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1991-93 Mississippi Embayment (New Madrid Seismic Zone) Experiment

The University of Wisconsin-Madison deployed three arrays of up to twelve 3-component digital seismographs across the New Madrid Seismic Zone in the winter and summer months of 1991-1993 (Figure 1) [Xia, 1994]. From February 9 to April 5, 1991 (ME91), 12 UW digital seismographs were deployed along the USGS refraction profiles [Mooney et al., 1983] in order to compare the basic characteristics of the wave propagation within the Reelfoot rift. Twenty-eight teleseismic events were recorded by the ME91 deployment. In 1992 (ME92), 5 UW instruments were deployed in clusters within the seismic zone of the embayment to evaluate the cause of the poor performance of the ME91 deployment. Two local and 35 teleseismic events were recorded in 2 months. From November 23, 1992 to March 11, 1993 (ME93), a final deployment of 12 UW digital seismographs also followed the USGS profiles in order to compare the basic characteristics of the wave propagation inside and outside the rift. Eighty-five teleseismic earthquakes were recorded by three or more of the UW seismographs during the final deployment. Event data collected by the temporary network from 1991-1993 are being made publicly available through the IRIS DMC as part of a NSF-supported project to archive historic UW-Madison digital seismic datasets collected by the research group of Prof. R. P. Meyer.

Data Collection and Processing

The instruments equipped with HS10-1 1Hz natural frequency seismometers were set to trigger on both local and teleseismic events and to record at 50 samples/sec for ME91 and ME93 and for 25 samples/sec for ME92. Table 1 presents the station coordinates. Table 2 contains the SEGY headers set during the UW-to-SEGY format conversion process (1991 data set). A smaller subset of SEGY headers, denoted (ME92-93) in Table 2 are preserved in the ME92 and ME93 data sets due to conversion of finalized day-volume directories from SAC file format. Approximately 70 percent of the ME93 data set is filtered (0.1-1 Hz). Clock corrections are incorporated within the SEGY data. The data have been assembled in the form of an event volumes for the 1991 data set and day volumes for the 1992-1993 data sets. Table 3 lists the events based on cluster analysis with events used by Xia [1994] indicated by comments.

Tape Provided

The data archive consists of one DAT tape with the event- and day-volume data (in PASSCAL SEGY format), this report in postscript and RTF formats, and miscellaneous information.

UW Seismic Recorders

The University of Wisconsin-Madison portable digital seismic recorders are wide-dynamic-range instruments (106 dB) designed for recording seismic waves from earthquakes or explosions (Table 4) [Powell, 1983]. Data from 1-Hz Hall-Sears HS-10-1 geophones were recorded at 100-Hz sampling rates, with a 4-pole Butterworth anti-aliasing filter at 24 Hz. A 13.6 kHz Omega receiver incorporated in each seismograph recorded data from the worldwide Omega navigational network concurrently with seismic signals. A timing-correction process developed for application to the UW seismic recorders provides 1/4 sample rms time error

relative to Universal Time [Schneider et al., 1987]. Ground motion may be estimated from an average value for voltage sensitivity of 150 V/m/s for the UW Hall-Sears geohones.

Related publications:

Hildenbrand, T.G., Kane, M.F. and Stauder, W., Magnetic and gravity anomalies in the northern Mississippi embayment and their spatial relation to seismicity. U.S. Geol. Surv. Misc. Field. Stud. Map, MF-941, 1985.

Mooney, W.D., Andrews, M.C., Ginzburg, A., Peters, D.A., and Hamilton, R.M., Crustal structure of the northern Mississippi Embayment and a comparison with other continental rift zones, *Tectonophysics, 94*, 324-334, 1983.

Powell, L.A., Engineering Description of the U.W. Portable Digital Seismograph, Proceedings of the Committee on Controlled Source Seismology (CCSS), Workshop on Portable Digital Seismograph Development, Los Altos, California, 121-122, 1983.

Schneider, J.F., R.C. Aster, L.A. Powell, and R.P. Meyer, Timing of portable seismographs from Omega navigation signals, *Bull. Seismo. Soc. Am.*, *77*, 1457-1478, 1987.

Xia, C., PkP delay time and shear-wave splitting studies in the New Madrid Seismic Zone, M.S. Thesis – University of Wisconsin-Madison, 84 pp., 1994.

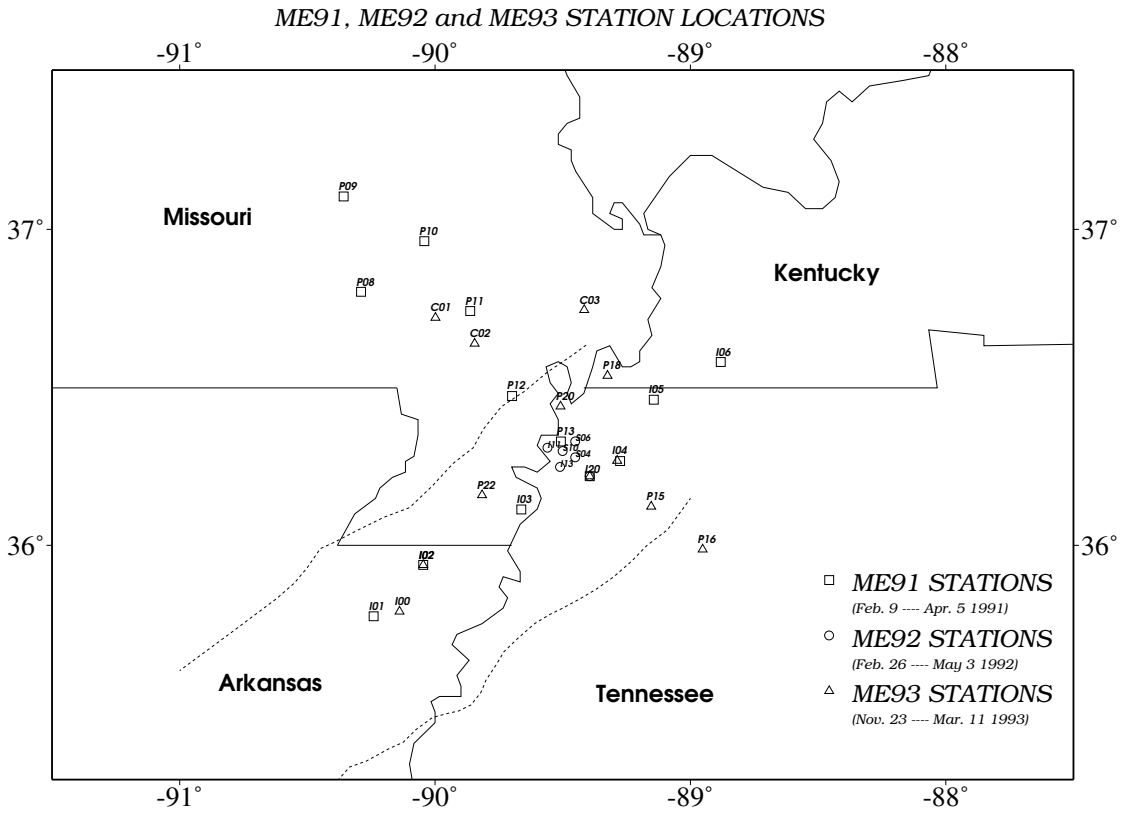

Figure 1. Map of UW station locations for the Mississippi Embayment experiment arrays from 1991 to 1993. Dashed lines mark the boundaries of the rift suggested from geomagnetic studies [Hildenbrand, 1985].

Table 1. Locations of UW stations deployed in the Mississippi Embayment from 1991 to 1993.

ID	Latitude		Longitude		Deployment
	(deg)	(min)	(deg)	(min)	
I01	35.000	46.452	90.000	14.400	ME91
I02	35.000	56.298	90.000	2.598	ME91
I02	35.000	56.268	90.000	2.742	ME93
I03	36.000	6.852	89.000	39.702	ME91
I04	36.000	16.164	89.000	17.220	ME93
I05	36.000	27.750	89.000	8.598	ME91
I06	36.000	34.902	88.000	52.902	ME91
I20	36.000	13.752	89.000	23.652	ME91
I20	36.000	13.800	89.000	23.400	ME92
I20	36.000	13.176	89.000	23.682	ME93
P08	36.000	48.252	90.000	17.352	ME91
P09	37.000	6.252	90.000	21.498	ME91
P10	36.000	57.798	90.000	2.550	ME91
P11	36.000	44.598	89.000	51.750	ME91
P12	36.000	28.500	89.000	41.898	ME91
P13	36.000	19.848	89.000	30.402	ME91
S04	36.000	16.800	89.000	27.000	ME92
S06	36.000	19.800	89.000	27.000	ME92
S10	36.000	18.000	89.000	30.000	ME92
I11	36.000	18.600	89.000	33.600	ME92
I13	36.000	15.000	89.000	30.600	ME92
C01	36.000	43.332	89.000	59.916	ME93
C02	36.000	38.460	89.000	50.688	ME93
I00	35.000	47.352	90.000	8.334	ME93
C03	36.000	44.784	89.000	24.996	ME93
P15	36.000	7.428	89.000	9.222	ME93
P16	35.000	59.232	88.000	57.156	ME93
P18	36.000	32.334	89.000	19.464	ME93
P20	36.000	26.466	89.000	30.486	ME93
P22	36.000	9.576	89.000	48.978	ME93

Table 2. PASSCAL SEGY headers set in the 1991-93 UW data sets. SEGY files for the 1992-1993 deployments were converted from SAC files via sac2segy (PASSCAL auxiliary program). These SEGY files contain a subset of the tabled header information denoted ME92-93 in the table below.

SEGY Headers set via UW data archiving	Comments (standard usage followed)
lineSeq	UW Instrument event# + channel
reelSeq	UW Instrument event# + channel
event_number	Experiment Event Number
channel_number	standard (1-3:V,N,E)
traceID	standard (1)
elevationScale	standard (1)
coordScale	standard (1)
coordUnits	standard (2 for lat and long)
sampleLength	standard (ME92-93)
num_samps*	standard (ME92-93)
deltaSample	microseconds
samp_rate	microseconds (ME92-93)
gainType	standard
gainConst	Standard: tr[i] (Volts) = tr[i]*scale_fac/gain
scale_fac	Scale to volts (1.9*10**-5 V/lsb). (ME92-93)- Set via sac2segy program.
year	Trace start time (ME92-93)
day	
hour	
minute	
second	
m_secs	
timeBasisCode	standard usage (2 is GMT)
trigyear	trigger time (info not available)
trigday	(Trigger headers set to start time)
trighour	
trigminute	
trigsecond	
trigmills	
data_form	standard usage (1 is 32-bit) (ME92-93)
inst_no	UW instrument number
station_name	W## with instr. number (1 to 21)
recLongOrX	receiver longitude*3600
recLatOrY	receiver latitude*3600
sourceLongOrX	source longitude*3600
sourceLatOrY	source latitude*3600
sourceDepth	source depth (m)

Table 3a. Events from the 1991 Mississippi Embayment experiment

Id	yr	mo	day	hr	min	sec	comment
1	91	2	12	21	56	55.730	
2	91	2	14	16	41	28.350	
3	91	2	14	20	12	39.730	
4	91	2	14	23	41	11.600	
5	91	2	16	1	34	54.370	
6	91	2	17	18	50	31.780	
7	91	2	18	0	17	33.800	
8	91	2	18	2	55	43.700	
9	91	2	18	5	59	41.680	
10	91	2	19	19	1	58.460	
11	91	2	20	4	57	50.440	
12	91	2	20	20	11	58.490	
13	91	2	20	21	58	7.480	Teleseismic Event, S-wave splitting Xia [1994]
14	91	2	20	23	30	36.600	
15	91	2	21	2	4	18.940	
16	91	2	21	2	44	37.940	
17	91	2	21	17	9	27.420	
18	91	2	21	20	52	38.370	
19	91	2	21	21	25	50.870	
20	91	2	23	20	56	57.230	
21	91	2	24	12	3	0.050	
22	91	2	25	22	21	49.070	
23	91	2	26	7	36	13.800	
24	91	2	27	8	44	59.660	Teleseismic Event, S-wave splitting Xia [1994]
25	91	2	27	20	23	42.900	
26	91	3	1	2	7	28.080	
27	91	3	1	14	14	1.550	
28	91	3	1	15	1	12.990	
29	91	3	1	17	17	6.970	
30	91	3	1	17	29	46.970	
31	91	3	1	17	34	59.600	
32	91	3	1	20	28	39.900	
33	91	3	2	3	36	4.350	
34	91	3	5	13	54	34.500	
35	91	3	5	22	8	23.500	
36	91	3	5	22	53	59.500	
37	91	3	6	19	1	31.430	
38	91	3	7	0	8	51.130	
39	91	3	7	0	41	25.130	
40	91	3	7	19	27	31.520	
41	91	3	7	20	22	36.070	
42	91	3	7	22	42	37.460	
43	91	3	8	9	12	14.650	
44	91	3	8	11	46	23.180	Teleseismic Event, S-wave splitting Xia [1994]
45	91	3	8	12	4	52.340	
46	91	3	8	17	53	10.150	
47	91	3	10	12	34	22.890	
48	91	3	10	21	11	55.810	
49	91	3	13	20	14	36.080	
50	91	3	14	16	7	9.680	
51	91	3	14	20	32	7.960	
52	91	3	15	19	1	10.840	

53	91	3	15	22	32	31.680	
54	91	3	16	6	7	4.490	
55	91	3	17	6	36	46.370	
56	91	3	18	20	40	5.610	
57	91	3	19	11	2	14.850	
58	91	3	19	12	21	34.500	
59	91	3	19	19	21	15.870	
60	91	3	20	22	29	8.980	
61	91	3	21	6	1	4.160	
62	91	3	21	7	41	4.860	
63	91	3	26	12	39	33.490	

Table 3b. Events from the 1992 Mississippi Embayment experiment

id	yr	day	hr	min	sec	comment
1	92	62	12	39	46	Teleseismic event, S wave splitting Xia [1994]
2	92	63	3	23	7	
3	92	63	4	39	30	
4	92	65	14	49	18	
5	92	67	1	15	12	
6	92	67	1	57	48	
7	92	77	6	47	41	
8	92	78	3	7	38	
9	92	80	17	20	11	
10	92	81	3	21	16	
11	92	81	5	9	50	
12	92	81	9	2	5	
13	92	84	10	10	33	
14	92	86	14	23	17	Teleseismic event, S wave splitting Xia [1994]
15	92	86	16	33	36	
16	92	87	13	31	26	
17	92	92	0	35	21	
18	92	94	6	17	4	
19	92	97	15	5	1	
20	92	98	3	58	15	Teleseismic event, S wave splitting Xia [1994]
21	92	100	2	59	45	
22	92	100	6	53	9	
23	92	100	15	18	29	
24	92	100	22	45	8	
25	92	106	5	43	56	
26	92	109	9	35	15	
27	92	109	20	6	27	
28	92	116	18	10	41	
29	92	117	7	45	51	
30	92	117	11	22	35	
31	92	118	8	33	30	

Table 3c. Events from the 1993 Mississippi Embayment experiment

id	yr	day	hr	min	sec	comment
1	93	8	12	59	36	Local Event, S-wave splitting Xia [1994]
2	93	9	10	59	26	Local Event, S-wave splitting Xia [1994]
3	93	10	23	2	47	
4	93	11	22	27	25	
5	93	12	21	54	17	
6	93	13	17	14	9	
7	93	13	19	8	21	
8	93	15	11	16	45	
9	93	17	13	53	1	
10	93	20	16	21	20	
11	93	20	2	48	16	
12	93	20	22	42	26	
13	93	20	22	46	12	
14	93	21	19	44	32	Local Event, S-wave splitting Xia [1994]
15	93	24	3	45	21	
16	93	24	6	15	4	
17	93	29	13	55	23	
18	93	36	6	3	33	
19	93	37	2	7	58	Local Event, S-wave splitting Xia [1994]
20	93	38	11	18	55	
21	93	38	13	39	11	
22	93	39	4	42	31	Teleseismic Event, PkP delay Xia [1994]
23	93	40	14	35	53	
24	93	41	11	11	0	Teleseismic Event, PkP delay Xia [1994]
25	93	43	18	30	22	
26	93	44	0	24	38	
27	93	44	18	33	6	
28	93	49	10	20	35	
29	93	53	7	16	19	
30	93	55	4	30	11	
31	93	55	12	39	32	
32	93	55	22	29	59	
33	93	56	13	19	20	
34	93	57	19	26	38	
35	93	59	0	48	49	
36	93	60	1	56	24	
37	93	61	0	27	25	
38	93	61	9	58	9	
39	93	62	21	20	29	
40	93	65	11	33	45	Teleseismic Event, S-wave splitting Xia [1994]
41	93	68	1	46	50	
42	93	69	6	31	3	Teleseismic Event, S-wave splitting Xia [1994]
43	93	70	20	46	58	
44	93	71	1	11	40	
45	92	328	6	34	48	
46	92	329	12	8	54	
47	92	329	1	2	21	Teleseismic Event, S-wave splitting Xia [1994]
48	92	329	12	8	47	
49	92	330	6	20	4	Teleseismic Event, PkP delay Xia [1994]
50	92	332	16	4	11	
51	92	335	9	38	54	
52	92	343	7	29	19	Teleseismic Event, S-wave splitting Xia [1994]

53	92	347	5	47	5	Teleseismic Event, S-wave splitting Xia [1994]
54	92	352	9	22	23	
55	92	352	11	12	48	
56	92	353	3	30	57	Teleseismic Event, PkP delay Xia [1994]
57	92	354	12	23	55	
58	92	355	21	9	58	
59	92	358	2	28	0	
60	92	358	3	21	18	
61	92	359	0	45	35	
62	92	361	15	3	5	
63	92	361	22	15	25	
64	92	362	10	11	31	Local Event, S-wave splitting Xia [1994]
65	92	362	22	5	34	Teleseismic Event, PkP delay Xia [1994]

Table 4. General specifications, University of Wisconsin-Madison digital 3-component recorders

DATA STORAGE:	5" reel 1/4" tape, 1800 feet	or	SCSI 3-1/2" disk
CAPACITY:	20 Mbyte		210 Mbyte
FORMAT:	4-track; 3-channel + error correction		multi-stream packet
DYNAMIC RANGE:	106 dB	Noise = 0.25 μV P-P	Clipping = 0.05 V P-P
CALIBRATION:	Random binary sequence and step current applied to seismometer coils through a bridge (at programmed start times)		
PASSBAND:	Low end: 2 poles at 0.09 Hz High end: 4-pole Butterworth at (0.25 * sample rate)		
SAMPLE RATE:	25, 50, 100, 200, 400 samples/second		
PRE-EVENT DELAY:	512, 1024, 2048 samples/channel		
MODES:	Programmed and/or multiple-mode triggered		
PROGRAMMING:	Time (ddd – hr:mn:sc), repeat interval and count for run, calibrate, trigger arm and disarm (24 entries)		
RUN TIMES:	Programmable to 1000 minutes in 1 sec steps with optional programmed limits on total recording time for each mode		
TRIGGER HARDWARE:	STA/delayed LTA ratio; broadband or teleseismic filtered		
TRIGGER SOFTWARE:	Three frequency band Walsh transform filter to discriminate teleseismic, regional, and noise; with independent run times		
STATUS REVIEW:	Omega signal, time, configuration, schedules, number of events recorded and time used for each mode, times of last 500 events, seismometer period and damping		
TIMING INTERNAL:	1 mHz TCXO, +/- 1 x 10^{-6} over temperature range		
EXTERNAL:	13.6 kHz Omega VLF phase recorded with seismic data;		
worldwide	coverage (except Antarctica and central Greenland) Post-processing time corrections: +/- 1 x 10^{-8} oscillator error; 1/4 sample RMS time error relative to U.T.		
POWER:	12.5 V DC +/- 20% 40 ma average current waiting for trigger 400 ma average current recording to tape 50 ma average current recording to disk		
DIMENSIONS:	56 x 33 x 40 cm		
WEIGHT:	22 kg		
TEMPERATURE:	0 deg to 50 deg C normal range (tape operates to 0 deg C) -20 deg to 70 dec C reduced spec. (disk operates to –20 deg C) -40 deg to 80 deg C storage		