

TECHNICAL REPORT 87-4

SEISMIC ACTIVITY NEAR THE V.C. SUMMER NUCLEAR STATION

For the Period
October - December 1987

by

Pradeep Talwani
Principal Investigator
Department of Geological Sciences
University of South Carolina
Columbia, S.C. 29208

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PRADEEP TALWANI
PRINCIPAL INVESTIGATOR

STEVE ACREE
KEVIN SEVERANCE

DEPARTMENT OF GEOLOGICAL SCIENCES
UNIVERSITY OF SOUTH CAROLINA
COLUMBIA, S.C. 29208

CONTRACT NO. N449678

INTRODUCTION

Analysis of the seismic activity near the V.C. Summer Nuclear Station in South Carolina between October 1 and December 31, 1987 is presented in this report. During this period a total of twenty-four events were recorded, fourteen of which were located. The largest shock was of magnitude 1.0 (October 4 - 1830 UTC). Seventeen percent (4) of the earthquakes were of magnitudes greater than zero. Two shocks were of B quality and were located at depths of 0.3 and 0.4 km.

SEISMIC NETWORK

Earthquakes recorded during this period were located using stations of the SCE&G and USGS/USC networks. The configuration of the stations utilized to locate the events in this report is shown in Figure 1 and station coordinates are listed in Appendix I.

DATA ANALYSIS

Hypocentral locations of the events were determined using the computer program HYP071 (Lee and Lahr, 1972) and the velocity model listed in Appendix II. The event magnitude (M_L) was determined from the signal duration at station JSC, using the following relation:

$$M_L = -1.83 + 2.04 \log D$$

where D is the signal duration (seconds).

An estimate of daily energy release is determined using a

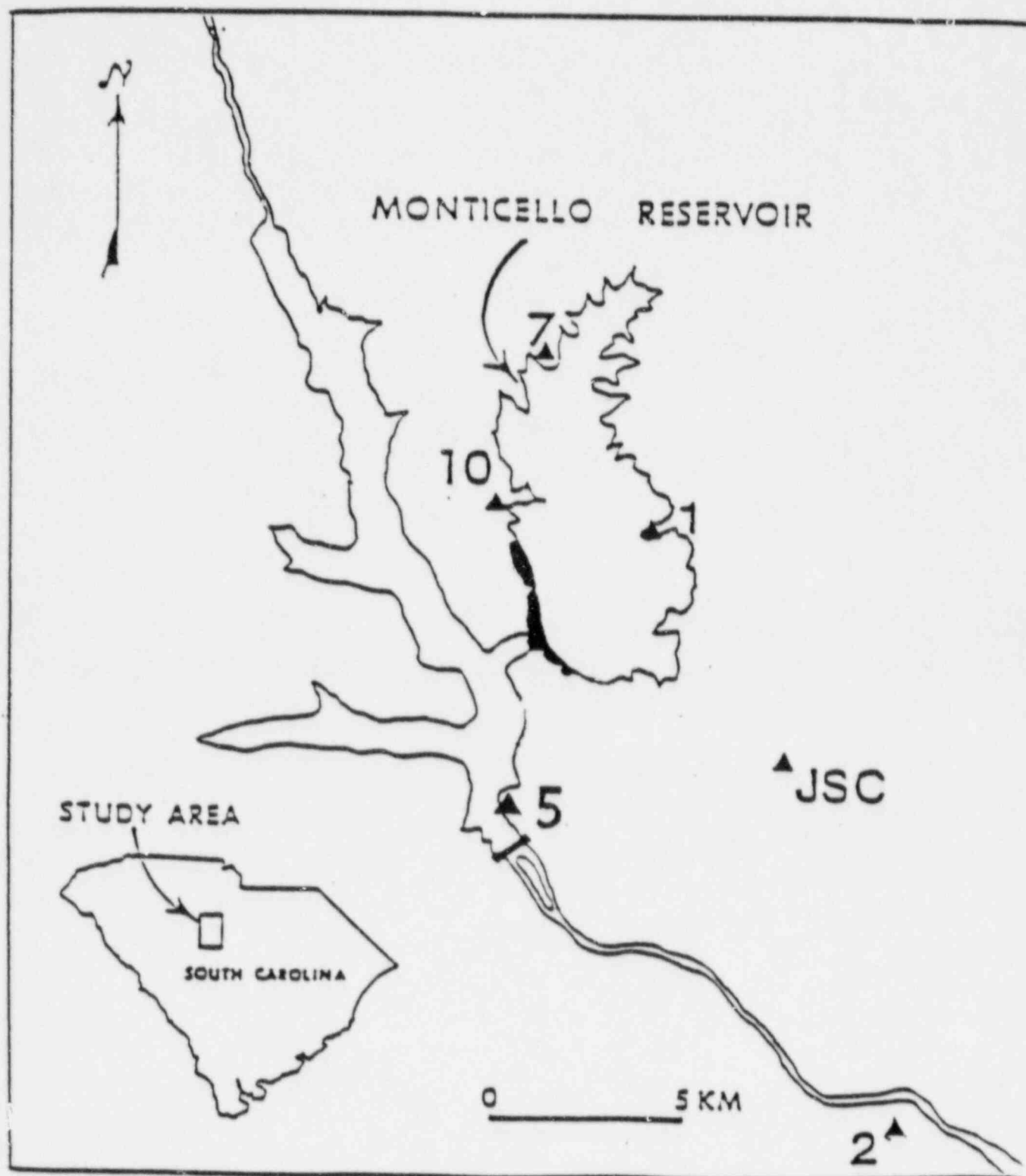


Figure 1. Location map of Monticello Reservoir area showing seismic stations used in locating activity during this period.

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

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

OBSERVED SEISMICITY FOR THE PERIOD OCTOBER-DECEMBER 1987

During this period twenty-four events were recorded and fourteen were located (see Appendix III). This level of activity was slightly greater than that observed during the previous reporting period, but the overall decline in seismicity is continuing as shown in Figure 2. The largest event of this quarter ($M_L=1.0$) occurred on October 4 at 1830 UTC. Four shocks (17%) were of magnitudes greater than zero.

The epicenters of earthquakes located during this quarter and during each month are presented in Figure 3 and Figures 4, 5, and 6, respectively. Most epicenters are located on the western shore of the reservoir. Only two earthquake locations were of quality B or better. These events were located at depths of 0.3 km and 0.4 km, respectively.

CORRELATION OF RESERVOIR WATER LEVEL 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 normal variations up to approximately five feet per day between the maximum and minimum water level. We have been monitoring the water level to see if there is any correlation

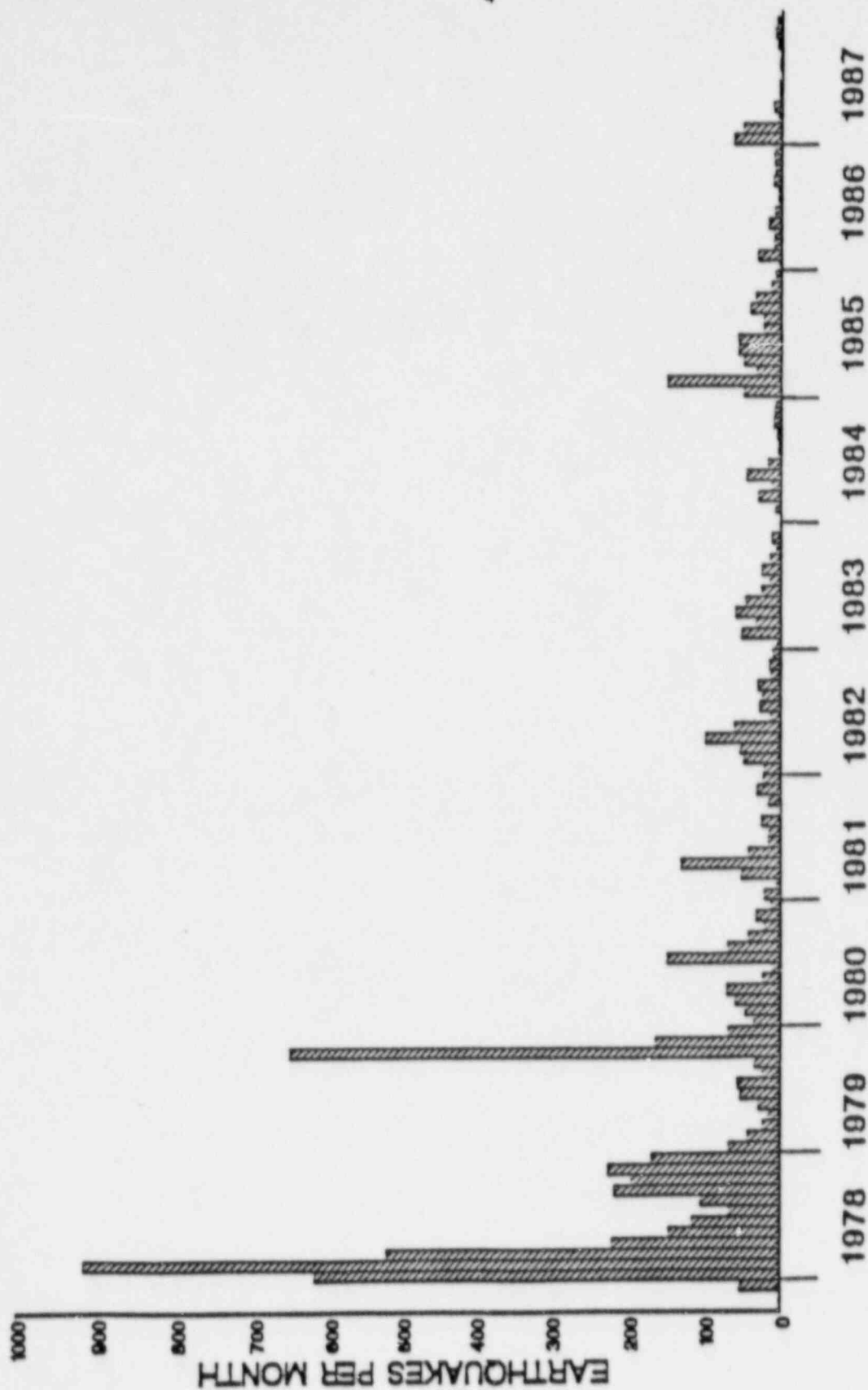


Figure 2. Earthquakes per month between Impoundment and December 1987.

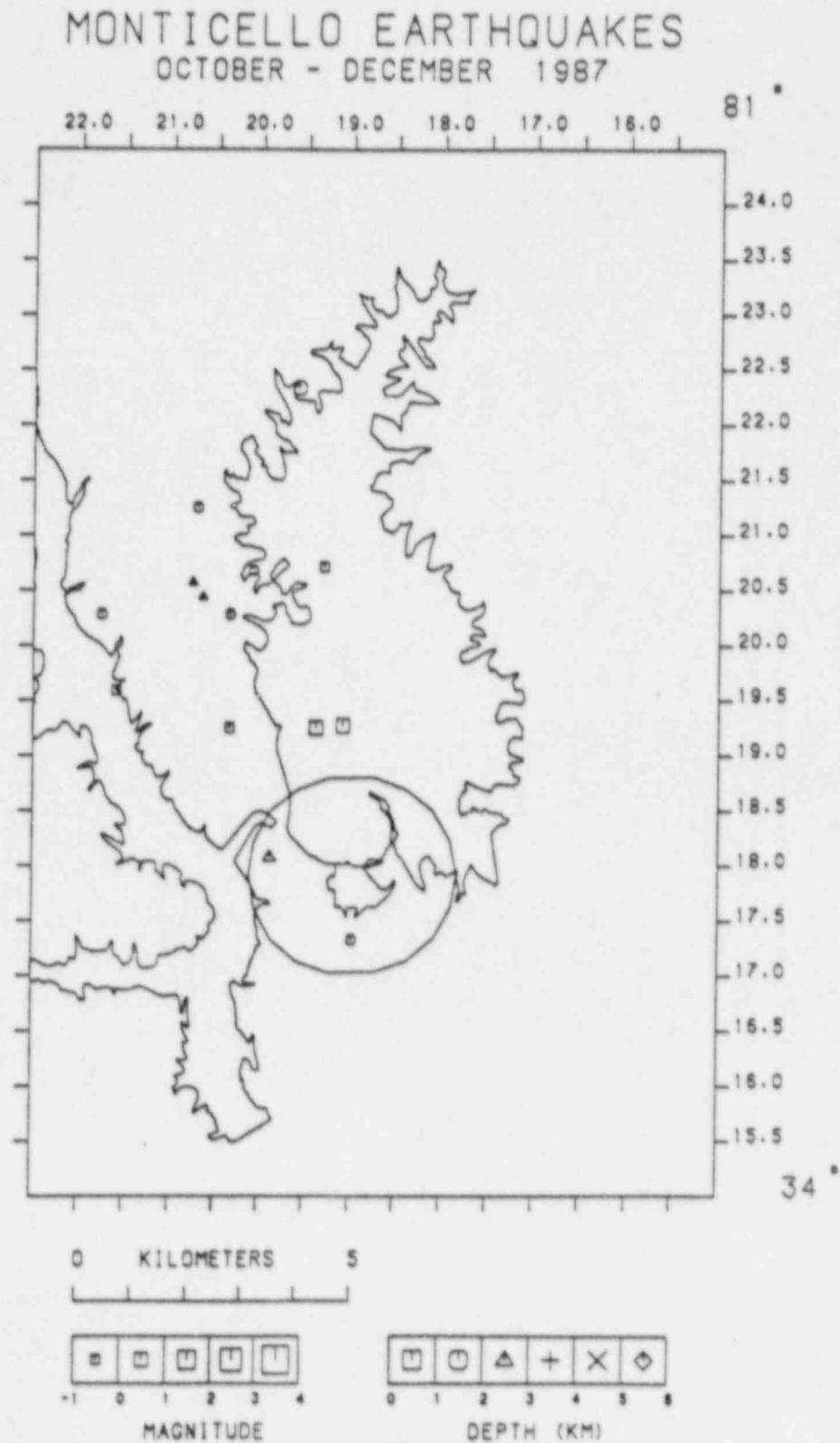


Figure 3. Seismic activity at Monticello Reservoir during October-December 1987.

MONTICELLO EARTHQUAKES OCTOBER 1987

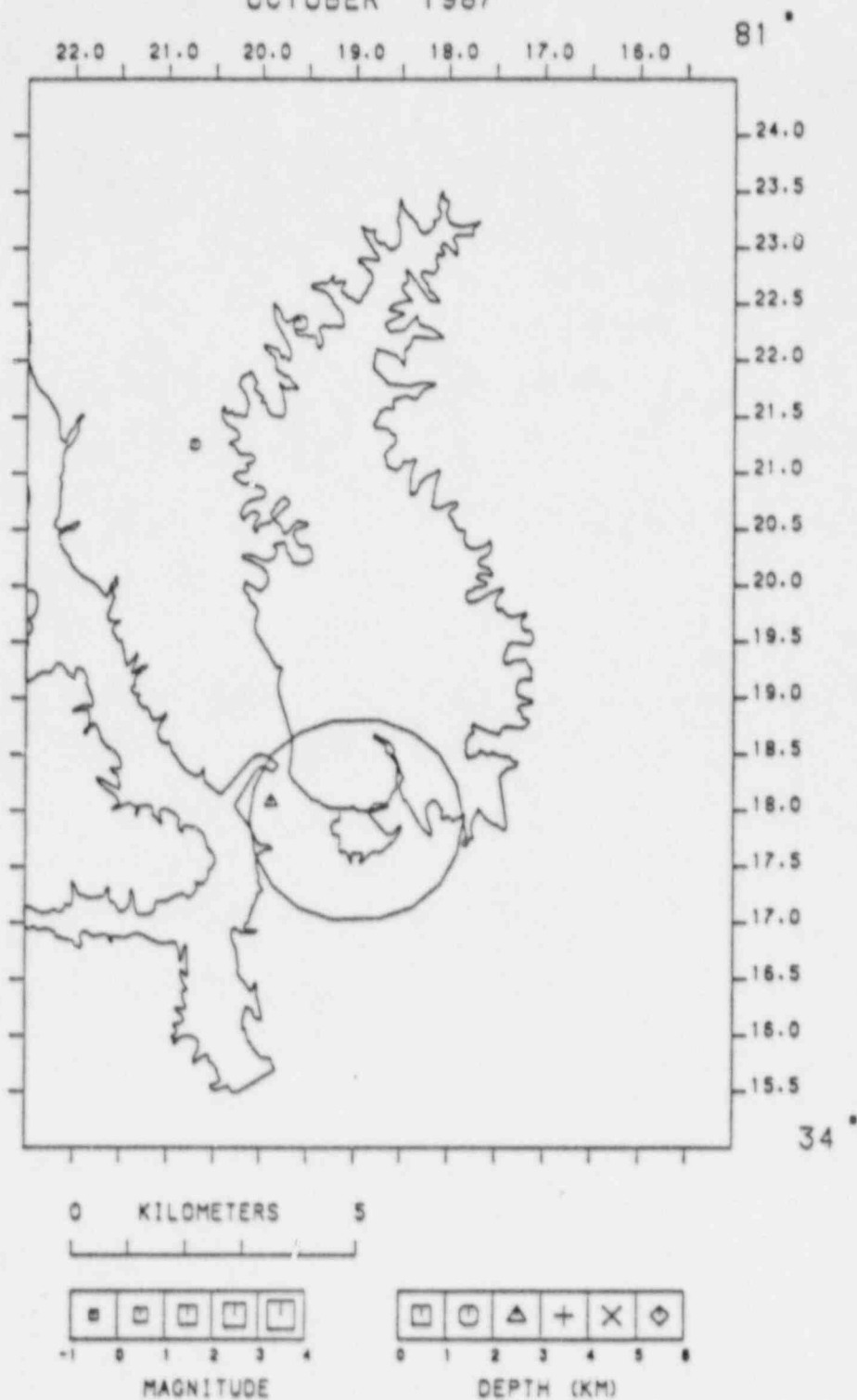


Figure 4. Seismic activity at Monticello Reservoir during October 1987.

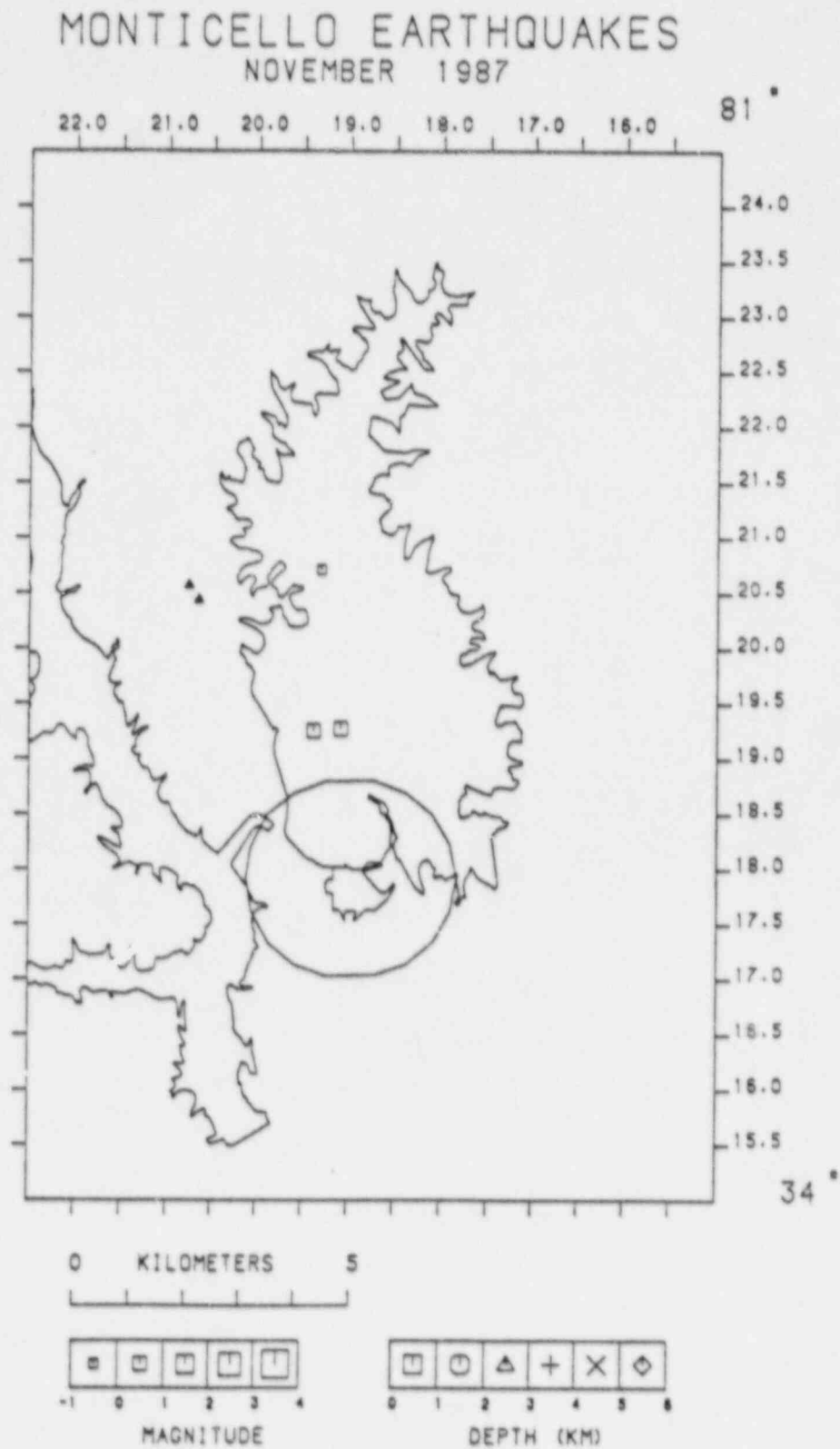


Figure 5. Seismic activity at Monticello Reservoir during November 1987.

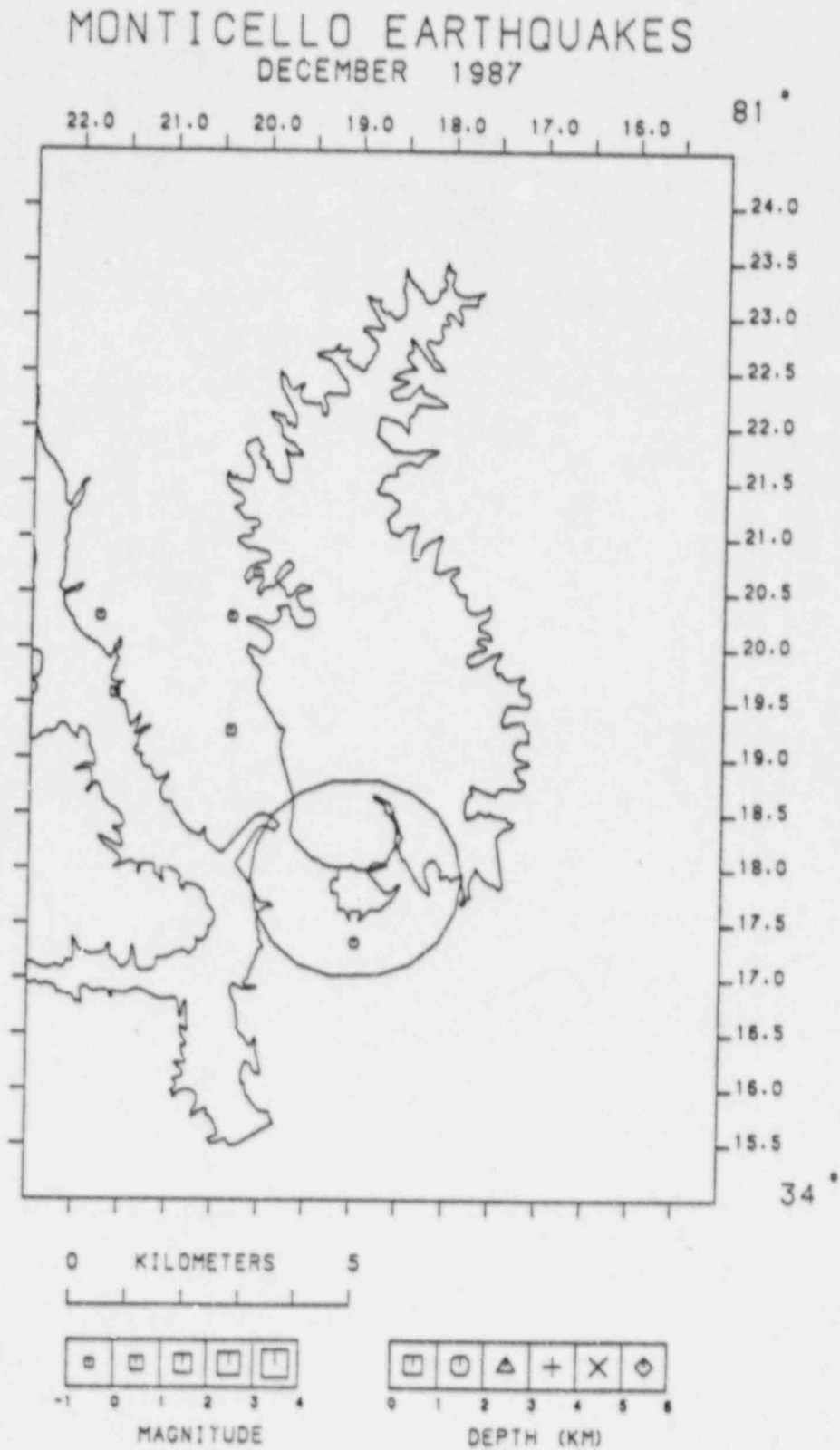


Figure 6. Seismic activity at Monticello Reservoir during December 1987.

between the daily or seasonal changes in the reservoir level and the local seismicity. Water level was compared with seismicity in Figure 7. The top two plots show the median water level and the change in water level each day. The number of events per day and the log of the energy released per day are shown in the lower two histograms which reveal four small earthquake swarms. These charts include both located and unlocated events around the reservoir. There is a possible correlation between the drop in median water level and higher daily fluctuation on November 1 - 6 (days 87.305 - 87.310) and seismicity.

CONCLUSIONS

The level of activity observed during the fourth quarter of 1987 was not significantly higher than that observed during the third quarter. No event was of a magnitude greater than 1.0. Four of the twenty-four earthquakes were of magnitudes greater than 0.0. Depths of both quality B earthquake locations were less than 0.5 km.

SUMMARY OF 1987 SEISMICITY

Seismic activity during 1987 (177 events) was not significantly greater than that recorded during 1986 (144 events) (Figure 2). The number of events per day recorded during 1987 is shown in Figure 8. The majority of the activity occurred during the first quarter of the year. A total of 177 earthquakes were recorded, 147 of which were located (83%). The majority of the

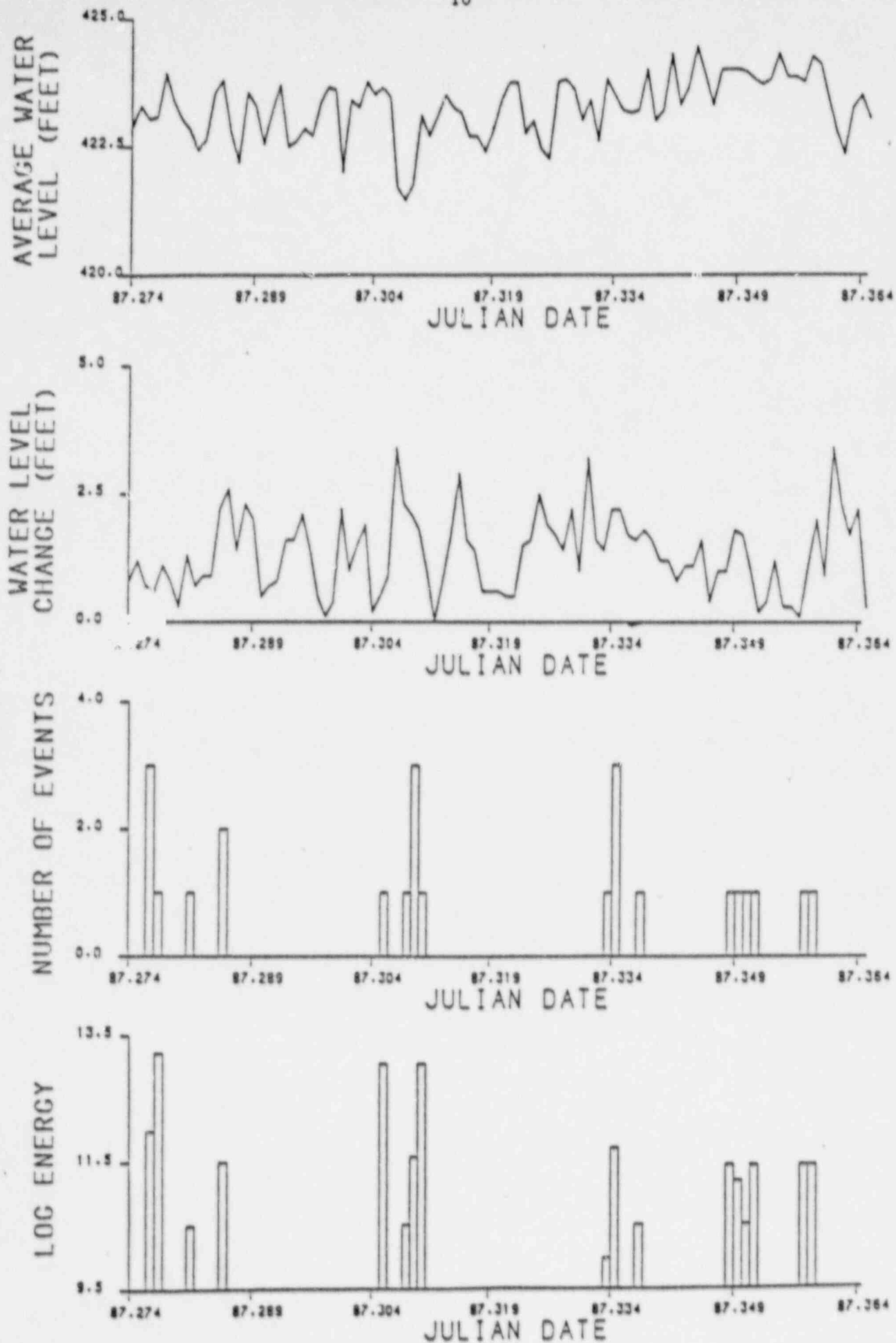


Figure 7. Comparison of the median daily lake level and daily change in water level with the number of earthquakes per day and the log of the energy released.

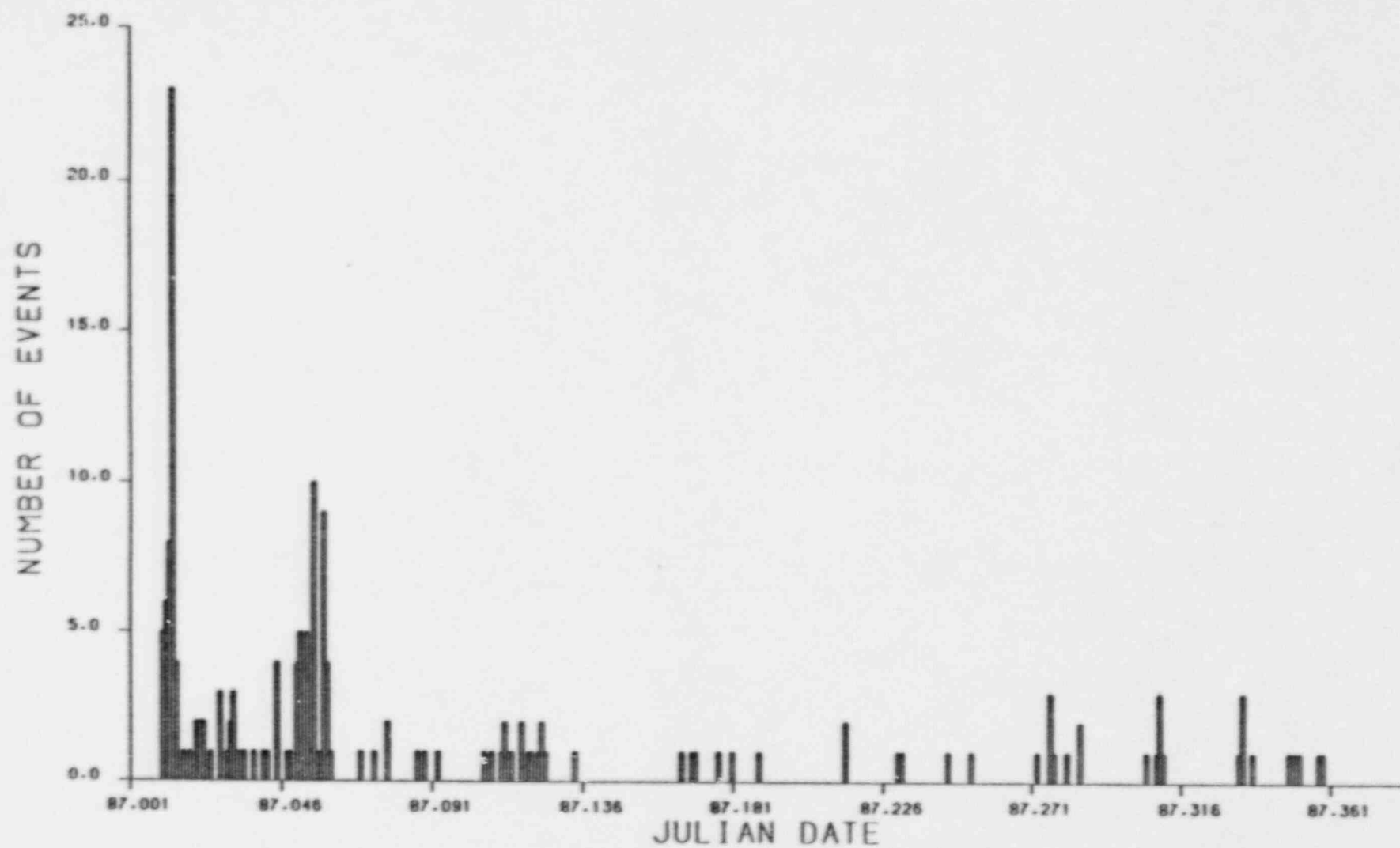


Figure 8. Earthquakes per day during 1987.

earthquakes were concentrated beneath the center of the reservoir (Figure 9). Thirty-seven percent (65) of the located events were of B quality. Depths calculated for the B quality events all were within 3.5 km of the surface. The majority of the B quality earthquakes were located at depths between 1.5 and 2.0 km (Figure 10).

The largest earthquake of the year was of magnitude $M_L = 1.9$ (January 13 - 0545 UTC). Only four events were of magnitudes greater than or equal to 1.0.

In summary, seismicity at Monticello Reservoir was of low magnitude during 1987. With the exception of earthquake swarms in January and February, the activity rate was low throughout the year.

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. Geological Survey, Open-File Report, 100 pp.

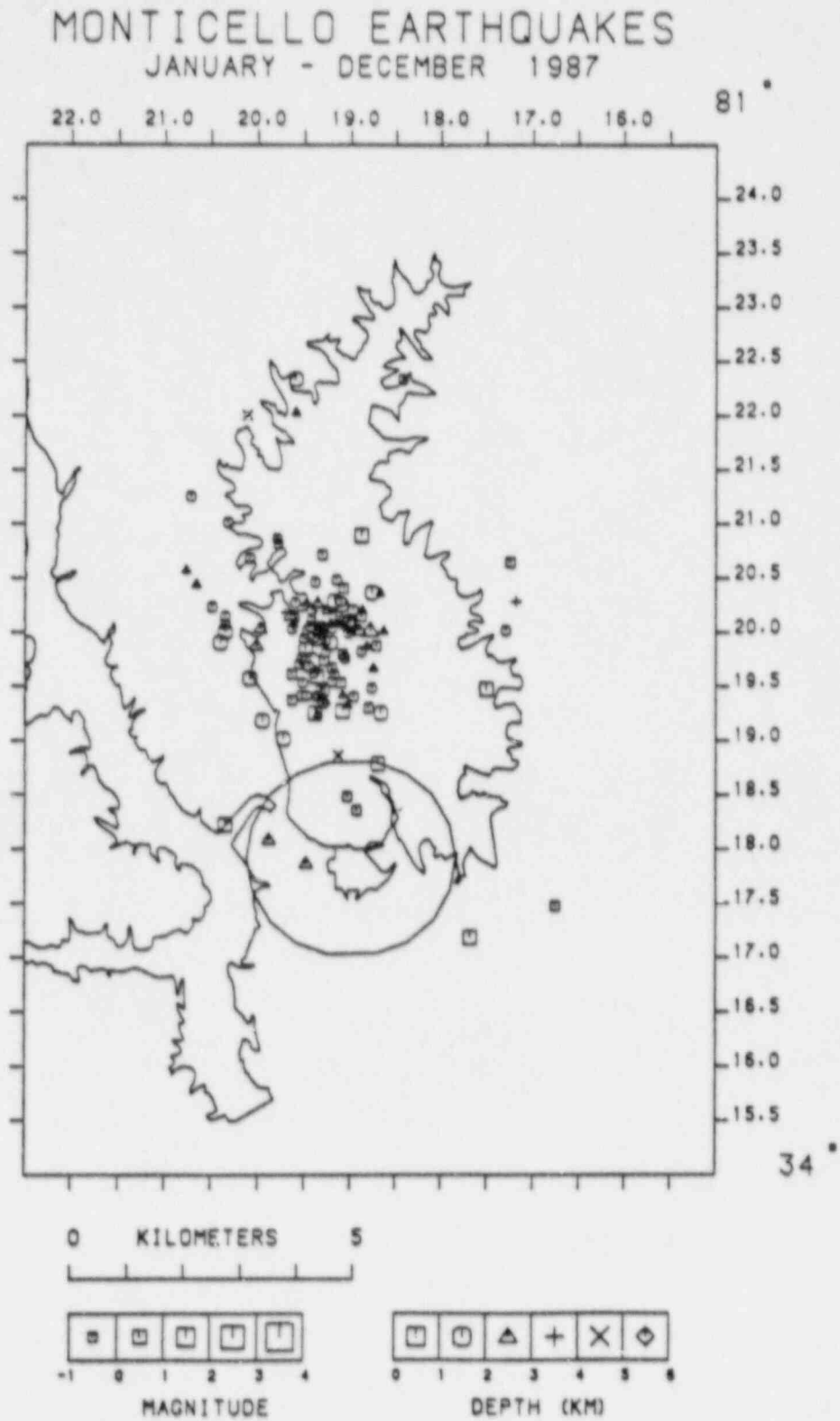
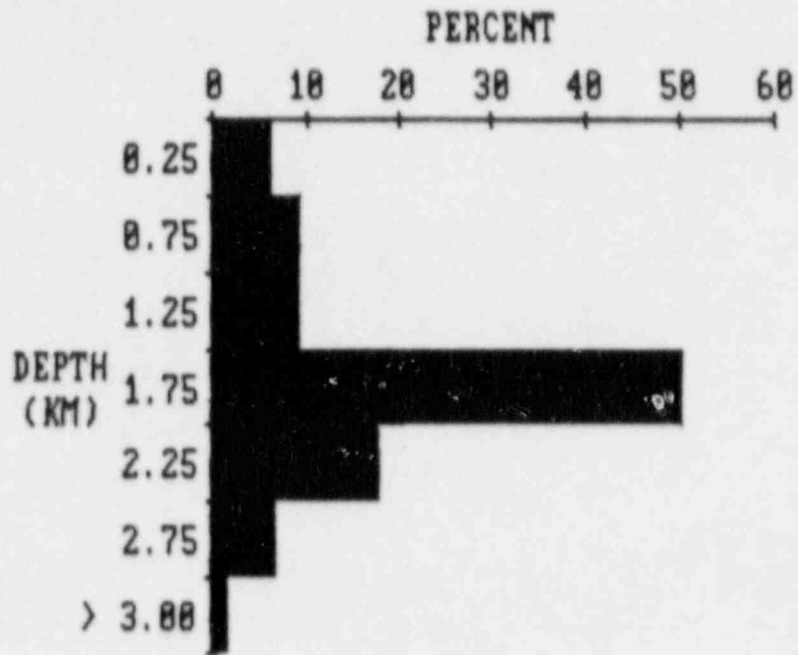


Figure 9. Seismic activity at Monticello Reservoir during 1987.



JANUARY - DECEMBER 1987

N = 65

Figure 10. Depth distribution of B quality events at Monticello Reservoir during 1987.

APPENDIX I

STATION LOCATIONS

NO.	STN.	LAT.°N	LONG.°W
1	JSC	34° 16.80'	81° 15.60'
2	001	34° 19.91'	81° 17.74'
3	002	34° 11.58'	81° 13.81'
4	005	34° 16.05'	81° 20.05'
5	007	34° 22.23'	81° 19.50'
7	010	34° 20.18'	81° 20.25'

APPENDIX II

MONTICELLO RESERVOIR

VELOCITY MODEL

Velocity km/sec	Depth to top 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

MONTICELLO EARTHQUAKES
OCTOBER-DECEMBER 1987

HYPO71 FORMAT

Column 1	Date.
Column 2	Origin time (UTC) h.m.sec.
Column 3	Latitude (N) degrees, min.
Column 4	Longitude (W) degrees, min.
Column 5	Depth (km).
Column 6	Local duration magnitude.
Column 7	No. of station readings used to locate event. P and S arrivals from same stations are regarded as 2 readings.
Column 8	Largest azimuthal separation in degrees between stations.
Column 9	Epicentral distance in km to nearest station.
Column 10	Root mean square error of time residuals in sec. $RMS = R_i^2 / NO$, where R_i is the time residual for the i th station.
Column 11	Standard error of the epicenter in km*.
Column 12	Standard error of the focal depth in km*.

*Statistical interpretation of standard errors involves assumptions which may not be met in earthquake locations. Therefore standard errors may not represent actual error limits.

If ERH or ERZ is blank, this means that it cannot be computed, because of insufficient data.

MONTICELLO EARTHQUAKES
OCTOBER-DECEMBER 1987

DATE	ORIGIN	LAT N	LONG W	DEPTH	MAG	NO	GAP	DMIN	RMS	ERH	ERZ	QM
871003	1138	31.69	34-22.33	81-19.60	1.00	0.01	4 307	0.2	0.06			C1
871004	1830	18.85	34-18.08	81-19.89	2.03	0.95	10 210	3.9	0.06	0.5	1.3	C1
871008	853	24.20	34-21.25	81-20.72	1.02	-0.86	7 246	2.1	0.05	0.4	0.8	C1
871101	1621	55.99	34-19.27	81-19.09	0.41	0.82	10 163	2.4	0.06	0.2	0.5	B1
871104	1123	54.22	34-20.71	81-19.31	0.40	-0.86	5 246	1.7	0.03	0.0	0.0	C1
871105	14 1	1.73	34-20.44	81-20.66	2.10	-0.60	5 257	0.8	0.02	0.5	0.4	C1
871105	14 6	52.81	34-20.57	81-20.77	2.14	-0.24	8 245	1.1	0.09	0.8	0.6	C1
871106	11 1	53.35	34-19.25	81-19.39	0.33	0.82	10 173	2.2	0.06	0.3	0.6	B1
871203	9 8	23.96	34-20.68	81-20.09	1.73	-0.86	7 183	1.0	0.02	0.1	0.2	C1
871214	2346	42.23	34-19.25	81-20.35	0.80	-0.24	5 243	1.7	0.08	2.0	3.2	C1
871216	051	38.68	34-20.28	81-20.35	1.00	-0.86	4 315	0.2	0.09			C1
871217	035	33.07	34-17.33	81-18.98	1.89	-0.24	5 125	2.9	0.07	1.0	3.6	C1
871223	047	49.49	34-19.59	81-21.60	0.14	-0.24	5 274	2.3	0.08	1.6	4.1	C1
871224	1345	47.47	34-20.28	81-21.76	1.81	-0.24	6 280	2.3	0.06	0.8	0.8	C1