TECHNICAL REPORT 84-2

SEISMIC ACTIVITY NEAR THE V.C. SUMMER NUCLEAR STATION

For the Period April - June 1984

by
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Contract No. N355486

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Introduction

This report presents a summary of seismic activity near the V.C. Summer Nuclear Power Station in South Carolina for the three month period between April 1 and June 30, 1984. During this reporting period, a total of 49 locatable events were recorded. None of the events had magnitudes greater than 2.0 and seven events had magnitudes between 1.0 and 2.0. The largest event occurred on May 11 and had a magnitude of 1.8.

Seismic Network

The report is based on the data recorded by the four-station network operated by S.C.E.&G. In addition, data from the permanent stations, JSC, 06A, and 008, were also used. Locations of these stations are shown in Figure 1, and their coordinates are listed in Appendix I.

Data Analysis

Location of the events is determined using HYPO71 program (Lee and Lahr, 1972) and the velocity model given in Appendix II. The event magnitude (M_L) is determined from signal duration at station JSC, using the following relation:

$$M_L = -1.83 + 2.04 \text{ Log } D$$

where D is the signal duration (seconds).

An estimate of daily energy release is determined using a simplified magnitude (M_L) energy (E) relation by Gutenberg and Richter (1956).

$$\log_{10} E = 11.8 + 1.5 M_L$$

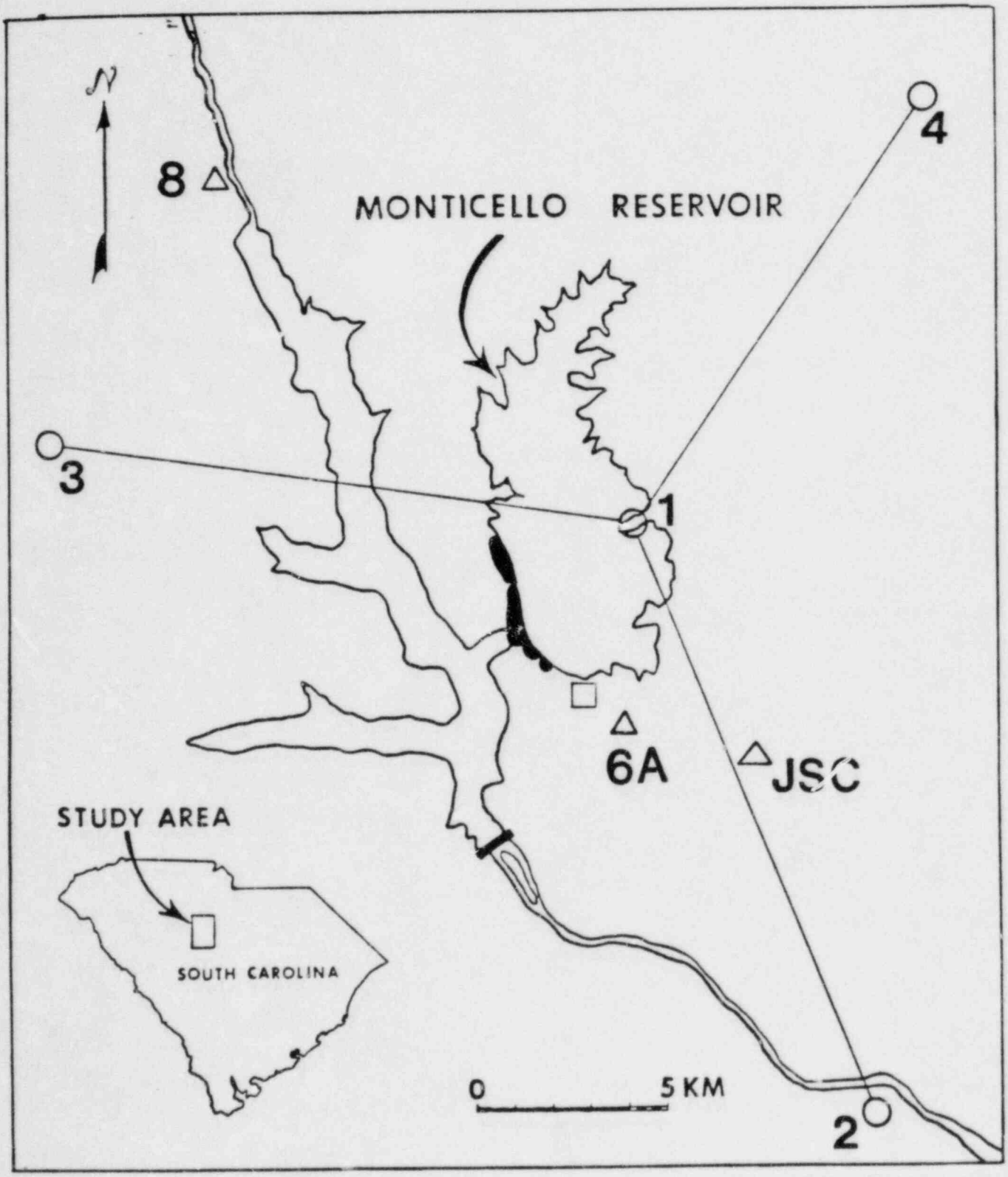

N
8
MONTICELLO RESERVOIR
4
3
1
6A
JSC
STUDY AREA
SOUTH CAROLINA
0
5 KM
2

Figure 1

Results

The 49 located events recorded during this period are listed in Appendix III. There were no events with magnitudes greater than 2.0. The seven events with magnitudes between 1.0 and 2.0 are listed in Table 1, and the remaining events were smaller.

Table 1

Date	Magnitude
April 27	1.0
May 11	1.8
May 11	1.3
May 17	1.0
May 19	1.3
May 20	1.3
June 20	1.2

Most of the seismic activity for the reporting period occurred during May in a broad east-west band across the central part of Monticello Reservoir. Depth estimates for all located events indicate that approximately 94% of the seismicity occurred within two kilometers of the surface. A comparison of depth variations based on quality B or better events for this recording period combined with the previous three months and for the past five years is shown in Figure 2. The depth ranges were divided into half kilometer increments up to 3.0 km, and events occurring at greater depths were grouped together. The largest percentage of events occurred in the 1.5 to 2.0 km increment every year. None of the activity in 1984 occurred at depths greater than 3.0 km; the deepest event was at 2.4 km.

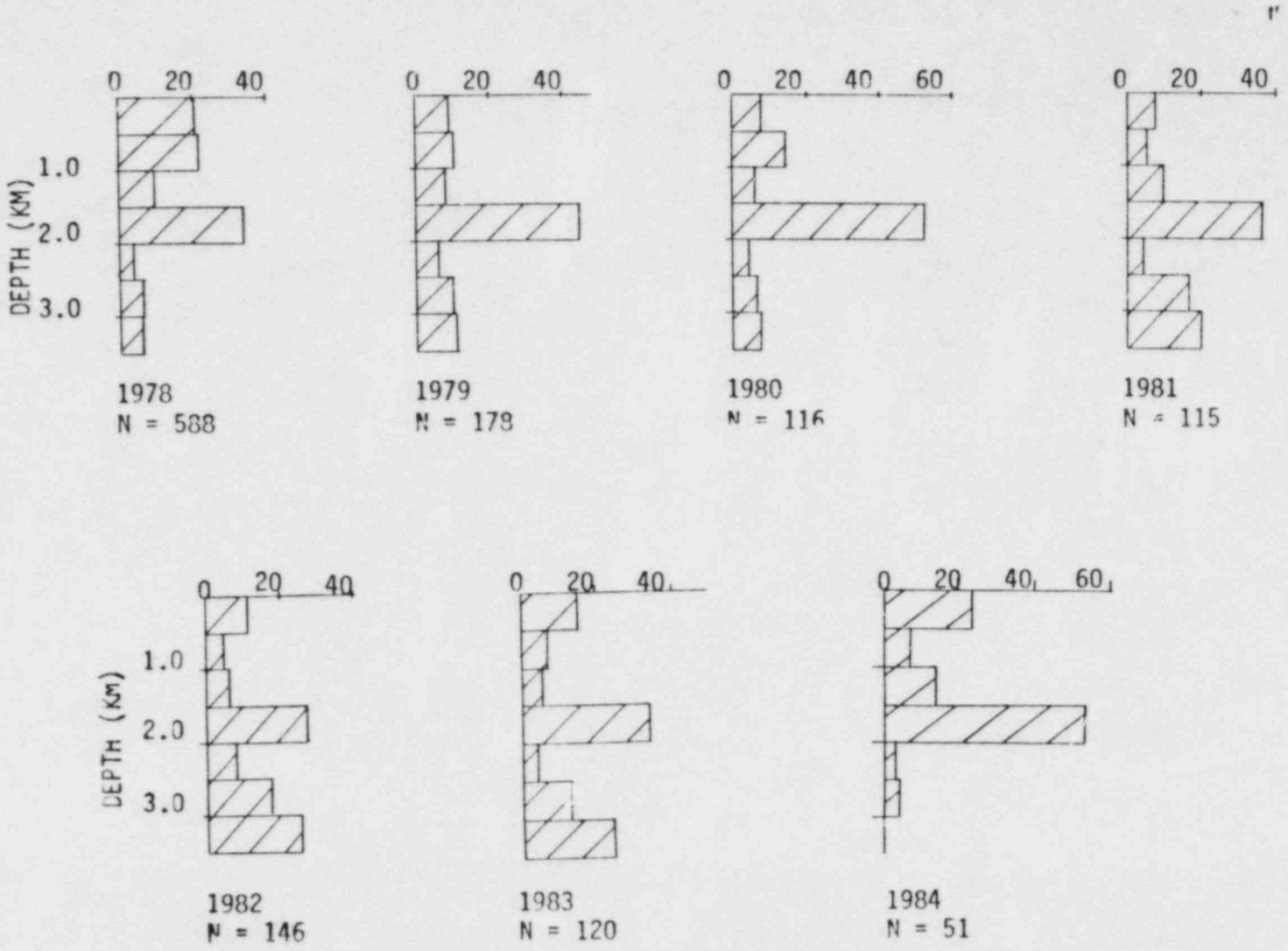

PERCENT
DEPTH (KM)
1.0
2.0
3.0
0 20 40
0 20 40
0 20 40 60
0 20 40
1978
N = 588
1979
N = 178
1980
N = 116
1981
N = 115
0 20 40
0 20 40
0 20 40 60
1982
N = 146
1983
N = 120
1984
N = 51

Figure 2

A cumulative plot of epicenters of events located during this period is shown in Figure 3 and a cross section of events located within one kilometer of line AA' is shown in Figure 4. Separation of epicentral locations by month is shown in Figures 5-7.

Reservoir Water Level and its Comparison with Seismicity

Monticello Reservoir is a pumped storage facility. Any decrease in reservoir level associated with power generation is recovered when water is pumped back into the reservoir. There can be variations up to about five feet per day between the maximum and minimum water level. We have been monitoring this water level to see if there is any correlation between the daily or seasonal changes in the reservoir level and the local seismicity. Figure 8 shows the comparison of water level to seismicity. The top two graphs show the water level and the change of water level per day. The number of events per day and log of energy released per day are shown on the lower two graphs. The histograms showing events per day and log of energy release include the unlocated events around the reservoir.

Conclusions

Seismic activity in the Monticello Reservoir area generally occurs in a long term trend of discrete swarms separated by relatively quiet periods. Figure 9 is a histogram of the number of events per month from December, 1977, through June, 1984. The swarm of activity in May, 1984 preceded by a low level of seismicity is consistent with the long term trend. The general level of activity continues to decrease, no increase in depth is noted, and the spatial extent for this period is confined within the reservoir.

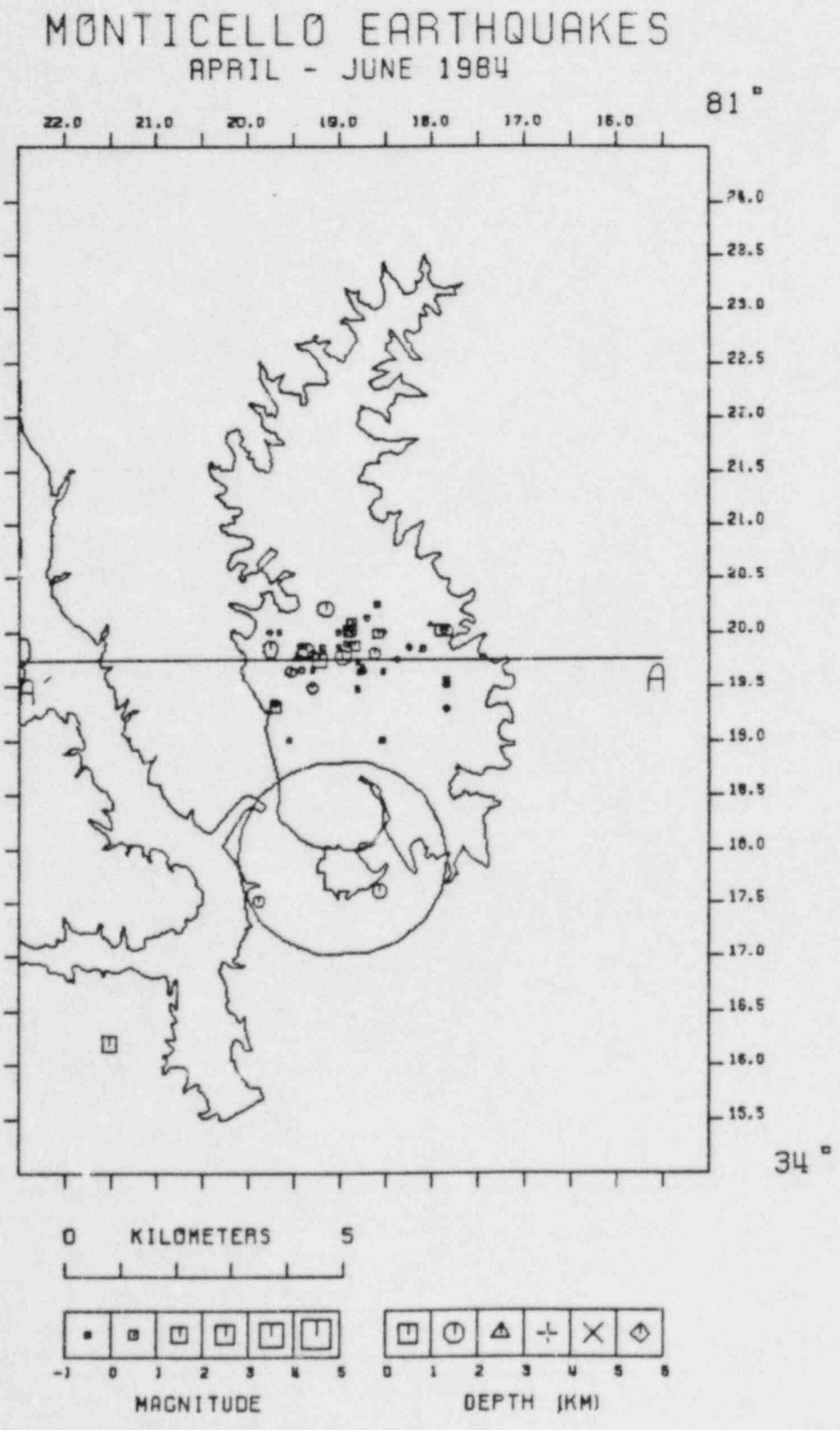

MONTICELLO EARTHQUAKES
APRIL - JUNE 1984
81°
34°
A
0 KILOMETERS 5
MAGNITUDE
DEPTH (KM)

Figure 3

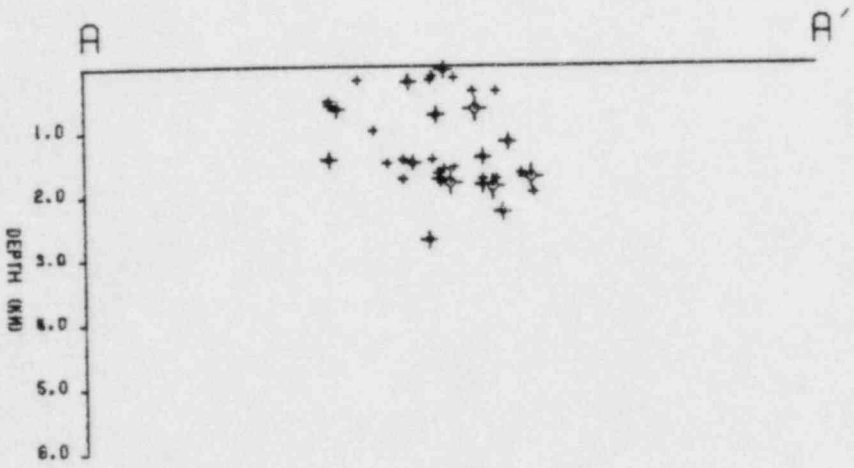


Figure 4: Cross section of events located within 1.0 km of AA'. No correlation of seismicity with depth is noted.

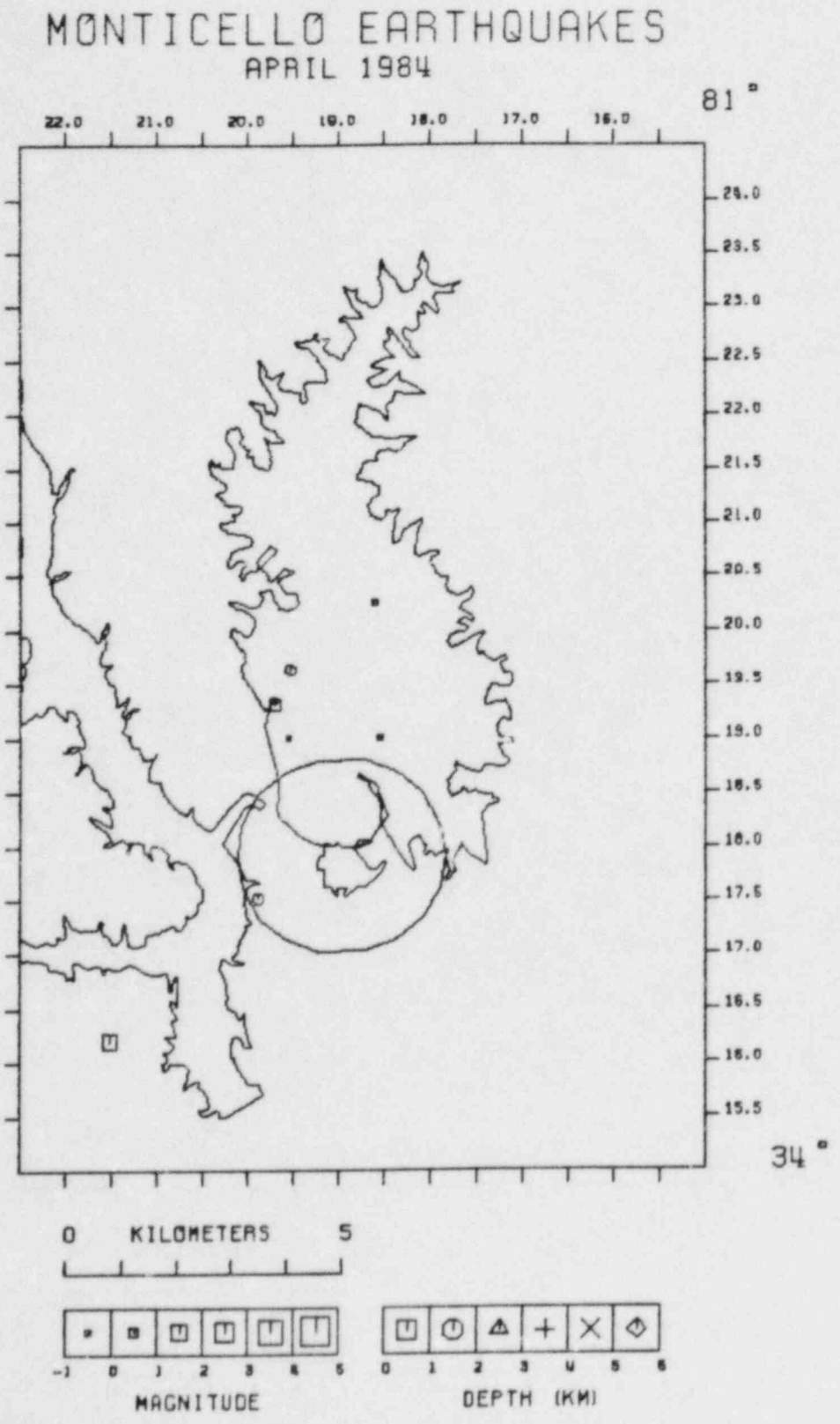

MONTICELLO EARTHQUAKES
APRIL 1984
81°
34°
0 KILOMETERS 5
MAGNITUDE
DEPTH (KM)

Figure 5

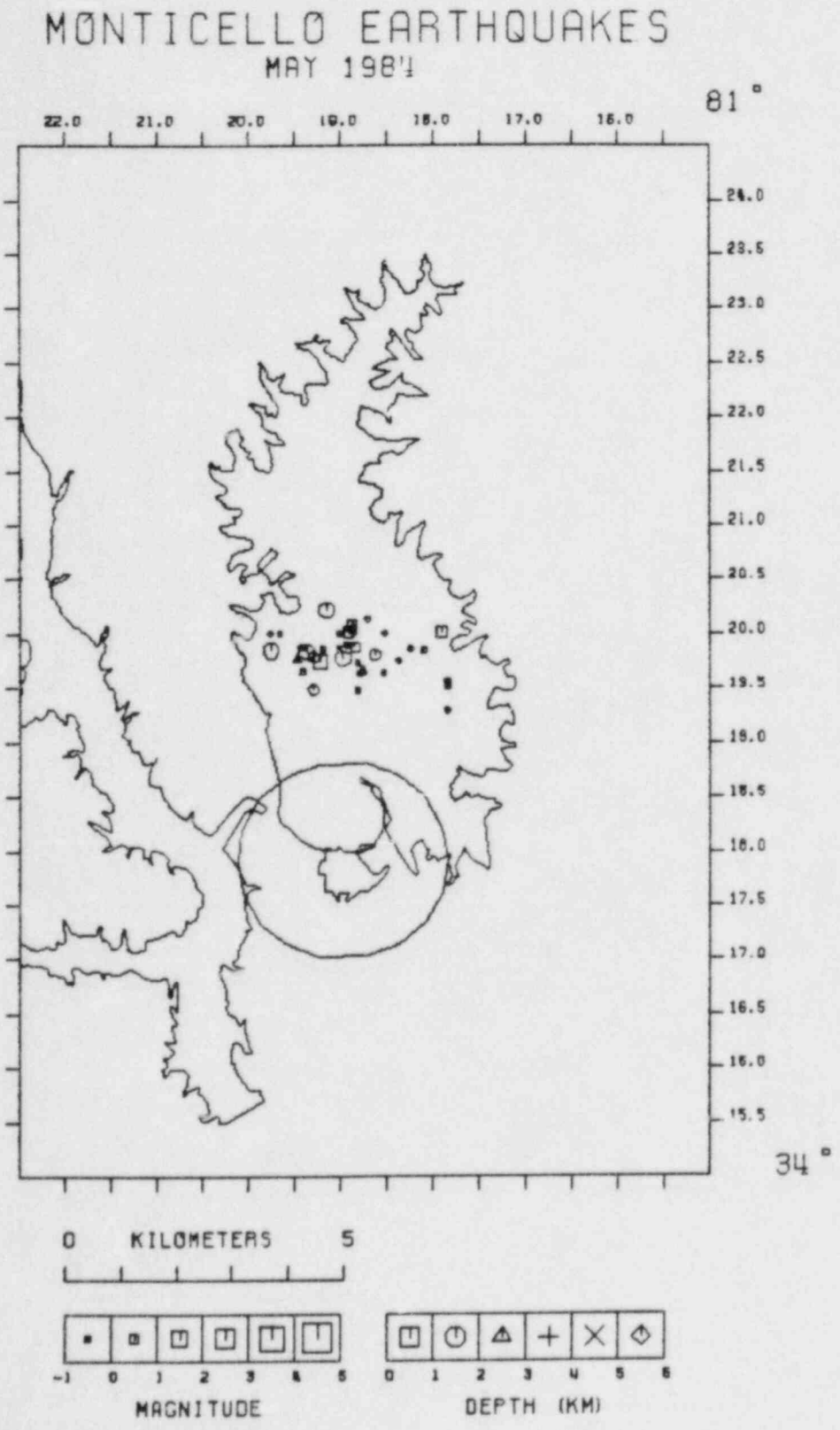

MONTICELLO EARTHQUAKES
MAY 1984
81°
34°
22.0
21.0
20.0
19.0
18.0
17.0
16.0
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
0 KILOMETERS 5
-1 0 1 2 3 4 5
MAGNITUDE
0 1 2 3 4 5 6
DEPTH (KM)

Figure 6

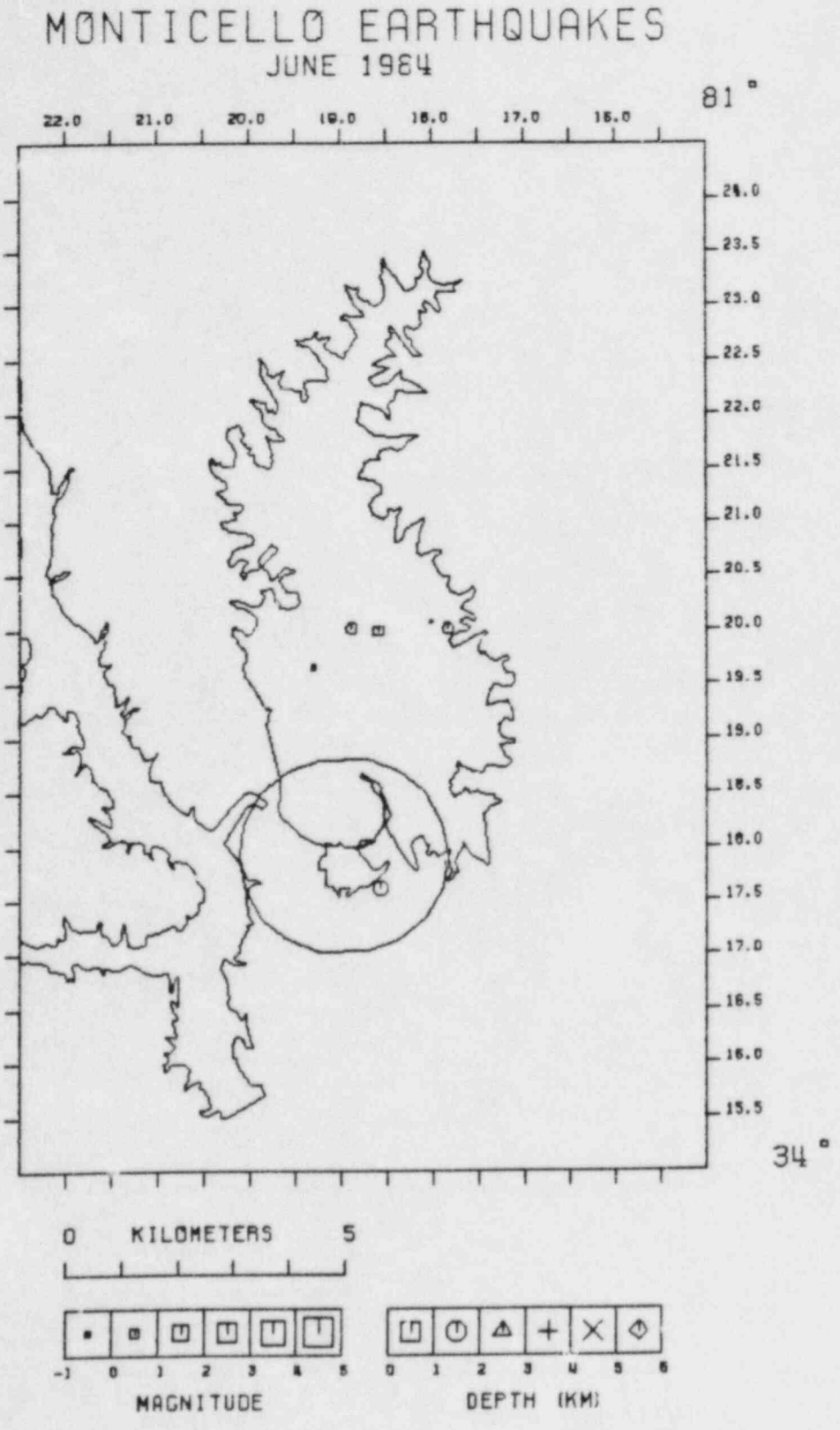
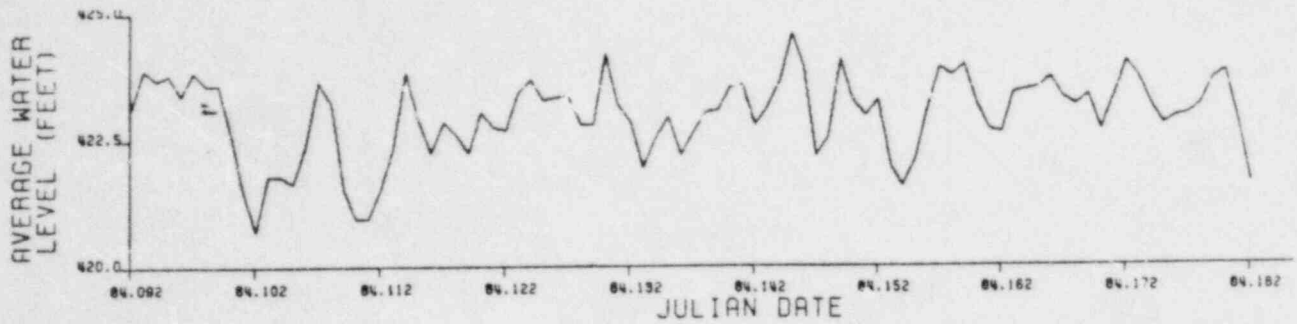
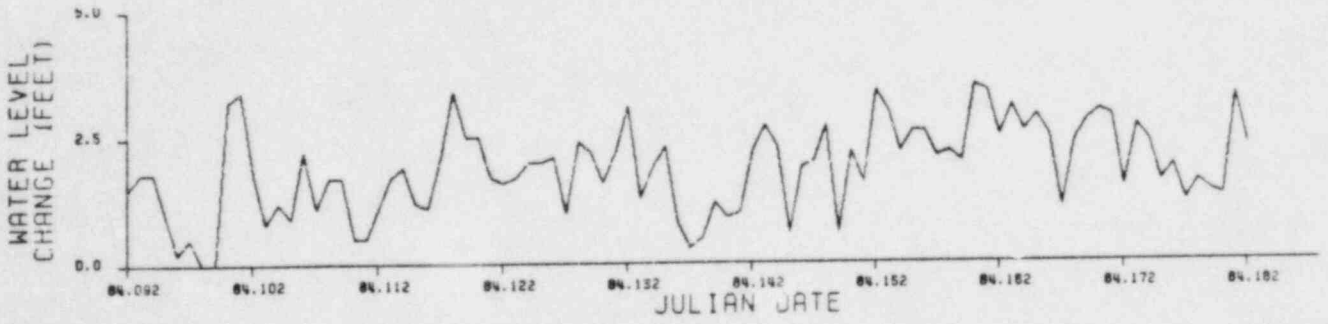
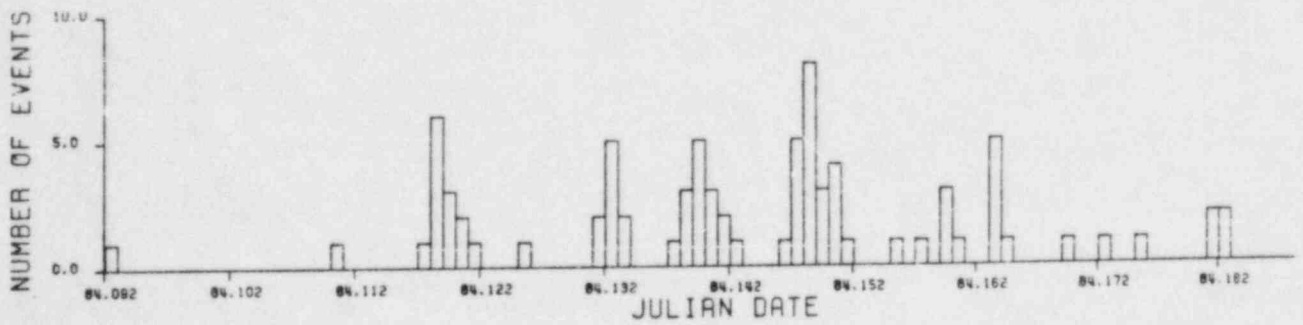

MONTICELLO EARTHQUAKES
JUNE 1984
81°
34°
22.0
21.0
20.0
19.0
18.0
17.0
16.0
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
0 KILOMETERS 5
-1 0 1 2 3 4 5
MAGNITUDE
0 1 2 3 4 5 6
DEPTH (KM)

Figure 7


AVERAGE WATER LEVEL (FEET)
422.5
420.0
84.092
84.102
84.112
84.122
84.132
84.142
84.152
84.162
84.172
84.182
JULIAN DATE


WATER LEVEL CHANGE (FEET)
2.5
0.0
84.092
84.102
84.112
84.122
84.132
84.142
84.152
84.162
84.172
84.182
JULIAN DATE


NUMBER OF EVENTS
5.0
0.0
84.092
84.102
84.112
84.122
84.132
84.142
84.152
84.162
84.172
84.182
JULIAN DATE

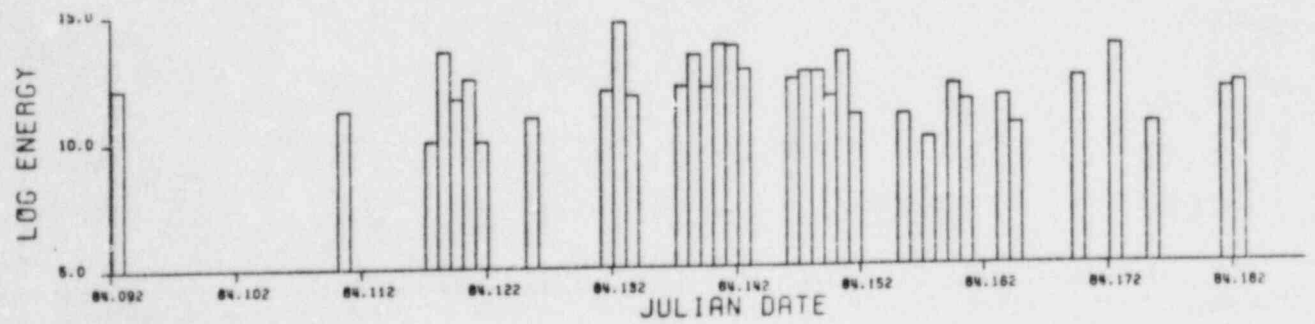

LOG ENERGY
10.0
84.092
84.102
84.112
84.122
84.132
84.142
84.152
84.162
84.172
84.182
JULIAN DATE

Figure 8

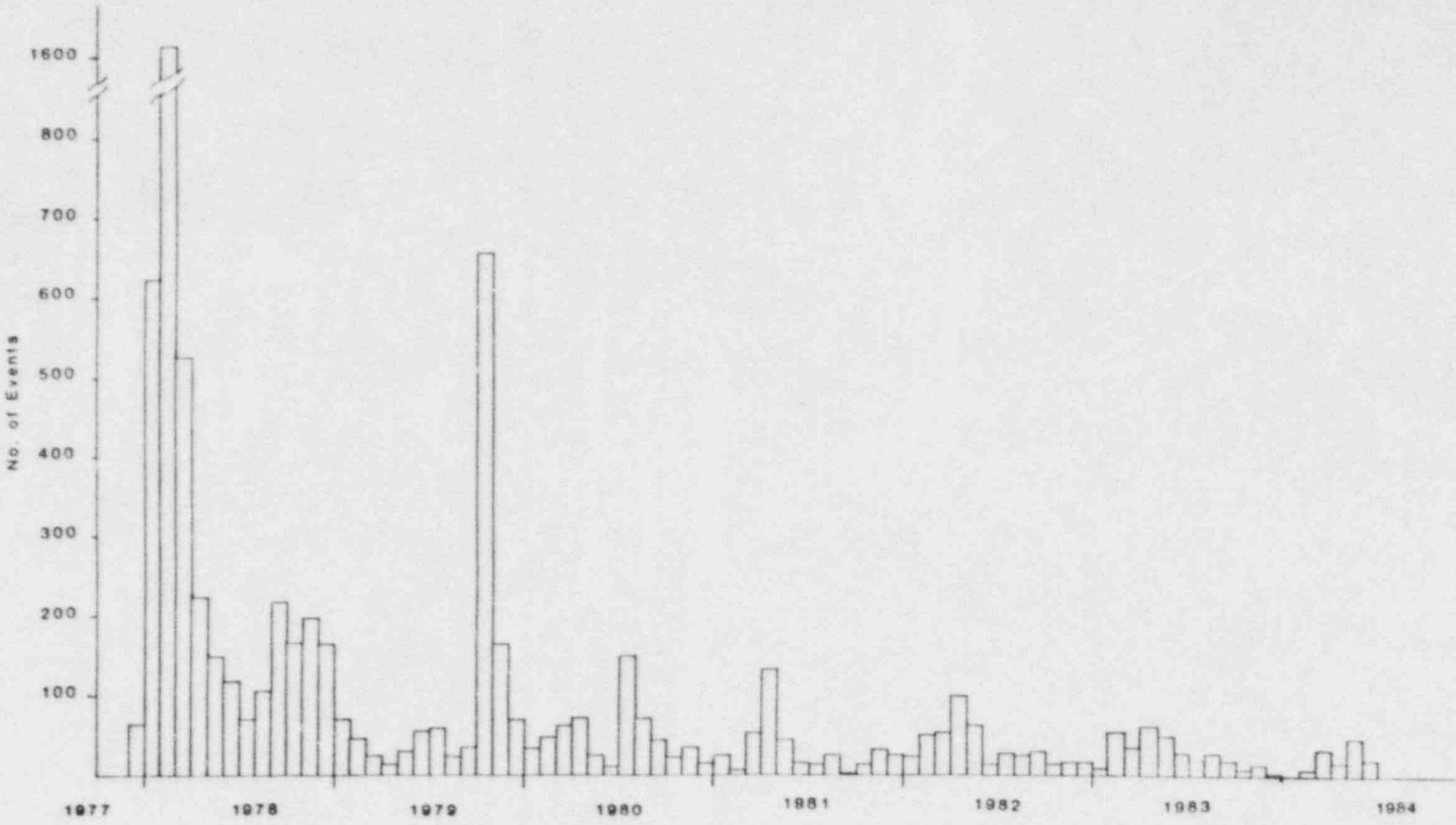

No. of Events
1600
800
700
600
500
400
300
200
100
1977
1978
1979
1980
1981
1982
1983
1984

Figure 9

References

Gutenberg, B. and Richter, C.F. (1956). Magnitude and energy of earthquakes, Ann. Geof. 9, p. 1-15.

Lee, W.H.K. and Lahr, J.C. (1972). A computer program for determining hypocenter, magnitude and first motion pattern of local earthquakes, Revisions of HYP071, U.S.G.S. Open-File Report, 100 pp.

APPENDICES

APPENDIX I

STATION LOCATION

NO.	STN.	LAT. N.	LONG. W.
1	001	34°19.91'	81°17.74'
2	002	34°11.58'	81°13.81'
3	003	34°21.09'	81°27.41'
4	004	34°25.72'	81°12.99'
5	JSC	34°16.80'	81°15.60'
6	008	34°24.53'	81°24.55'
7	06A	34°17.32'	81°18.15'

APPENDIX II

MONTICELLO RESERVOIR

VELOCITY MODEL

Velocity km/sec	Depth km
1.00	0.00
5.40	0.03
5.90	0.18
6.10	0.46
6.30	0.82
8.10	30.00

APPENDIX III

DATE	ORIGIN		LAT N	LONG W	DEPTH	MAG	NO	GAP	DMIN	RMS	ERH	ERZ	QM
840401	2349	44.41	34-20.26	81-18.60	0.18	-0.40	8	245	1.5	0.09	0.8	1.1	C1
840419	2051	17.52	34-17.52	81-19.89	1.96	0.29	7	160	5.5	0.05	0.3	1.5	B1
840427	1048	48.11	34-19.31	81-19.71	0.22	0.87	10	138	3.2	0.07	0.3	0.7	B1
840427	2017	56.68	34-16.20	81-21.52	0.08	1.02	5	271	9.0	0.02	1.1	1.2	C1
840428	147	2.63	34-19.35	81-19.71	0.99	-0.24	7	137	3.2	0.03	0.2	1.2	B1
840428	333	31.18	34-19.01	81-18.55	0.04	-0.40	7	134	2.1	0.07	0.3	1.0	B1
840428	828	30.36	34-19.01	81-19.56	0.29	-0.86	5	140	3.2	0.09	1.1	3.4	C1
840429	021	29.92	34-19.64	81-19.54	1.19	0.44	8	152	2.8	0.06	0.3	1.1	B1
840504	1720	37.57	34-19.85	81-18.11	0.21	-0.60	7	239	0.6	0.09	0.9	1.1	C1
840510	148	16.81	34-19.77	81-19.48	2.28	0.01	8	131	2.7	0.03	0.1	0.3	B1
840510	217	17.74	34-20.01	81-19.67	1.67	-0.24	8	130	3.0	0.08	0.4	1.0	B1
840511	2041	36.00	34-19.85	81-19.76	1.74	1.83	8	150	3.1	0.09	0.5	1.3	B1
840511	2043	44.84	34-19.84	81-19.38	1.90	1.32	8	146	2.5	0.05	0.3	0.6	B1
840511	2045	1.77	34-19.49	81-19.30	1.86	0.82	6	152	7.6	0.09	0.7	7.1	C1
840516	1854	52.43	34-19.79	81-19.30	1.43	0.21	10	130	2.4	0.04	0.2	0.5	B1
840517	1523	11.87	34-19.73	81-18.82	1.45	-0.24	10	128	1.7	0.08	0.3	0.6	B1
840517	19 1	50.28	34-20.22	81-19.16	1.76	1.02	10	126	2.3	0.07	0.3	0.7	B1
840517	2049	56.52	34-19.75	81-18.38	1.53	-0.11	10	125	1.0	0.09	0.3	0.5	B1
840518	056	18.05	34-19.86	81-19.20	0.41	-0.60	8	129	2.2	0.04	0.2	0.4	B1
840518	233	42.97	34-19.60	81-19.42	0.40	-0.60	9	132	2.6	0.05	0.2	0.9	B1
840518	3 6	28.90	34-19.51	81-17.84	0.54	-0.11	7	214	0.8	0.08	1.4	0.9	C1
840518	351	15.65	34-20.01	81-19.02	1.60	-0.24	9	126	2.0	0.08	0.3	0.7	B1
840518	723	20.42	34-19.86	81-18.25	1.00	-0.24	7	241	0.8	0.08	1.2	0.6	C1
840519	8 2	17.54	34-19.74	81-19.23	0.67	1.29	10	130	2.3	0.07	0.3	0.7	B1
840519	8 5	13.70	34-19.29	81-17.84	1.79	-0.40	7	211	1.2	0.06	0.8	0.6	C1
840519	2255	26.25	34-19.57	81-17.84	0.60	-0.40	7	216	0.6	0.08	1.5	0.9	C1
840520	8 6	17.90	34-19.78	81-18.08	1.82	1.27	9	128	1.9	0.06	0.3	1.0	B1
840520	834	19.04	34-20.01	81-19.77	1.99	-0.40	10	130	3.1	0.09	0.4	1.0	B1
840521	18 5	58.02	34-19.81	81-18.64	1.51	0.63	9	126	1.9	0.08	0.3	1.2	B1
840525	2332	46.08	34-19.66	81-18.77	2.71	0.37	10	128	1.7	0.09	0.4	0.6	B1
840526	1542	24.50	34-20.14	81-18.72	1.23	-0.24	10	123	1.6	0.09	0.4	0.7	B1
840526	1633	17.63	34-20.01	81-18.87	1.69	-0.11	7	125	1.7	0.07	0.3	0.6	B1
840526	1718	0.34	34-20.01	81-18.92	0.07	0.51	10	125	1.8	0.06	0.2	0.6	B1
840526	18 7	46.22	34-19.64	81-18.79	0.21	-0.60	6	245	1.7	0.07	0.6	0.7	C1
840526	1824	54.19	34-19.90	81-18.93	1.62	-0.40	9	127	1.8	0.07	0.3	0.6	B1
840527	331	34.60	34-19.88	81-19.43	1.77	-0.60	6	252	2.6	0.05	0.9	0.8	C1
840527	526	42.65	34-19.64	81-18.54	1.78	-0.11	9	127	1.3	0.09	0.4	0.7	B1
840527	752	29.47	34-19.88	81-18.85	0.75	0.12	10	126	1.7	0.08	0.3	0.6	B1
840527	945	27.71	34-20.01	81-18.53	1.46	-0.24	10	123	1.2	0.09	0.3	0.5	B1
840527	1618	5.42	34-20.08	81-18.88	0.24	0.29	8	247	1.8	0.07	0.5	0.7	C1
840527	1618	52.45	34-20.01	81-17.91	0.66	0.12	8	238	0.3	0.08	1.3	0.3	C1
840527	17 7	4.45	34-19.87	81-19.02	0.17	-0.40	4	263	2.0	0.03			C1
840530	1921	57.01	34-19.48	81-18.82	0.14	-0.60	9	130	1.8	0.06	0.2	0.6	B1
840603	340	6.92	34-19.66	81-19.30	1.77	-0.60	6	149	2.4	0.05	0.4	0.8	B1
840607	429	35.04	34-20.01	81-18.89	1.78	0.21	13	112	1.8	0.07	0.2	0.5	B1
840617	1453	30.14	34-19.90	81-18.59	0.23	0.37	9	124	1.3	0.06	0.3	0.8	B1
840620	8 4	5.84	34-17.61	81-18.58	1.54	1.21	13	102	1.9	0.04	0.1	0.5	B1
840629	2334	19.41	34-20.01	81-17.84	1.45	0.01	7	237	0.2	0.06	1.0	0.5	C1
840630	0 4	45.26	34-20.07	81-18.02	2.35	-0.24	6	248	0.5	0.02	0.3	0.1	C1