Technical Report 83-1

SEISMIC ACTIVITY NEAR THE V. C. SUMMER NUCLEAR STATION

For the Period

January - March

1983

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 a three month period between January 1 and March 31, 1983. During this reporting period, a total of 88 locatable events were recorded. The largest magnitude recorded was M_L = 2.0 on February 19, 1983. Four events were recorded with magnitudes between 1.0 and 2.0 and are listed below.

Date	Magnitude
January 31	1.50
February 8	1.09
February 9	1.06
February 20	1.24

SEISMIC NETWORK

The report is based on the data recorded by a four-station network operated by S.C.E. and G. In addition, data from a permanent station (JSC) of the South Carolina seismographic network are also used. Location of all these stations is 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

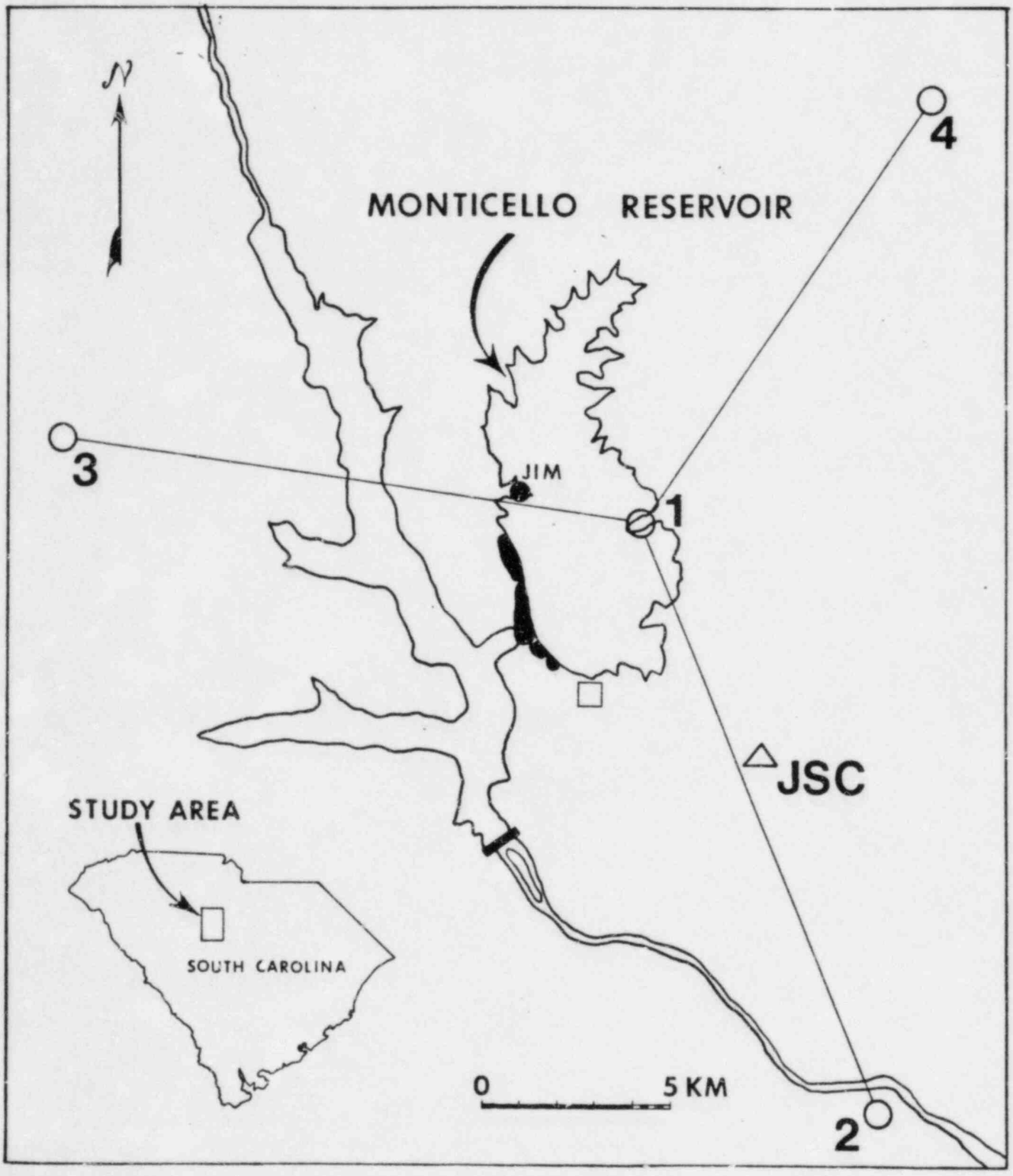
N
MONTICELLO RESERVOIR
JIM
1
2
3
4
JSC
STUDY AREA
SOUTH CAROLINA
0
5 KM

Figure 1

magnitude (M_L) energy (E) relation by Gutenberg and Richter, 1956.

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

RESULTS

The 88 located events recorded during this period are listed in Appendix III. One event was of magnitude 2.0, four had magnitudes between 1.0 and 2.0, and the remaining events were of magnitudes below 1.0. The large event (M_L = 2.0) on 2-19-83 was relocated using data on other stations of the Monticello and S.C. Seismic Network. Its depth was found to change from 1.75 km to 0.45 km. Depth estimates indicate approximately 63% of the activity was within 2.0 km depth, 14% was between 1.0 and 2.0 km and the remaining events occurred below 3.0 km. Figure 2 shows the percentage of events occurring in 0.5 km depth increments for this reporting period in comparison with the previous five years based on A and B quality events. Most of the activity occurs between 1.5 and 2.0 km depth, and the percentage of events at greater than 3.0 km depth is about the same as in 1982. However, as stated in previous reports, when past events were relocated using magnetic tape data, the depths were found to be lower than the true depths.

A cumulative plot of epicenters of events located during this reporting period is shown in Figure 3, a cross section in Figure 4, and a monthly breakdown of epicentral locations is shown in Figures 5-7. We note that most of the activity occurred in February and March and was concentrated in the middle of the reservoir.

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

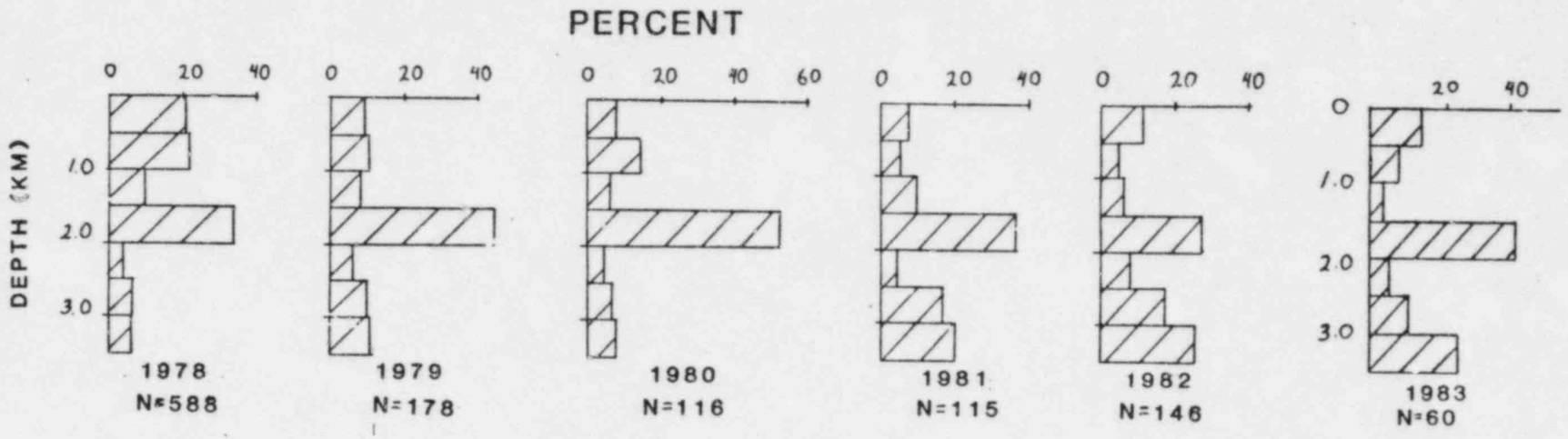
PERCENT
DEPTH (KM)
0
20
40
60
1.0
2.0
3.0
1978
N=588
1979
N=178
1980
N=116
1981
N=115
1982
N=146
1983
N=60

Figure 2

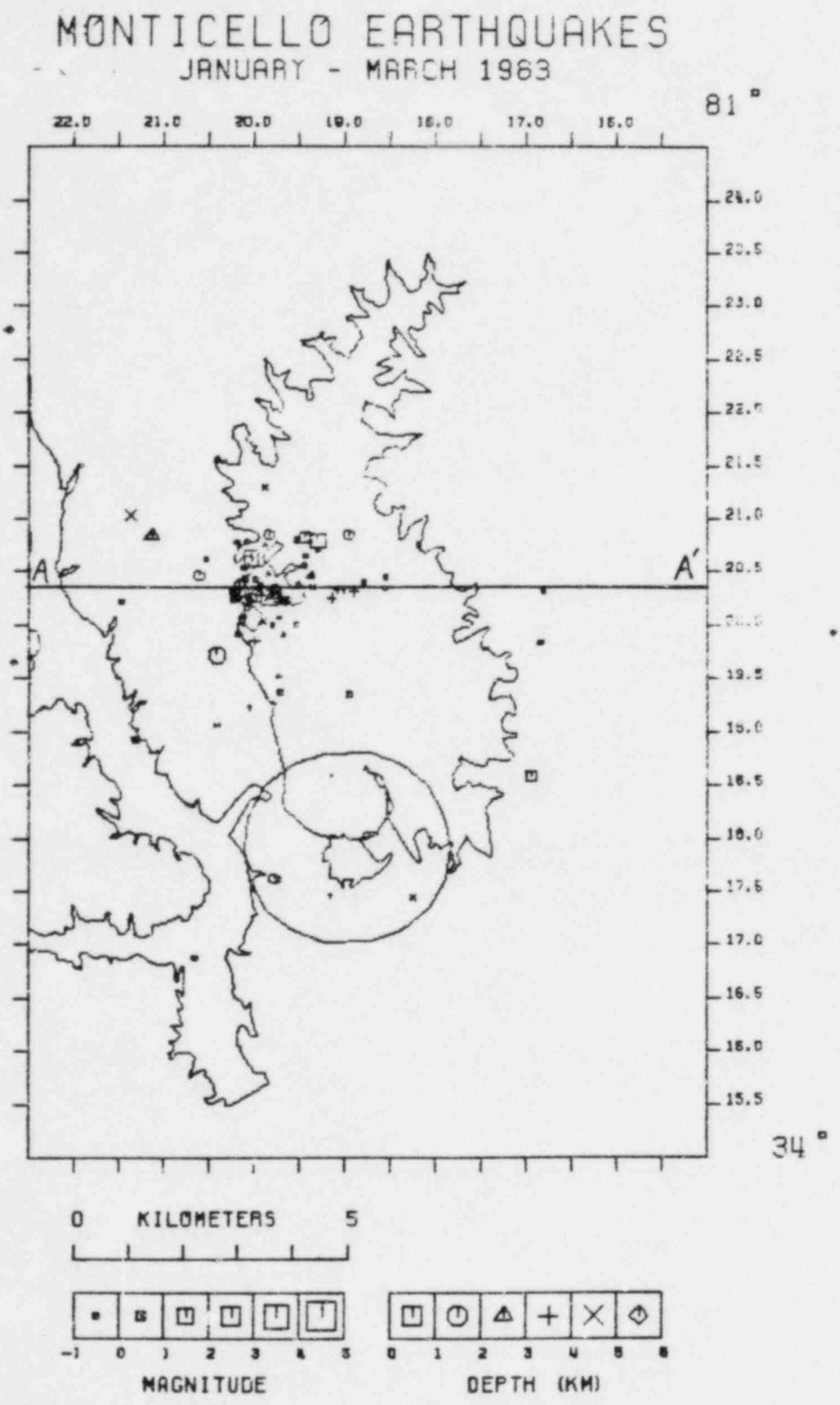
MONTICELLO EARTHQUAKES
JANUARY - MARCH 1963
81°
34°
A
A'
0 KILOMETERS 5
MAGNITUDE
DEPTH (KM)

Figure 3

Figure 4

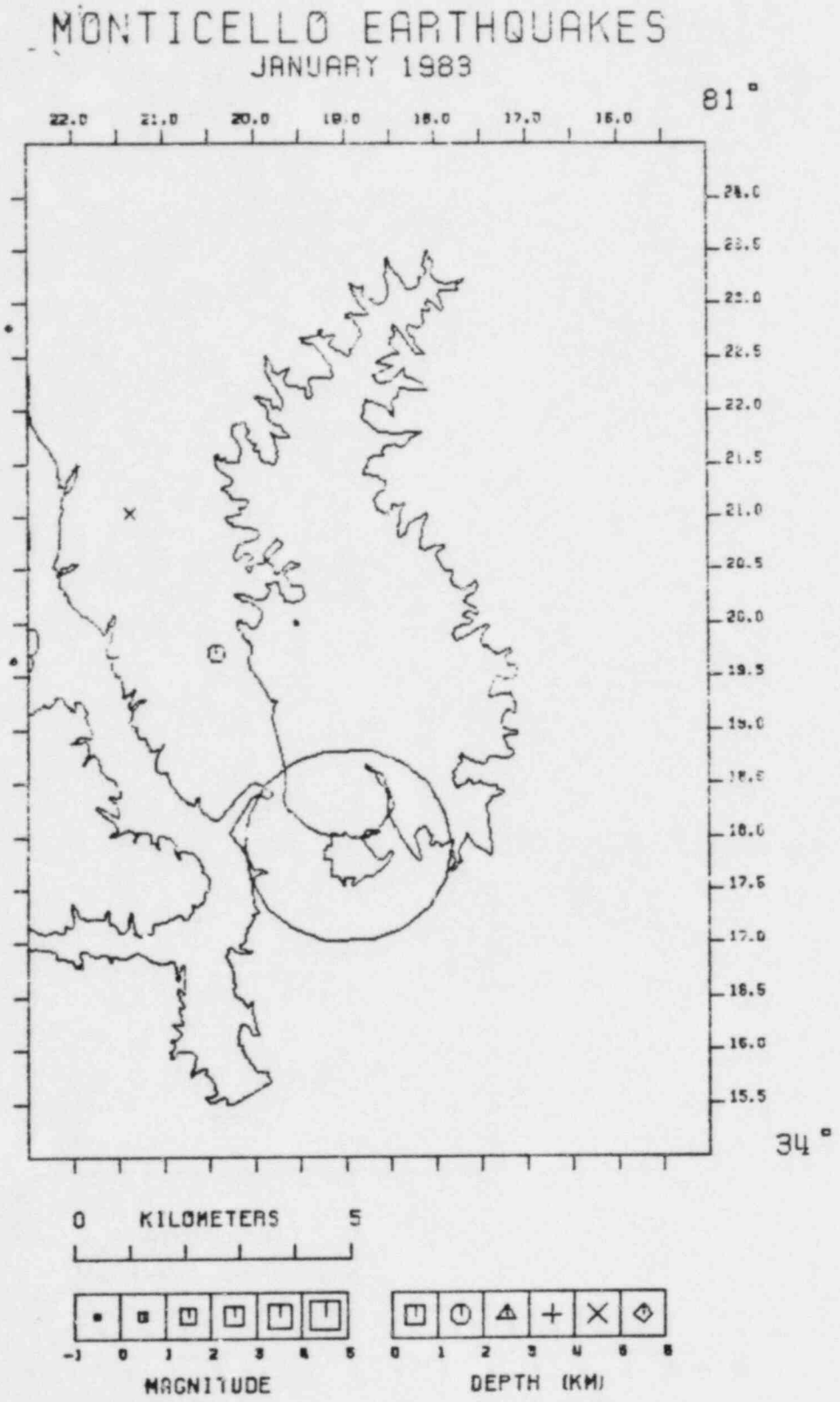
MONTICELLO EARTHQUAKES
JANUARY 1983
81°
34°
22.0
21.0
20.0
19.0
18.0
17.0
16.0
0 KILOMETERS 5
MAGNITUDE
DEPTH (KM)

Figure 5

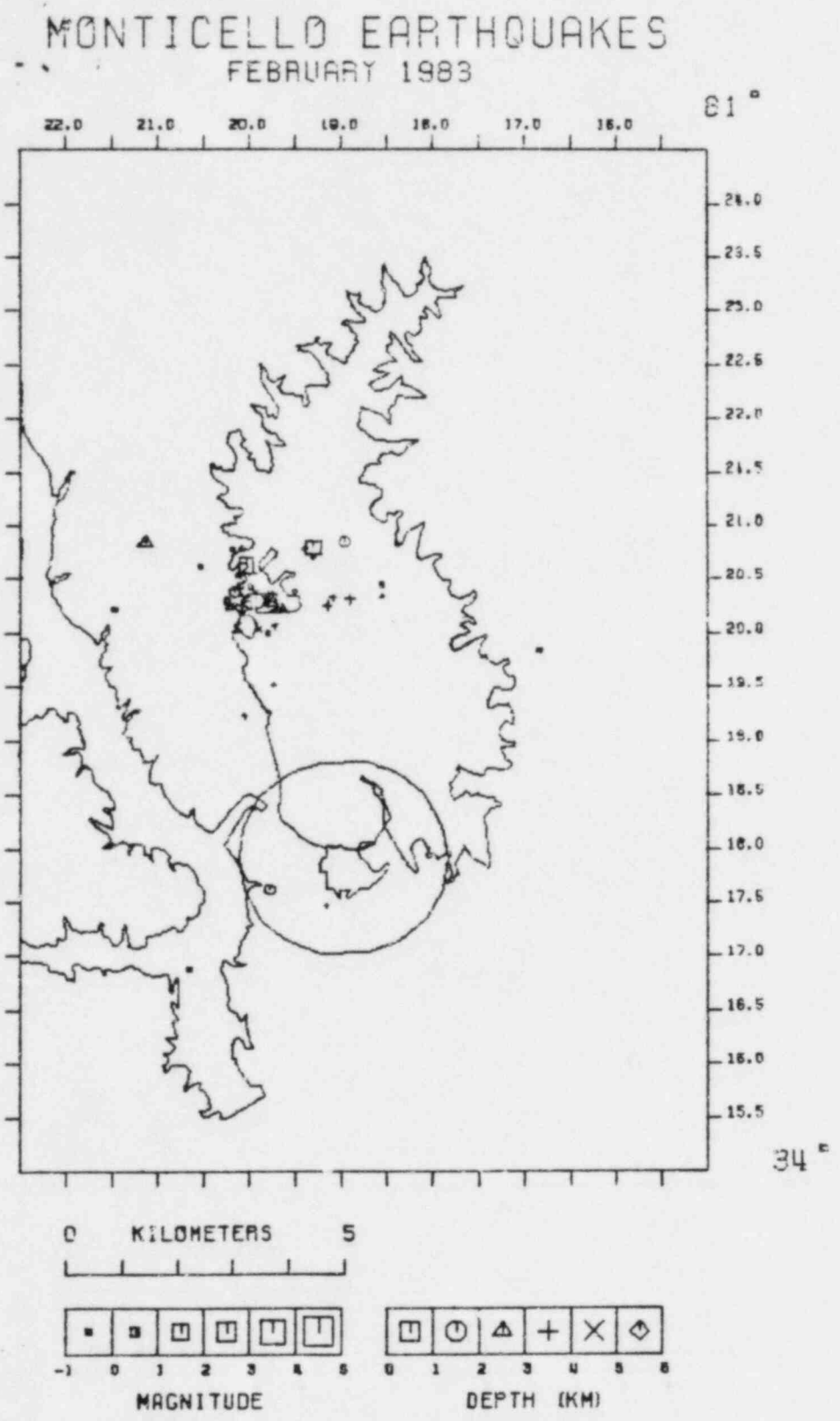
MONTICELLO EARTHQUAKES
FEBRUARY 1983
81°
34°
22.0
21.0
20.0
19.0
18.0
17.0
16.0
24.0
23.5
23.0
22.5
22.0
21.5
21.0
20.5
20.0
19.5
19.0
18.5
18.0
17.5
17.0
16.5
16.0
15.5
0 KILOMETERS 5
-1 0 1 2 3 4 5
MAGNITUDE
0 1 2 3 4 5 6
DEPTH (KM)

Figure 6

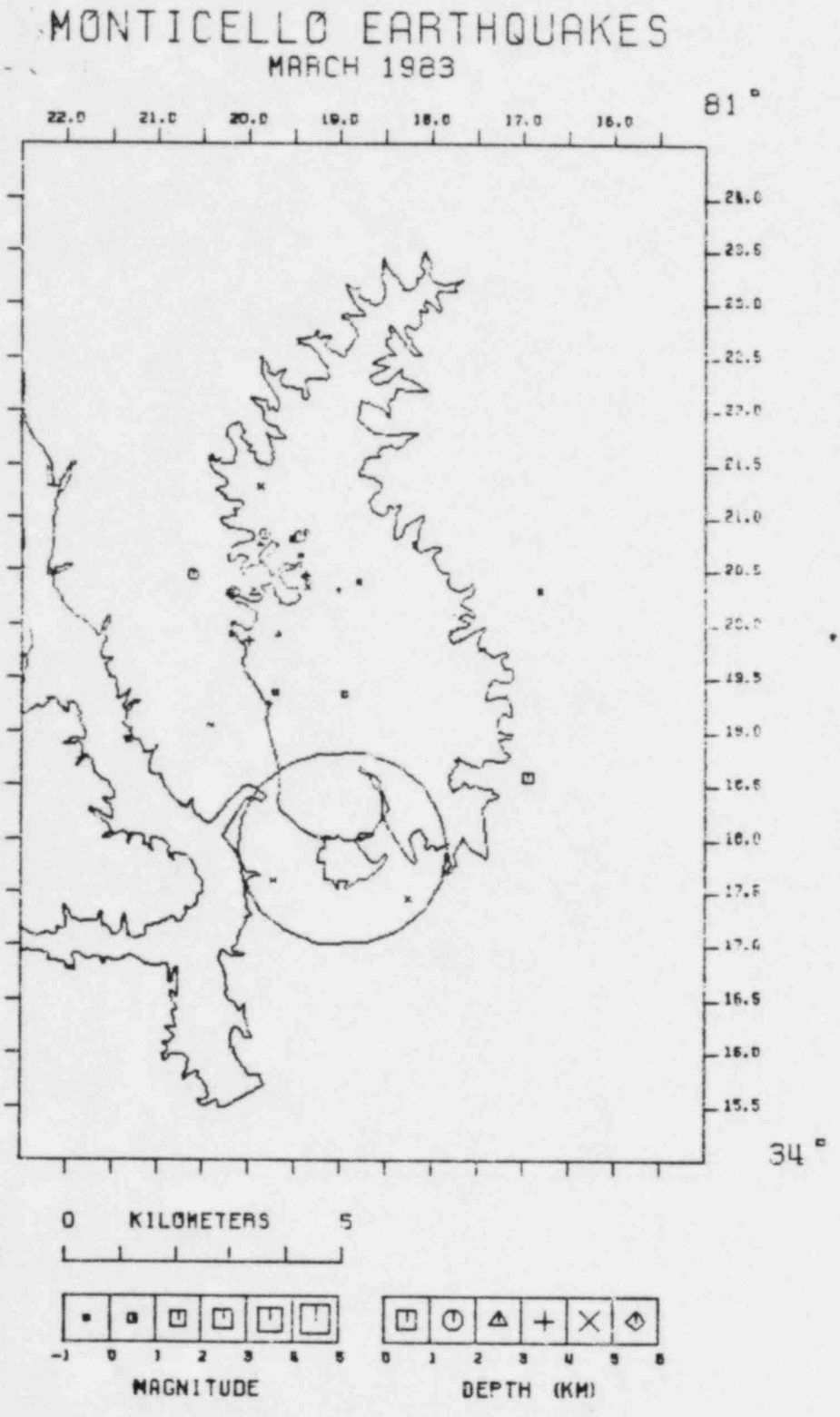
MONTICELLO EARTHQUAKES
MARCH 1983
81°
34°
0 KILOMETERS 5
MAGNITUDE
DEPTH (KM)

Figure 7

5 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

Seismically, the Monticello Reservoir area during the January through March 1983, reporting period was more active than in the previous six months. Figure 9 is a histogram of the number of events per month from December 1977 through March 1983, suggesting a long term trend of discrete swarms of seismicity separated by relatively quiet periods. The seismicity level for this period is consistent with the trend by indicating a swarm following a quiet period, with an overall decrease in the level of seismicity. The majority of depths for the three month period continue to be in the 1.5 to 2.0 km range.

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 HYPO 71, U.S.G.S. Open File Report, 100 pp.

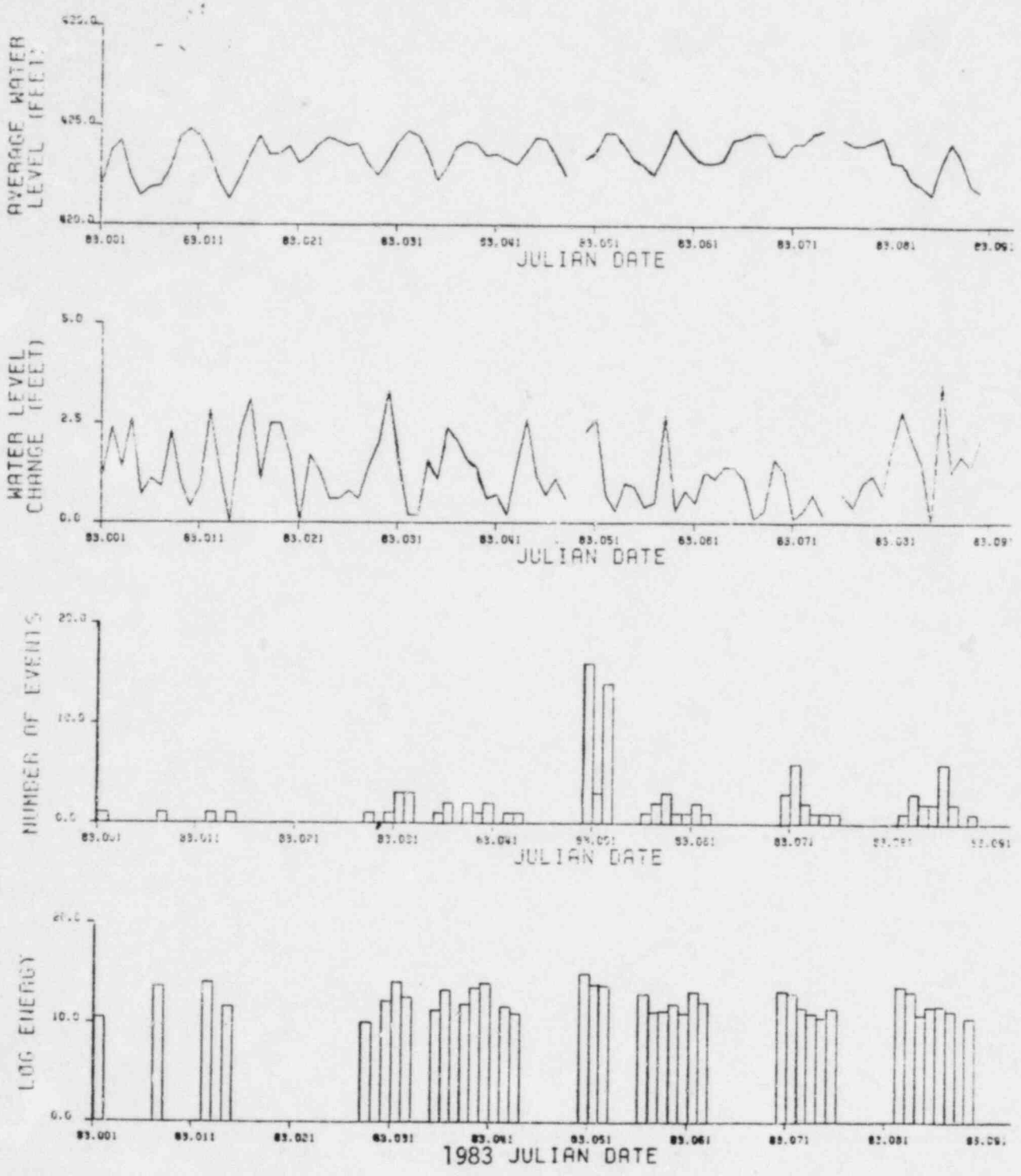
AVERAGE WATER LEVEL (FEET)
JULIAN DATE
WATER LEVEL CHANGE (FEET)
5.0
2.5
0.0
JULIAN DATE
NUMBER OF EVENTS
JULIAN DATE
LOG ENERGY
10.0
0.0
1983 JULIAN DATE

Figure 8

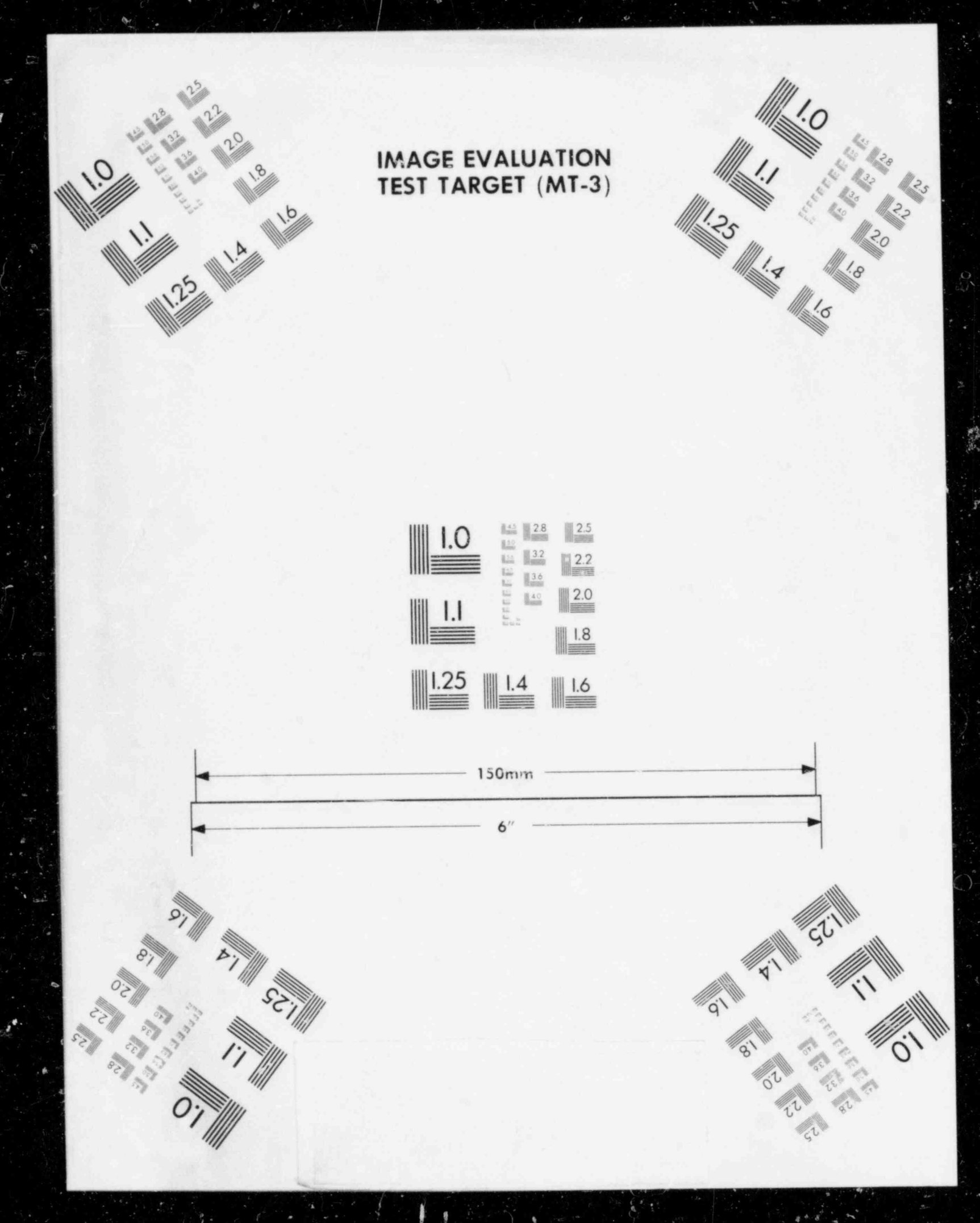
IMAGE EVALUATION
TEST TARGET (MT-3)
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
150mm
6"

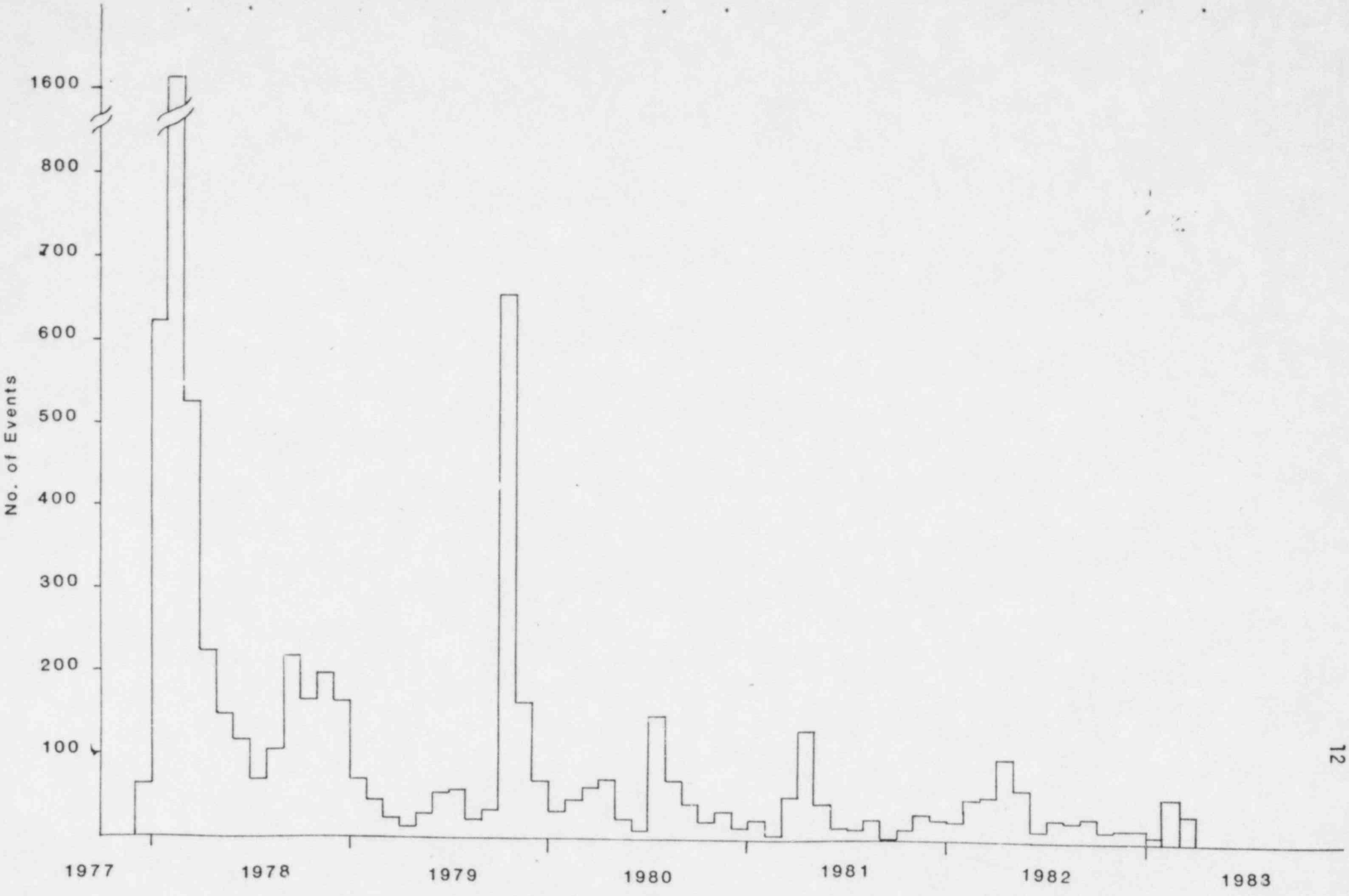
1600
800
700
600
500
400
300
200
100
No. of Events
1977
1978
1979
1980
1981
1982
1983

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°15.60'
6	008	34°24.53'	81°24.55'

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
830101	422 51.16	34-22.78	81-22.70	1.91	-0.85	6	238	7.9	0.00	0.0	0.0	C1
830128	14 2 9.82	34-26.96	81-17.03	1.97	-1.22	6	222	5.6	0.03	0.3	2.0	C1
830130	1656 21.18	34-21.03	81-21.37	4.25	0.21	5	145	5.9	0.01	0.2	0.6	C1
830131	2114 2.53	34-19.65	81-22.66	1.05	-0.85	5	226	7.6	0.04	1.3	32.9	D1
830131	2149 34.88	34-20.01	81-19.54	0.72	-0.24	10	136	2.8	0.04	0.3	0.7	B1
830131	23 0 33.30	34-19.72	81-20.42	1.76	1.50	8	152	4.1	0.05	0.6	2.0	C1
830201	124 21.50	34-20.07	81-19.73	2.34	-0.40	7	176	3.1	0.01	0.2	0.3	B1
830201	1021 4.56	34-20.28	81-19.78	2.59	0.44	8	135	3.2	0.06	0.3	1.1	C1
830204	1357 55.44	34-19.23	81-20.06	3.10	-0.40	10	141	3.8	0.08	0.4	0.8	B1
830205	848 58.87	34-20.31	81-20.25	1.77	-0.40	7	250	3.9	0.08	1.2	2.1	C1
830205	20 0 43.01	34-17.62	81-19.78	1.89	0.95	10	158	5.3	0.04	0.2	0.8	B1
830207	239 24.41	34-27.16	81-20.63	0.31	-0.11	9	240	12.0	0.09	0.7	1.6	C1
830207	15 2 23.06	34-20.70	81-19.31	3.62	-0.40	10	133	2.8	0.08	0.3	0.6	B1
830208	0 6 28.54	34-20.79	81-19.31	0.49	1.09	8	134	2.9	0.03	0.2	0.6	B1
830209	118 17.46	34-20.79	81-19.40	2.83	-0.60	10	135	3.0	0.08	0.3	0.7	B1
830209	310 57.62	34-20.84	31-21.14	2.84	1.05	9	141	5.5	0.08	0.4	1.1	B1
830211	2048 45.84	34-20.35	81-18.56	2.64	-0.11	6	245	1.5	0.05	0.9	0.4	C1
830212	336 4.71	34-20.22	81-21.48	1.97	-0.60	8	136	5.8	0.09	0.5	2.2	C1
830219	1421 17.14	34-20.06	81-20.14	0.95	-0.24	10	131	3.7	0.03	0.1	1.2	B1
830219	1451 2.22	34-20.43	81-19.99	1.76	-0.24	10	131	3.6	0.05	0.2	0.7	B1
830219	1614 40.02	34-20.04	81-19.91	4.46	-0.40	8	130	8.9	0.03	0.1	0.5	B1
830219	1616 13.76	34-20.25	81-20.18	5.24	-0.24	8	130	9.5	0.04	0.2	0.6	B1
830219	1847 39.03	34-20.01	81-19.80	1.69	-0.86	10	130	3.2	0.06	0.2	0.8	B1
830219	1847 42.33	34-20.21	81-19.67	1.62	-0.60	10	127	3.0	0.03	0.1	0.4	B1
830219	1847 50.60	34-20.39	81-19.51	1.92	-0.40	9	129	2.9	0.03	0.1	0.3	B1
830219	1848 7.33	34-20.35	81-20.00	1.76	-0.60	10	130	3.6	0.09	0.3	1.1	B1
830219	1848 12.99	34-20.34	81-19.80	1.96	-0.86	9	130	3.3	0.07	0.3	0.9	B1

830219	1916	55.83	34-20.62	81-20.54	1.96	-0.60	10	136	4.5	0.06	0.3	1.0 B1
830219	1950	31.60	34-19.84	81-16.84	0.62	-0.86	7	133	1.4	0.04	2.0	4.3 B1
830219	2025	21.15	34-20.28	81-19.82	0.45	2.00	16	71	0.7	0.08	0.3	0.6 A1
830219	21 8	39.93	34-17.46	81-19.17	3.85	-0.60	5	266	5.0	0.05	0.4	0.3 C1
830220	1551	36.51	34-20.25	81-20.24	1.78	-0.11	10	130	3.3	0.08	0.3	1.1 B1
830220	2256	27.96	34-20.24	81-19.63	1.77	-0.40	8	254	3.0	0.08	1.1	1.3 C1
830220	2348	55.58	34-20.63	81-20.04	0.04	1.24	8	135	3.8	0.04	0.2	0.4 B1
830221	3 9	15.08	34-20.26	81-20.04	0.90	0.99	10	129	3.6	0.06	0.2	4.1 B1
830221	322	21.43	34-20.43	81-20.11	0.28	-0.40	10	132	3.8	0.05	0.2	0.5 B1
830221	749	58.03	34-20.54	81-20.12	0.01	-0.60	7	134	3.8	0.02	0.1	0.0 B1
830221	8 4	59.58	34-20.23	81-20.05	1.58	-0.60	6	129	3.6	0.02	0.1	0.4 B1
830221	8 6	51.35	34-20.78	81-20.19	0.12	-0.24	7	137	4.1	0.07	0.2	0.6 B1
830221	8 9	38.27	34-20.38	81-20.17	1.78	0.21	10	131	3.8	0.06	0.2	0.9 B1
830221	810	25.13	34-20.79	81-20.09	1.34	-0.40	10	137	4.0	0.03	0.1	0.8 B1
830221	816	8.88	34-20.17	81-20.08	0.36	-0.40	10	130	3.6	0.07	0.3	1.1 B1
830221	817	32.37	34-20.29	81-20.07	1.72	-0.40	10	130	3.6	0.04	0.2	0.6 B1
830221	822	50.78	34-20.36	81-20.09	2.12	-0.86	6	274	3.7	0.01	0.1	0.2 C1
830221	1041	15.64	34-20.27	81-19.75	1.98	0.12	8	128	3.2	0.07	0.3	0.9 B1
830221	1043	46.28	34-20.38	81-19.94	1.00	-0.11	8	131	3.5	0.06	0.3	2.5 B1
830221	1059	39.89	34-19.52	81-19.74	3.45	-0.60	5	207	3.2	0.03	0.1	0.1 C1
830221	1219	5.61	34-20.32	81-18.91	3.39	0.87	10	126	1.9	0.04	0.2	0.3 B1
830225	1521	37.28	34-20.85	81-18.97	1.71	0.58	8	133	2.6	0.04	0.2	0.4 B1
830226	11 1	13.86	34-16.88	81-20.66	1.36	-0.86	9	174	7.2	0.05	0.2	3.1 C1
830227	1137	34.93	34-20.09	81-20.13	1.78	-0.85	10	131	3.7	0.01	0.0	0.2 B1
830227	1250	57.56	34-20.45	81-18.56	1.11	-1.22	8	245	1.6	0.07	0.9	0.8 C1
830227	2041	16.26	34-20.33	81-19.10	3.50	-0.60	8	136	2.2	0.08	0.4	0.7 B1
830228	1639	41.33	34-20.26	81-19.16	3.22	0.01	10	126	2.3	0.05	0.2	0.4 B1
830301	6 0	27.97	34-19.92	81-20.19	1.89	-0.60	8	133	3.1	0.08	0.4	3.8 B1
830302	1848	46.85	34-20.30	81-20.21	1.80	-0.86	10	130	3.9	0.06	0.3	1.0 B1
830302	2116	52.29	34-25.17	81-23.85	5.30	0.82	10	231	3.3	0.06	0.4	0.8 C1

830303	2135	1.42	34-20.30	81-20.17	1.81	0.12	9	130	3.8	0.03	0.1	0.5 B1
830311	833	31.35	34-19.85	81-20.00	3.90	0.12	6	152	3.8	0.04	0.3	1.4 B1
830311	856	37.74	34-20.31	81-19.95	2.79	0.21	6	130	9.3	0.05	0.3	2.4 B1
830311	1118	33.41	34-20.46	81-19.38	5.98	0.78	8	130	2.7	0.05	0.3	0.4 B1
830312	054	0.09	34-19.92	81-19.69	2.72	-0.60	7	131	3.0	0.05	0.2	0.5 B1
830312	144	32.96	34-20.76	81-18.19	1.71	-0.86	5	243	1.7	0.04	1.2	0.7 C1
830312	437	38.49	34-20.40	81-18.80	1.77	-0.40	6	247	1.9	0.05	1.0	0.6 C1
830312	755	32.47	34-20.56	81-19.45	1.96	-0.24	8	131	2.9	0.05	0.2	0.6 B1
830312	1153	12.98	34-20.65	81-19.43	1.99	-0.86	6	254	9.2	0.06	1.9	7.2 D1
830312	14 7	36.33	34-20.47	81-20.62	1.77	0.73	7	134	4.5	0.04	0.3	1.8 B1
830313	1416	25.80	34-19.36	81-18.96	0.29	-0.40	7	247	2.1	0.04	0.4	0.5 C1
830313	1417	5.65	34-19.37	81-19.71	0.43	-0.40	7	253	3.2	0.03	0.3	0.7 C1
830314	1338	3.48	34-20.76	81-19.89	2.67	-0.60	7	136	3.7	0.03	0.1	0.4 B1
830315	736	58.86	34-17.44	81-18.25	4.14	-0.86	5	222	4.2	0.03	0.8	0.6 C1
830316	152	33.31	34-17.61	81-19.74	4.74	-0.24	8	158	5.2	0.03	0.2	0.4 B1
830323	2215	12.76	34-18.58	81-16.95	0.38	0.57	6	127	2.7	0.05	0.5	1.1 B1
830324	4 4	3.66	34-20.83	81-19.45	1.88	0.82	9	135	3.1	0.05	0.2	0.7 B1
830324	412	0.19	34-20.85	81-19.84	1.75	0.44	9	137	3.7	0.04	0.2	0.7 B1
830324	524	50.23	34-18.93	81-21.33	0.79	-0.86	5	266	5.8	0.07	1.0	2.5 C1
830325	1118	33.88	34-20.36	81-19.37	4.31	-0.86	9	128	2.6	0.03	0.1	0.2 B1
830326	17 3	2.84	34-20.46	81-19.40	2.54	-0.24	9	130	2.7	0.05	0.2	0.5 B1
830326	17 3	57.50	34-20.33	81-19.02	3.41	-0.40	7	127	2.1	0.04	0.2	0.3 B1
830327	610	16.99	34-20.48	81-19.85	2.05	-0.40	8	132	3.4	0.03	0.1	0.3 B1
830327	1616	33.51	34-19.93	81-13.61	5.75	-0.86	4	176	6.5	0.09		C1
830327	1616	59.68	34-20.80	81-19.54	1.97	-0.40	7	135	3.2	0.06	0.3	0.8 B1
830327	1617	14.89	34-19.06	81-20.42	4.48	-1.22	5	146	11.4	0.00	0.0	0.2 C1
830327	1618	31.61	34-20.87	81-19.39	1.59	-0.86	5	254	3.1	0.01	0.2	0.2 C1
830327	1848	29.66	34-20.33	81-16.82	0.92	-0.40	5	150	1.6	0.09	5.2	15.7 D1
830328	742	17.10	34-21.29	81-19.89	4.44	-0.60	7	144	4.2	0.04	0.2	0.4 B1
830330	1356	56.07	34-17.52	81-20.02	4.50	-0.86	6	161	5.6	0.03	0.2	0.5 B1

TECHNICAL REPORT 82-4

SEISMIC ACTIVITY NEAR THE V.C. SUMMER NUCLEAR STATION

For the Period October - December 1982

by

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