TECHNICAL REPORT 84-3

SEISMIC ACTIVITY NEAR THE V.C. SUMMER NUCLEAR STATION

For the Period July - September 1984

by
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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 July 1 and September 30, 1984. During this reporting period, a total of twelve locatable events were recorded. None of the events had magnitudes greater than 2.0 and three had magnitudes between 1.0 and 2.0. The largest events were of magnitudes 1.5 and occurred on July 20 and September 25.

Seismic Network

The report is primarily based on data recorded by the four station network operated by S.C.E. and G. and the permanent station JSC. Because of poor records during September (Table 1), the permanent stations 6A and 9A were used to supplement the data. Locations of the stations are shown in Figure 1 and their coordinates are listed in Appendix I.

Table 1. Number of days per month station in operation

Month	Station	No. of Days
July	1	31
	2	31
	3	28
	4	30
August	1	31
	2	31
	3	0
	4	31
September	1	24
	2	10
	3	14
	4	17

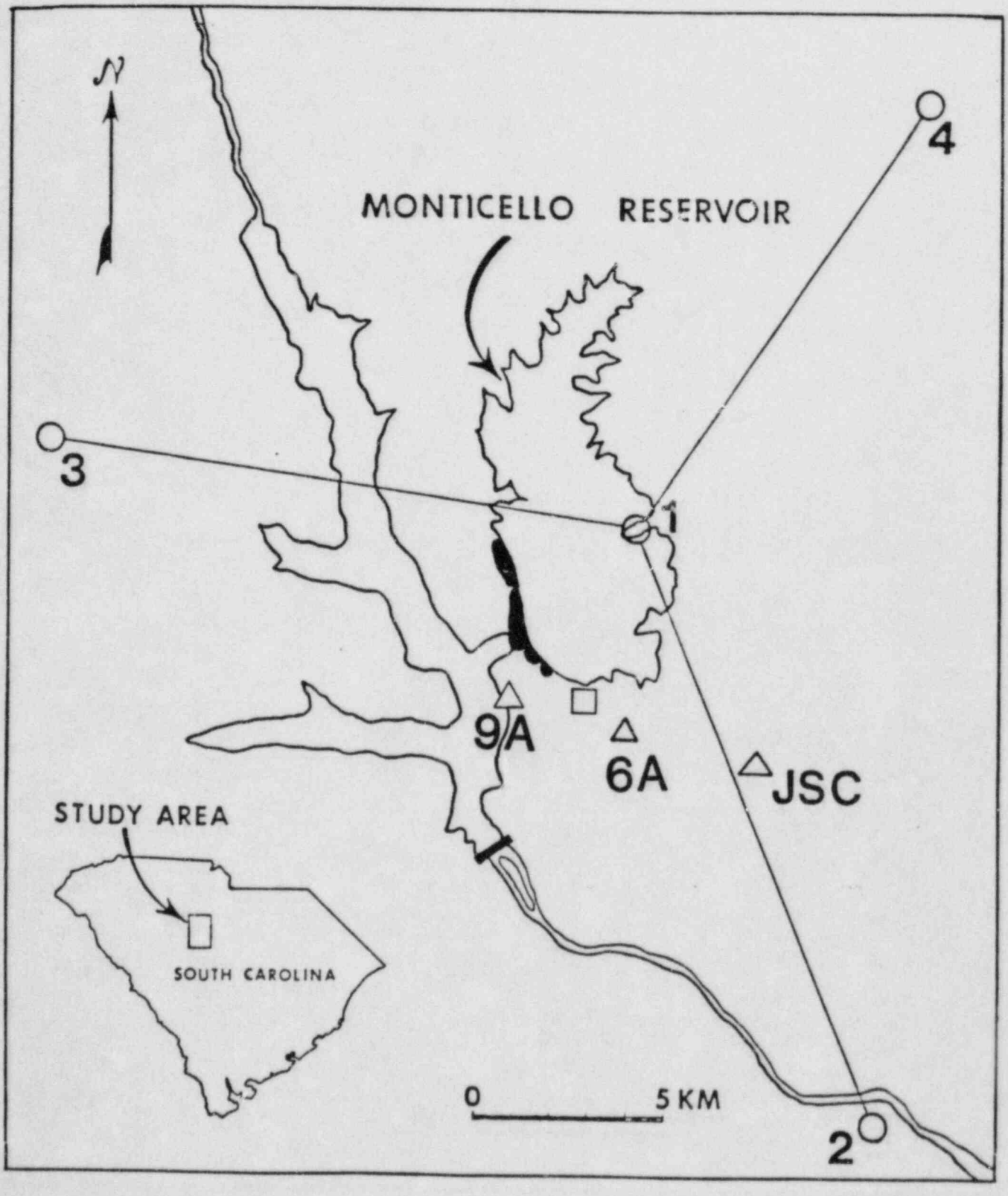

N
MONTICELLO RESERVOIR
4
3
1
9A
6A
JSC
STUDY AREA
SOUTH CAROLINA
0
5 KM
2

Figure 1

Data Analysis

Locations of the events are 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).

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

Results

The twelve locatable events recorded during this period are listed in Appendix III. There were no events with magnitudes greater than 2.0. The three events with magnitudes between 1.0 and 2.0 are listed in Table 2 and the remaining events were small ($M_L < 1.0$).

Table 2.

Date	Magnitude
July 20	1.46
July 27	1.09
September 25	1.52

Most of the seismic activity for the three month reporting period was confined to within the reservoir in a

northerly linear trend. Depth estimates for all located events indicate that 75% of the activity occurred within two kilometers of the surface. The deepest event occurred at 3.5 km. A comparison of depth variations based on quality B or better events for the first nine months of 1984 and for the past five years is shown in Figure 2. The depth ranges were divided into one-half kilometer increments up to 3.0 km, and events occurring at greater than 3.0 km were grouped together. The largest percentage of events occurred in the 1.5 to 2.0 km increment every year. None of the A or B quality events in 1984 occurred at depths greater than 3.0 km; the deepest event was at 2.9 km.

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

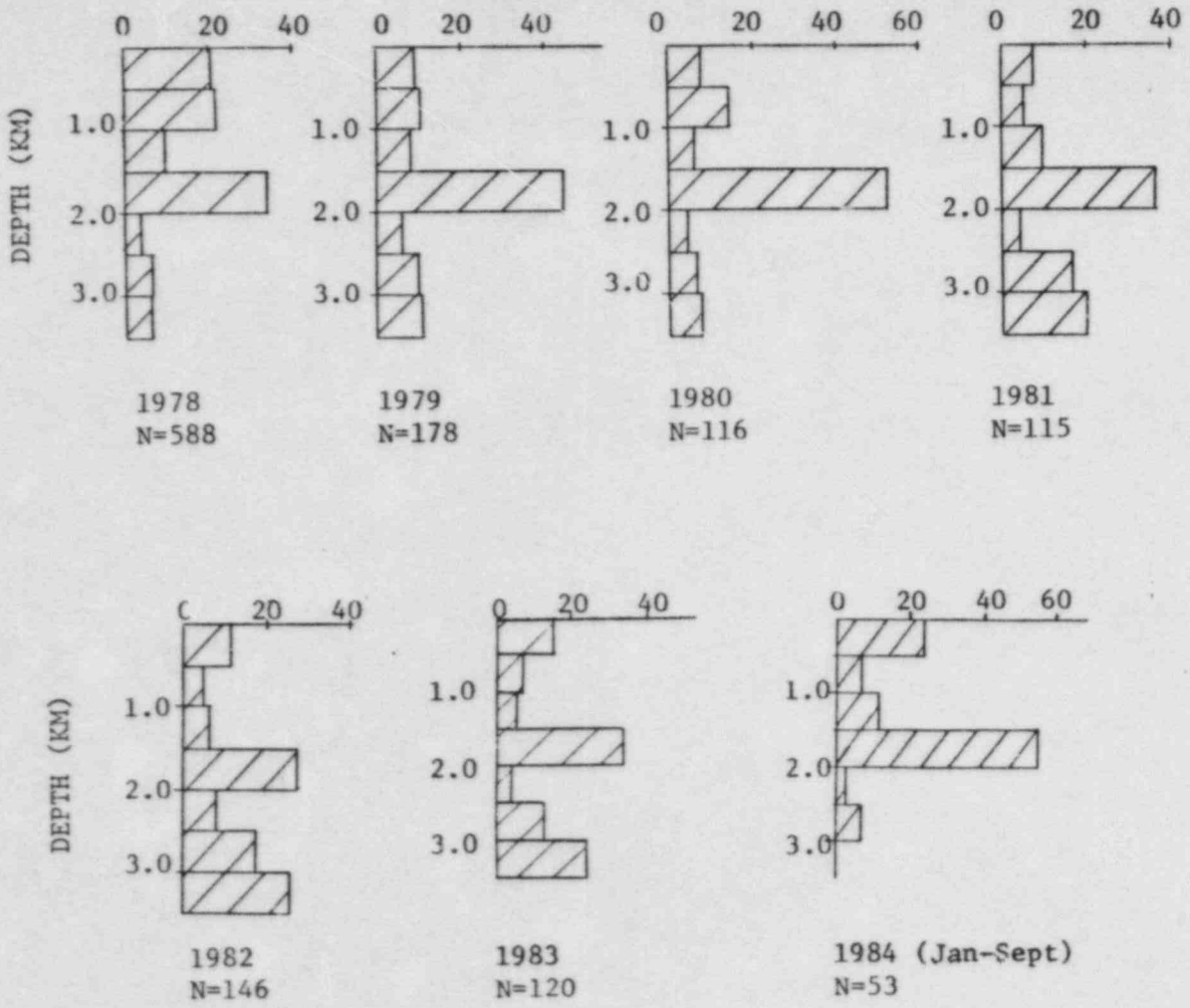

PERCENT
DEPTH (KM)
0
20
40
60
1.0
2.0
3.0
1978
N=588
1979
N=178
1980
N=116
1981
N=115
1982
N=146
1983
N=120
1984 (Jan-Sept)
N=53

Figure 2

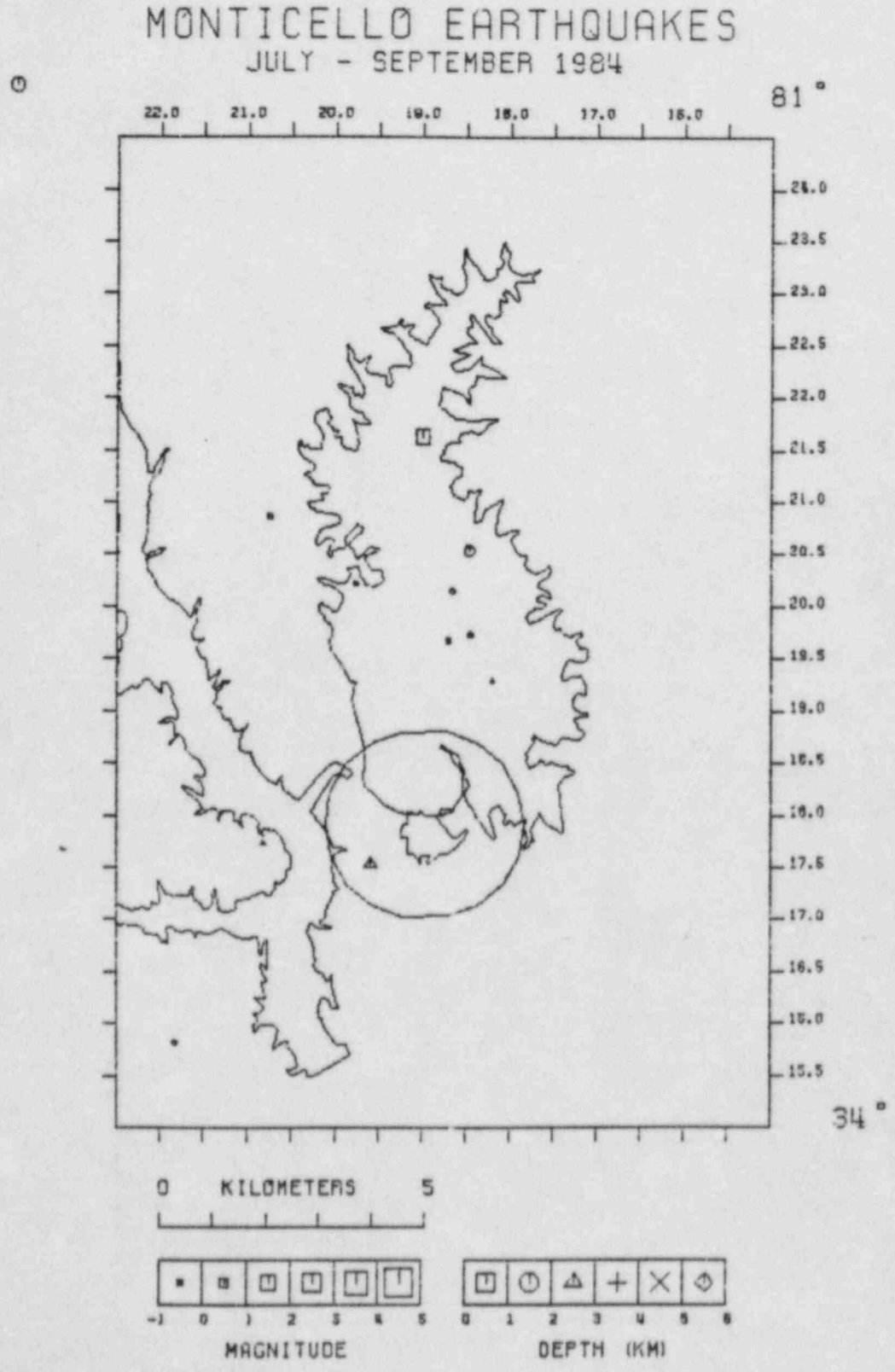
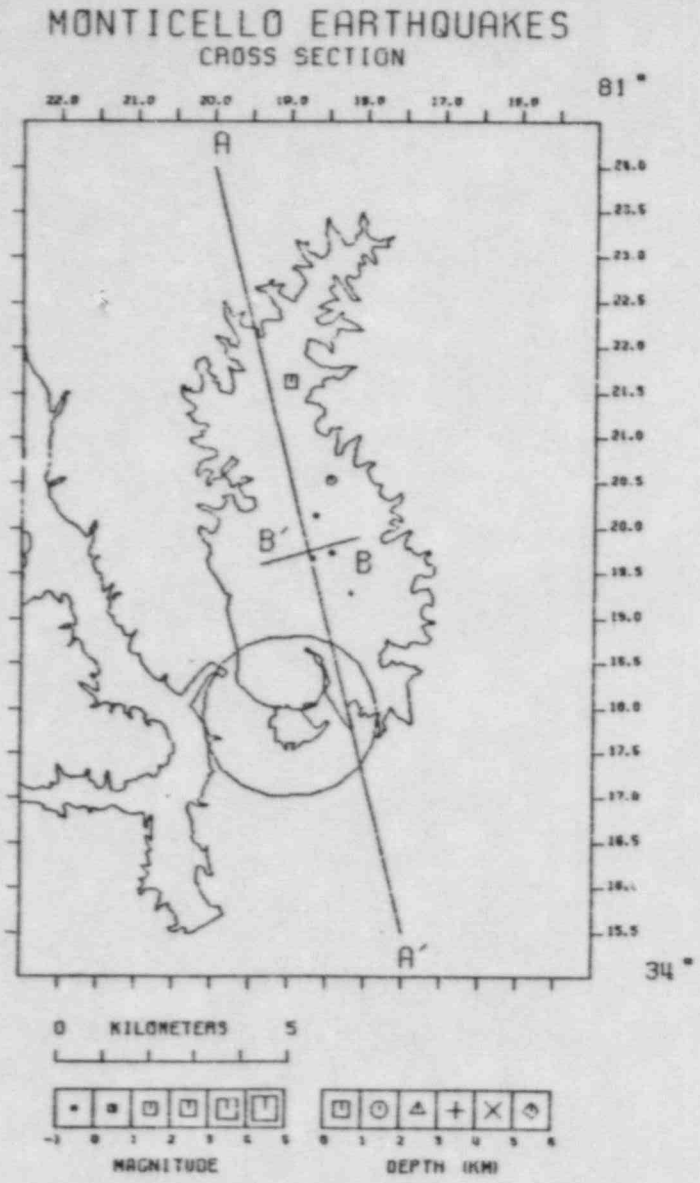

MONTICELLO EARTHQUAKES
JULY - SEPTEMBER 1984
81°
34°
22.0
21.0
20.0
19.0
18.0
17.0
16.0
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
0 KILOMETERS 5
-1 0 1 2 3 4 5
MAGNITUDE
0 1 2 3 4 5 6
DEPTH (KM)

Figure 3


MONTICELLO EARTHQUAKES
CROSS SECTION
81°
34°
A
A'
B
B'
0 KILOMETERS 5
MAGNITUDE
DEPTH (KM)

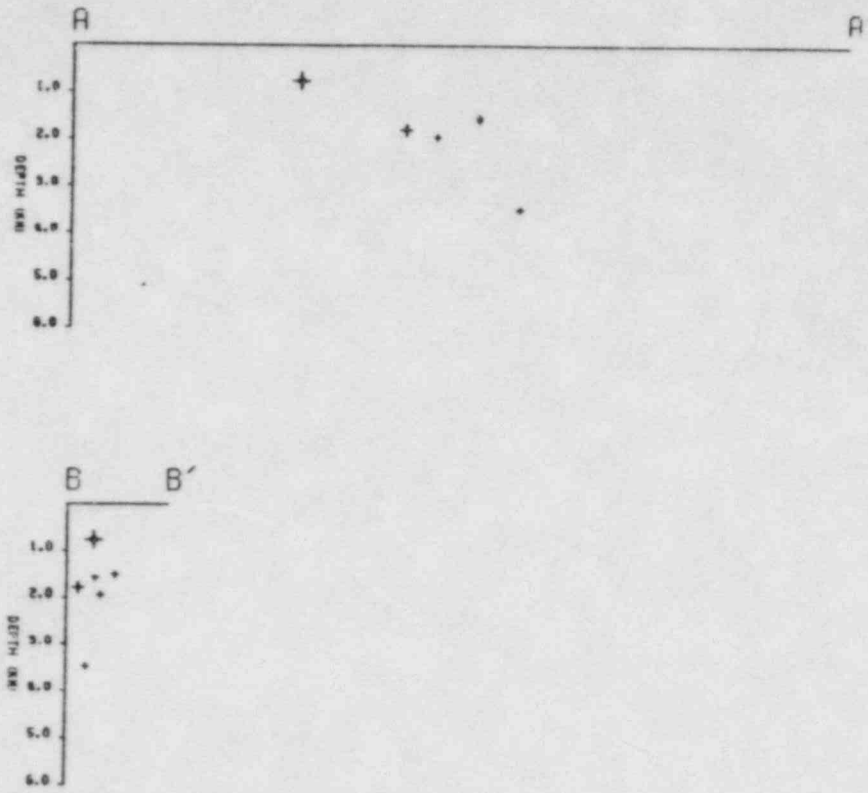

A
A'
B
B'
DEPTH (KM)

Figure 4

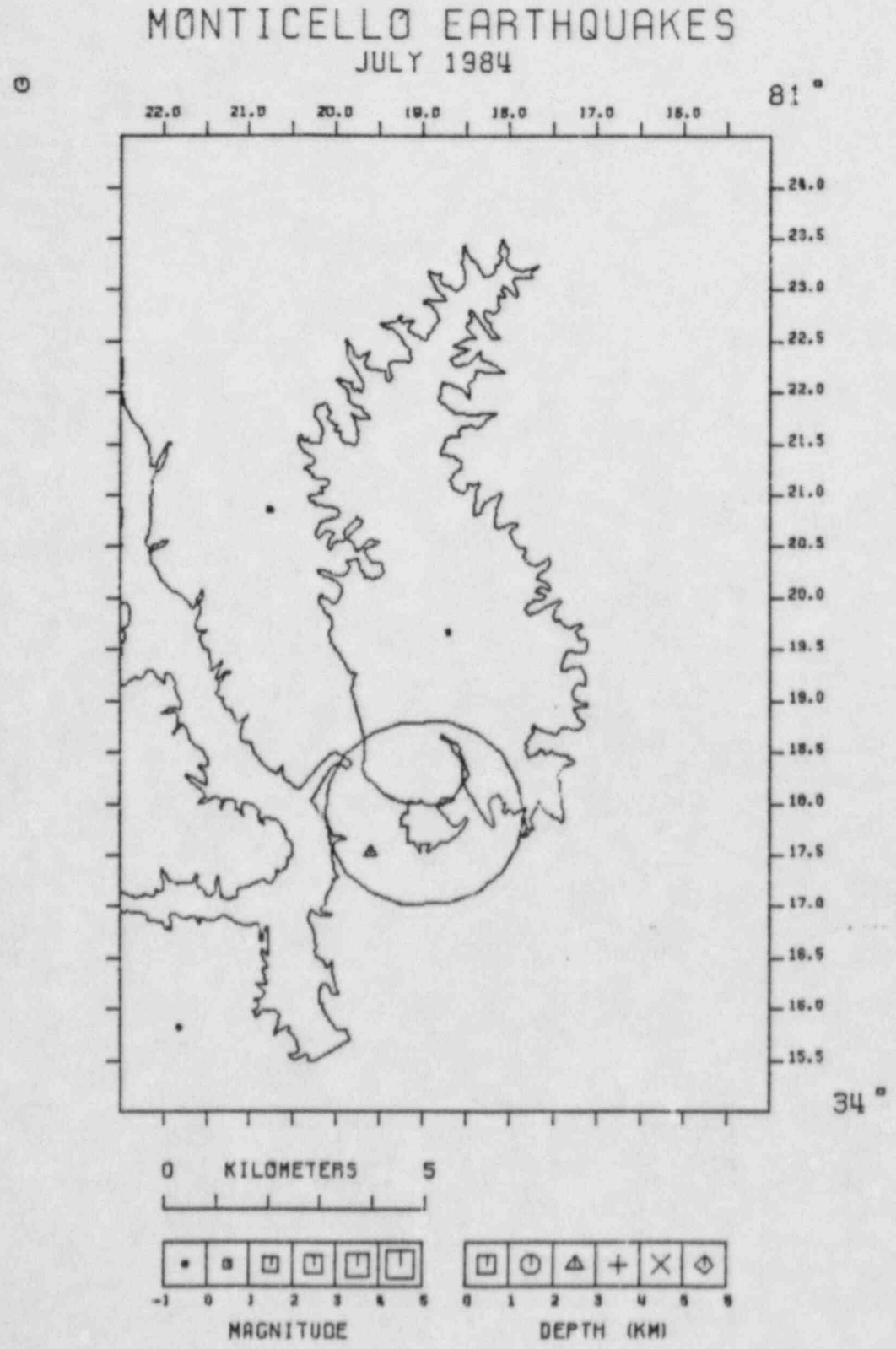

MONTICELLO EARTHQUAKES
JULY 1984
81°
34°
22.0
21.0
20.0
19.0
18.0
17.0
16.0
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
0 KILOMETERS 5
-1 0 1 2 3 4 5
MAGNITUDE
0 1 2 3 4 5 6
DEPTH (KM)

Figure 5

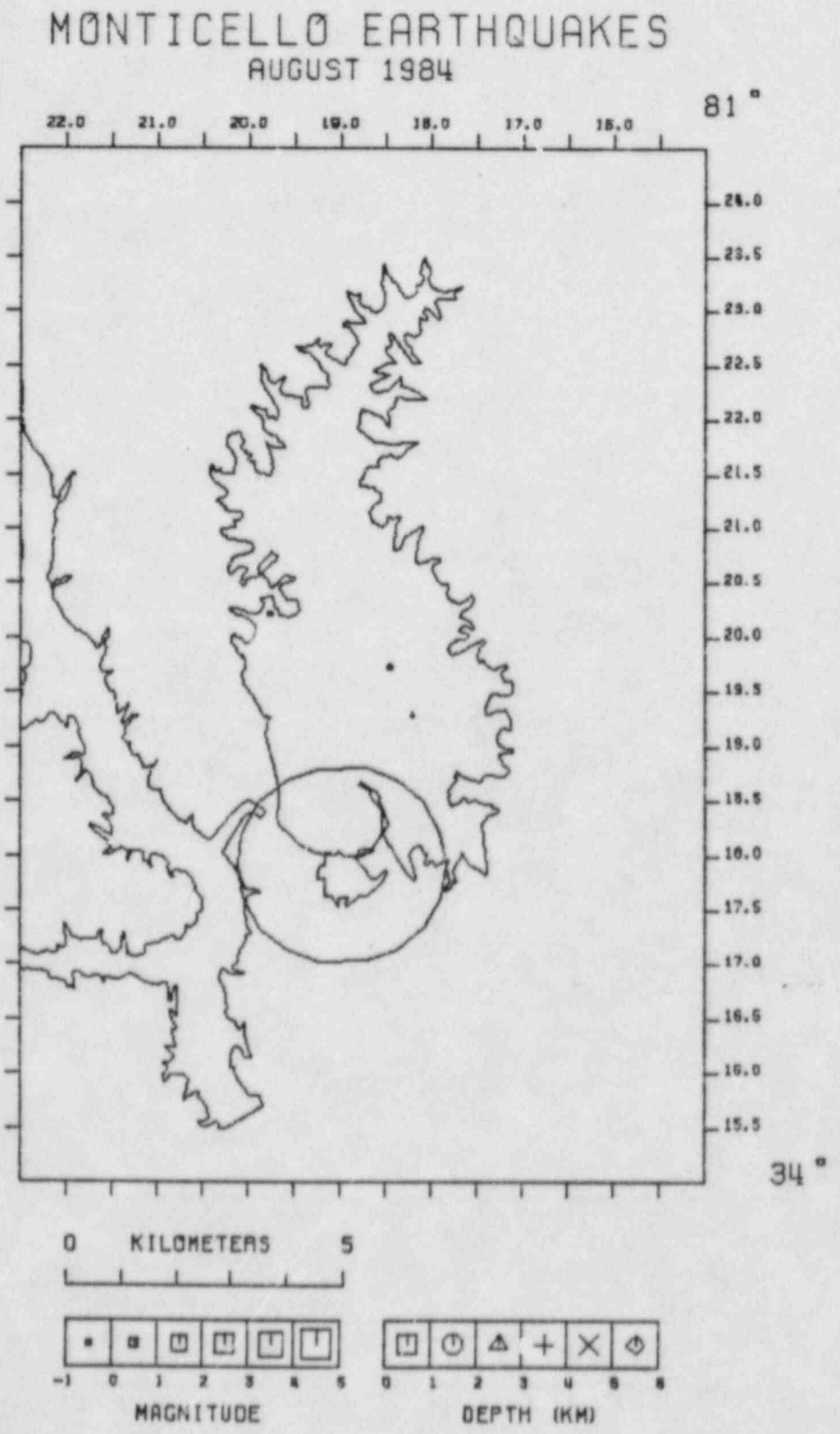

MONTICELLO EARTHQUAKES
AUGUST 1984
81°
34°
0 KILOMETERS 5
MAGNITUDE
DEPTH (KM)

Figure 6

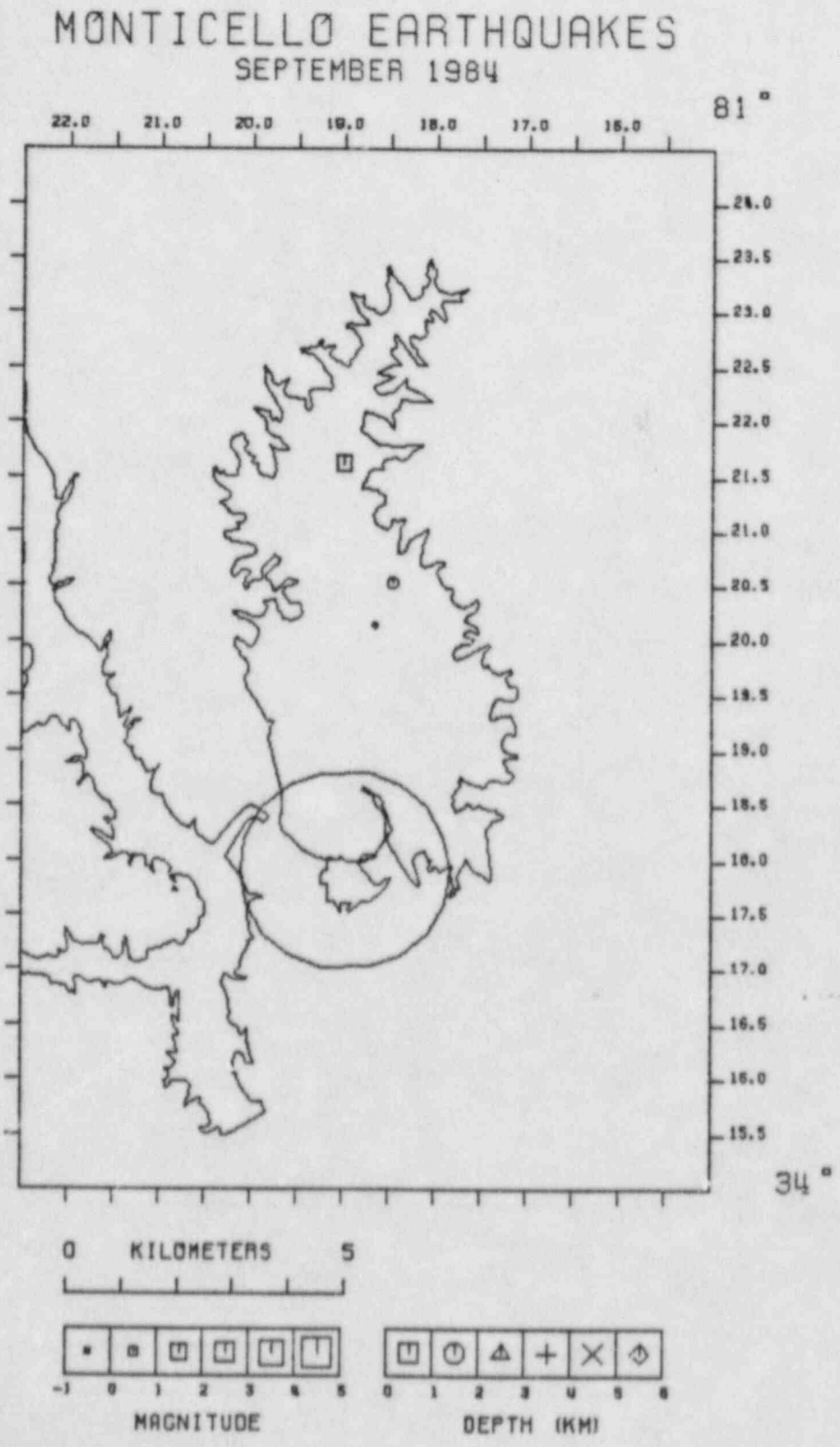

MONTICELLO EARTHQUAKES
SEPTEMBER 1984
81°
22.0
21.0
20.0
19.0
18.0
17.0
16.0
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
34°
0 KILOMETERS 5
-1 0 1 2 3 4 5
MAGNITUDE
0 1 2 3 4 5 6
DEPTH (KM)

Figure 7

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 September, 1984. The low level of seismicity for this three month period is consistent with the previous years trend as again it was preceded by a swarm in the spring. However, the peaks of the swarms have decreased as has the general level of activity. No increase in depth of seismicity was noted during this period, and the spatial extent continued to be confined to within the reservoir area.

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 HYPO71, U.S.G.S. Open-File Report, 100 pp.

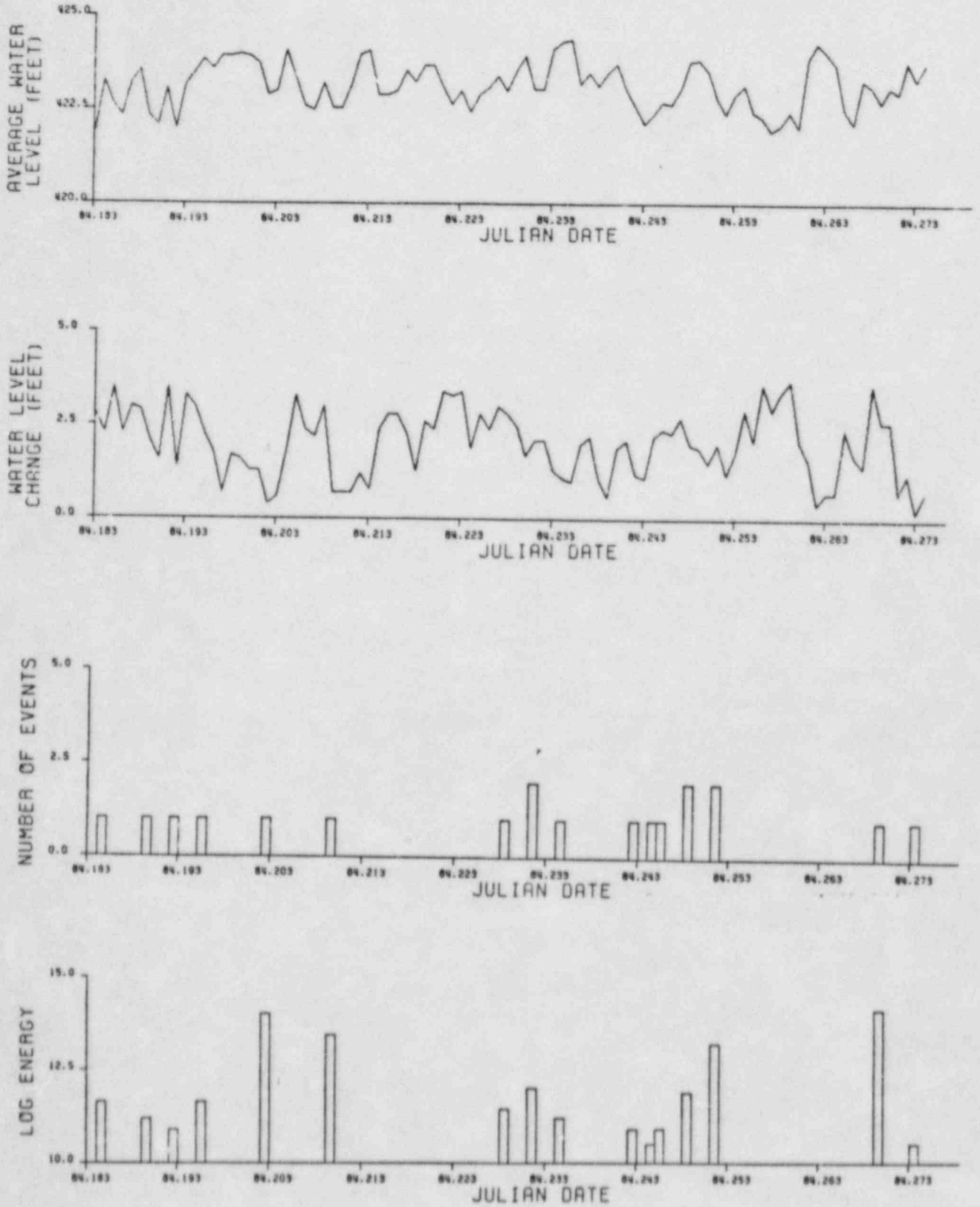

AVERAGE WATER LEVEL (FEET)
425.0
422.5
420.0
84.183
84.193
84.203
84.213
84.223
84.233
84.243
84.253
84.263
84.273
JULIAN DATE
WATER LEVEL CHANGE (FEET)
5.0
2.5
0.0
JULIAN DATE
NUMBER OF EVENTS
JULIAN DATE
LOG ENERGY
15.0
12.5
10.0
JULIAN DATE

Figure 8

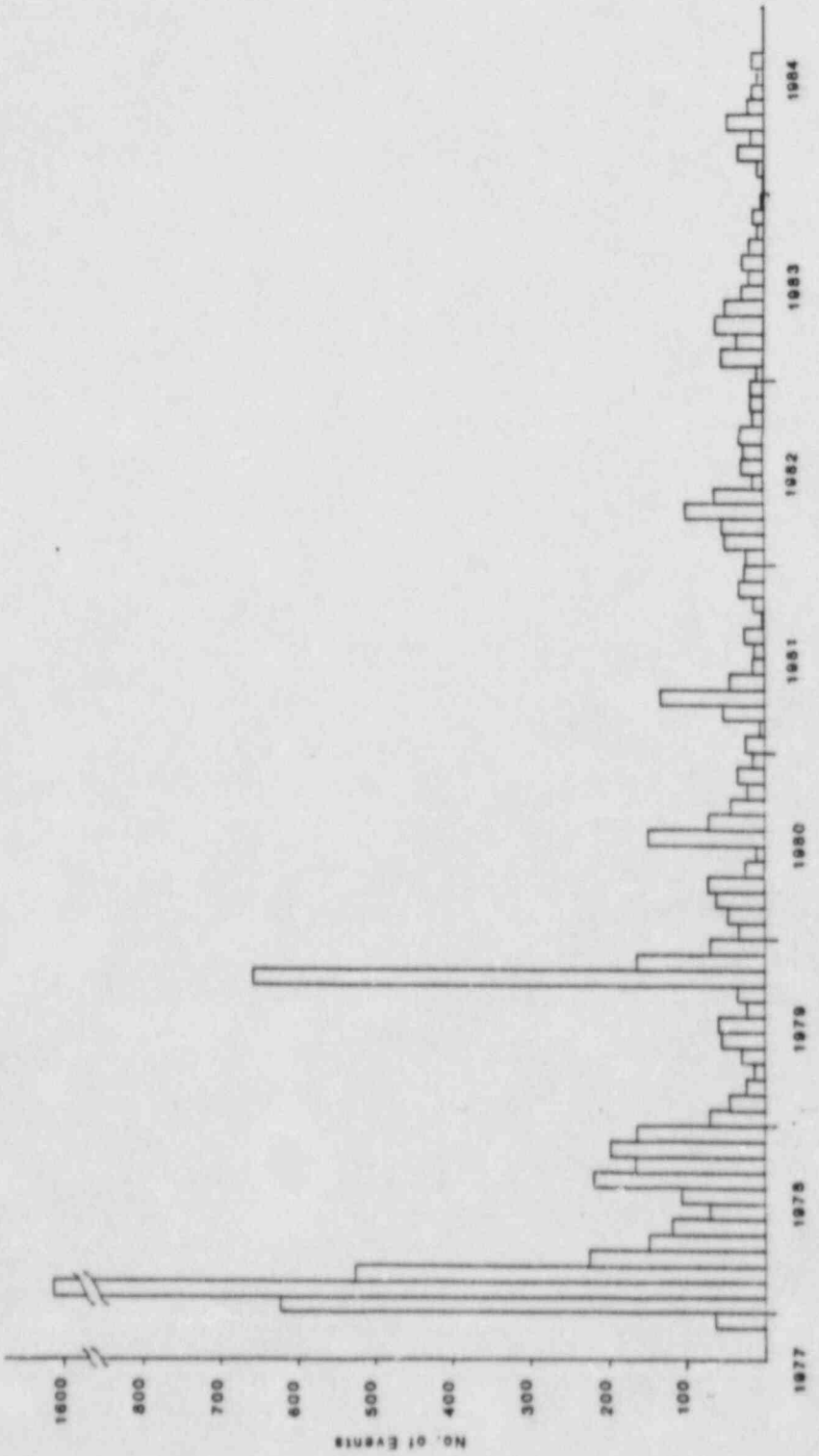

1600
800
700
600
500
400
300
200
100
NO. OF EVENTS
1977
1978
1979
1980
1981
1982
1983
1984

Figure 9

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° 12.09'
6	06A	34° 17.32'	81° 18.15'
7	09A	34° 17.24'	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	Q
840702	1337 51.17	34-20.80	81-20.76	1.91	-0.11	10	141	5.1	0.05	0.1	0.5	A
840707	712 32.67	34-19.82	81-18.71	1.51	-0.40	8	192	9.2	0.05	0.1	0.4	A
840710	1725 41.62	34-15.82	81-21.85	1.97	-0.60	8	192	9.2	0.04	0.1	0.3	A
840720	1532 22.88	34-25.03	81-23.60	3.33	1.09	10	278	9.2	0.07	0.1	0.4	A
840727	1955 31.20	34-17.53	81-19.21	3.99	-0.24	7	158	5.1	0.08	0.1	0.3	A
840815	220 56.47	34-19.73	81-18.66	0.00	-0.40	5	225	1.1	0.05	0.1	0.3	A
840821	651 30.31	34-20.22	81-19.77	0.00	-0.60	5	225	1.1	0.02	0.1	0.2	A
840829	11 2.83	34-17.73	81-20.83	2.24	-0.09	7	225	3.2	0.07	0.1	0.3	A
840901	1458 1.25	34-20.54	81-18.47	1.31	-0.91	10	200	5.2	0.07	0.1	0.3	A
840907	952 10.39	34-20.15	81-18.60	1.94	-0.86	8	200	1.1	0.02	0.1	0.2	A
840907	1059 35.81	34-21.03	81-19.00	0.76	1.52	10	243	3.7	0.08	0.1	0.7	A
840925	13 6 43.81	34-21.03	81-19.00	0.76	1.52	10	243	3.7	0.08	0.1	0.7	A