A Report on the Seismic Activity at Lake Jocassee Between December 1, 1977 and February 28, 1978

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INTRODUCTION

During the reporting period seismicity was monitored at Lake Jocassee. Low level (averaging about one event per day), low magnitude ($M_L \leq 2.0$), shallow ($Z \leq 4.0$km) activity was recorded in the vicinity.

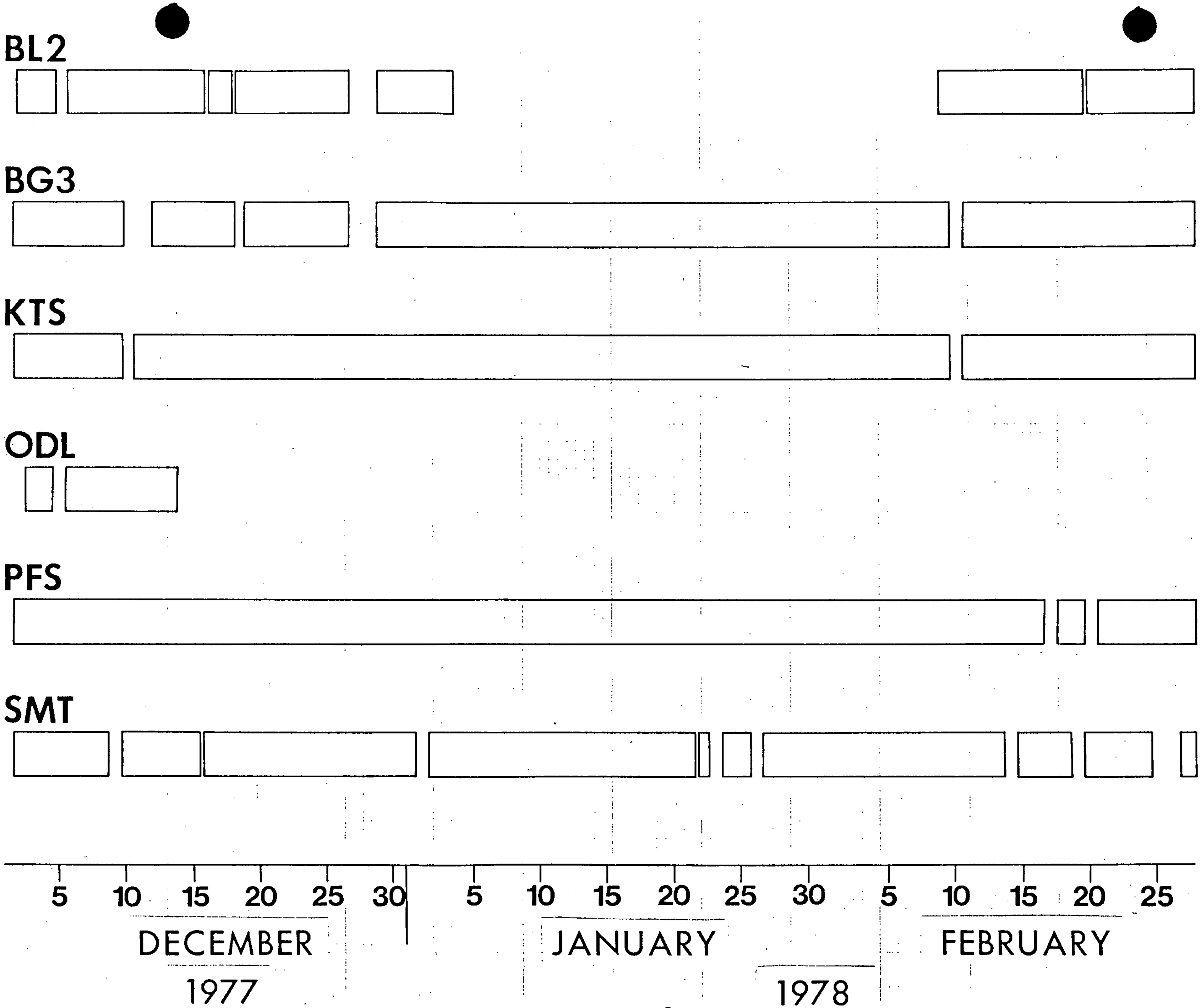
SEISMIC STATION DEPLOYMENT

Up to five portable seismographs (Sprengnether MEQ 800 model) were used, together with Duke Power Company's permanent station at SMT. The location of sites occupied are listed in Appendix I, and are shown in Fig. 2. In identifying the sites in later discussion and in tables, the location number (first column) is used. The deployment times at various sites are shown in Fig. 1. Two seismographs were temporarily moved from the Jocassee network to Lake Keowee where there was activity. The seismograph which occupied location ODL was removed December 13th and was returned after the end of the reporting period. The other seismograph which occupied site BL2 was removed January 3rd and returned on February 8, 1978.

RESULTS

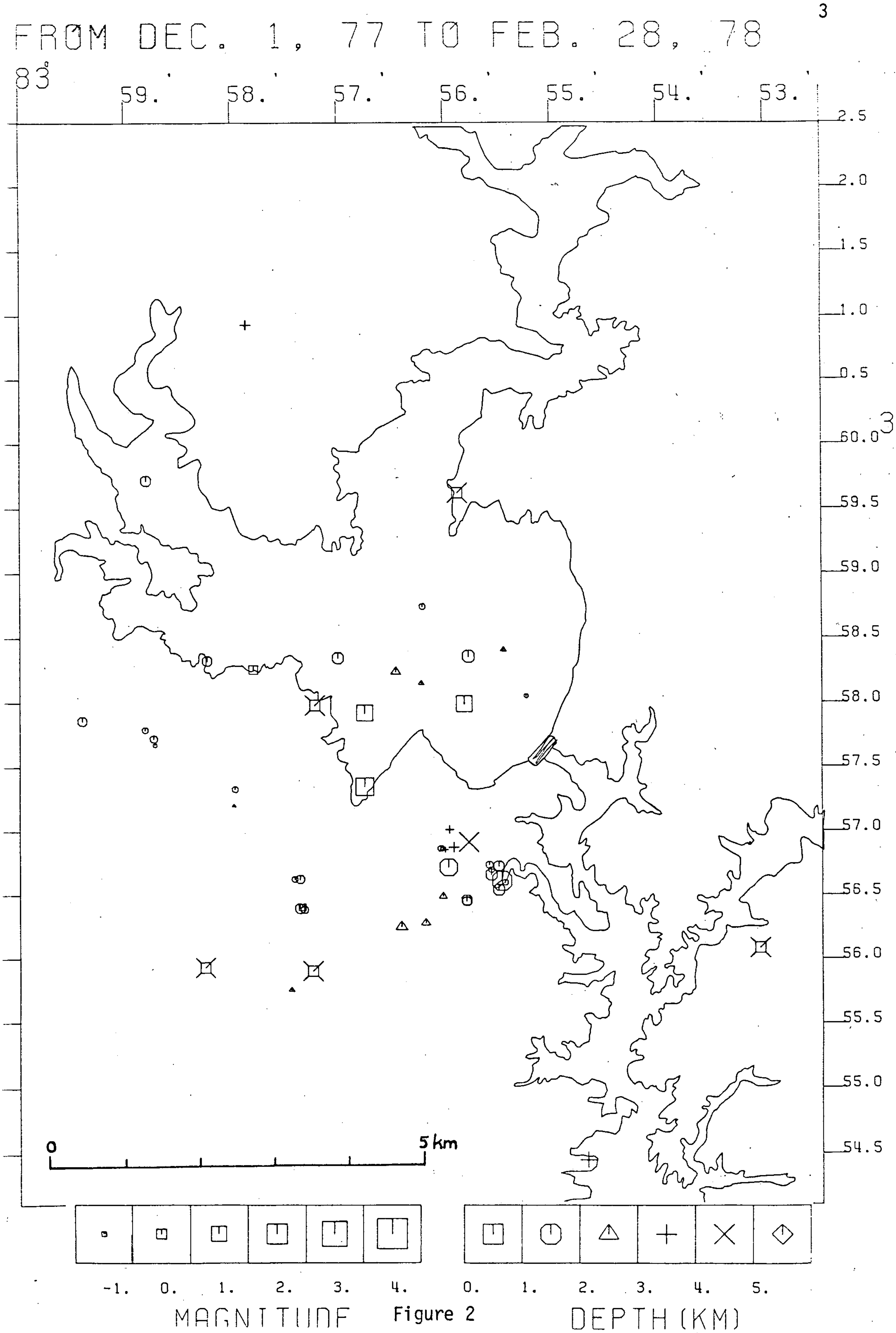
Events were located by using a computer program, HYPO71 (Lee and Lahr, 1972) and a velocity model developed for the Clark Hill reservoir area (Appendix II). The location accuracy is about $\pm$ 200 m while the depths are usually good to $\pm$ 400 m.

In the reporting period (December 1, 1977 - February 28, 1978) 91 events were recorded. Of these 48 events were located and are shown in Fig. 2 and are listed in Appendix IV. The activity was confined to the southern half



BL2
BG3
KTS
ODL
PFS
SMT
5
10
15
20
25
30
5
10
15
20
25
30
5
10
15
20
25
DECEMBER
1977
JANUARY
1978
FEBRUARY

Figure 1



FRØM DEC. 1, 77 TO FEB. 28, 78
83°
59.
58.
57.
56.
55.
54.
53.
2.5
2.0
1.5
1.0
0.5
60.0
34.
59.5
59.0
58.5
58.0
57.5
57.0
56.5
56.0
55.5
55.0
54.5
0
5 km
-1.
0.
1.
2.
3.
4.
MAGNITUDE
0.
1.
2.
3.
4.
5.
DEPTH (KM)

Figure 2

TABLE 1

EVENTS OF $M_L > 1$

Date	Time (UCT)	M_L
771208	07:00:35	1.5
771222	16:15:28	1.8
771230	22:27:00	1.5
780202	18:19:35	1.8
780203	08:03:15	1.4
780205	13:08:50	1.1
780226	05:05:20	1.1

of the Jocassee network. During the period (December 1, 1977 - February 28, 1978) seven events with magnitude greater than 1 were recorded, and are listed in Table 1. The largest were magnitude 1.8 events on December 22 and on February 2. Figure 3 shows the location of all the located events between November 8, 1975 and February 28, 1978. In Fig. 4, the seismicity is compared with water level fluctuations. These data are plotted on the same time axis for the period December 1, 1977 to February 28, 1978. Starting at the top are the daily water level readings at 8 AM (local time). The bars indicate the maximum and minimum water level for that day. In the ordinate, 100 ft. corresponds to a full pond elevation of 1110 ft. a.s.l. The daily variation of water level (computed for readings at 8AM and plotted midway between them) is shown in the next row. The daily energy release and the number of events are shown in the two bottom rows. There appears to be no obvious correlation between the seismicity and the water level or its fluctuations. Figure 5 shows seismic data for the period January, 1975, thru February, 1978. Each data point represents a ten-day period.

CONCLUSIONS

Low level seismicity is still continuing in the vicinity of Lake Jocassee, although the frequency decreased.

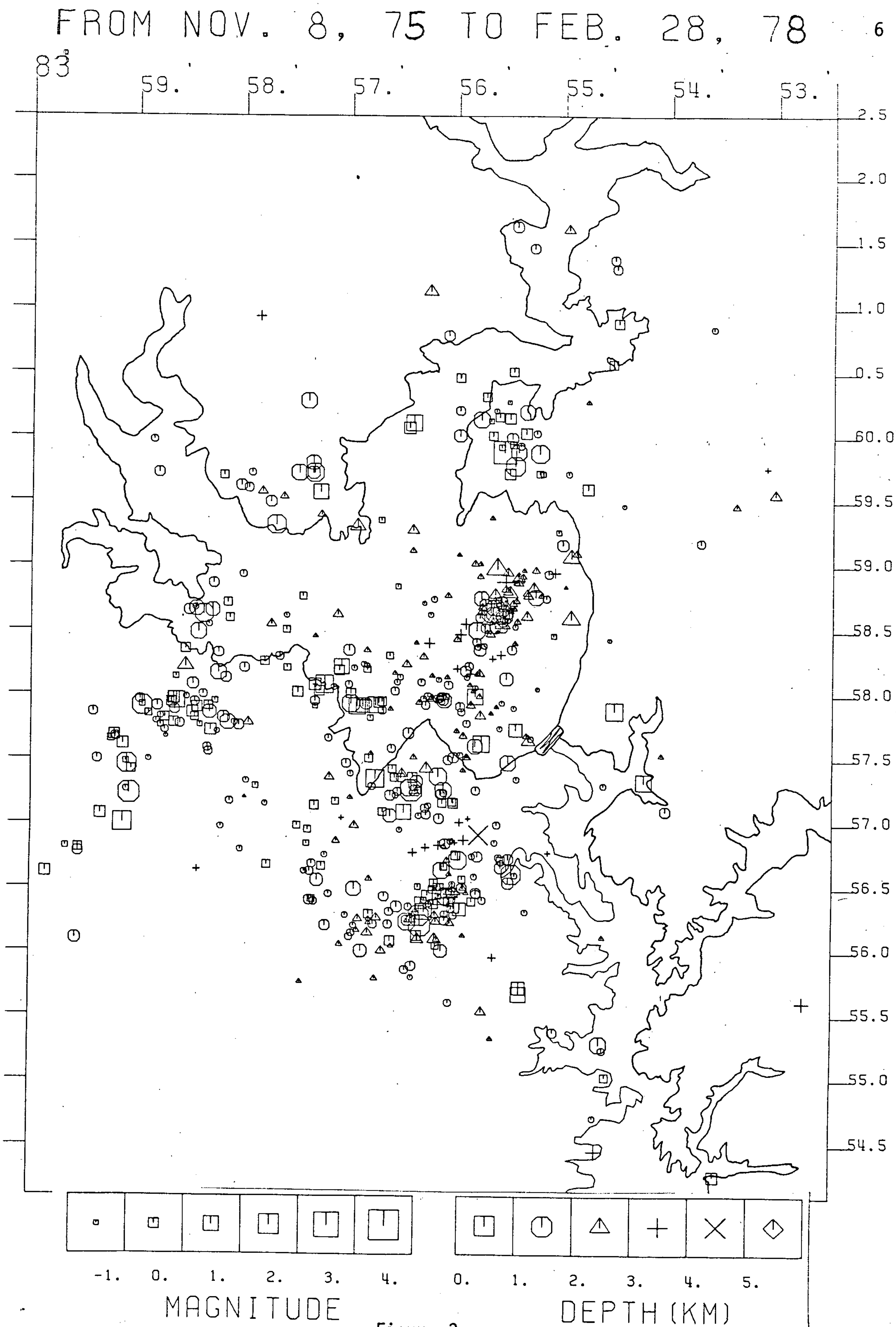

FROM NOV. 8, 75 TO FEB. 28, 78
83
59.
58.
57.
56.
55.
54.
53.
2.5
2.0
1.5
1.0
0.5
60.0
59.5
59.0
58.5
58.0
57.5
57.0
56.5
56.0
55.5
55.0
54.5
-1.
0.
1.
2.
3.
4.
MAGNITUDE
0.
1.
2.
3.
4.
5.
DEPTH (KM)

Figure 3

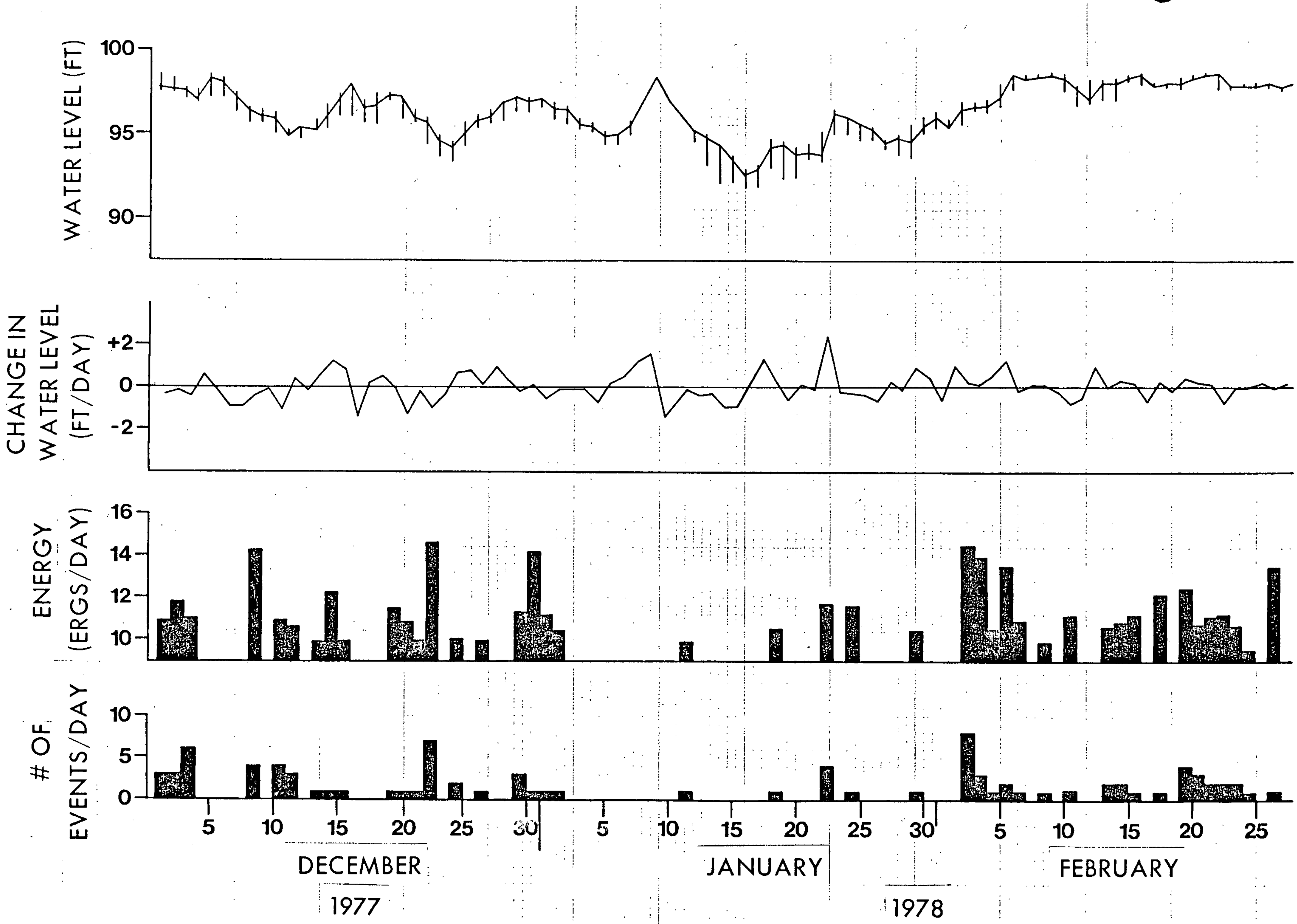
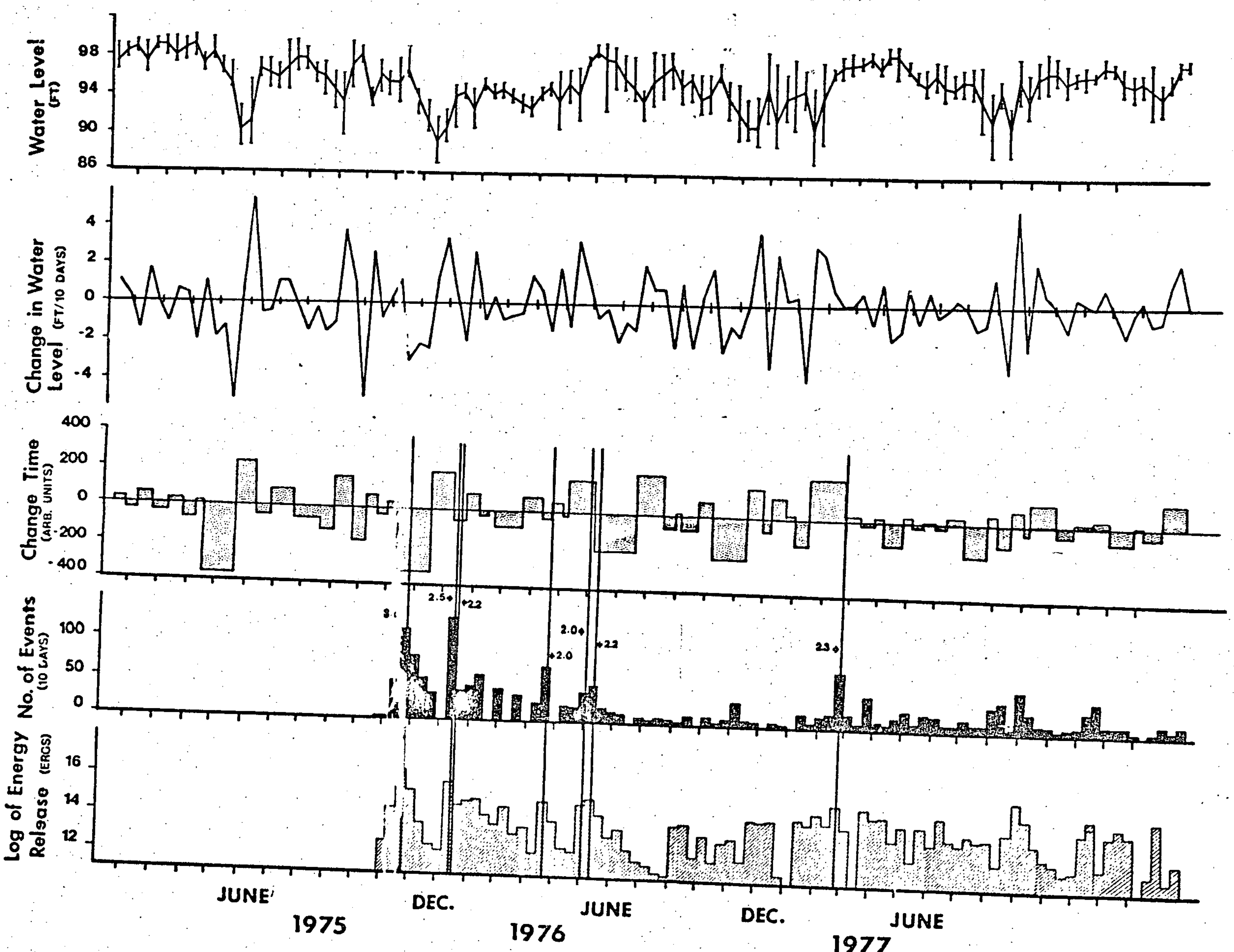

WATER LEVEL (FT)
100
95
90
CHANGE IN WATER LEVEL (FT/DAY)
+2
0
-2
ENERGY (ERGS/DAY)
16
14
12
10
OF EVENTS/DAY
10
5
0
5 10 15 20 25 30 5 10 15 20 25 30 5 10 15 20 25
DECEMBER
1977
JANUARY
1978
FEBRUARY

Figure 4



Water Level (FT)
98
94
90
86
Change in Water Level (FT/10 DAYS)
4
2
0
-2
-4
Change Time (ARB. UNITS)
400
200
0
-200
-400
No. of Events (10 DAYS)
100
50
0
2.5
2.2
2.0
2.0
2.2
2.3
Log of Energy Release (ERGS)
16
14
12
JUNE
1975
DEC.
1976
JUNE
DEC.
1977
JUNE

FIGURE 5

A P P E N D I C E S

APPENDIX I

STATION LOCATIONS

No.	Stn.	Lat. N.	Long. W.
1	BL2	$34^\circ 57.92$	$82^\circ 57.24$
2	KTS	$34^\circ 56.00$	$82^\circ 53.08$
3	BG3	$34^\circ 59.58$	$82^\circ 55.90$
4	ODL	$34^\circ 55.82$	$82^\circ 57.26$
5	MCS	$34^\circ 57.12$	$83^\circ 00.45$
6	PFS	$34^\circ 58.50$	$83^\circ 00.29$
7	SMT	$34^\circ 55.85$	$82^\circ 58.26$
8	ELJ	$34^\circ 59.05$	$82^\circ 54.57$

APPENDIX II

VELOCITY MODEL

HYPO71 was used to locate various events. The crustal model used is

Velocity km/sec	Depth km
5.75	0
6.2	0.5
8.1	30.0

This model was developed for the Clark Hill reservoir - also located on gneissic rocks in the South Carolina Piedmont (Talwani, 1975).

APPENDIX III

LIST OF EVENTS FROM DECEMBER 1977 - FEBRUARY 28, 1978

In Column 3 the "station of max. duration" refers to the location of a station where the recorded duration event was maximum. The station number corresponds to that listed in Appendix I. The maximum recorded duration for any event is given in column 4. In column 5 are listed the total number of stations recording the event. The daily energy release is listed in column 6. The daily energy is calculated using a simplified magnitude - energy relation (Gutenberg and Richter, 1956), i.e.,

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

where M_L = calculated duration magnitude. For Jocassee (Talwani and others, 1976),

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

where D = duration of event in seconds. Events with magnitude ≥ 1 are listed in column 7.

APPENDIX IV

LOCATION OF EVENTS FROM MARCH 1 - MAY 31, 1977

Computer printout of HYPO71 showing data for location of events.

Column 1	Date.
Column 2	Origin time (UCT) 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 $=\sqrt{R_i^2/NO}$, 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*.

*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.

DATE	TIME H: M: S	STN OF MAX. DURATION	DURATION (SEC)	NO. OF STN REC. EVENT	ENERGY PER DAY (ERGS)	$M_L > 1.0$
771201	01:23:14	1	2	1		
	02:43:59	1	3	3		
	04:44:22	1	3	1	10.87	
771202	09:40:58	6	8	4		
	10:22:29	1	2	1		
	10:42:15	1	2	1	11.77	
771203	02:06:53	1	2	4		
	02:09:26	1	3	6		
	02:09:47	4	3	6		
	02:12:54	1	2	6		
	02:12:56	1	2	6		
	02:14:59	6	4	6	11.87	
771204	00:28:54	?	?	5		
771208	00:03:22	4	3	2		
	07:00:35	2	45	5		1.5
	07:52:57	1	2	1		
	13:20:18	1	6	5	14.11	
771210	01:35:30	4	3	2		
	01:11:38	4	1	1		
	10:06:38	4	2	1		
	21:34:37	1	3	1	10.88	
771211	02:50:37	1	2	3		
	02:53:07	3	3	5		
	23:04:17	1	3	1	10.65	
771213	17:45:44	1	2	3	9.97	
771214	06:40:16	2	12	4	12.35	
771215	01:31:59	1	2	2	9.97	
771219	03:06:50	7	6	1	11.43	
771220	05:04:28	3	4	1	10.89	
771221	03:53:16	6	2	2	9.97	
771222	09:34:32	1	2	2		
	09:59:54	2	7	5		
	11:17:31	6	2	1		
	13:24:20	6	4	1		
	14:04:05	6	2	1		
	16:15:28	6	65	5		1.8
	18:52:58	2	8	5	14.60	

DATE	TIME H: M: S	STN OF MAX. DURATION	DURATION (SEC)	NO. OF STN REC. EVENT	ENERGY PER DAY (ERGS)	$M_L > 1.0$
771224	02:33:34	2	3	2		
	13:22:03	2	4	5	11.04	
771226	10:02:05	3	2	2	9.97	
771229	10:30:41	6	2	1		
	17:22:17	6	5	5		
	19:31:42	1	3	4	11.29	
771230	22:27:00	2	47	5	14.17	1.5
771231	23:27:55	1	5	5	11.19	
780101	23:22:47	1	3	2	10.51	
780111	17:28:10	3	2	2	9.97	
780118	06:23:36	3	3	4	10.51	
780122	08:59:46	2	3	3		
	17:38:38	7	4	4		
	23:08:34	6	4	4		
	23:09:10	7	7	4	11.79	
780124	09:47:13	6	7	4	11.64	
780129	13:38:39	7	3	4	10.51	
780202	18:19:35	7	60	4		1.8
	18:19:51	?	?	4		
	18:27:36	3	2	2		
	19:48:33	2	10	4		
	20:50:14	3	5	1		
	21:10:23	3	3	4		
	21:47:45	2	8	4		
	22:47:34	2	9	4	14.49	
780203	08:30:15	2	40	4		1.4
	08:30:32	?	?	4		
	21:58:18	2	10	4	13.96	
780204	19:19:35	2	3	1	10.51	
780205	05:54:45	6	6	3		
	13:08:50	2	30	3	13.57	1.1
780206	09:37:56	3	4	4	10.89	
780208	12:54:61	2	2	3	9.97	

DATE	TIME H: M: S	STN OF MAX. DURATION	DURATION (SEC)	NO. OF STN REC. EVENT	ENERGY PER DAY (ERGS)	$M_L > 1.0$
780210	21:27:22	1	5	5	11.19	
780213	04:24:13	1	2	4		
	07:37:39	1	3	4	10.62	
780214	04:35:10	1	3	4		
	11:47:09	1	3	3	10.81	
780215	03:28:39	2	5	5	11.19	
780217	23:51:58	3	10	5	12.11	
780219	12:21:55	2	9	5		
	13:05:16	2	12	4		
	17:06:07	2	5	2		
	19:36:18	7	3	1	12.51	
780220	17:12:45	1	2	1		
	17:22:12	1	2	3		
	17:26:10	1	3	3	10.71	
780221	03:13:10	6	4	3		
	08:17:05	1	3	4	11.04	
780222	02:05:49	1	4	4		
	18:46:24	6	4	2	11.19	
780223	01:08:57	1	2	1		
	05:01:25	7	3	3	10.62	
780224	01:09:53	1	2	5	9.47	
780226	05:05:20	1	30	5	13.57	1.1

FROM DEC. 1, 77 TO FEB. 28, 78

	DATE	ORIGIN	LAT N	LONG W	DEPTH	MAG	NO	GAP	DMIN	RMS	ERH	ERZ	QM
1	771202	940 56.94	35- 0.91	82-57.87	3.21	0.01	10	285	3.9	0.06	0.6	0.7	C1
2	771203	2 9 25.76	34-56.79	82-56.06	1.98	-0.86	10	118	2.6	0.01	0.1	0.1	B1
3	771203	2 9 46.15	34-56.79	82-56.04	2.16	-0.86	12	118	2.6	0.04	0.2	0.4	B1
4	771204	028 53.18	34-58.18	82-56.48	2.24	-0.11	12	132	1.3	0.06	0.2	0.4	B1
5	771208	7 0 33.79	34-57.28	82-56.77	0.90	1.54	11	96	1.4	0.04	0.2	0.5	B1
6	771208	1320 17.99	34-56.37	82-55.82	1.25	-0.24	12	145	2.4	0.04	0.2	0.6	B1
7	771210	253 6.08	34-58.35	82-55.47	2.65	-0.86	8	156	2.4	0.05	0.4	0.8	B1
8	771214	640 15.09	34-56.17	82-56.43	2.79	0.37	10	164	2.9	0.03	0.1	0.3	B1
9	771222	959 53.07	34-58.27	82-58.24	1.59	-0.11	10	192	1.7	0.07	0.3	0.6	C1
10	771222	1615 27.27	34-56.84	82-55.60	4.02	1.87	6	158	3.0	0.04	0.7	0.7	B1
11	771222	1852 57.29	34-56.80	82-55.94	3.56	0.01	10	135	2.9	0.02	0.1	0.2	B1
12	771229	1722 16.06	34-56.94	82-55.98	3.73	-0.40	10	129	2.6	0.03	0.1	0.3	B1
13	771229	1931 40.80	34-56.78	82-56.02	3.71	-0.86	10	135	2.8	0.02	0.1	0.2	B1
14	780103	21 9 7.39	34-58.29	82-55.64	0.83	-0.60	6	231	2.4	0.09	1.1	4.6	C1
15	780118	623 34.58	34-58.09	82-56.24	2.78	-0.86	6	206	2.8	0.01	0.1	0.1	C1
16	780122	859 35.25	34-55.67	82-57.46	2.38	-0.86	6	201	1.3	0.02	1.0	0.3	C1
17	780122	1738 37.06	34-56.31	82-57.34	1.04	-0.60	8	143	1.6	0.02	0.1	0.3	B1
18	780122	23 8 32.78	34-56.33	82-57.36	0.28	-0.60	8	142	1.6	0.01	0.1	0.1	B1
19	780122	23 9 9.34	34-56.32	82-57.38	1.23	-0.11	8	142	1.0	0.02	0.1	0.3	B1
20	780124	947 11.78	34-56.20	82-56.20	2.52	-0.11	8	164	3.2	0.05	0.3	0.7	B1
21	780129	1338 38.37	34-56.52	82-55.46	1.52	-0.86	8	149	3.8	0.01	0.1	0.3	B1
22	780202	1819 34.79	34-56.53	82-55.49	1.15	1.80	16	111	3.8	0.04	0.1	0.8	B1
23	780202	1948 32.22	34-56.46	82-55.52	1.23	0.21	8	152	3.8	0.01	0.0	0.3	B1
24	780202	2110 22.25	34-56.62	82-55.59	1.46	-0.86	8	144	4.0	0.02	0.1	0.5	B1
25	780202	2147 44.53	34-56.65	82-55.52	1.72	0.01	8	143	3.9	0.01	0.0	0.2	B1
26	780203	830 14.60	34-56.64	82-55.99	1.76	1.44	14	104	3.8	0.06	0.2	0.8	B1
27	780203	2158 17.33	34-56.58	82-55.59	1.82	0.21	8	146	4.0	0.03	0.2	0.7	B1
28	780205	554 42.78	34-57.80	82-59.41	1.85	-0.24	6	209	2.7	0.03	0.3	0.7	C1
29	780205	13 8 49.02	34-54.35	82-54.69	3.42	1.18	12	147	3.9	0.06	0.2	0.6	B1
30	780206	937 56.23	34-56.66	82-55.61	1.88	-0.60	8	142	4.1	0.03	0.2	0.7	B1
31	780208	1254 59.53	34-56.39	82-55.73	0.91	-1.22	6	188	4.0	0.03	1.4	3.9	C1
32	780210	2027 21.40	34-56.55	82-57.38	1.87	-0.40	10	127	1.9	0.03	0.1	0.2	B1
33	780213	424 12.28	34-57.99	82-55.26	1.13	-1.22	6	156	3.0	0.02	0.1	0.7	B1
34	780213	737 38.80	34-56.55	82-58.15	0.71	-0.86	6	237	2.9	0.02	0.6	1.8	C1
35	780214	435 9.44	34-57.26	82-57.98	1.07	-0.86	8	148	1.7	0.01	0.1	0.2	B1
36	780214	1147 8.31	34-57.13	82-57.99	2.40	-1.22	6	155	2.4	0.01	0.1	0.3	B1
37	780215	338 37.88	34-56.41	82-56.04	2.40	-0.40	10	153	3.3	0.02	0.1	0.3	B1
38	780217	2351 57.78	34-58.29	82-57.02	1.98	0.21	10	159	0.8	0.02	0.1	0.2	B1
39	780219	1221 54.27	34-57.93	82-55.84	0.32	1.14	10	132	2.1	0.03	0.1	0.3	B1
40	780219	13 5 16.17	34-58.30	82-55.80	1.72	0.37	8	244	2.3	0.02	0.2	0.3	C1
41	780219	2358 32.97	34-58.20	82-57.81	0.19	-0.24	8	220	1.0	0.09	0.3	0.5	C1
42	780220	1722 11.50	34-57.61	82-58.73	1.93	-1.22	6	181	2.3	0.02	0.7	0.6	C1
43	780220	1726 10.13	34-57.73	82-58.82	1.69	-0.86	6	188	2.4	0.02	0.7	0.7	C1
44	780221	313 10.17	34-57.66	82-58.74	1.64	-0.60	6	183	2.3	0.02	0.6	0.6	C1
45	780221	817 5.32	34-58.69	82-56.23	1.28	-0.86	8	140	1.7	0.02	0.1	0.2	B1
46	780222	2 5 47.96	34-59.68	82-58.81	1.86	0.0	4	251	4.4	0.02	0.0	0.0	C1
47	780223	5 1 24.27	34-56.55	82-57.43	1.83	-0.86	6	202	1.8	0.01	0.1	0.2	C1
48	780226	5 5 19.15	34-57.86	82-56.77	0.82	1.18	10	104	0.7	0.04	0.2	0.3	B1