SEISMIC ACTIVITY NEAR THE
V.C. SUMMER NUCLEAR STATION

FOR THE PERIOD

JULY - SEPTEMBER 1992

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INTRODUCTION

Analysis of the seismic activity near the V.C. Summer Nuclear Station in South Carolina between July 1 and September 30, 1992 is presented in this report. During this period, 9 events were recorded in the vicinity of Monticello Reservoir, 2 of which were located. The largest magnitude recorded during this period was M_L=1.0. This earthquake was located outside the reservoir.

SEISMIC NETWORK

Earthquakes during this period were recorded on stations of Monticello Reservoir and South Carolina Seismic Network. The configuration of stations utilized to locate Monticello events is shown in Figure 1 and station coordinates listed in Appendix I. The operational status of the network is given in Appendix II.

DATA ANALYSIS

Hypocentral locations have been determined using the computer program HYPO71 (Lee and Lahr, 1972). The velocity model used in the earthquake locations is given in Appendix III. The format of the output is given in Appendix IV. The event magnitude was determined from the signal duration at 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 was determined using a simplified magnitude (M_L) . energy (E) relation by Gutenberg and Richter (1956):

$$\text{Log}_{10} E = 11.8 + 1.5 M_L$$

OBSERVED SEISMICITY DURING JULY-SEPTEMBER, 1992

Seismicity around Monticello Reservoir was generally low during this period. There was one event in August, and eight in September. Of these 9 events, 2 were located (Figure 2). The located events were of poor quality (C or D). The largest event in the quarter occurred on August 25 (17:04:57.66 UTC) and it had a magnitude M_L = 1.0. This event occurred to the northwest of the lake and was not well located. However, it is included in the analysis due to the uncertainty in location. The other located event of M_L = 0.8 (September 8, 1992) occurred to the east of the reservoir. The remaining seven unlocated events were of small magnitude (M_L = -0.4).

The long term decline in seismicity observed at Monticello Reservoir is continuing (Figure 3). The cumulative seismicity at Monticello Reservoir shows a relative flattening since 1985-86 (Figure 4).

CORRELATION OF WATER LEVEL WITH SEISMICITY

Monticello Reservoir is a pumped storage facility. Any decrease in the reservoir level associated with power generation is recovered when water is pumped back into the reservoir. There can be normal variations up to five feet per day between maximum and minimum water levels. The water level has been monitored to see if there is any correlation between the daily or seasonal changes in the reservoir level and the local seismicity. Water levels are compared with seismicity in Figure 5. The top panel shows the average water level; the error bars show the maximum and minimum water levels each day. The second panel shows the change in water level from day to day. The number of events per day and the log of energy released are shown in the lower histograms. These charts include all reported earthquakes listed in Appendices V and VI. The average water level, daily changes in water level, number of earthquakes and energy release are given in Appendix VII. No systematic correlation was observed between the seismicity and reservoir level fluctuations.

CONCLUSIONS

The level of seismicity during the third quarter was slightly lower, as compared to the previous quarter. The largest recorded magnitude was $M_L=1.0$. Both of the located events lie outside of the reservoir. No systematic correlation was observed between the reservoir level fluctuations and the seismicity.

REFERENCES

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

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

Monticello Reservoir Seismic Network
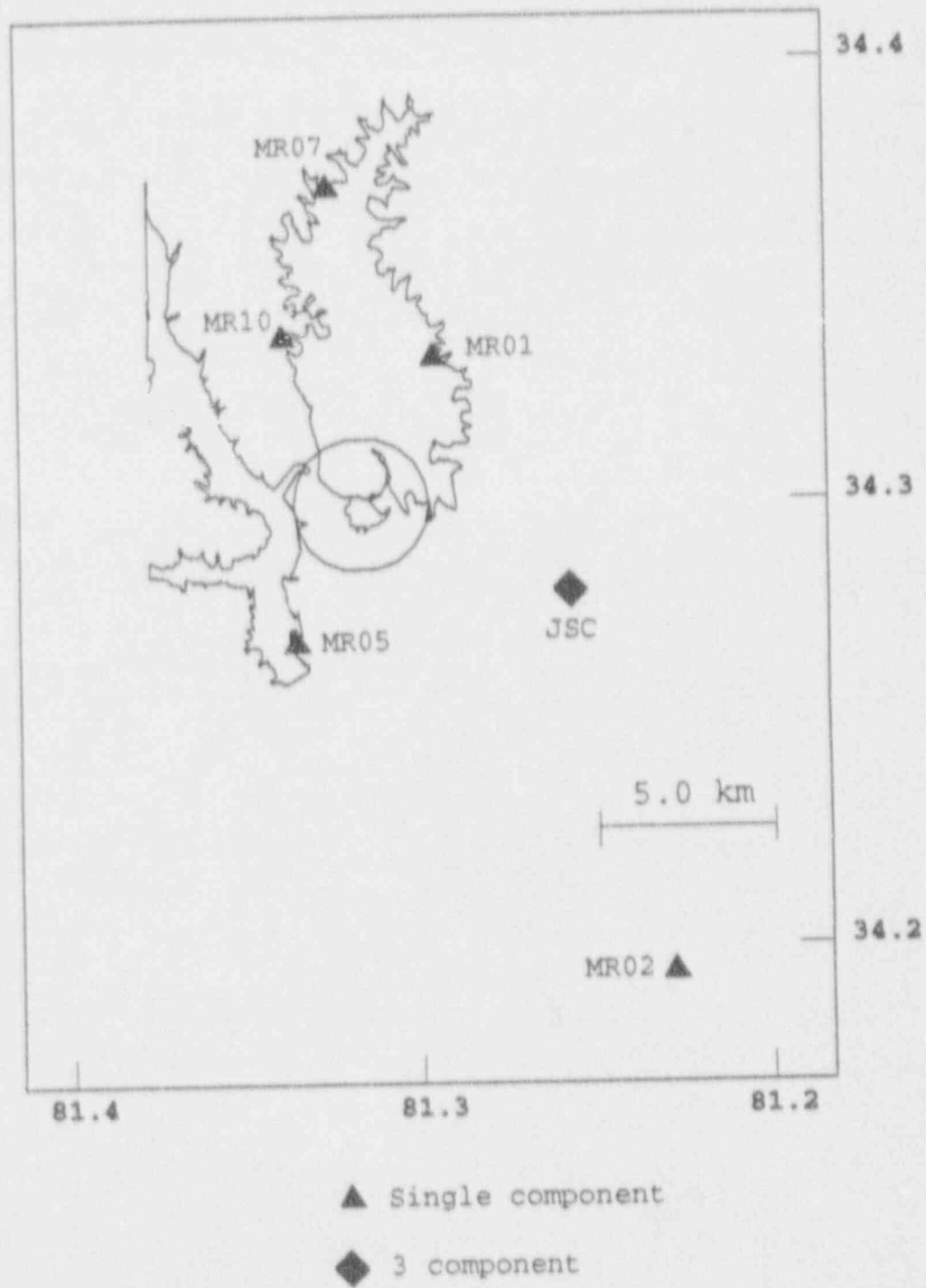

Figure 1   Location of Monticello Reservoir area showing seismic stations used in locating seismicity.
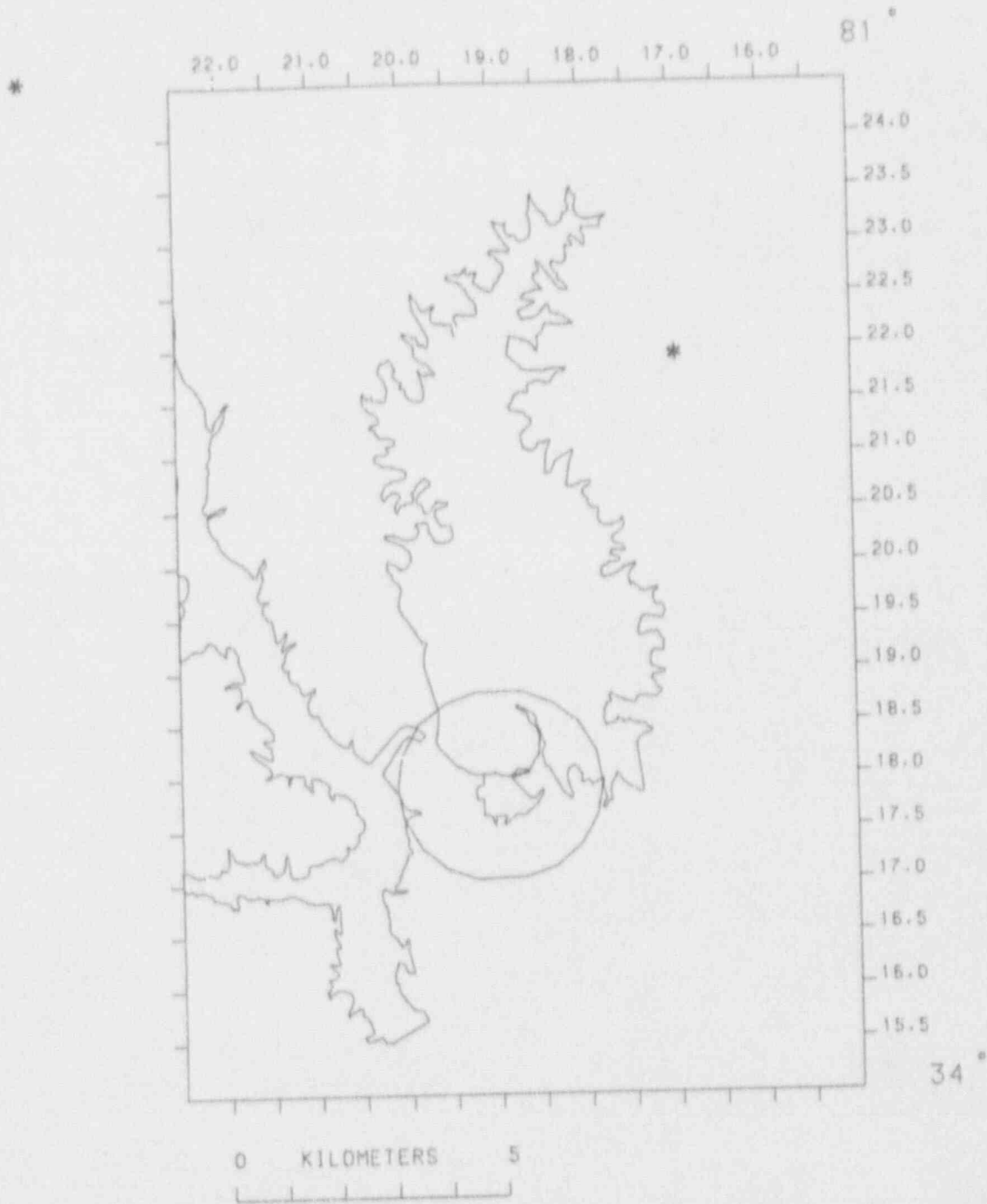
Figure 2.   Earthquakes located near Monticello Reservoir during the period July-
September, 1992

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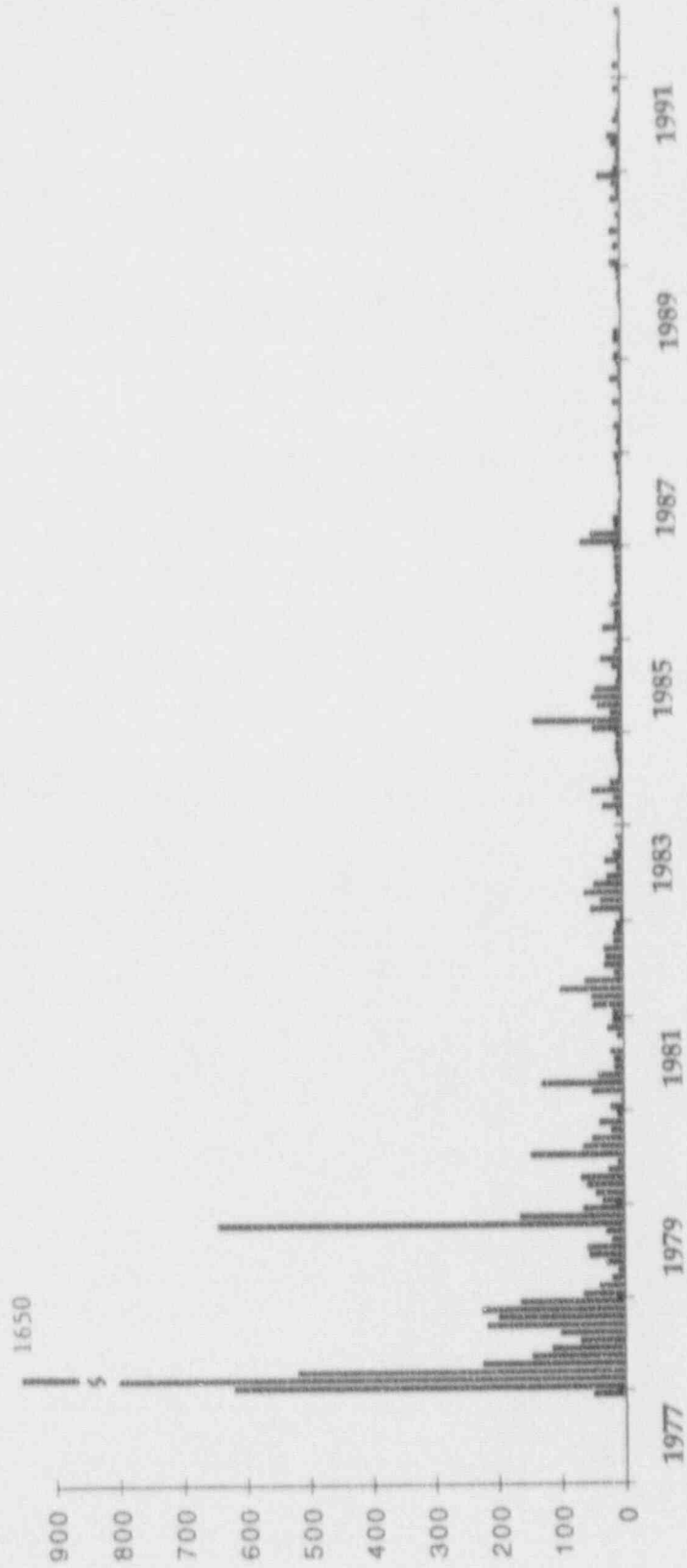
Figure 3.   Earthquake between impoundment and September 1992.
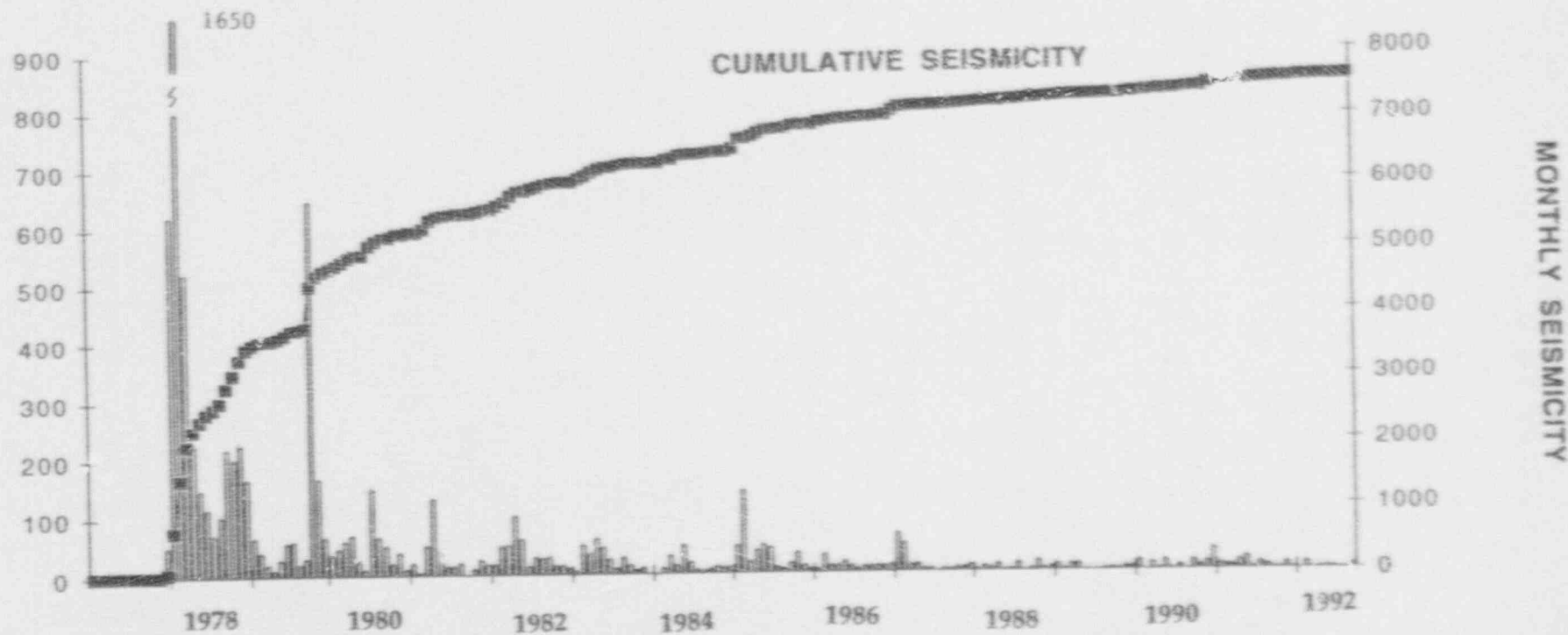
Figure 4.   Monthly   seismicity (bars) and cumulative seismicity (line) near
Monticello Reservoir since impoundment.
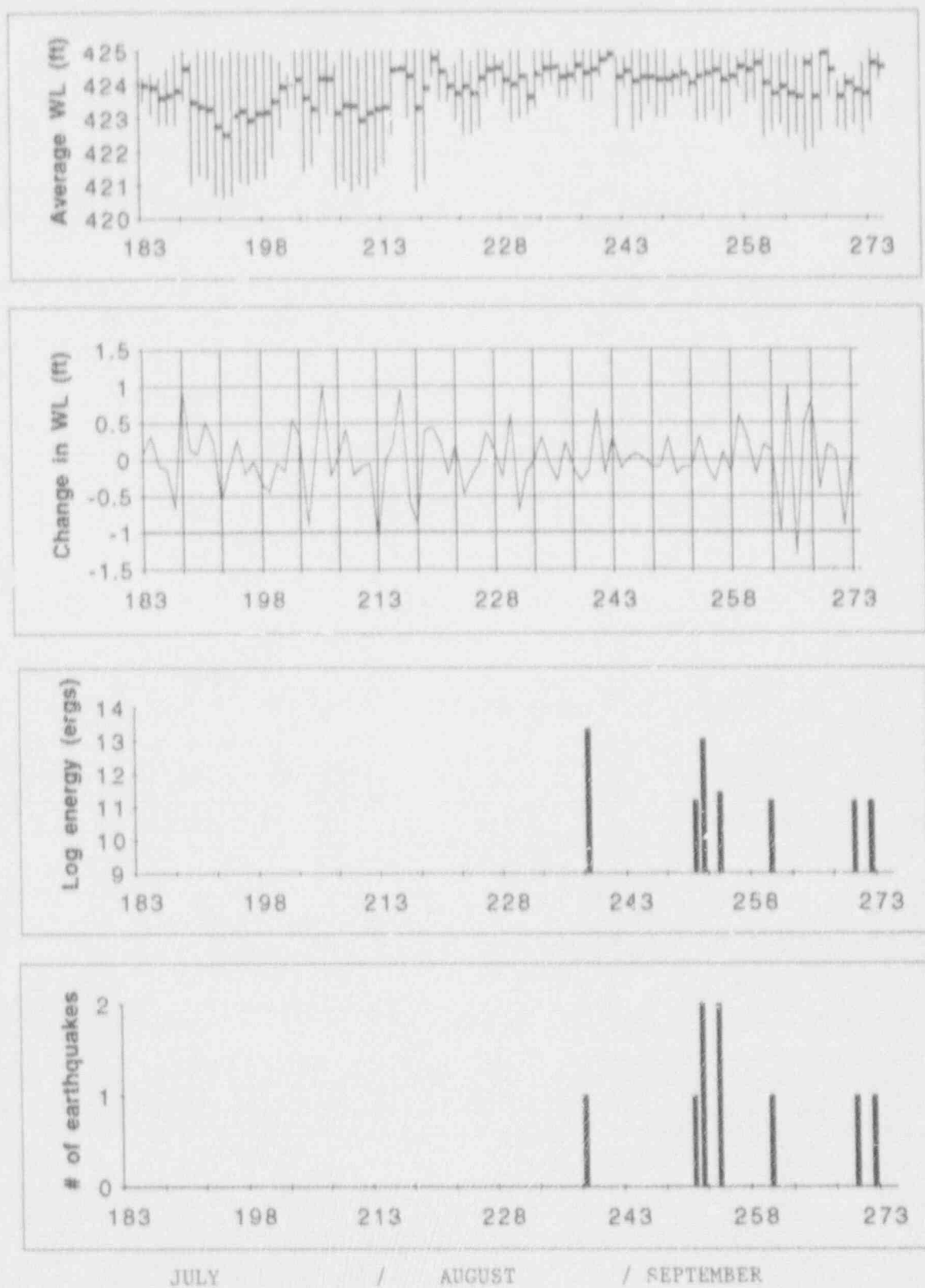
Figure 5.   Comparison of daily lake levels, changes in lake level, number of earthquakes and the log of energy release (ergs per day) at Monticello Reservoir. Error bars in the top panel indicate daily fluctuations in water level

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APPENDIX I

STATION LOCATIONS

STATION	LAT° N	LONG °W
JSC	34°16.80′	81°15.60′
001	34°19.91′	81°17.74′
002	34°11.58′	81°13.81′
005	34°16.05′	81°20.05′
007	34°22.23′	81°19.50′
010	34°20.18′	81°20.25′

APPENDIX II

SEISMIC STATION OPERATIONAL STATUS

JULY 01-SEPTEMBER 30, 1992

STATION	PERCENT DOWNTIME
MR01	10
MR02	4
MR05	24
MR07	5
MR10	6
JSC	0

APPENDIX III

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

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APPENDIX IV

MONTICELLO EARTHQUAKES

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 ith station.
Column	11	Standard error of the epicenter in km*.
Column	12	Standard error of the focal depth in km*.
Column	13	Quality of the epicentral location.

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

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

Appendix V

MONTICELLO RESERVOIR EARTHQUAKES

JULY - SEPTEMBER 1992

DATE	ORIGIN	LAT N	LONG W	DEPTH	MAG	NO	GAP	DMIN	RMS	ERH	ERZ	QM
920825	17 4 57.66	34-24.50	81-24.40	0.69	1.02	7	333	8.6	0.23		5.4	D1
920908	1755 43.74	34-21.98	81-16.80	2.00	0.82	6	253	4.2	0.08	1.2	3.6	C1

APPENDIX VI

Events with S-P ≤ 2.5 s recorded around Monticello
Reservoir during July - September, 1992

SL.NO	DATE	STATION	P-Arrival Hr min sec	S-P SEC	Ep.Dist(km) (S-P)X6.5	DUR SEC	MAG
1	92 09 07	MR07	16:04 17.20	0.1	0.85	5	-0.4
2	92 09 08	MR07	07:48 48.70	0.2	1.7	5	-0.4
3	92 09 10	MR07	14:45 20.90	0.1	0.85	5	-0.4
4	92 09 10	MR07	15:46 27.70	0.1	0.85	5	-0.4
5	92 09 16	JSC	15:38 53.10	0.1	0.85	5	-0.4
6	92 09 26	MR07	04:46 36.60	0.1	0.85	5	-0.4
7	92 09 28	JSC	22:46 07.90	0.1	0.85	5	-0.4

Appendix VII

Maximum and minimum water levels, change in water level, number of
earthquakes and log of energy release per day at Monticello Reservoir
during July 1-September 30,1992. Dates are given in Julian Calender.

DATE	WL (max)	WL (min)	Average	Change	# eqs	Energy
183	424.2	423.5	424.0	0.068	0	0
184	424.3	423.1	423.9	0.316	0	0
185	424.2	422.8	423.6	-0.08	0	0
186	424.5	422.8	423.7	-0.136	0	0
187	424.9	422.8	423.8	-0.674	0	0
188	425	423.5	424.5	0.998	0	0
189	424.7	421	423.5	0.136	0	0
190	425	421.3	423.3	0.076	0	0
191	425	421.2	423.3	0.504	0	0
192	425	420.7	422.8	0.256	0	0
193	424.8	420.6	422.5	-0.576	0	0
194	425	420.7	423.1	-0.12	0	0
195	425	421.1	423.2	0.276	0	0
196	424.9	421	422.9	-0.204	0	0
197	424.9	421.2	423.1	-0.032	0	0
198	425	421.2	423.2	-0.324	0	0
199	424.9	421.8	423.5	-0.437	0	0
200	424.7	422.7	423.9	-0.051	0	0
201	424.3	423.3	424.0	-0.16	0	0
202	425	423.3	424.1	0.544	0	0
203	425	421.4	423.6	0.32	0	0
204	425	421.6	423.3	-0.896	0	0
205	425	422.5	424.2	0.028	0	0
206	425	423.1	424.1	1.004	0	0
207	424.6	420.9	423.1	-0.228	0	0
208	425	421.1	423.4	0.024	0	0
209	425	420.8	423.3	0.404	0	0
210	424.8	421	422.9	-0.212	0	0
211	425	420.9	423.1	-0.104	0	0
212	425	421.3	423.2	-0.048	0	0
213	425	421.6	423.3	-1.12	0	0
214	425	422.5	424.4	-0.038	0	0
215	424.5	424.4	424.5	0.222	0	0
216	425	423	424.2	0.952	0	0
217	425	420.8	423.3	-0.588	0	0
218	425	421.1	423.9	-0.892	0	0
219	425	424.2	424.8	0.384	0	0
220	425	423.5	424.4	0.44	0	0
221	424.4	423.5	423.9	0.224	0	0
222	424.6	422.9	423.7	-0.2	0	0
223	425	422.5	423.9	0.204	0	0
224	424.7	422.5	423.7	-0.468	0	0
225	425	422.7	424.2	-0.24	0	0
226	425	423.6	424.4	-0.056	0	0
227	424.9	423.9	424.5	0.38	0	0
228	424.7	423.3	424.1	0.112	0	0
229	425	422.9	424.0	-0.24	0	0

230	425	423	424.2	0.62	0	0
231	424.3	423.1	423.6	-0.7	0	0
232	425	423.3	424.3	-0.172	0	0
233	425	423.9	424.5	-0.032	0	0
234	425	424	424.5	0.304	0	0
235	424.6	423.6	424.2	-0.056	0	0
236	424.6	423.6	424.3	-0.292	0	0
237	425	424	424.5	0.236	0	0
238	425	423.5	424.3	-0.104	1	13.33
239	425	423.5	424.4	-0.3	0	0
240	425	424.2	424.7	-0.158	0	0
241	425	424.7	424.9	0.682	0	0
242	424.8	422.7	424.2	-0.184	0	0
243	424.8	423.9	424.4	0.304	0	0
244	425	422.6	424.1	-0.12	0	0
245	425	422.9	424.2	0.008	0	0
246	424.9	423.4	424.2	0.08	0	0
247	425	423	424.1	0	0	0
248	425	423	424.1	-0.1	0	0
249	424.4	423.6	424.2	-0.1	0	0
250	424.8	423.6	424.3	0.3	0	0
251	424.3	423.6	424	-0.2	1	11.19
252	425	422.9	424.2	-0.1	2	13.04
253	425	422.9	424.3	-0.1	0	0
254	425	423.2	424.4	0.3	2	11.44
255	424.9	422.8	424.1	-0.1	0	0
256	424.9	423	424.2	-0.3	0	0
257	424.8	423.9	424.5	0.1	0	0
258	425	423.4	424.4	-0.2	0	0
259	425	423.5	424.6	0.6	0	0
260	425	422.4	424	0.3	1	11.19
261	424.9	422.6	423.7	-0.2	0	0
262	424.9	422.8	423.9	0.2	0	0
263	425	422.4	423.7	0.1	0	0
264	424.8	422.5	423.6	-1	0	0
265	424.8	422	424.6	1	0	0
266	424.9	422.1	423.6	-1.3	0	0
267	424.6	422.6	424.9	0.5	0	0
268	425	423.6	421.4	0.8	0	0
269	424.1	422.7	423.6	-0.4	0	0
270	424.3	422.6	424	0.2	1	11.19
271	424.2	422.8	423.8	0.1	0	0
272	424.6	422.5	423.7	-0.9	1	11.19
273	425	422.9	424.6	0.1	0	0
274	424.9	424.1	424.5		0	0