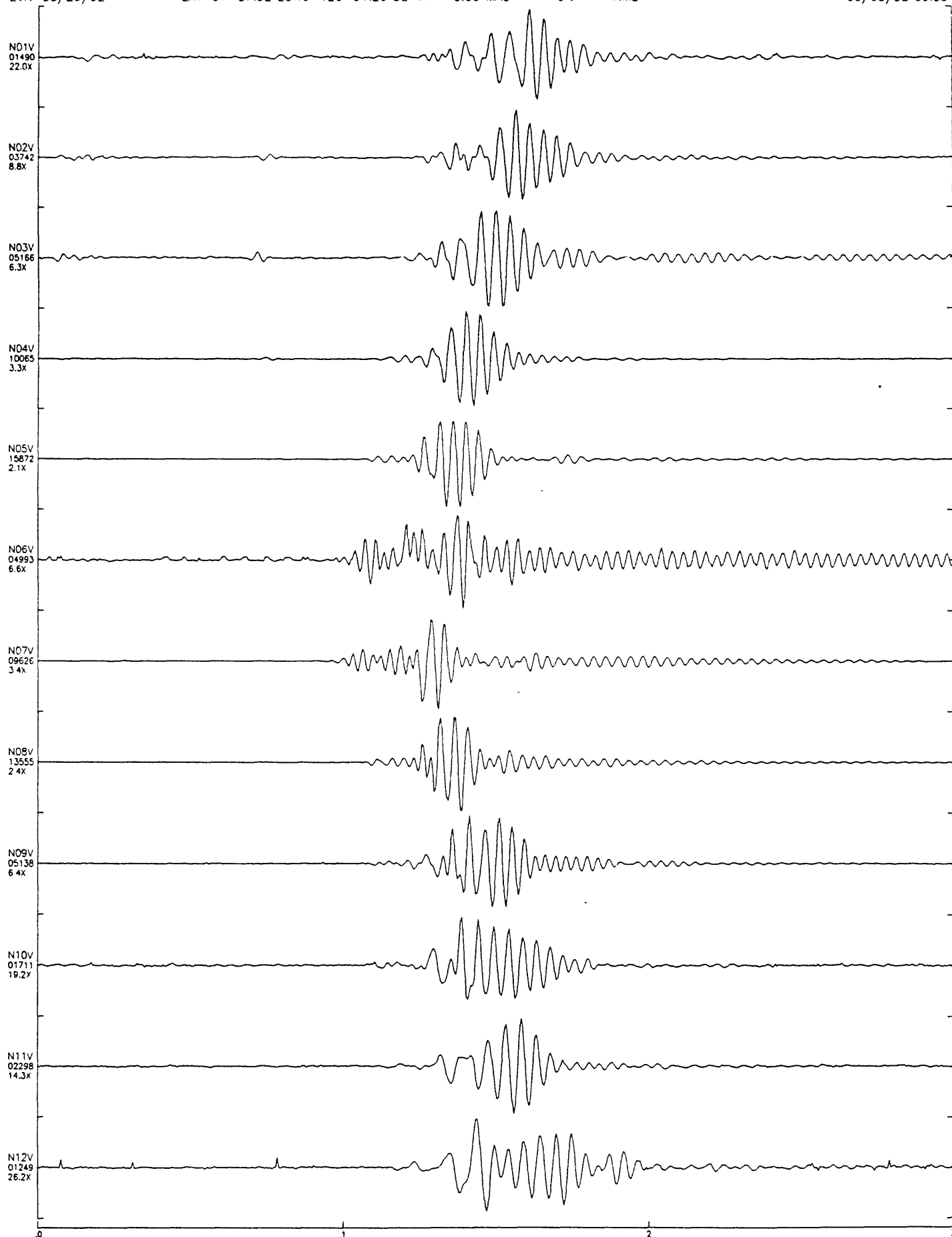
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245

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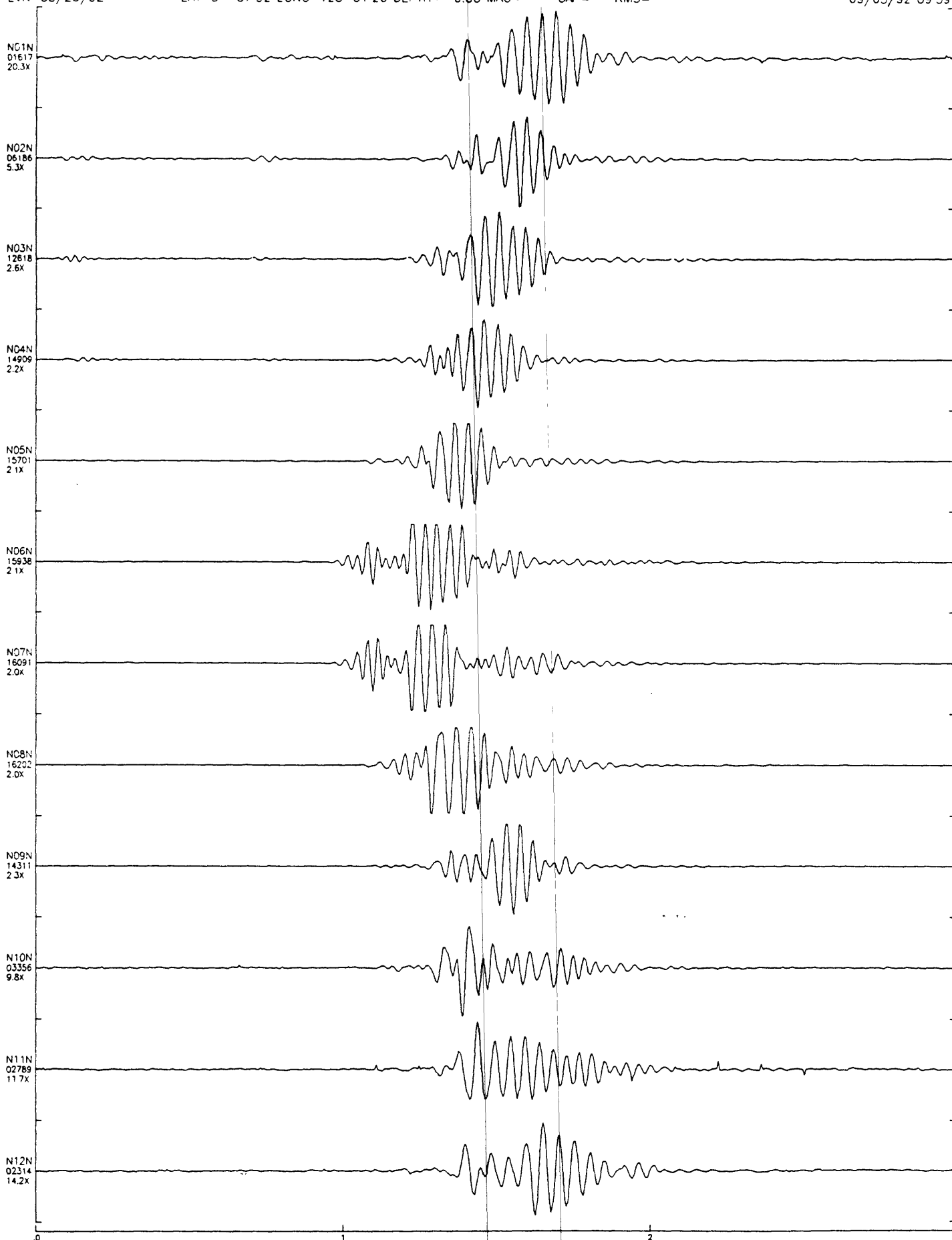
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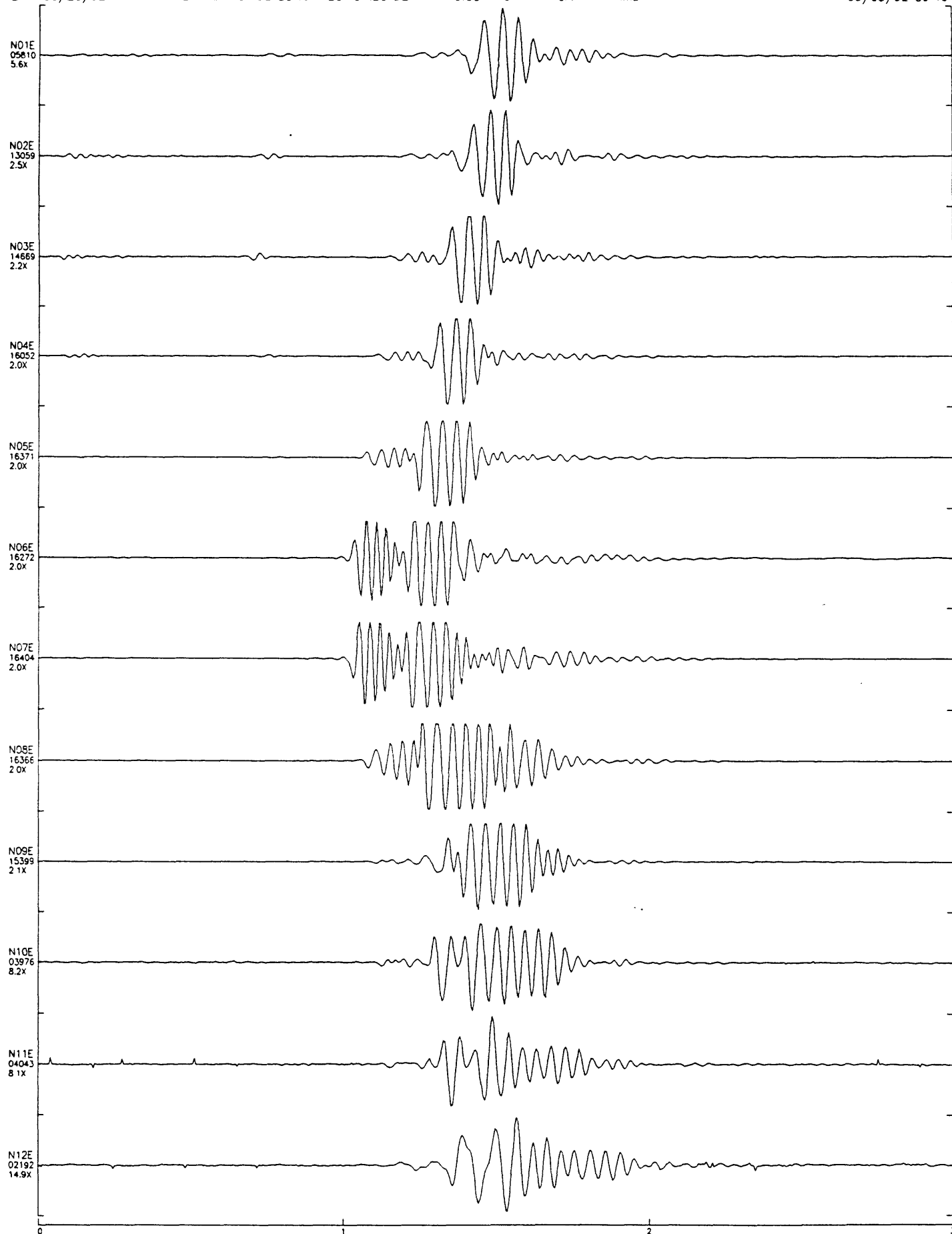


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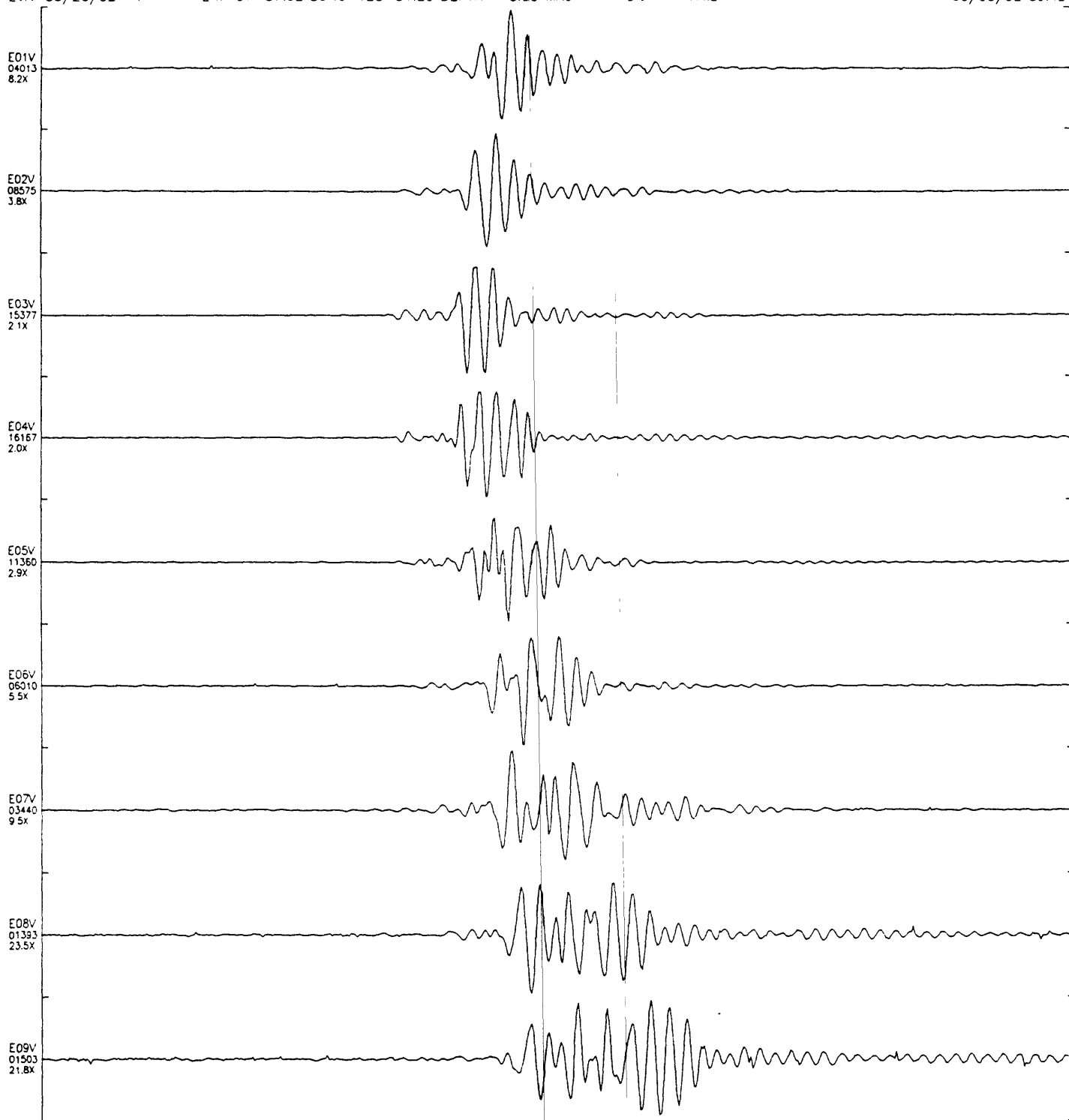
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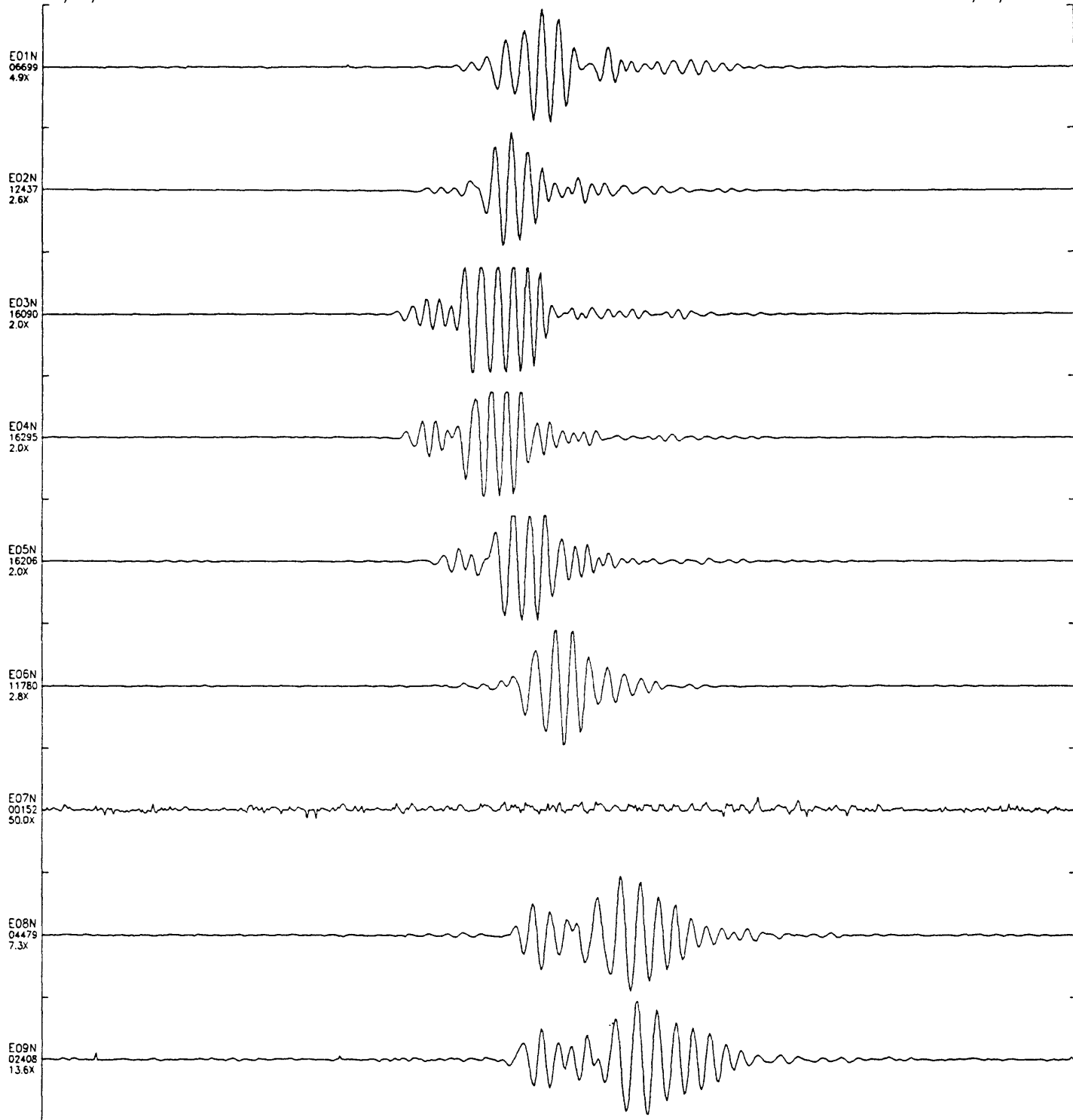


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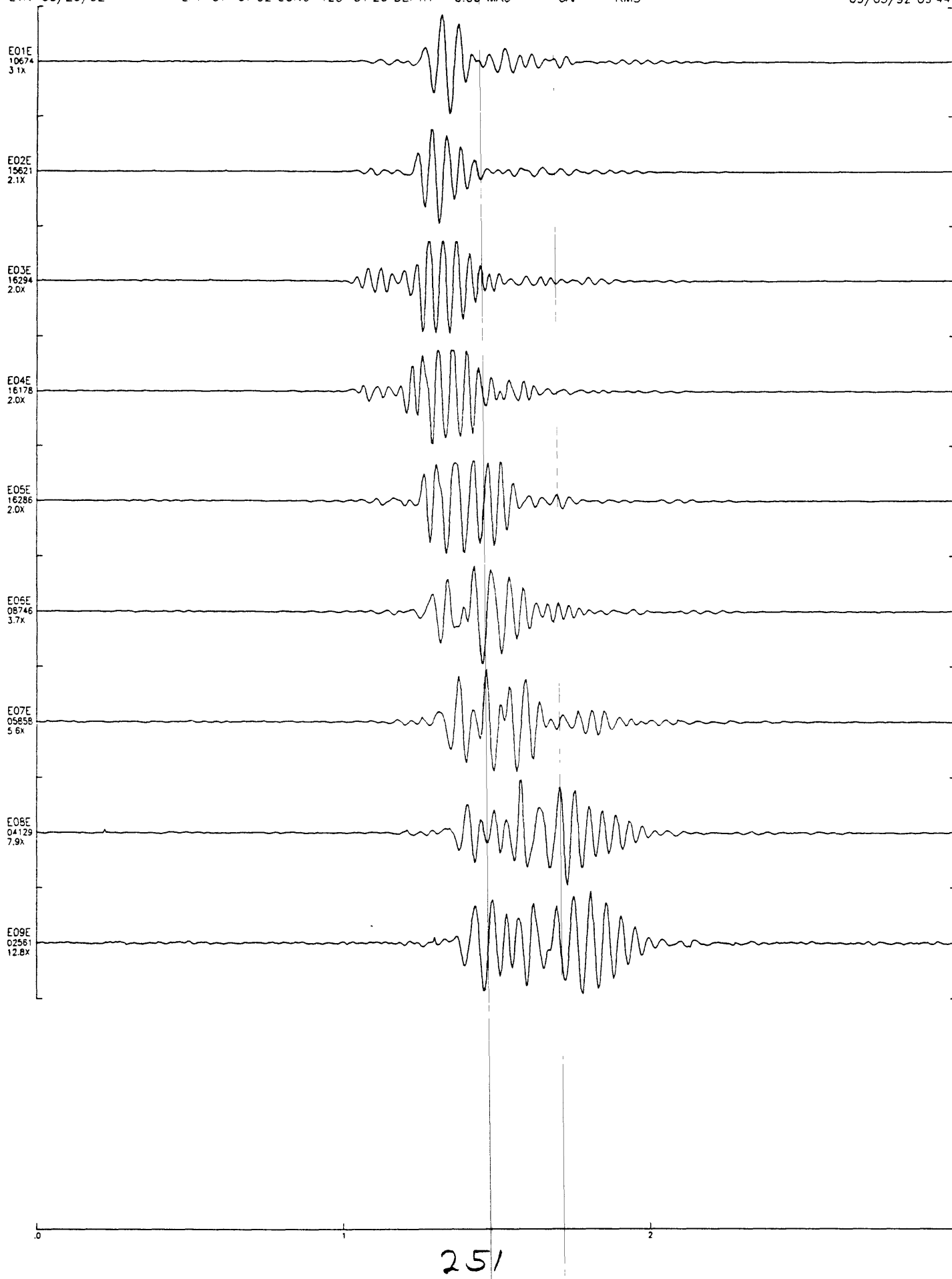
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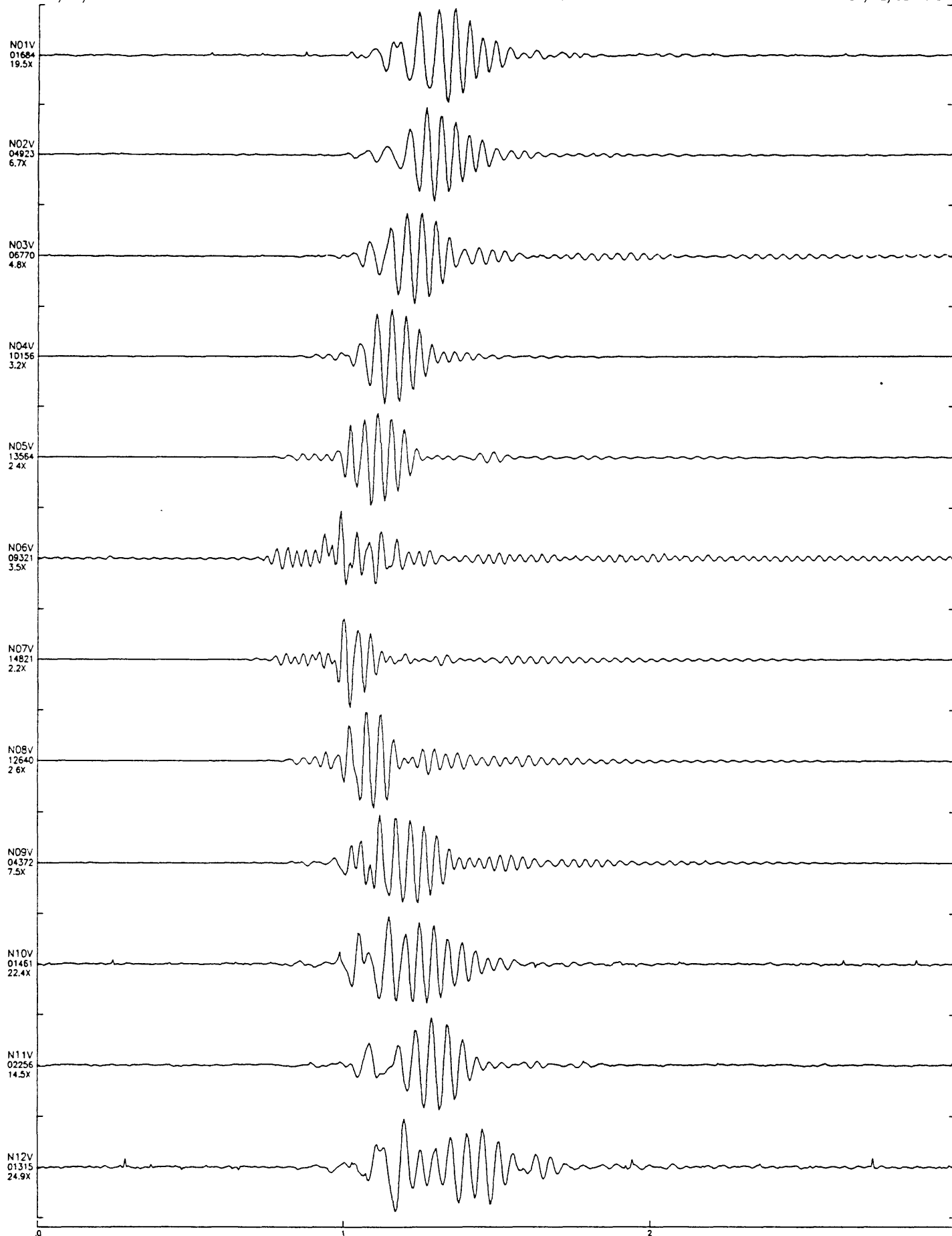


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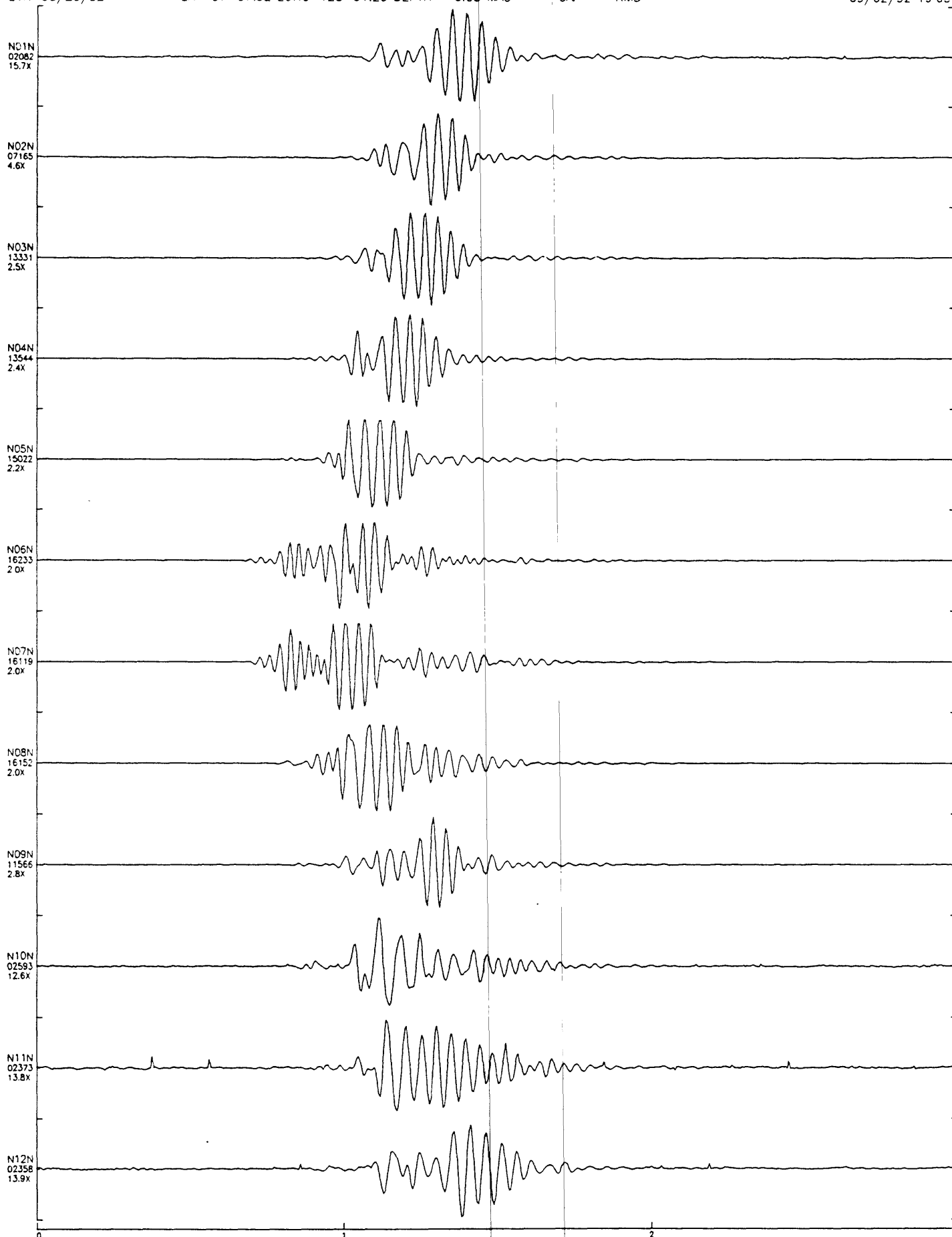
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09/03/92 09.44





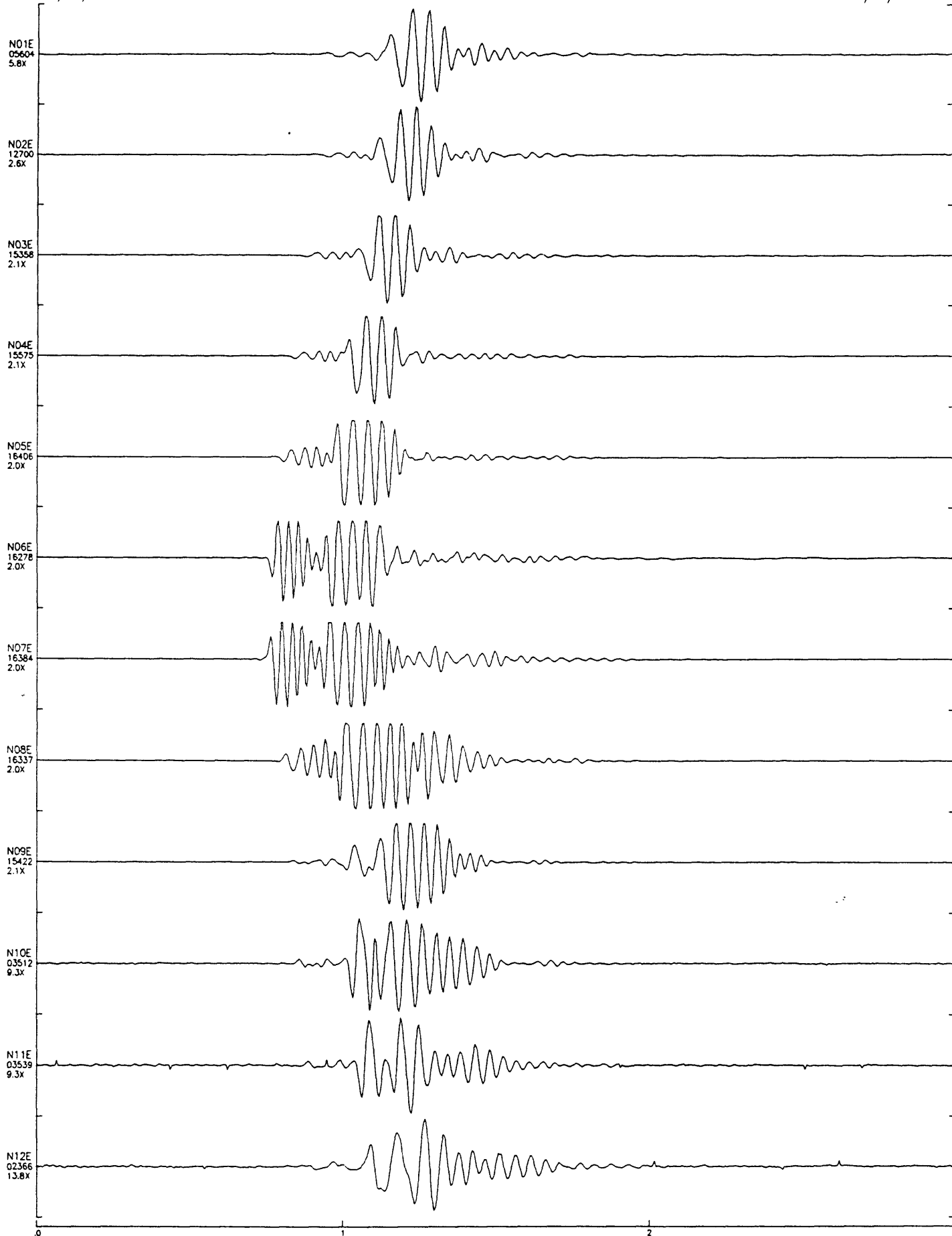
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09/02/92 19 03



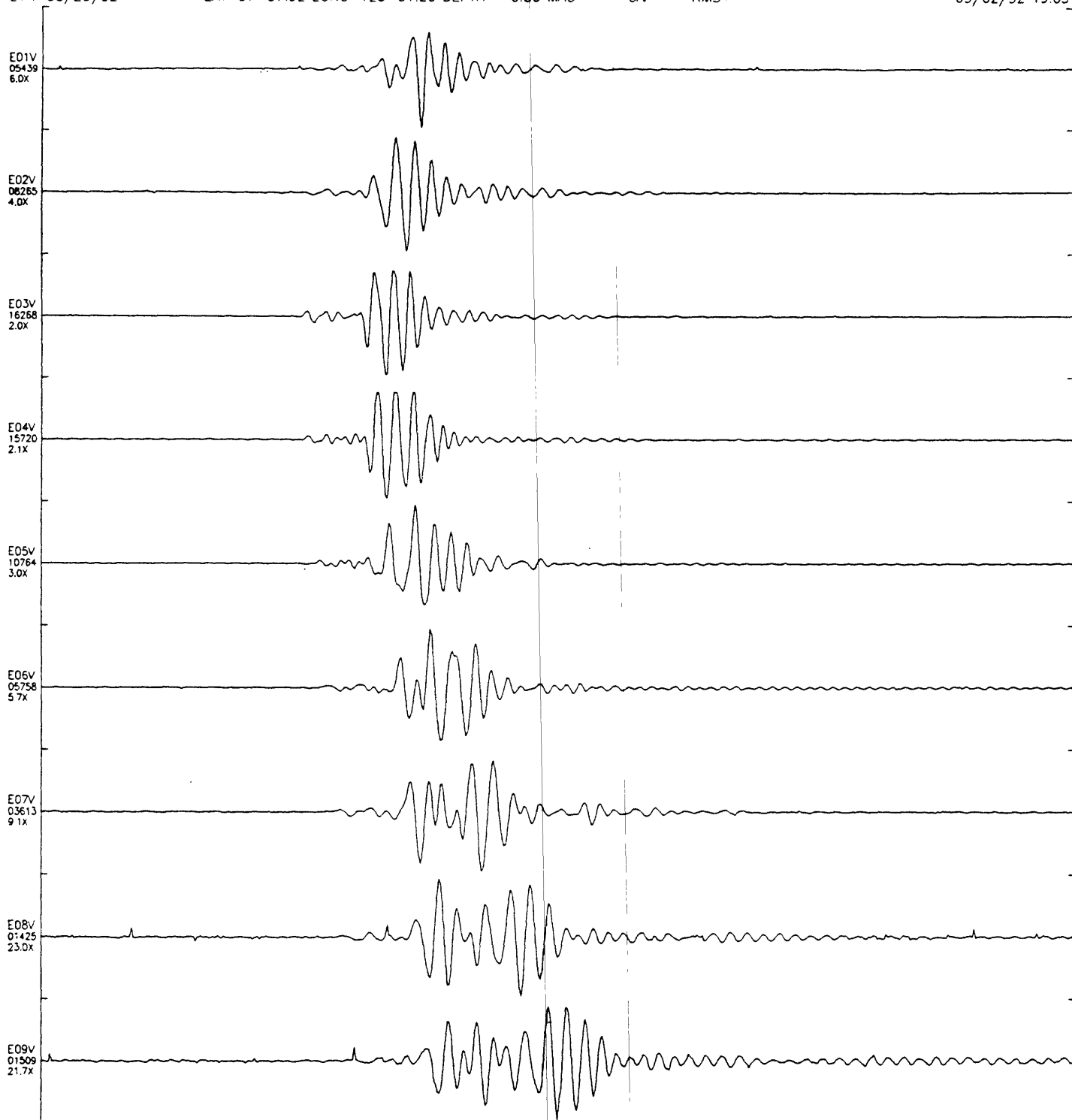
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Sheet 1
09/02/92 19 04



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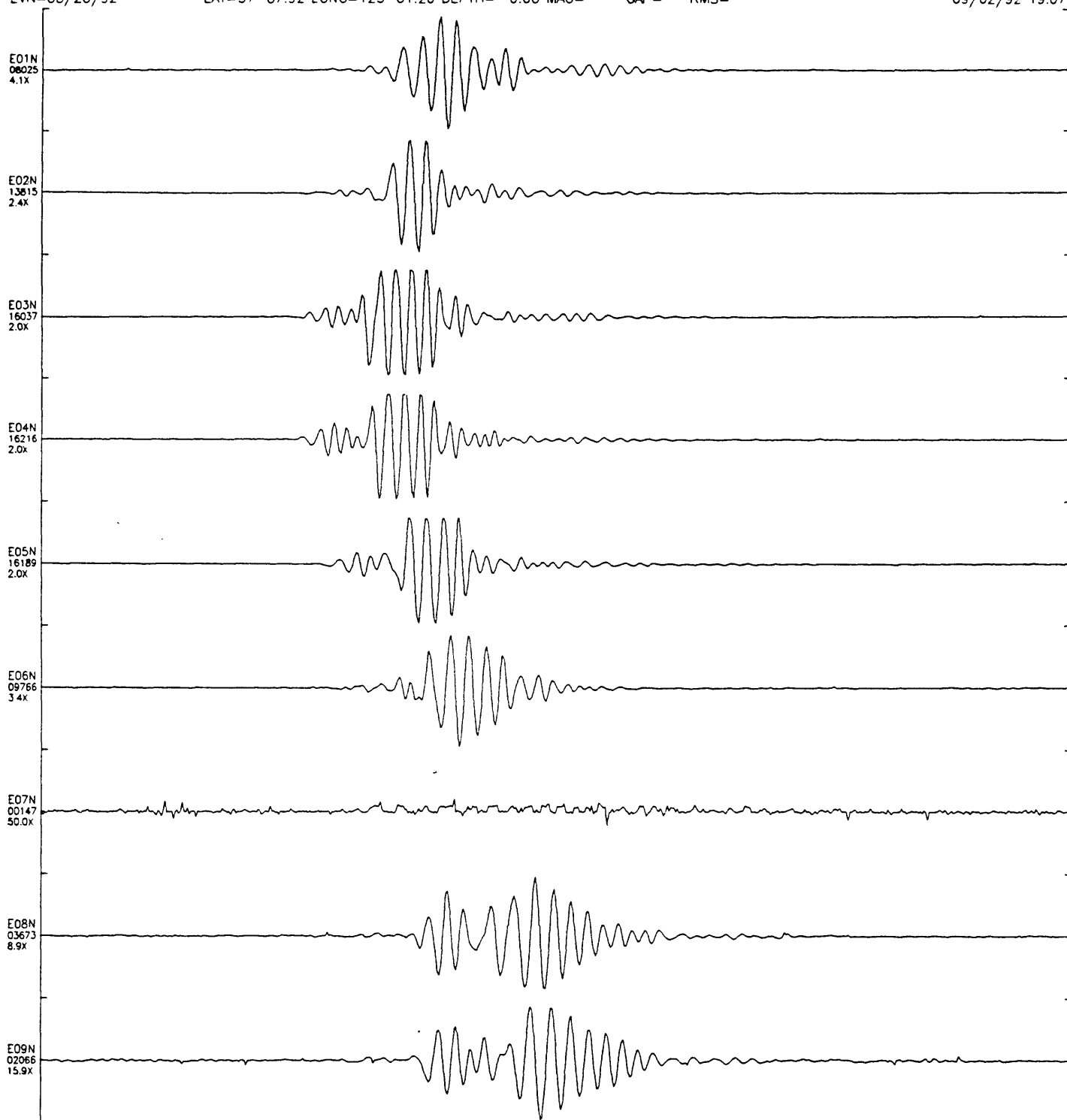
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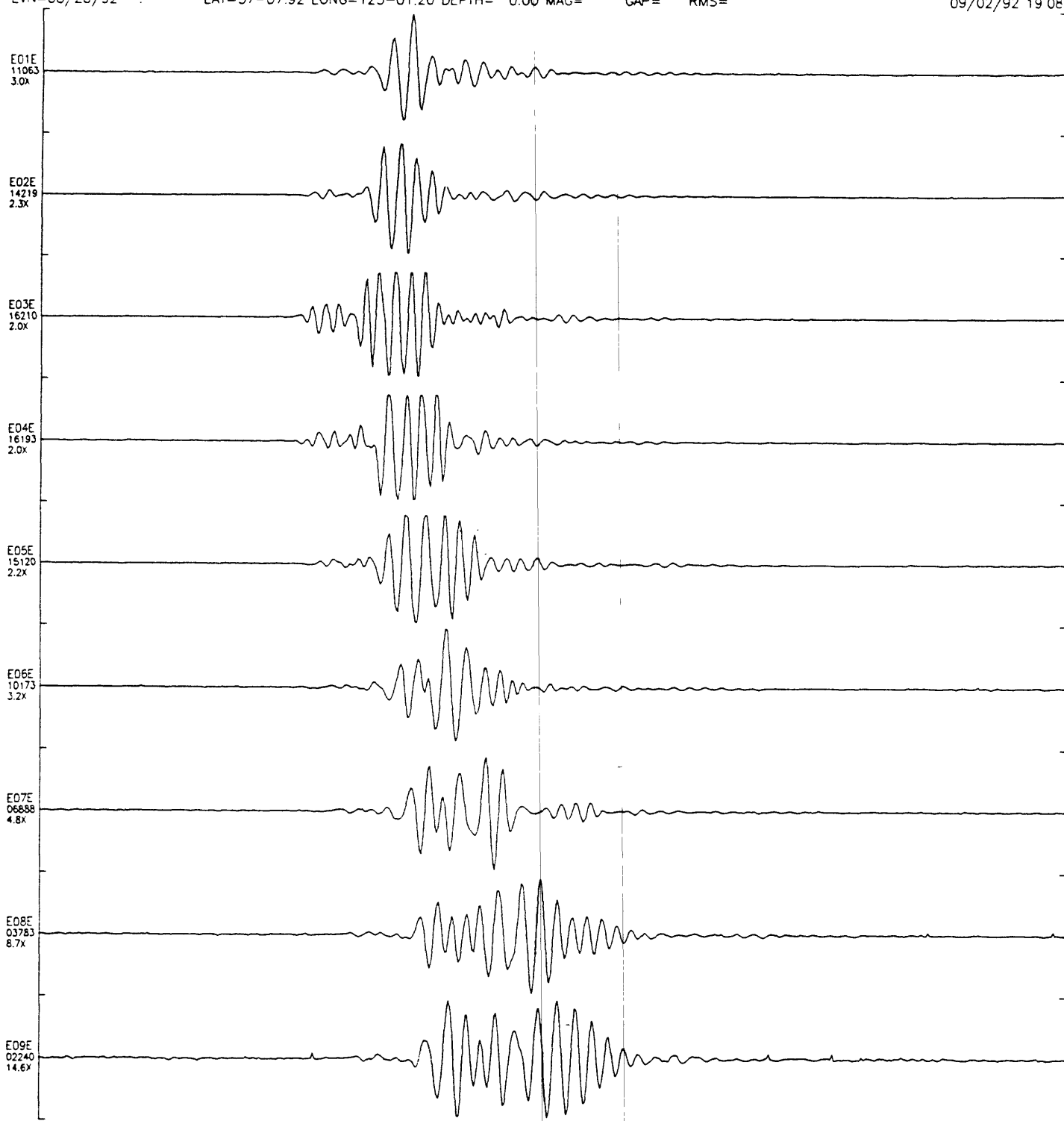
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09/02/92 19.07



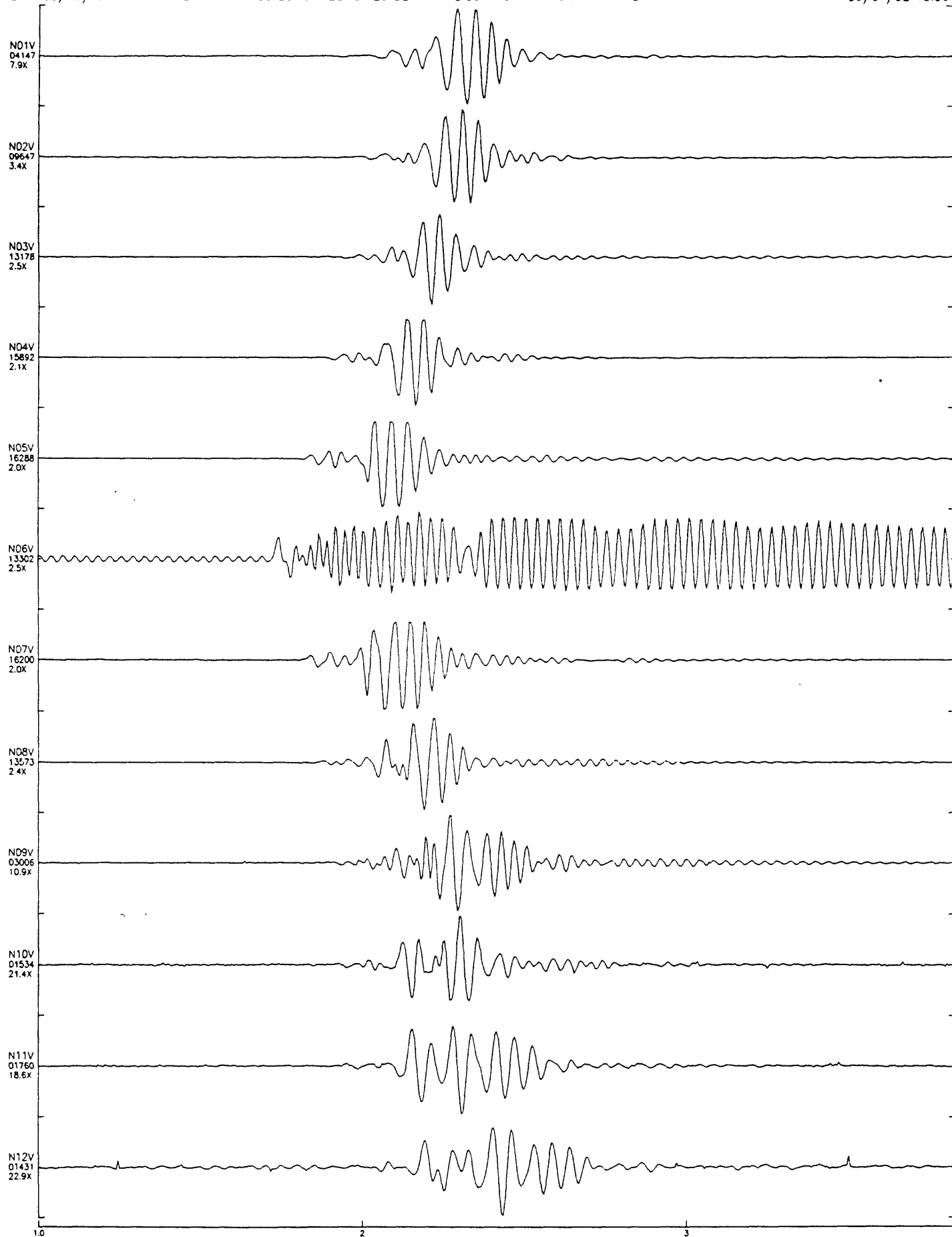
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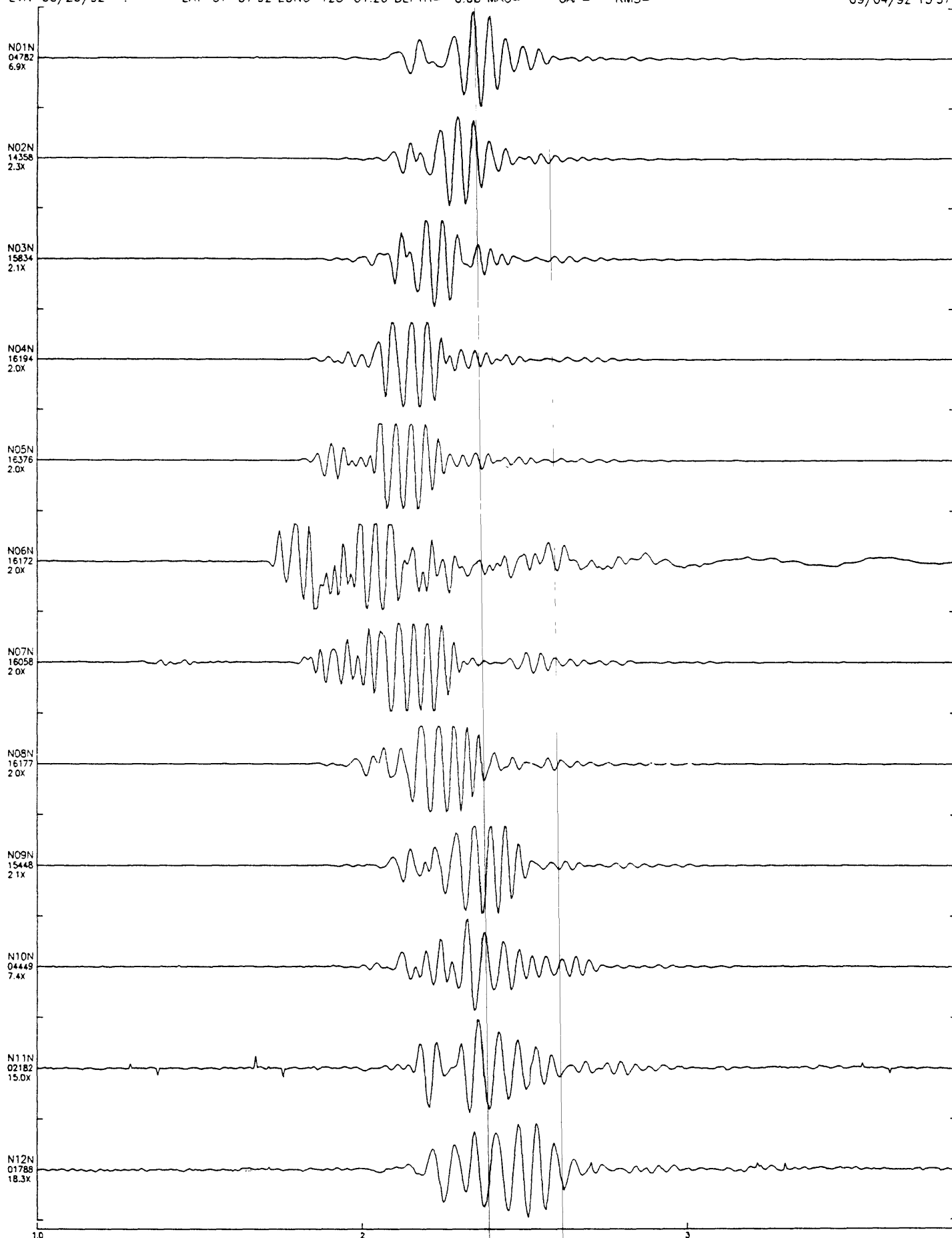
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09/04/92 13.56



258

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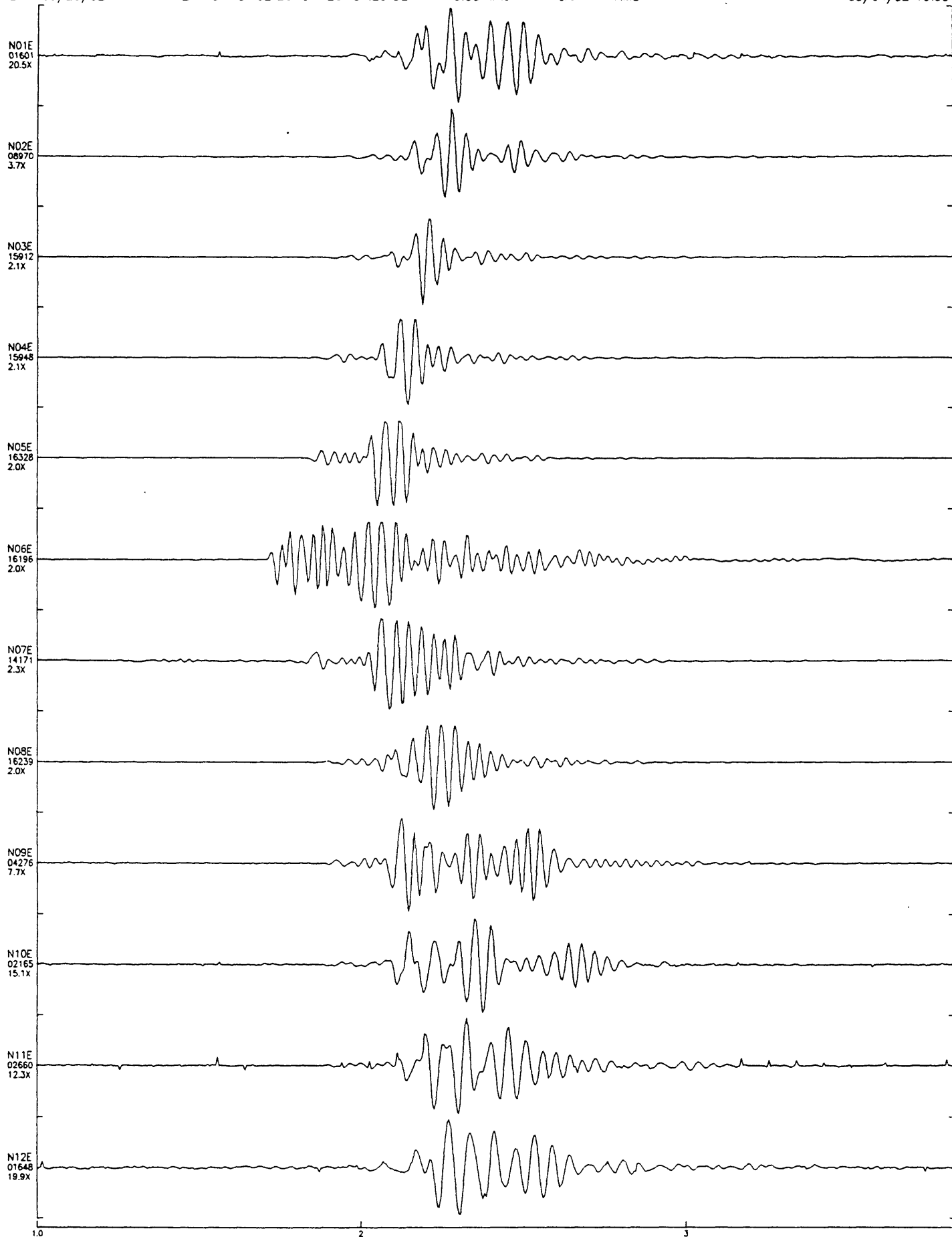
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259

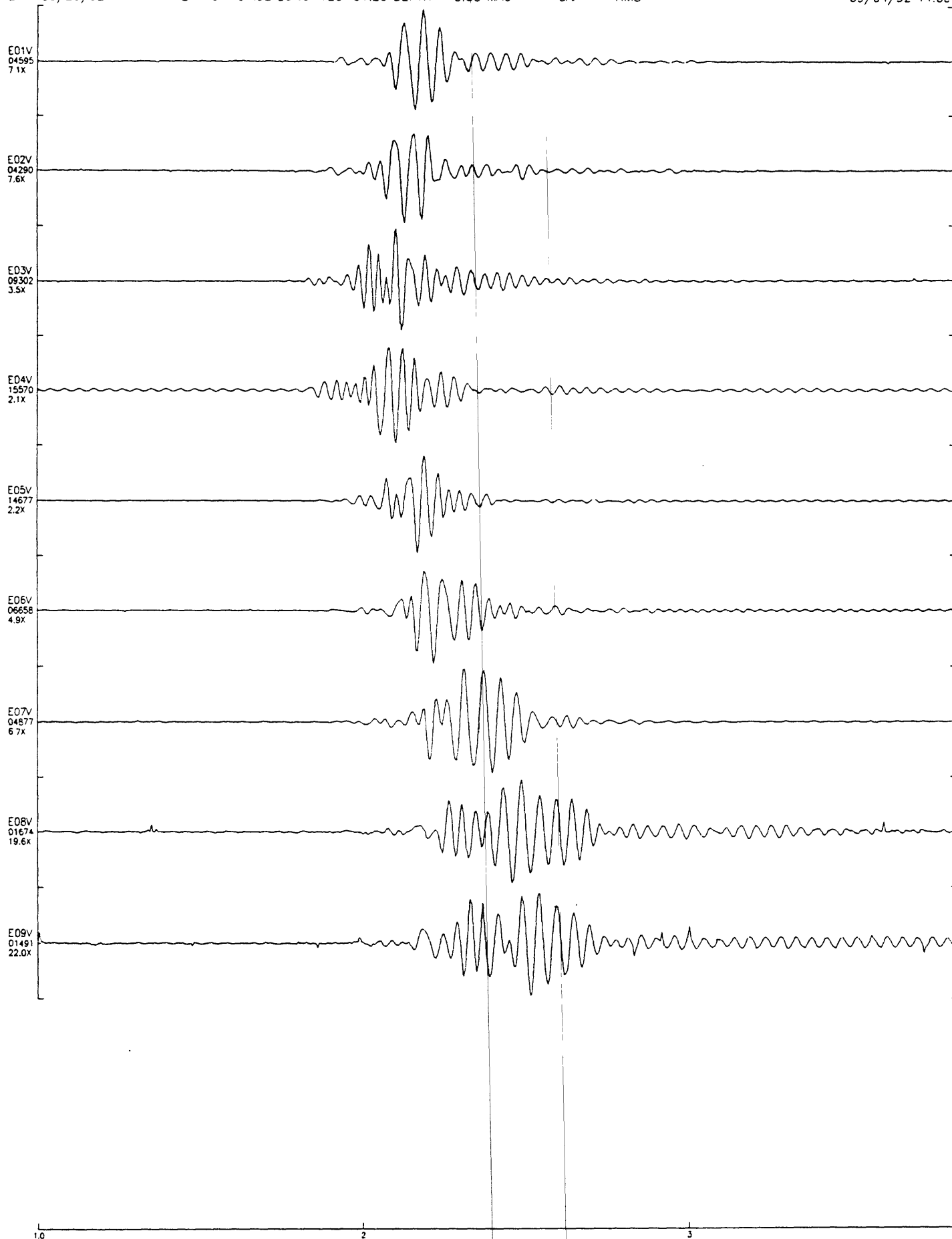
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09/04/92 13.58



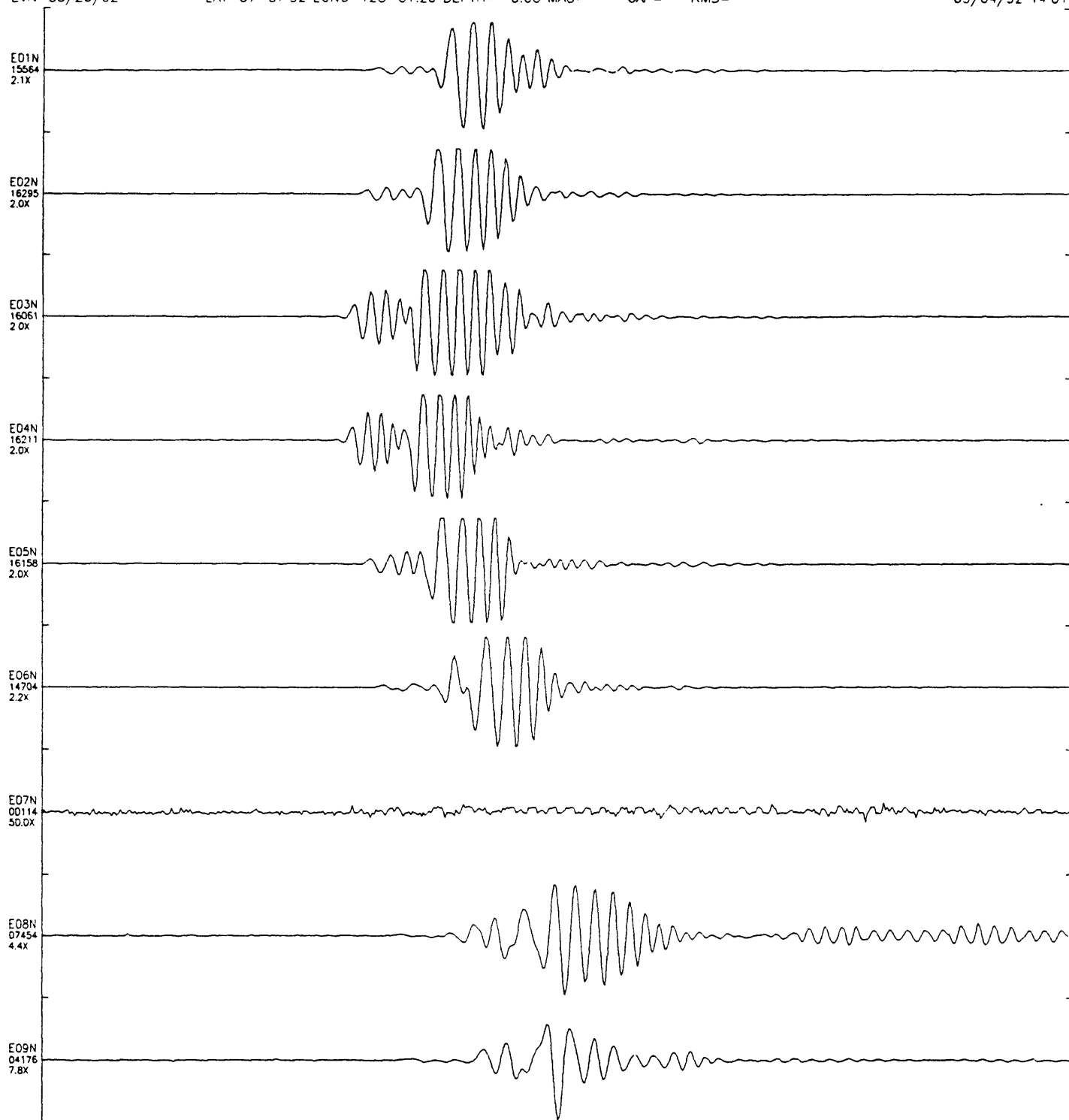
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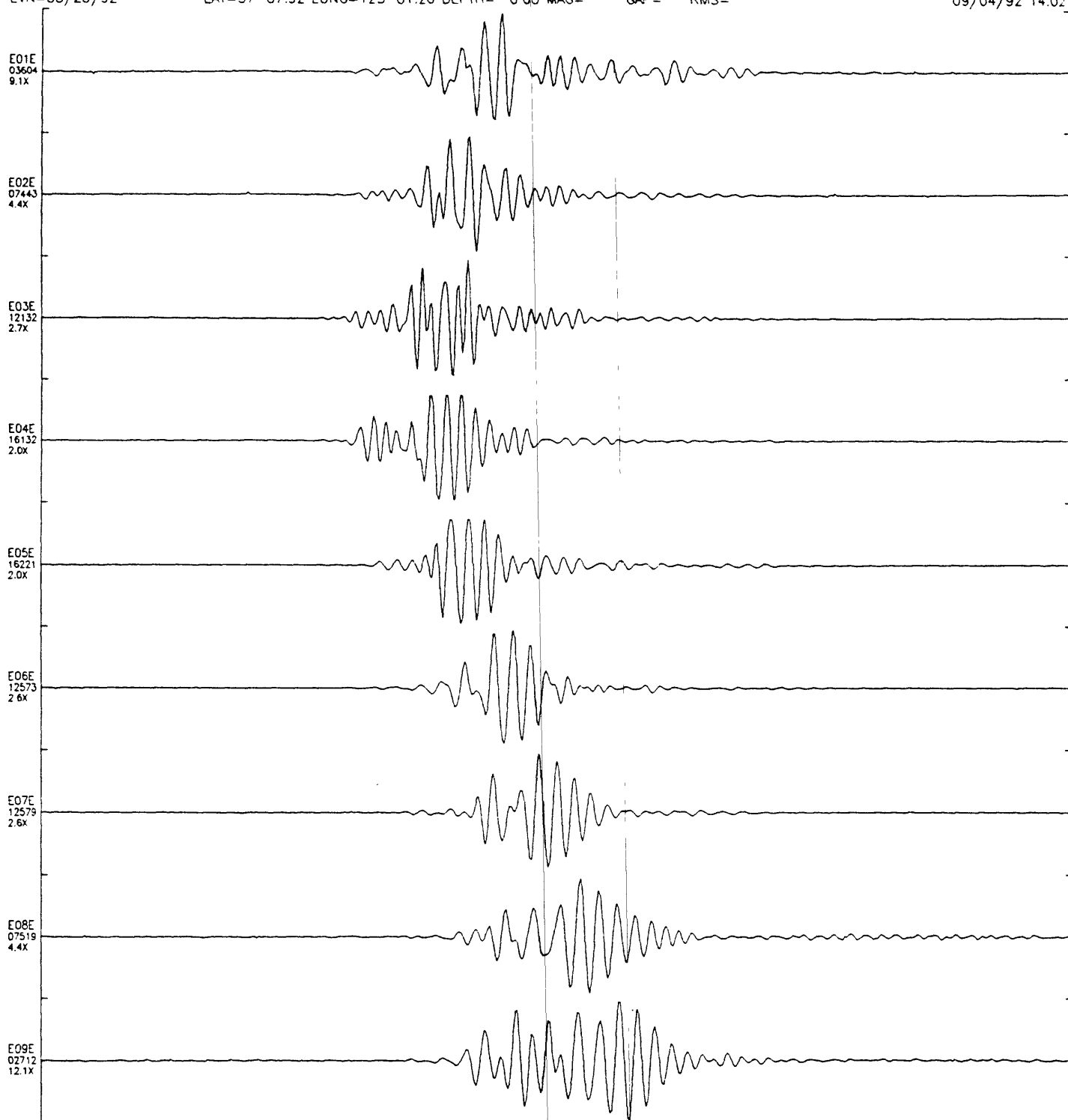
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09/04/92 14 01



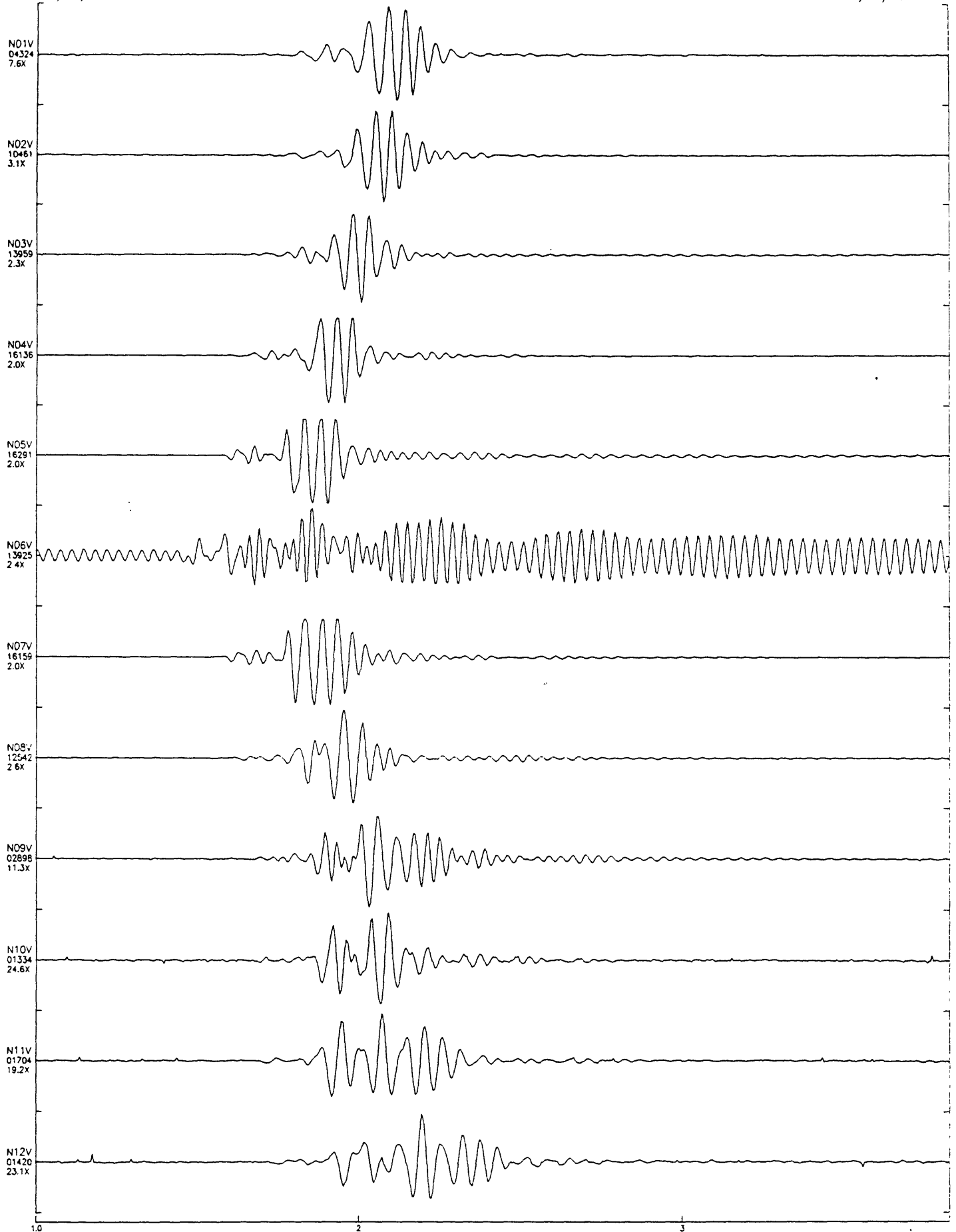
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Sheet 1
09/04/92 14.02



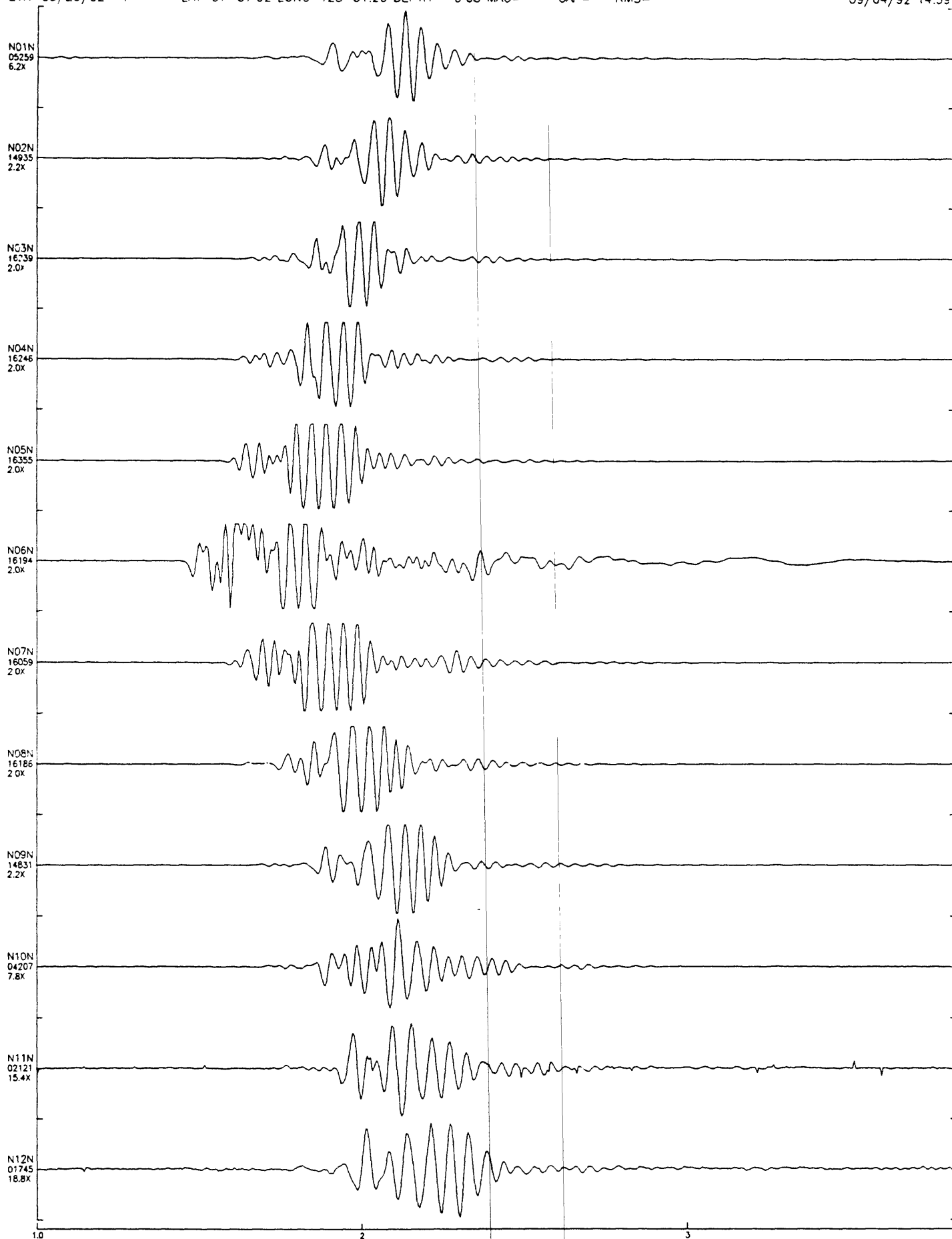
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09/04/92 14:37



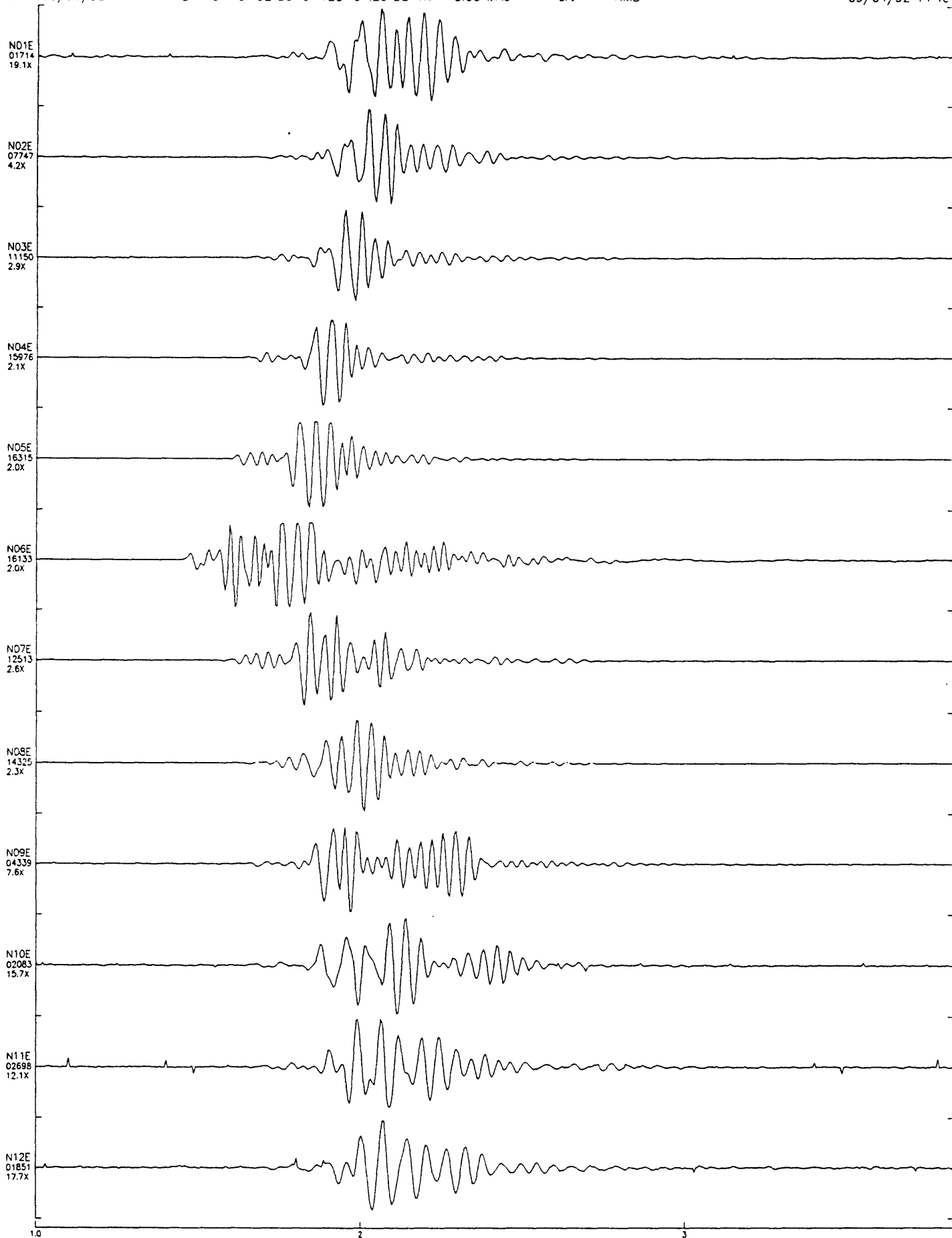
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Sheet 1
09/04/92 14:39



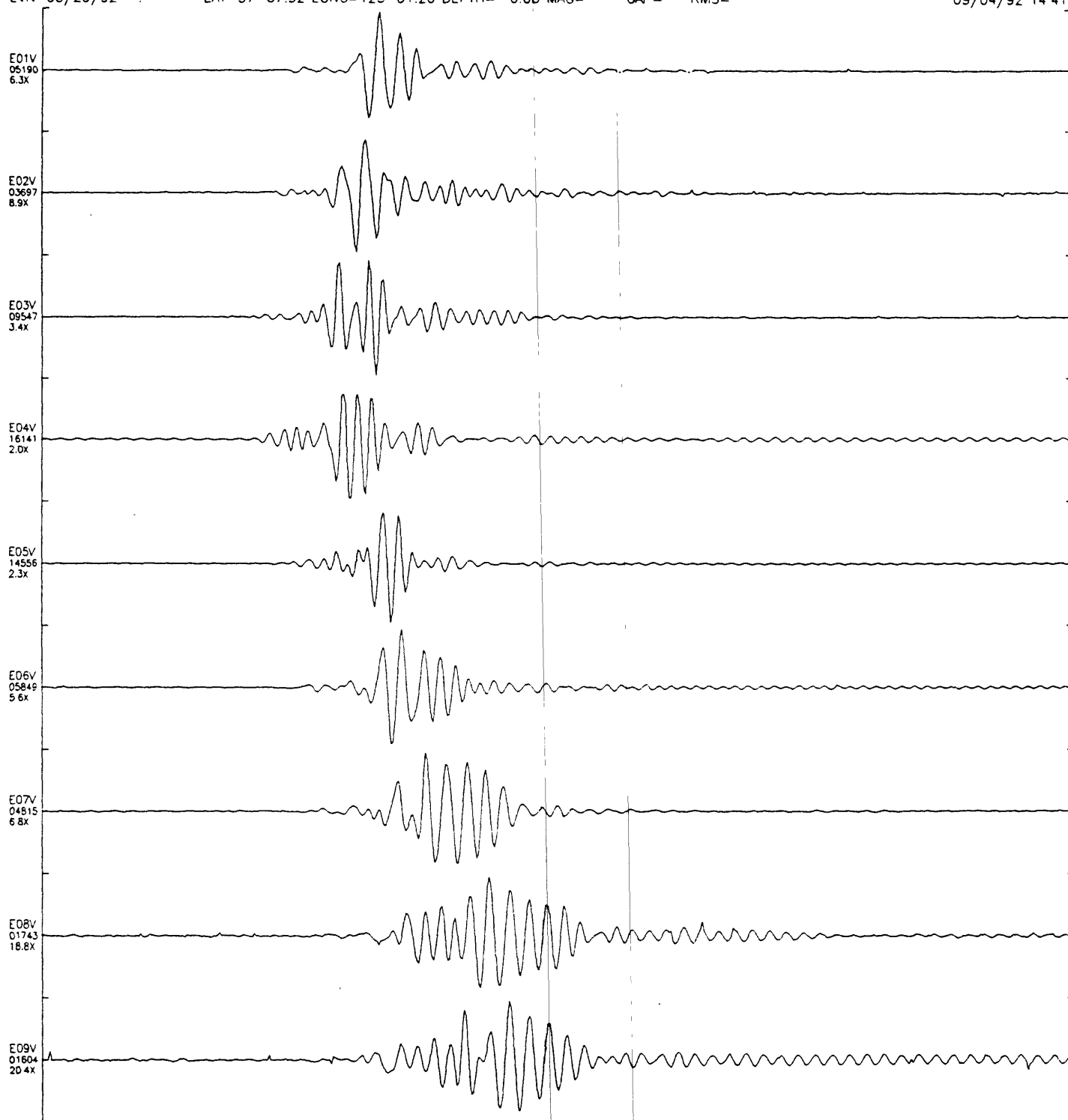
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Sheet 1
09/04/92 14 40



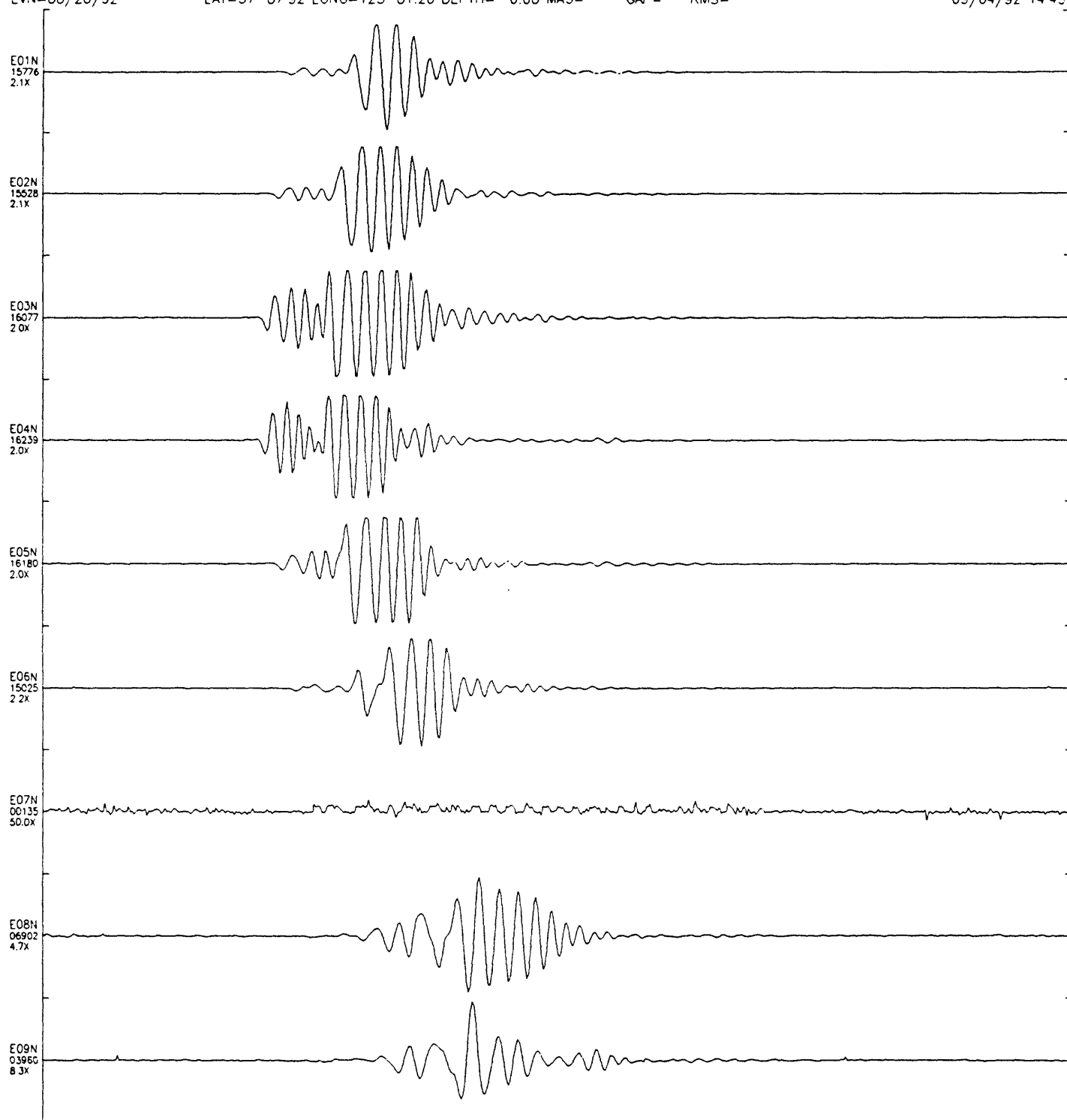
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Sheet 1
09/04/92 14 41



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Sheet 1
09/04/92 14 43



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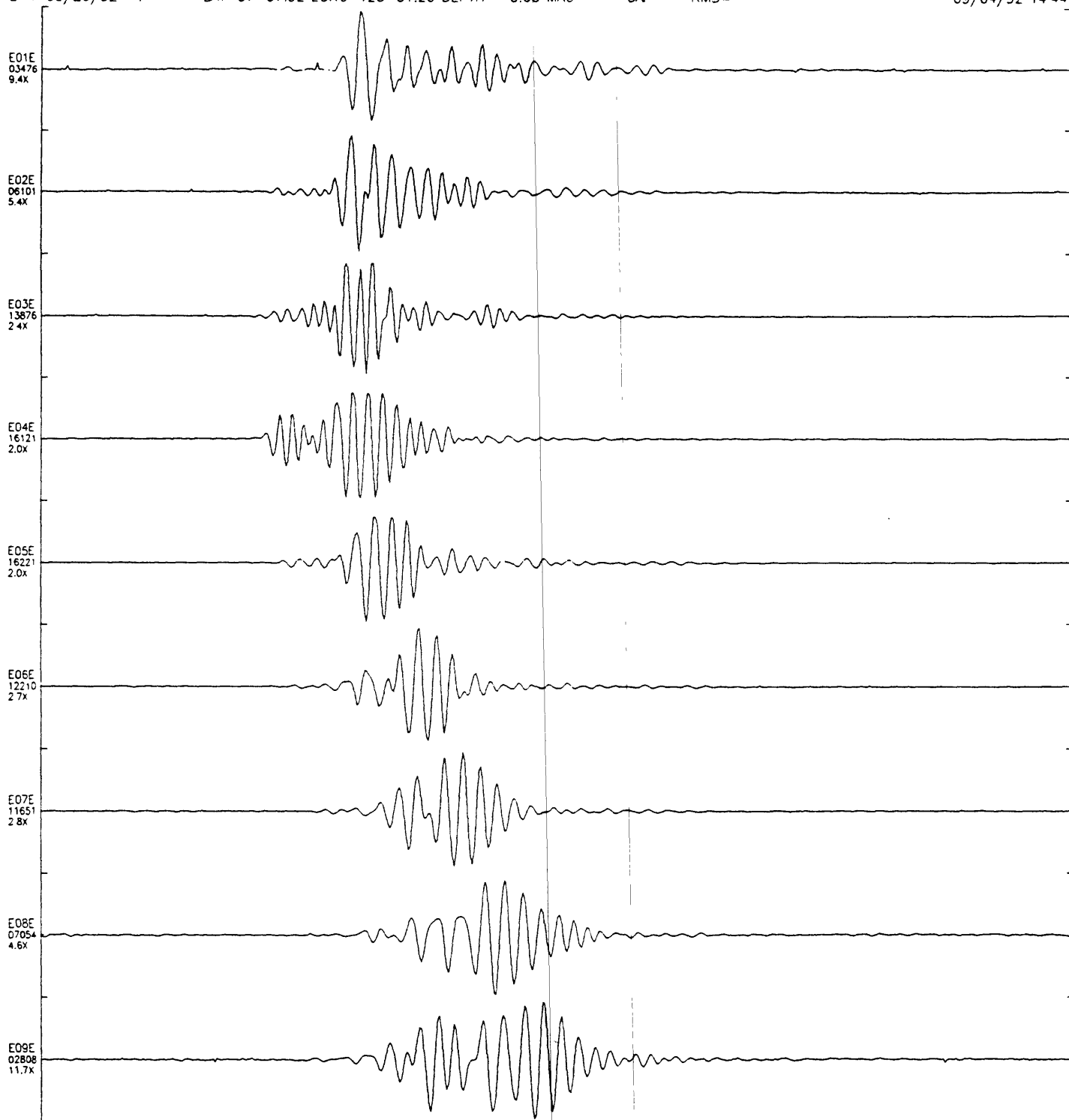
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268

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Sheet 1
09/04/92 14:44



I. Title Page.

U. S. DEPARTMENT OF THE INTERIOR

U. S. GEOLOGICAL SURVEY

ZAYANTE SEISMIC EXPERIMENT: DATA REPORT

by

Zayante Seismic Experiment Team

c/o W. H. K. Lee

MS 977, 345 Middlefield Road

Menlo Park, CA 94025

Open-File Report 92-561-B

October, 1992

II. Disclaimer.

Although these programs have been used by the U.S. Geological Survey, no warranty, expressed or implied, is made by the USGS as to the accuracy and functioning of the programs and related program material, nor shall the fact of distribution constitute any such warranty, and no responsibility is assumed by the USGS in connection therewith.

III. Date of Latest Revision.

October 4, 1992.

IV. Text.

A-1

INTRODUCTION

A shallow seismic refraction experiment was carried out in the Santa Cruz Mountain on August 20, 1992 (local time). These diskettes contain data files used for OFR 92-zzzA in SUDS format. Users are referred to the above mentioned report for details (in particular, Table 2).

V. Diskette Contents.

(1) Diskette #1 contains 11 data files:

92082003	CT1	107036	09-08-92	1:30p
92082003	CT2	107036	09-04-92	10:33a
92082004	CT1	107036	09-03-92	12:45p
92082008	CT1	74224	09-08-92	1:24p
92082008	CT2	107036	09-08-92	1:27p
92082009	CT1	107036	09-04-92	10:21a
9208200C	CT1	139892	09-01-92	2:20p
9208200C	CT2	172704	09-01-92	2:21p
9208200F	CT1	172660	09-01-92	2:22p
9208200H	CT1	139892	09-01-92	2:26p
9208200H	CT2	139892	09-01-92	2:27p

(2) Diskette #2 contains 11 data files:

9208200L	CT1	139848	09-01-92	2:34p
9208200M	CT1	139848	09-01-92	2:52p
9208200O	CT1	139892	09-01-92	2:53p
9208200Q	CT1	107036	09-01-92	2:54p
9208200S	CT1	107080	09-01-92	2:55p
9208200V	CT1	139848	09-01-92	2:35p
9208200V	CT2	139848	09-01-92	2:36p
9208200X	CT1	139892	09-01-92	2:56p
9208200Y	CT1	139892	09-01-92	2:58p
9208200Z	CT1	107036	09-01-92	2:59p
92082010	CT1	139892	09-01-92	3:02p

(3) Diskette #3 contains 11 data files:

92082020	CT1	139848	09-01-92	2:41p
92082020	CT2	107036	09-01-92	2:42p
92082023	CT1	139848	09-01-92	3:05p
92082026	CT1	139848	09-01-92	3:06p
92082029	CT1	139848	09-01-92	2:47p
92082029	CT2	139848	09-01-92	2:48p
9208202A	CT1	139848	09-01-92	3:08p
9208202C	CT1	107036	09-01-92	3:09p
9208202D	CT1	107036	09-01-92	3:11p
92082100	CT1	107036	09-03-92	12:27p
92082101	CT1	107036	09-03-92	12:30p

(4) Diskette #4 contains 8 data files:

92082102	CT1	107036	09-03-92	6:55p
92082103	CT1	107036	09-03-92	6:55p
92082104	CT1	107036	09-03-92	12:32p
92082106	CT1	107036	09-03-92	12:34p
92082107	CT1	107036	09-03-92	12:36p
92082108	CT1	107036	09-03-92	6:54p
92082109	CT1	107036	09-08-92	1:37p
9208210A	CT1	107036	09-03-92	12:39p

Open-File Report 92-561-A and -B. Zayante Seismic Experiment: Data Report, Zayante Seismic Experiment Team. 1992. 269 p. and four 3.5-in. diskettes.

This report describes the data collected for the Zayante Seismic Experiment, a shallow refraction experiment using two types of seismic sources: a sledge hammer as a source of compressional waves and an air-powered shear-wave generator as a source of shear waves. The recording array consisted of 23 Mark Products L-22, three-component seismometers arranged as a cross oriented north-south and east-west.

Open-File Report 92-561-A (269 p.) contains a description of the experiment and the collected data. We present 204 typical waveforms collected from each source. These waveforms are shown in figures. Open-File Report 92-561-B contains four 3.5-in diskettes containing the digital data of the 204 typical waveforms collected from each source.

Requirements for part B: IBM 386 or 486 PC or compatible; minimum 1 MB RAM; math coprocessor; VGA graphics board and monitor; minimum 40 MB hard disk; 3.5-inch floppy disk drive; PC or MS DOS 4.01 or later, and IASPEI Software Library Volumes 1, 2, and 3 (published jointly by IASPEI and the Seismological Society of America, El Cerrito, CA 94530).