Recd 12/4/79

A REPORT ON THE

AUGUST 25, 1979 JOCASSEE EARTHQUAKE

Pradeep Talwani, Principal Investigator

and

Don Stevenson and Ken Taylor

Geology Department
University of South Carolina
Columbia, South Carolina 29208

INTRODUCTION

On August 25, 1979 (9:31 PM EDST, Aug. 26, 01.31 UCT) a magnitude 3.7 (M_{bLg}, BLA) earthquake occurred in the vicinity of Lake Jocassee, South Carolina. This MM intensity VI event was felt in an area of about 15,000 sq. km and was recorded locally on the three station Lake Jocassee seismographic network, and regionally on seismic stations in South Carolina, North Carolina, Georgia, Tennessee and Virginia. Within 24 hours of the event we deployed four Sprengnether MEQ 800 portable seismographs in the epicentral area. This report presents an analysis of seismic data recorded in the 20 day period following that initial event of August 25. During this period (August 26, 1979 - September 15, 1979) 26 aftershocks were recorded and they ranged in magnitude from -.60 to 2.0.

INSTRUMENTATION

The main shock of August 25 was recorded on 3 permanent seismic stations in the immediate vicinity of Lake Jocassee. All aftershocks were recorded on four additional portable seismographs which were deployed on August 26, 1979. The station locations are shown in Figure 1.

RESULTS

In the reporting period 26 locatable events were recorded (Appendix I). Figure 2 shows location of the main event on August 25 and aftershocks. Most of the activity occurred in a group approximately 1 km south of the lake and about 3 km from the dam.

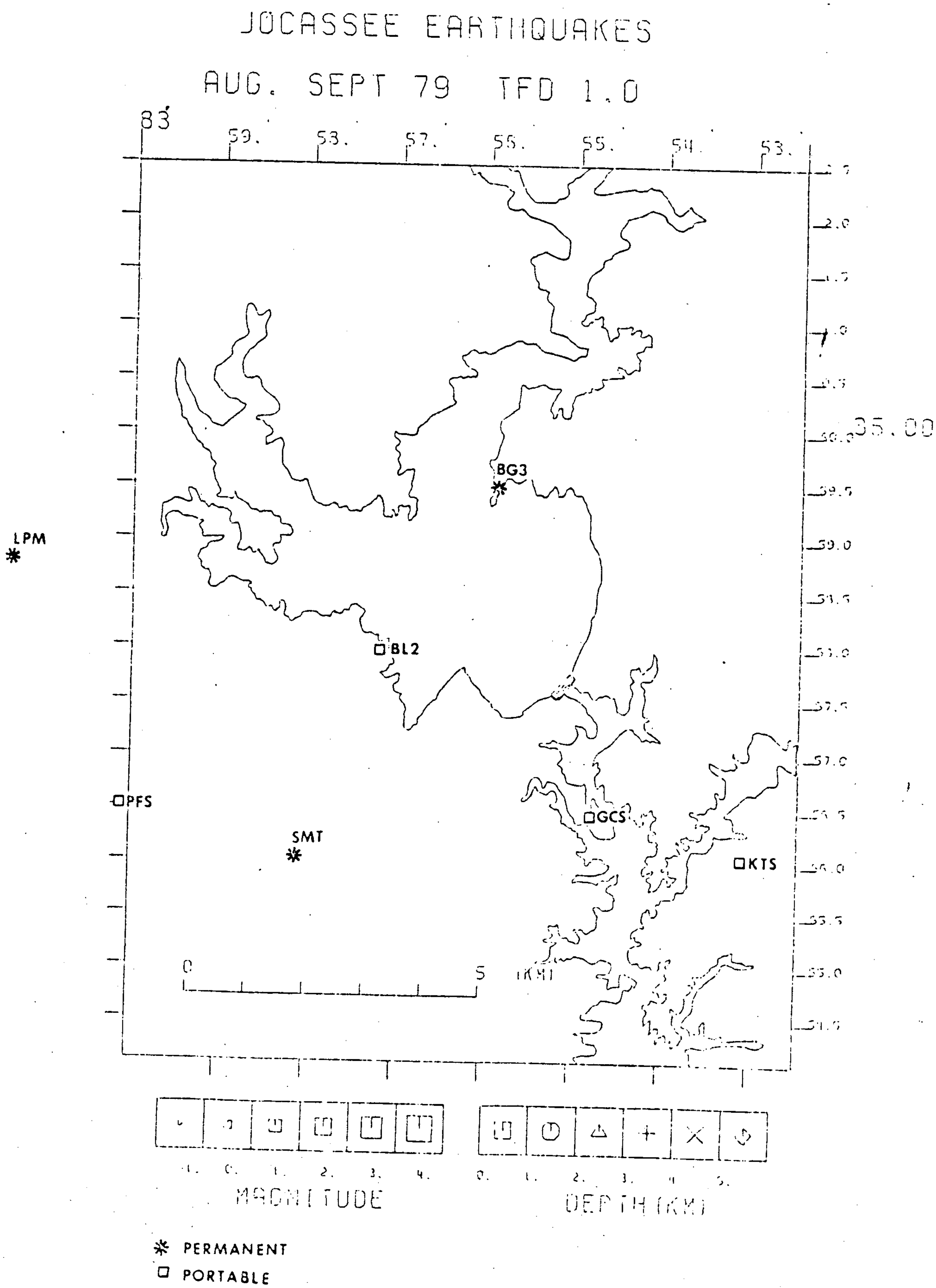
JOCASSEE EARTHQUAKES
AUG. SEPT 79 TFD 1.0
83
59.
58.
57.
56.
55.
54.
53.
35.00
BG3
LPM
BL2
PFS
SMT
GCS
KTS
0
5
(KM)
MAGNITUDE
DEPTH(KM)
PERMANENT
PORTABLE

Figure 1

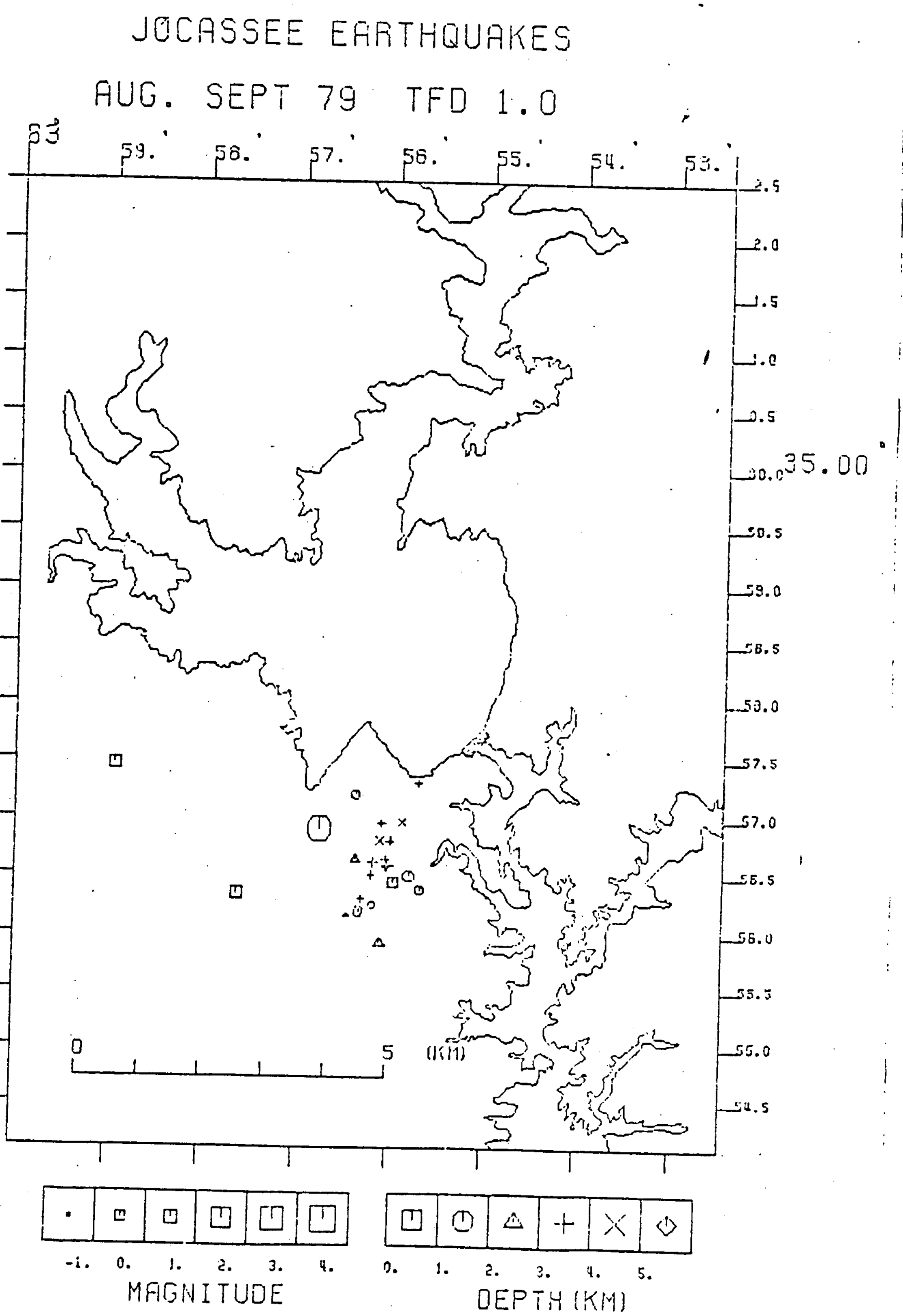
JØCASSEE EARTHQUAKES
AUG. SEPT 79 TFD 1.0
83
59.
58.
57.
56.
55.
54.
53.
2.5
2.0
1.5
1.0
0.5
30.0
35.00
59.5
59.0
58.5
58.0
57.5
57.0
56.5
56.0
55.5
55.0
54.5
0
5
(KM)
-1.
0.
1.
2.
3.
4.
MAGNITUDE
0.
1.
2.
3.
4.
5.
DEPTH (KM)

Figure 2

LOCATION AND MAGNITUDE OF MAIN SHOCK

The initial location of the main shock (listed in Appendix I) was obtained by using HYPO71 (Lee and Lahr, 1972) and a trial depth of 1 km, using only P-wave first arrival times at the three stations. (S wave arrivals could not be used as the various arrivals were clipped). Using only 3 arrival times is inadequate to obtain the correct depth, and the computer location was obtained with the depth fixed at 1 km. However the depths of most of the aftershocks (obtained by using both P and S phases) ranged from 2 to 4 km. This suggested that the depth of the main shock was also in that range. The main event was then relocated with trial depths of 2 and 3 km (Table 1).

In view of the depth of the aftershocks and the quality of the computer solution for the three trial focal depths (TFD) we suggest that a TFD = 2 km gives the best solution.

The main event was assigned a magnitude 3.6 by NEIS, whereas a M_{bLg} 3.7 was assigned by Dr. Bollinger - based on data from BLA and other stations of the VPI seismographic network. This event also provided a check on the local magnitude scale that we had been using at Lake Jocassee. According to that, the magnitude of this event was 3.1. The scale is being revised now.

INTENSITY SURVEY

An intensity survey was carried out personally in the epicentral area, and through newspapers in Anderson (S.C.), Brevard (N.C.) and Seneca (S.C.). These resulted in 85 responses. These data were supplemented with 32 responses from Postmasters in a larger region obtained by Carl Stover of

TABLE 1

Trial Focal Depth (km)	Origin Time 01h 31m	Lat N (34°)	Long W (82°)	Depth (km)
1	46.66'	56.89'	56.64'	1.0
2	46.59'	56.69'	56.36'	2.0
3	46.51'	56.57'	56.26'	3.0

USGS. An isoseismal map (Figure 3) indicates a felt area of over 15,000 sq. km, of which intensity V shaking occurred in 1220 sq. km. In Figure 3 the epicenter is indicated by an asterick. The epicentral area appears to be elongated in a NE - SW direction - corresponding to the geologic grain in the area. The locations reporting a MM intensity V or greater are summarized in Table 2.

DISCUSSION

The occurrence of a M_{bLg} 3.7 event, almost four years after the start of reservoir induced seismicity at Lake Jocassee was surprising. The seismicity had decreased from an average of about 5 events/day (Dec. 75 - Jan. 76) to about 1 recorded event every 2 days (Dec. 78). The level of seismicity had decreased from M_L 3.2 (Nov. 75) to about 3 events/year ($2.5 > M_L > 2.0$). To seek possible association with the lake level the daily (8 AM reading) water level is plotted for the period June - Sept. 1979 (Figure 4, top row). The maximum and minimum lake levels are indicated by bars. The daily change in water level is shown in the next row. The daily seismic energy release and number of events are shown in the two bottom rows. The seismicity appears to be random. The only suggestions of association with the lake level are large fluctuations in the lake level, and that the average lake level has been high. This is perhaps more apparent in Figure 5 which shows data over a 4 3/4 year period (January 1975 - September 1979). Each data point represents a 10-day period. From top to bottom: First row shows the average water level in Lake Jocassee over a 10-day period, with the bars indicating the maximum and minimum water level in that 10-day period. The change in water level

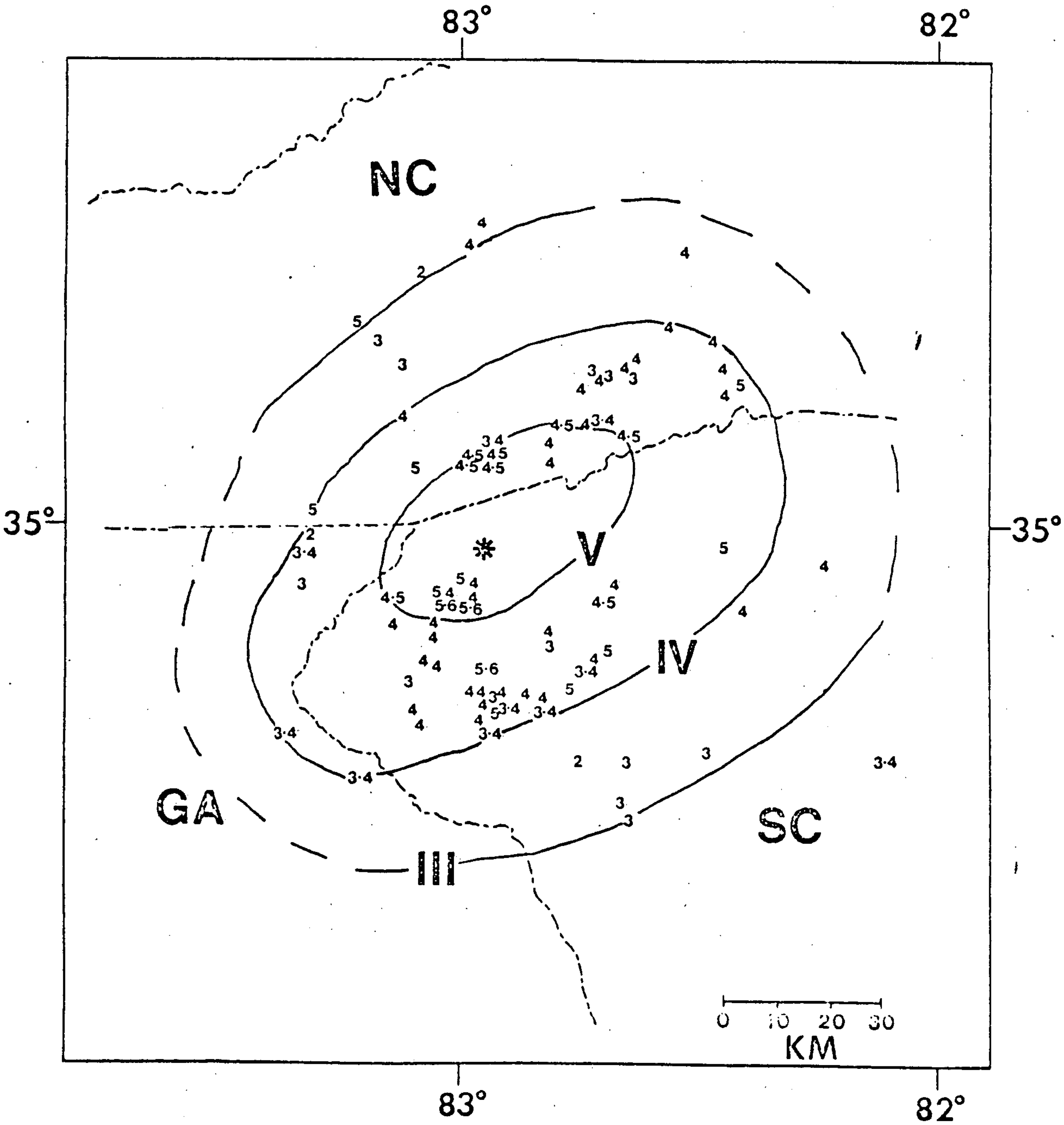

Figure 3

TABLE 2

		LOCATION
INTENSITY V—VI	S.C.	SALEM, TAMASSEE, SENECA
INTENSITY V	S.C.	TRAVELERS REST, LIBERTY, CENTRAL, TAMASSEE, SALEM, SENECA
	N.C.	LAKE TOXAWAY, CASHIERS, WEBSTER, SCALY MT., ZIRCONIA

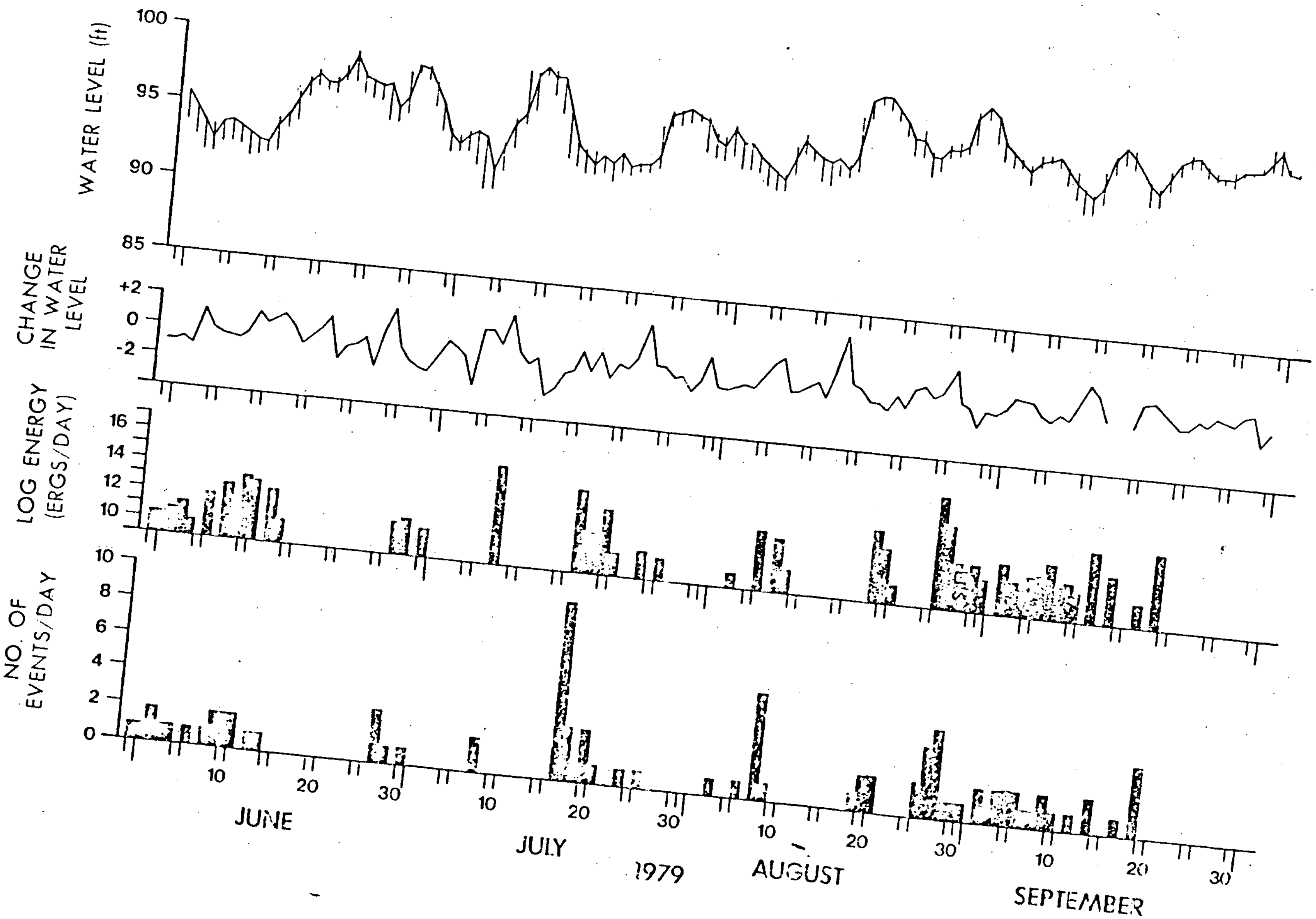
WATER LEVEL (ft)
100
95
90
85
CHANGE IN WATER LEVEL
+2
0
-2
LOG ENERGY (ERGS/DAY)
16
14
12
10
NO. OF EVENTS/DAY
10
8
6
4
2
0
10
20
30
JUNE
JULY
1979
AUGUST
SEPTEMBER

Figure 4

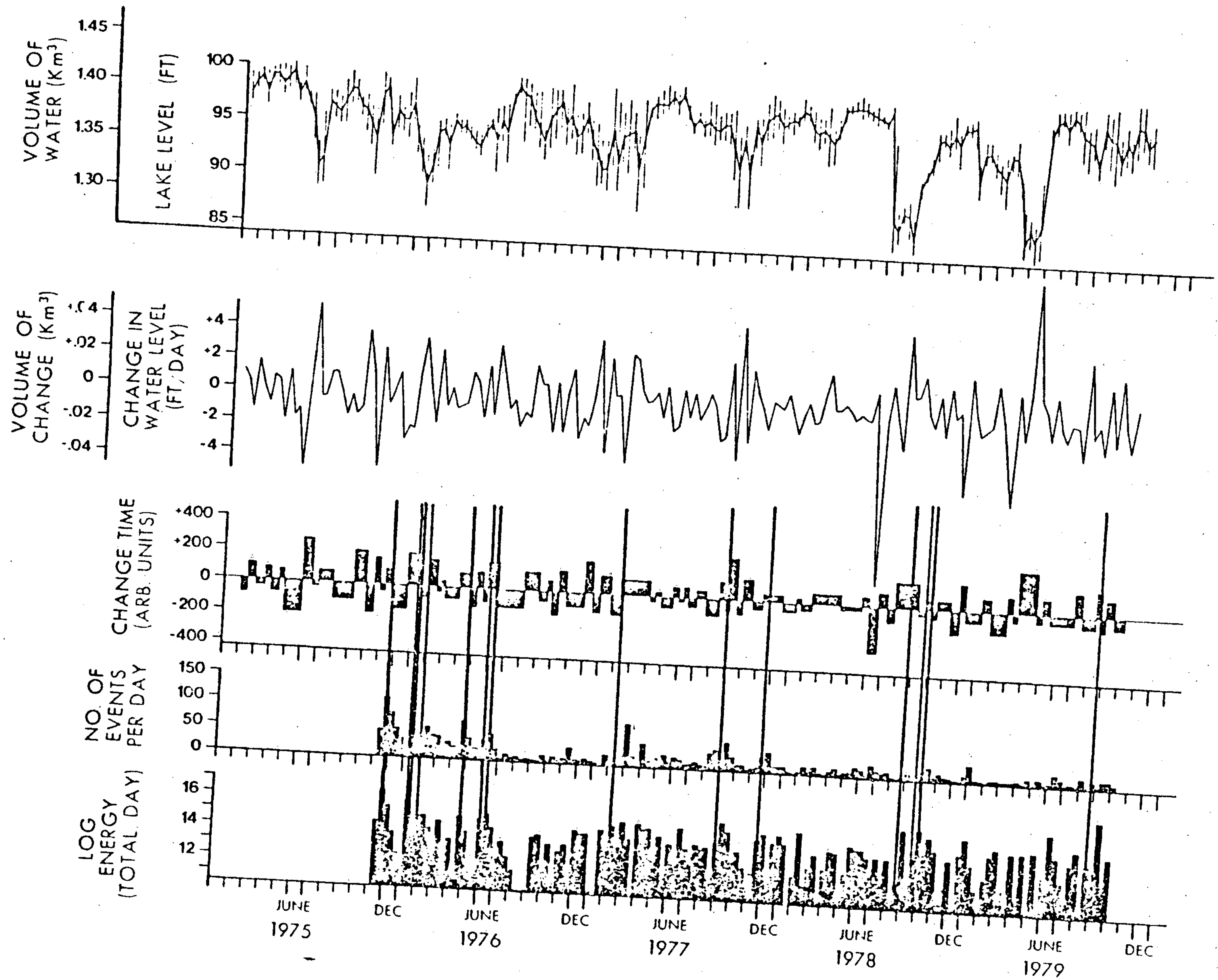
VOLUME OF WATER (Km³)
LAKE LEVEL (FT)
VOLUME OF CHANGE (Km³)
CHANGE IN WATER LEVEL (FT/DAY)
CHANGE TIME (ARB. UNITS)
NO. OF EVENTS PER DAY
LOG ENERGY (TOTAL DAY)
JUNE
DEC
1975
1976
1977
1978
1979

Figure 5

between the 10-day mean water levels is shown in the next row. In order to quantify this change, the area in each segment, below and above the zero (or no change) line was calculated in arbitrary units. This 'change time', representing the duration and amount of change, is plotted in the next row. This was compared with the total number of events (in 10-day period) and the times of events with magnitude greater than 2 were noted.

The most dramatic decrease in the lake level occurred in early summer 1978. After July 1978, the lake level was raised for the next few months and correspondingly there was a large 'change time'. Few weeks following the raising of the lake there occurred three $M_L > 2.0$ events (8/21/78, 9/21/78 and 10/05/78). We suggest that the general increase in the level of activity was caused by the rapid rise of water level in the lake.

In February and March 1979 the lake level had been lowered to 85' (100' corresponds to 1,110' ASL) and was rapidly raised to 97' in March - April 1979. We suggest that this rapid increase in water level, with a corresponding large 'change time' triggered a series of events that culminated in the M_{bLg} 3.7 event on August 25, 1979.

The earthquake (#13) occurred in a "seismic gap" between the aftershock zones of previous large earthquakes and its aftershocks were deeper than those of events #3 and #7 (Figure 6).

CONCLUSION

In our previous report (through 1978) we had concluded that, "Now a large number of the 'locked' portions have been unlocked -- and the rocks have adjusted to the new stress condition caused by impoundment. The level of seismicity has dropped considerably. The lack of earthquakes

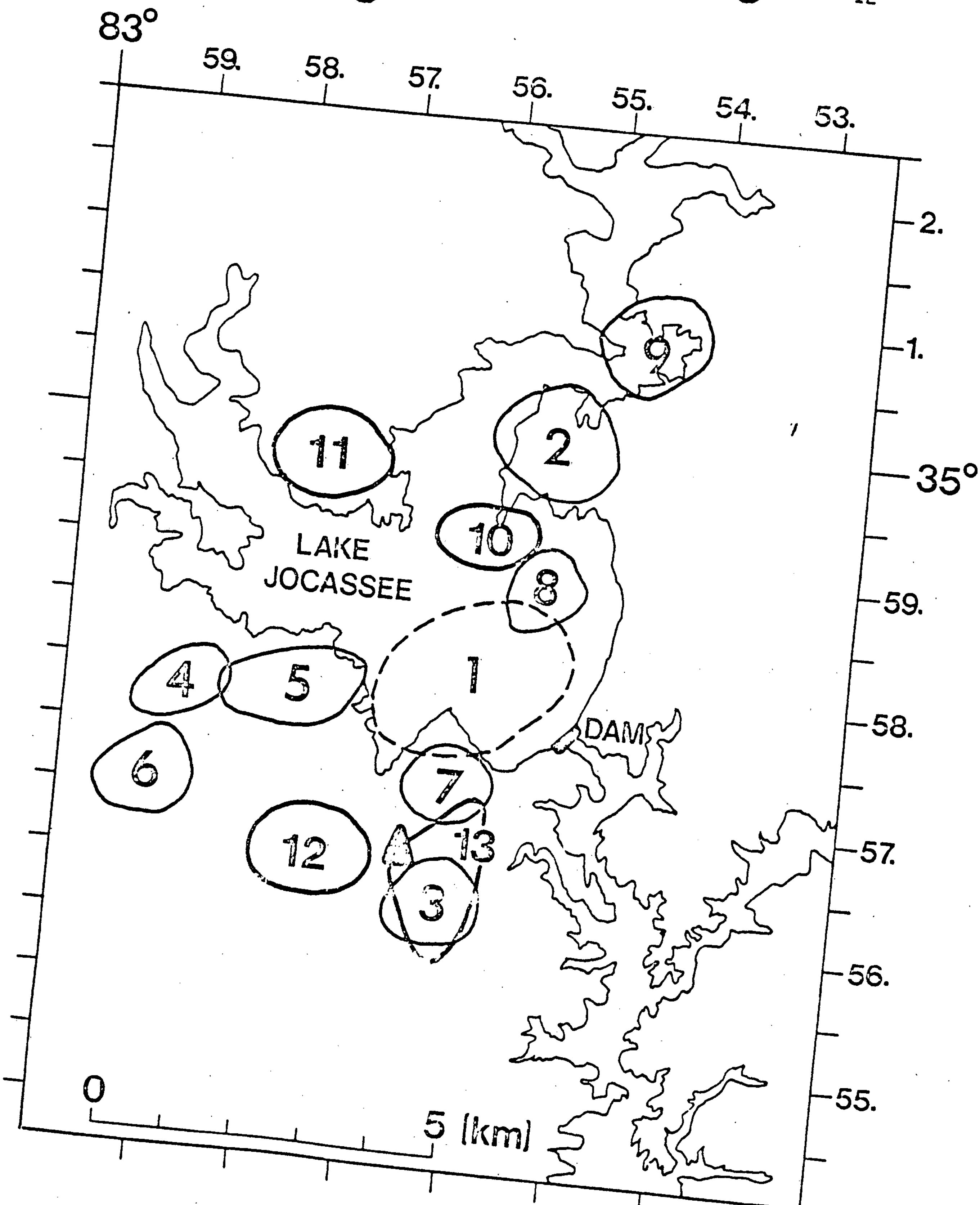
83°
59.
58.
57.
56.
55.
54.
53.
2.
1.
35°
59.
58.
57.
56.
55.
LAKE
JOCASSEE
DAM
1
2
3
4
5
6
7
8
9
10
11
12
13
0
5 (km)

Figure 6

with $M_L \geq 3.0$ after the initial shock suggests that the surface areas of the locked portions (to which the magnitude is related) are too small to cause any major shock ($M_L > 3.0$). Consequently we would conclude that the activity will continue to decline unless there is a period of prolonged lowering of lake level followed by a period of sustained, rapid refilling." Our previous observation thus appears to have been borne out by the occurrence of the August 25, 1979 event. Thus it appears the conclusion quoted above is still valid.

APPENDIX

QUALITY AND DATA CONTROL FACTORS

28	0.13	29.00	29.00	0.42	2	0	-2.00	5.00	0.0	10.00

DATE	ORIGIN	LAT N	LONG W	DEPTH	MAG	NO	GAP	DMIN	RMS	ERH	ERZ	Q
790826	131 46.68	34-56.83	82-56.77	1.00	3.11	3	219	3.0	0.01	0.0	0.0	C1
790826	145 11.41	34-56.56	82-56.38	2.39	0.21	6	239	3.3	0.01	0.1	0.2	C1
790827	5 7 23.81	34-55.95	82-56.15	1.74	2.00	9	178	3.3	0.08	0.6	3.0	C1
790827	13 4 44.99	34-56.38	82-55.83	4.36	-0.86	7	156	4.0	0.09	0.8	1.5	B1
790828	710 40.37	34-56.43	82-56.22	3.82	-0.40	6	172	3.2	0.01	0.2	0.3	B1
790828	735 48.74	34-56.11	82-56.34	1.98	-0.11	8	185	3.6	0.04	0.3	1.2	C1
790828	1150 40.01	34-55.50	82-56.06	3.47	-0.60	6	169	3.2	0.01	0.2	0.2	B1
790828	1711 16.32	34-55.17	82-56.20	1.76	-0.40	8	182	3.6	0.03	0.2	0.8	C1
790828	1946 47.83	34-55.84	82-56.11	2.93	0.37	5	195	4.6	0.05	0.5	1.1	C1
790829	1224 51.59	34-56.30	82-55.70	1.84	-0.11	6	261	4.1	0.03	0.4	1.1	C1
790830	136 55.03	34-56.42	82-55.82	1.81	0.21	8	196	3.5	0.07	0.4	1.2	C1
790831	23 6 5.87	34-56.88	82-56.11	3.53	-0.40	6	155	2.6	0.01	0.1	0.2	B1
790902	4 9 47.53	34-56.37	82-55.98	0.84	0.37	8	190	3.5	0.09	0.4	0.7	C1
790903	330 29.98	34-57.13	82-56.39	1.91	-0.40	8	154	1.9	0.05	0.6	1.1	B1
790904	147 51.29	34-56.08	82-56.47	2.87	-0.86	5	157	3.6	0.02	0.3	0.6	C1
790904	1133 43.67	34-54.00	82-56.48	3.84	-0.86	6	255	6.4	0.13	2.0	4.6	C1
790905	1043 17.67	34-57.39	82-58.95	0.74	0.51	10	178	2.5	0.10	0.9	1.1	B1
790905	1211 43.60	34-56.13	82-56.36	1.78	-0.40	9	168	3.1	0.11	0.5	3.3	C1
790906	636 21.23	34-56.54	82-56.20	3.27	-0.11	5	166	3.0	0.01	0.1	0.1	B1
790906	2259 41.68	34-56.22	82-56.32	3.23	-0.40	8	181	2.2	0.02	0.2	0.3	C1
790907	712 35.66	34-56.26	82-57.64	0.26	0.57	12	183	3.1	0.08	0.4	0.6	C1
790908	1034 29.39	34-56.73	82-56.12	4.38	-0.40	8	160	2.0	0.09	1.2	1.1	C1
790909	2030 5.19	34-56.56	82-56.07	3.70	-0.24	6	167	3.1	0.01	0.1	0.2	B1
790909	2359 57.84	34-57.24	82-55.73	3.78	-0.60	9	181	2.6	0.09	0.9	1.1	C1
790910	913 37.91	34-56.90	82-55.89	4.16	-0.60	8	159	2.8	0.04	0.4	0.5	B1
790912	1220 44.92	34-56.04	82-57.62	0.60	1.24	11	192	3.5	0.11	0.5	7.5	D1
790914	741 59.32	34-56.73	82-56.02	3.71	-0.24	8	147	2.9	0.01	0.1	0.1	B1
790925	16 6 36.25	34-56.79	82-56.64	1.00	1.80	3	224	3.1	0.02	0.0	0.0	C1