GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION
SPONSORED PROJECT INITIATION

Date: 9/21/79

Project Title: Aftershock Monitoring in East Tennessee

Project No: G-35-663

Project Director: Dr. Leland T. Long

Sponsor: Tennessee Valley Authority; Chattanooga, Tennessee 37401

Agreement Period: From 8/18/79 Until 9/17/79

Type Agreement: Task Statement under Contract No. TV-50547A, Acct. No. 991-30-40.22

Amount: $1,700

DELIVERABLES
Reports Required: Summary of Data; Original Seismograms (to be returned to GIT for permanent storage) -

Sponsor Contact Person (s):

Technical Matters	Contractual Matters (thru OCA)
Don Reinbold Technical Monitor Tennessee Valley Authority 1340 Commerce Union Bank Bldg. Chattanooga, Tennessee 37401	Mr. E. D. Daugherty Chief, Research Services Tennessee Valley Authority 1340 Commerce Union Bank Bldg. Chattanooga, Tennessee 37401

Defense Priority Rating:

Assigned to: Geophysical Sciences (School/Laboratory)

COPIES TO:

- Project Director
- Division Chief (EES)
- School/Laboratory Director
- Dean/Director—EES
- Accounting Office
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- Project Code (GTRI)
- Other C. E. Smith

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 10/5/81

Project Title: Aftershock Monitoring in East Tennessee

Project No: G-35-663

Project Director: Dr. L. T. Long

Sponsor: Tennessee Valley Authority, Chattanooga, TN

Effective Termination Date: 9/17/79

Clearance of Accounting Charges: 9/17/79

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice and ~~Closing Documents~~
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Assigned to: Geophysical Sciences (School/~~Laboratory~~)

COPIES TO:

Administrative Coordinator	Research Security Services	EES Public Relations (2)
Research Property Management	~~Reports Coordinator (OCA)~~	Computer Input
Accounting	Legal Services (OCA)	Project File
Procurement/EES Supply Services	Library	Other _____

FORM OCA 10:781

G-35-663

GEORGIA INSTITUTE OF TECHNOLOGY
SCHOOL OF GEOPHYSICAL SCIENCES
Atlanta, Georgia 30332
(404) 894-2857

June 25, 1981

Mr. E. D. Dougherty
Chief, Research Services
Tennessee Valley Authority
1340 Commerce Union Bank Bldg.
Chattanooga, Tennessee 37401

Subject: Contract No. TV-50547A - Summary of Data and Original Seismograms (GT-G-35-663) deliverables 2 and 3

Dear Sirs:

The contract to monitor aftershocks in southeastern Tennessee contained two deliverables. The first was a Summary of Data which was presented informally to Don Reinbolt of TVA. A more complete summary of data was compiled about one year after termination of the contract. A copy of that report is attached. The second deliverable consisted of the original seismograms. These were delivered to TVA and have been returned to Georgia Tech as stipulated in the contract.

I believe this letter should satisfy all reporting requirements. If any other item remains outstanding please write or call.

Sincerely,

Leland T. Long
(404) 894-2860

LTL:ba
enclosure

The August 13, 1979, Southeast Tennessee Earthquake

by L. T. Long, J. Musser, Gordon Smith, Anton Dainty and Andy Binford

Introduction

On August 13, 1979 at 05:18:56.6 UT an earthquake of approximate magnitude 3.3 occurred in southeastern Tennessee about 20 km SSW of Tellico Plains. Immediately following detection of the event, investigators from Georgia Tech and the Tennessee Earthquake Information Center placed portable seismic equipment near the estimated epicenter. A four station aftershock survey was initiated August 14, 1979 and was extended to September 18, 1979 with assistance from the Tennessee Valley Authority. Following the survey additional regional seismic recordings for the main event were obtained and analyzed. The objectives of this report are to present the results of Georgia Tech's investigation of the data for the main event and from the aftershock survey.

Regional Seismicity

The epicenter of the August 13, 1979 event is located in the Valley and Ridge Province of the Appalachian Mountains near its boundary with the Blue Ridge Province (Figure 1). The area is underlain by strongly folded and faulted Precambrian to Pennsylvanian sediments. The area of southeastern Tennessee within an approximate radius of 100 km of the epicenter of the August 13, 1979 earthquake has experienced a moderate level of seismic activity. The epicenter falls within the southern Appalachian Seismic Zone of Bollinger (1973). From 1829 to 1976 there were 38 events felt in southeastern Tennessee within a radius of 100 km of the August 13, 1979 event. The largest of these occurred in March 1913 and had a maximum epicentral intensity of VII (MM) (see Figure 2).

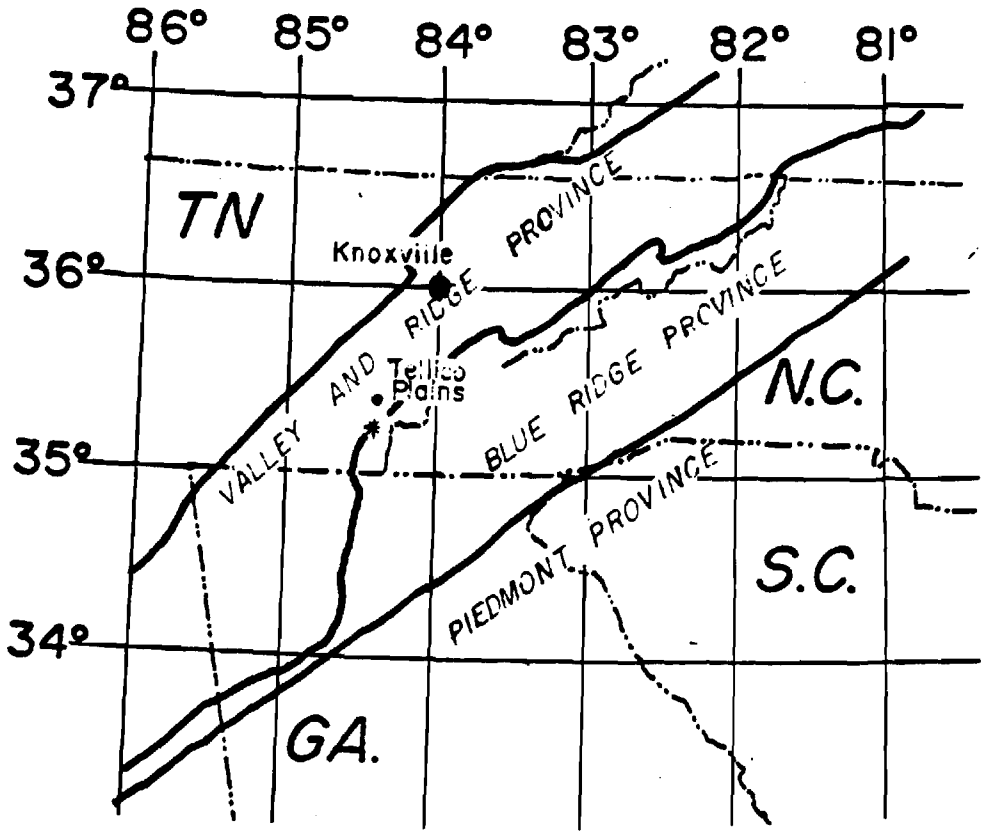

Figure 1. Location map for southeastern Tennessee.

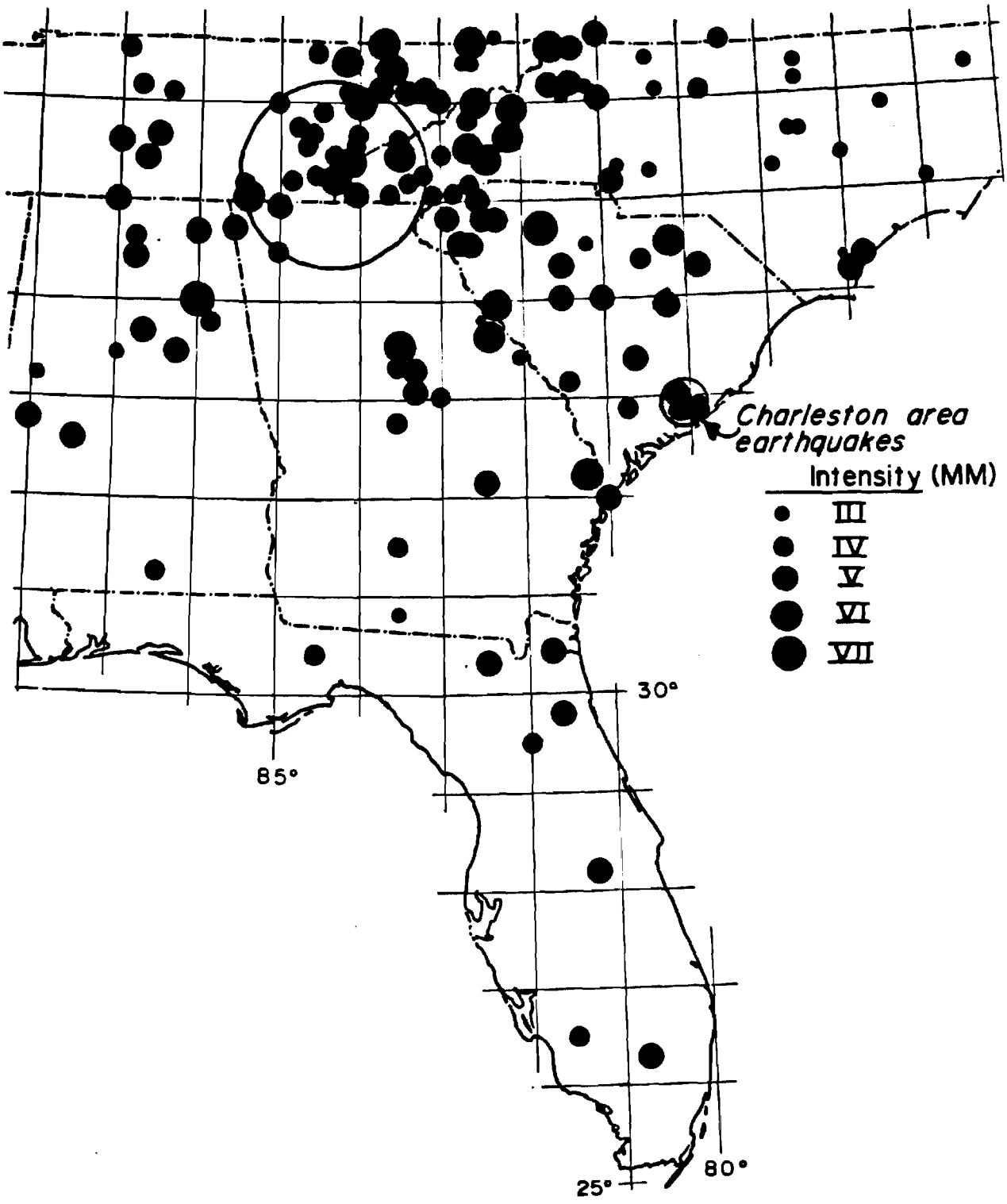

Figure 2. Regional Seismicity map. Circle denotes 100 km radius from the location of August 13, 1979 earthquake.

Intensity Survey

Immediately following the August 13, 1979 event Georgia Tech initiated an intensity survey in the immediately vicinity of the epicenter. Over 45 individual responses were obtained in the field or subsequently mailed to Georgia Tech. In addition the U.S. Geological Survey initiated a survey of post masters covering a considerably wider area. From these two sets of questionnaires, intensities were evaluated according to the Modified Mercalli scale and the felt reports are summarized in Figure 3. Table 1 is a summary of the intensity data showing the distribution of observed intensities at each community. The Intensity IV area has an approximate radius of 40 km and Intensity IV (MM) is considered the maximum intensity for the event. There were only a very few indications of Intensity V in the central area and these were not sufficient to justify a maximum intensity rating above IV. The total felt area was approximately 15,000 km^2 and the intensity IV area was about 5,000 km^2.

Location

Usable records for the East Tennessee event of August 13, 1979 were obtained from 15 regional seismic stations (see Table 2 for arrival times). The hypocenter determined from these arrival times is 35°13.20'N±1.91 km and 84°23.43'W ±1.63 km with an error ellipse with an area of 12.8 km^2 (see Table 2 for details). The depth of focus was 5.0 km ± 4.5 km. However, the depth of focus computation requires knowledge of the Moho depth near the epicenter. If the Moho depth is deeper than that of the model used for location (i.e. 33 km) the event may appear to be located above the surface. Hence, we modified the model in the location program to correspond to a depth of 49.6 km which

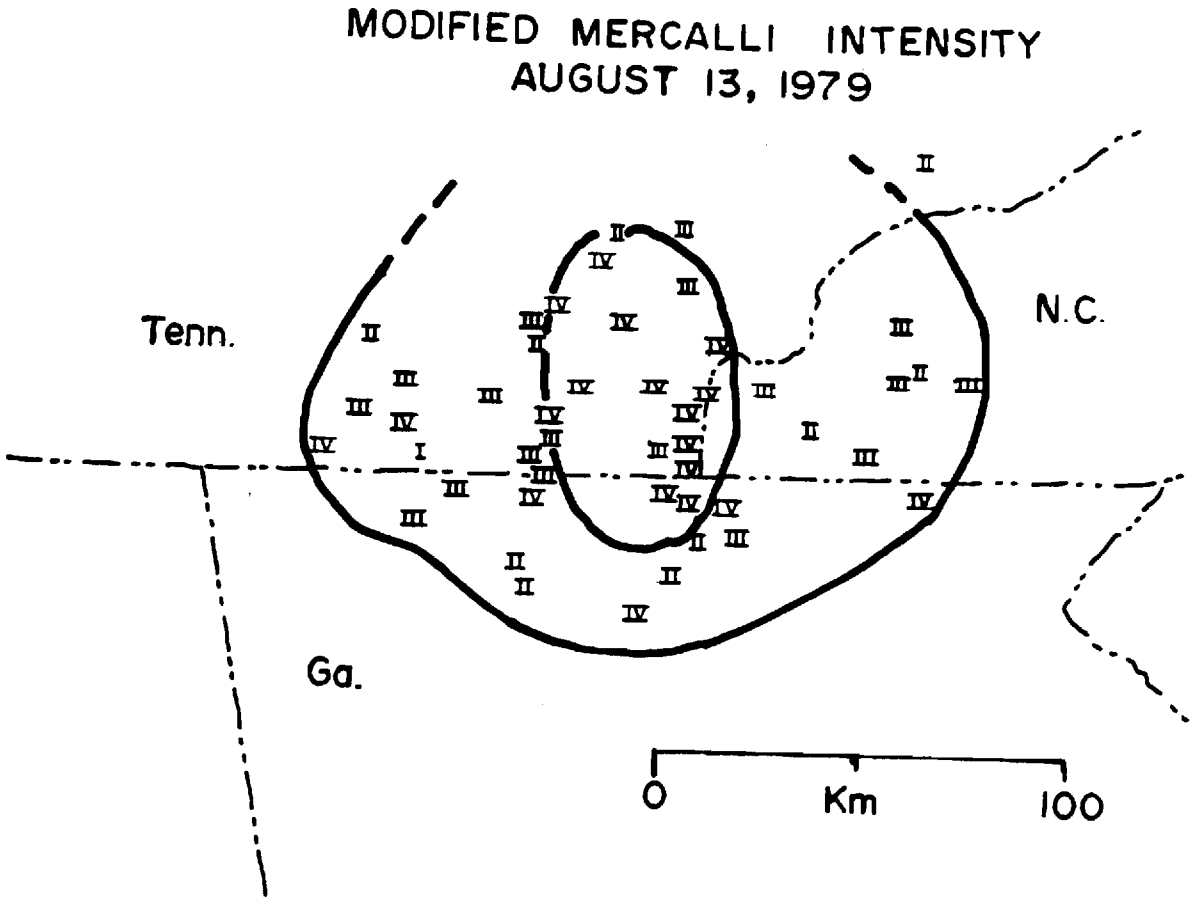

Figure 3. Distribution of Intensity Data (Modified Mercalli) for the August 13, 1979 earthquake in southeastern Tennessee.

Table 1. Summary of Intensity Data for the southeastern Tennessee event of August 13, 1979

City	County	State	Avg.	I	II	III	IV	V
				Intensity(ies)				
Copperhill	Polk	TN	III			1		
Old Fort	Polk	TN	III			1		
Murphy	Cherokee	NC	III		1	1	3	
Blue Ridge	Fannin	GA	III			1	1	
Unaka	Cherokee	NC	III			1		
Cherrylog	Gilmer	GA	II		1			
Hiawasse	Towns	GA	IV				1	
Epworth	Fannin	GA	IV				1	
Ooltewah	Hamilton	TN	IV				1	
Townsend	Blount	TN	II		1			
Benton	Polk	TN	IV				1	
Ducktown	Polk	TN	IV				6	1
Postelle	Polk	TN	III			1		
McCaysville	Fannin	GA	IV				1	
Tobbinsville	Monroe	TN	III			1		
Mt. Vernon	Monroe	TN	III			1		
Farner	Polk	TN	IV				1	
Apison	Hamilton	TN	I	1				
Cisco	Murray	GA	IV				1	
Ellijay	Gilmer	GA	IV				1	
Daisy	Hamilton	TN	II		1			
Varnell	Whitfield	GA	III			1		
Andrews	Cherokee	NC	III			1		
Harrison	Hamilton	TN	III			1		
Brasstown	Caly	NC	III			1		
Chattanooga	Hamilton	TN	IV				1	
Madisonville	Monroe	TN	III			2	2	
Cleveland	Bradley	TN	III		1	2	3	
Mineral Bluff	Fannin	GA	IV				1	
Charleston	Bradley	TN	III			1		
Telico Plains	Monroe	TN	IV			3	8	2
Delano	Polk	TN	IV			1	3	
Ocoee	Polk	TN	IV				1	
Reliance	Polk	TN	IV				1	
Marietta	Cobb	GA	I	1				
Cohutta	Whitfield	GA	III			1		
Chatsworth	Murray	GA	II		1			
Eton	Murray	GA	II		1			
Etowah	McMinn	TN	IV				1	
Aquone	Macon	NC	III			1		
Niota	McMinn	TN	II		1			
Shelbyville	Bedford	TN	II		1			
Riceville	McMinn	TN	IV				1	
Topton	Cherokee	NC	II		1			
Decatur	Meigs	TN	I	1				
Calhoun	McMinn	TN	IV				1	
Tenngo	Murray	GA	III			1		
Coker Creek	Monroe	TN	IV		1	3	3	1
Athens	McMinn	TN	IV				2	
Conasauga	Polk	TN	III			1		
Morganton	Fannin	GA	III			1		
Mixson	Hamilton	TN	III			1		
Turtletown	Polk	TN	IV				2	

Table 2. Arrival times at regional seismic stations and location data for the August 13, 1979 earthquake.

	Phase	Station	Arrival Hr	Min	Sec	Error ± Sec.
1	PLG	CDG	5	19	8.800	.100
2	SLG-PLG	CDG	0	0	8.800	.100
3	PLG	TVG	5	19	17.060	.100
4	PN	REG	5	19	31.100	.500
5	SN-PN	REG	0	0	25.040	.500
6	PN	CH6	5	19	31.200	.500
7	PN	EP1	5	19	31.150	.500
8	SN-PN	EP1	0	0	25.100	.500
9	PN	ETG	5	19	32.960	.500
10	PN	WDG	5	19	33.000	.500
11	SN-PN	WDG	0	0	25.560	.500
12	PLG	TKL	5	19	9.200	.100
13	SLG	TKL	5	19	18.200	.100
14	SLG-PLG	CPO	0	0	14.800	.100
15	PLG	SRN	5	19	50.500	1.000
16	SLG	SRN	5	20	28.300	1.000
17	PLG	SRW	5	19	51.800	1.000
18	SLG	SRW	5	20	32.000	1.000
19	PLG	SRD	5	19	50.000	1.000
20	SLG	SRD	5	20	30.800	1.000
21	PLG	SRN	5	19	52.000	1.000
22	SLG	SRN	5	20	28.200	1.000
23	PN	HBF	5	19	58.550	5.000
24	PN	SGS	5	19	54.950	5.000
25	PN	MTT	5	19	40.050	5.000
26	PN	LHS	5	19	45.400	5.000
27	PN	PRM	5	19	31.650	5.000
28	PN	CHF	5	19	29.950	5.000
29	PN	JSC	5	19	41.750	5.000
30	PN	SH1	5	20	4.500	5.000
31	SLG	SH1	5	21	11.300	5.000
32	PN	SH2	5	20	4.300	5.000
33	SLG	SH2	5	21	10.200	5.000
34	PN	SH3	5	20	5.700	5.000
35	SLG	SH3	5	21	12.100	5.000
36	PLG	BG3	5	19	20.170	1.000
37	PLG	LPM	5	19	18.900	1.000
38	PLG	SMT	5	19	20.140	1.000
39	PN	SRN	5	19	44.000	1.000
40	PN	SRW	5	19	45.300	1.000
41	PN	SRD	5	19	44.400	1.000
42	PN	SRN	5	19	43.400	1.000

Table 2. (Continued....)

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ
CDG	PLG	5	19	8.80	.10	72.24	200.5
CDG	SLG-PLG	0	0	8.80	.10	72.24	200.5
TVG	PLG	5	19	17.06	.10	125.03	221.9
REG	PN	5	19	31.10	.50	219.27	153.6
REG	SN-PN	0	0	25.04	.50	219.27	153.6
CH6	PN	5	19	31.20	.50	224.72	130.6
EP1	PN	5	19	31.15	.50	221.41	129.0
EP1	SN-PN	0	0	25.10	.50	221.41	129.0
ETG	PN	5	19	32.96	.50	233.93	155.6
WDG	PN	5	19	33.00	.50	231.02	150.9
WDG	SN-PN	0	0	25.56	.50	231.02	150.9
TKL	PLG	5	19	9.20	.10	74.22	48.9
TKL	SLG	5	19	18.20	.10	74.22	48.9
CPO	SLG-PLG	0	0	14.80	.10	115.19	291.2
HBF	PN	5	19	58.55	1.00	444.96	124.0
SGS	PN	5	19	54.95	1.00	418.61	121.9
JSC	PN	5	19	41.75	1.00	303.64	109.9
LHS	PN	5	19	45.40	1.00	336.31	104.0
PRM	PN	5	19	31.65	1.00	223.50	124.0
CHF	PN	5	19	29.95	1.00	211.05	128.5

ERROR ELLIPSE IS AS FOLLOWS:

SEMIMINOR AXIS LENGTH =	1.5248	KM.
SEMIMAJOR AXIS LENGTH =	2.6873	KM.
AZIMUTH OF MAJOR AXIS =	143.7282	DEG.
AREA OF ELLIPSE =	12.8731	SQ.KM.
ECCENTRICITY =	.8234	

MEAN RESIDUAL : .30749 STANDARD DEVIATION : .53015

is equivalent to subtracting exactly 2.0 seconds from the arrival times of the Pn phases. The depth of the Moho in the vicinity of the August 13, 1979 event varies from 40 to 55 km deep on the basis of data from Kean and Long (1980). The depth computed for an assumed Moho at 49.6 km was 9.7 km ± 4.5 km. Interpolation of the Moho depth from Kean and Long (1980) on the basis of the revised epicenter indicate a 45 km Moho depth. Then correcting the 9.7 km depth of focus for the difference between a 45 and 49.6 km deep Moho gives 5.0 km ± 4.5 km depth. This estimate is consistent with a 6.0 km depth of focus found for one of the aftershocks (see discussion below). If one assumes a 6 km depth of focus for the main shock, then the method of Kean and Long (1980) implies a 46.5 km deep Moho which is consistent with their data for the north Georgia area.

Magnitude

The magnitude of the event was determined from duration data from ten stations. For these stations the duration ranged from 240 to 270 seconds. Using Bollinger's (1979) formula

$$m_b = 2.44 \text{ Log}_{10} D - 2.87$$

a magnitude of 3.0 was found. Using a similar formula from the U. S. Geological Survey which they apply to the South Carolina seismic network

$$m(D) = 2.0 \text{ Log}_{10}(D) - 1.5$$

the magnitude was 3.6. We will assume an average magnitude of M(D) = 3.3 ± 0.3 as a reasonable estimate for the August 13, 1979 main event.

Focal Mechanism

A study of the directions of first motion was made for 16 stations (Table 3). The first motions were then evaluated for the domain of valid focal mechanisms using a computer technique developed in Guinn and

Table 3. First Motion data for southeastern Tennessee earthquake of August 13, 1979.

AZIMUTH	TOA	1ST MOTION
44.400	65.000	1.00
204.900	65.000	1.00
151.400	42.000	-1.00
156.200	42.000	-1.00
154.100	42.000	-1.00
130.500	42.000	-1.00
292.300	65.000	1.00
123.700	42.000	-1.00
128.400	42.000	-1.00
123.900	42.000	-1.00
121.700	42.000	-1.00
11.000	65.000	1.00
84.400	42.000	-1.00
85.400	42.000	-1.00
84.900	42.000	-1.00
221.100	65.000	1.00

TYPE 1, SPACE TO TOP OF PAGE AND PRESS RETURN

Long (1977). The distribution of first motions is given in Figure 4. The valid P T and B axes for these first motions are shown in Figure 5. The P-axis is constrained by the data distribution to (S45°E, 70° dip) within 20°. Two dominant zones of B and T axis are allowed. These indicate fault plains as given in Table 4.

Table 4. Fault plains for focal mechanism solutions

	Strike	Dip
Solution 1	N65W	25 S
	N80E	65N
Solution 2	N70W	50NE
	N10W	55W

We interpret the data in table 4 to imply normal faulting on northwest trending faults. The normal faulting mechanisms differs from previous focal mechanism for southeastern Tennessee which indicate thrust faulting (see Guinn 1977). This event and previous events indicate faulting which is normal to the dominant trend of the near surface faults and geologic units which represent Paleozoic deformation.

Aftershock Study

Associated with this event were four aftershocks recorded at regional stations within four hours of the main event. The third of these was recorded at four stations in the Georgia Tech network and was independently located at 35°17.8'N, 84°30.7°W. Its origin time was at 5:36:28.6 ± 0.9 sec on August 13, 1979.

Within one day after the main event on August 13, 1979 the Tennessee Earthquake Information Center and Georgia Institute of Technology established a joint aftershock monitoring network consisting of four smoked paper recorders. Records were changed daily by Georgia

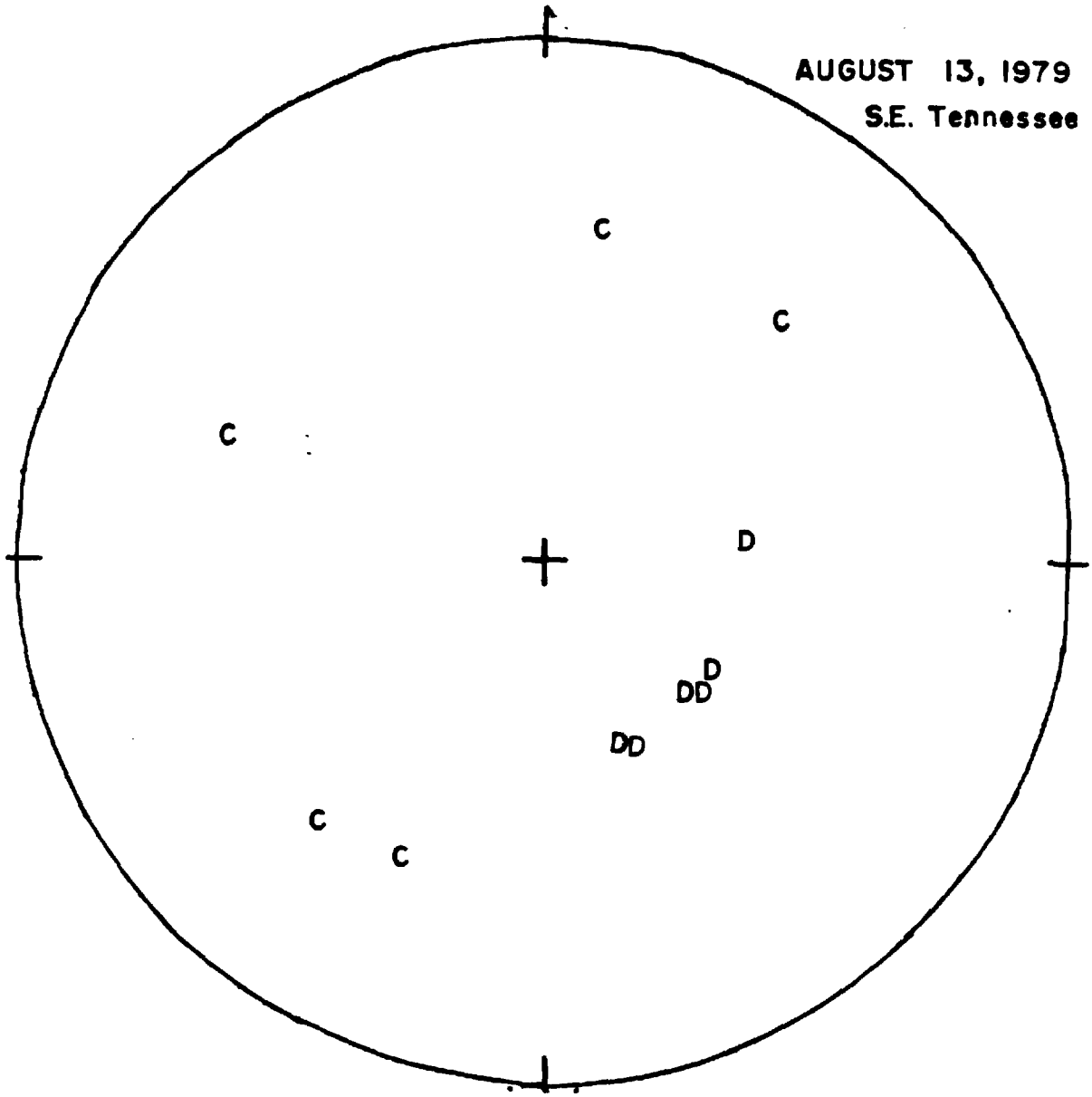

Figure 4. Lower hemisphere plot of first Motion data for the August 13, 1979 southeastern Tennessee earthquake.

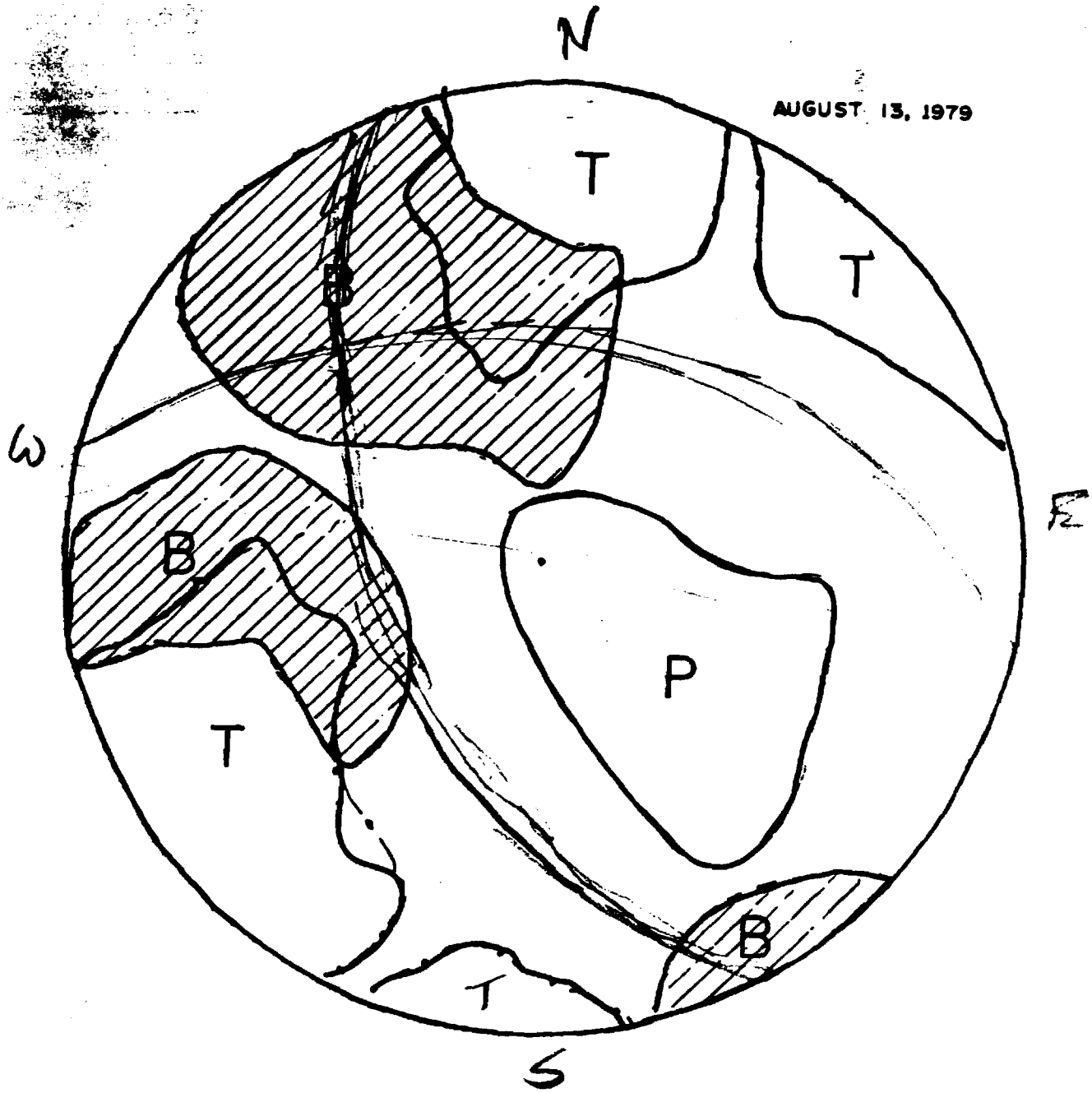

Figure 5. Lower hemisphere projection of valid P, T, and B, axis for the August 13, 1979 southeastern Tennessee earthquake.

Tech and Tennessee Valley Authority personnel for a period of one month and the timing was correlated with WWV daily. The stations were placed at locations surrounding the epicenter of the main event (see Table 6).

From August 14 to August 15, three possible aftershocks were recorded by these stations. One was recorded at only one station and was not located. The other two were located (see Table 5). The depth of focus for the aftershock occurring at 8:14:14.7 on August 15, 1979 was at 6.5 km. This value was used earlier to confirm the depth of the main event. After this aftershock, the temporary recording stations were relocated in order to better surround the epicenters of the recorded aftershocks (see Table 5).

These stations were operated for one month and during that time eleven possible aftershocks were recorded (see Table 6). Of these only

Table 6.

PLT	35°13'12.0"N, 84°27'37.5"W	1120 ft.
IVY	35°17'25.5"N, 84°26'43.5"W	1280 ft.
FCT	35°16'18.0"N, 84°22'18.0"W	1625 ft.
DRT	35°12'37.5"N, 84°21'45.0"W	1850 ft.

two were recorded at more than one station. During the aftershock monitoring period a magnitude 3.2 event was recorded on September 12, 1979. The event occurred near Maryville, TN. In addition, several teleseismic events and regional blasts were recorded.

Discussion of Results

The depth of focus of the events indicates a source in the basement rocks of the underthrust crust as interpreted from COCORP data (Cook). The focal mechanism deviates from past data and may indicate a highly non-uniform stress field in the crust. The depth of focus also may

explain why the maximum intensity was limited to IV(MM). Additional data are needed to clarify these results.

Acknowledgments

The Tennessee Earthquake Information Center provided coordination and assistance in establishing the aftershock monitoring program and also provided one of the portable instruments used in the monitoring. The aftershock monitoring was largely made possible by a grant from the Tennessee Valley Authority. Don Reinbolt of TVA assisted generously in the field work.

Table 5. Listing of events recorded during the aftershock monitoring of the August 13, 1979 earthquake in southeastern Tennessee.

EVENTS RECORDED : GEORGIA TECH EAST TENNESSEE NETWORK (TEMPORARY)

AUGUST - SEPTEMBER , 1979

DATE	STA.	A.T.	S-P	T	O.T.	DIST.	LOCATION/COMMENTS
08/14	BNC	08:21:34.43	11.87	16.78	08:21:20.15	95.04	NOT LOCATED
08/15	BNC	02:27:54.10	1.76	2.94	02:27:51.16	15.12	LATITUDE=35.0153 (350:00.92N) +/-3.438KM. NO DEPTH SEQUENCE
08/15	REL	02:27:54.30	2.68	3.14	02:27:51.16	18.24	LONGITUDE=84.4265 (84D:25.70W) +/-1.075
08/15	BNC	02:39:47.00	.85	1.17	02:39:45.83	6.83	NOT LOCATED: POSSIBLE BLAST
08/15	BNC	08:09:17.40	2.28	2.66	08:09:14.74	15.359	STATION NOT USED IN LOCATION ROUTINE
08/15	LBZ	08:09:17.76	2.22	3.02	08:09:14.74	16.62	LATITUDE=35.1519 (350:09.11N) +/-.043KM. NO DEPTH SEQUENCE
08/15	REL	08:09:17.75	2.19	3.01	08:09:14.74	16.51	LONGITUDE=84.3322 (84D:19.93W) +/-.056KM.
08/22	BRT	02:53:34.10	2.36	3.23	02:53:30.87	18.86	NOT LOCATED
08/22	BRT	05:30:18.45	2.49	3.41	05:30:15.04	19.88	NOT LOCATED
08/26	IVY	01:32:09.62	19.50	24.61	01:31:45.01	150.88	JUCASSEE, S.C. EVENT (MAGNITUDE 3.7)
08/26	FCT	01:32:09.38	18.60	24.37	01:31:45.01	142.94	LATITUDE=34.8471 (348:50.80N) NO DEPTH SEQUENCE
08/26	BRT	01:32:08.13	19.00	23.12	01:31:45.01	139.12	LONGITUDE=82.9467 (82D:56.80W)
08/26	IVY	03:40:04.45	3.70	1.70	03:40:02.75	24.82	LATITUDE=35.4946 (350:29.67N) +/-11.07KM.
08/26	BRT	03:40:06.70	3.85	3.95	03:40:02.75	30.77	LONGITUDE=84.4026 (84D:24.15W) +/-2.739KM.
08/29	FCT	01:15:46.45	2.36	3.23	01:15:43.2	18.86	NOT LOCATED: POSSIBLE AFTERSHOCK
08/30	BRT	04:14:53.98	2.93	4.02	04:14:49.96	23.45	NOT LOCATED: POSSIBLE AFTERSHOCK
08/31	BRT	06:26:18.79	2.38	3.27	06:26:15.52	19.07	NOT LOCATED
09/01	FCT	23:16:30.06	3.00	4.11	23:16:25.95	23.99	NOT LOCATED
09/04	PLT	04:18:36.54	3.01	4.12	04:18:32.42	24.07	NOT LOCATED
09/09	FCT	16:57:26.42	3.44	4.71	16:57:21.71	27.53	NOT LOCATED
09/09	BRT	12:11:19.80	.47	.65	12:11:19.15	3.77	NOT LOCATED
09/11	IVY	03:43:30.88	*	*	*	*	NOT LOCATED: ARRAIGNMENT TIMING ERRORS?
09/11	PLT	03:43:38.13	*	*	*	*	ONLY ONE POSSIBLE PG PHASE OBSERVED
09/11	BRT	03:43:48.34	.80	1.01	03:43:55.35	5.91	
09/11	FCT	03:43:54.28	*	*	*	*	
09/11	IVY	04:25:31.13	10.50	12.85	04:25:18.28	77.35	LATITUDE 35.9420 (35D:56.52N) +/- 10.734KM. DEPTH=8.000KM.
09/11	FCT	04:25:31.47	11.00	13.19	04:25:18.28	82.74	LONGITUDE=84.7756 (84D:43.54W) +/ 5.894KM.
09/11	PLT	04:25:32.74	10.75	14.46	04:25:18.28	84.15	
09/11	BRT	04:25:32.87	12.00	14.59	04:25:18.28	88.21	
09/12	IVY	06:24:14.00	6.60	8.17	06:24:05.19	48.28	LATITUDE=35.4938 (350:29.62N) NO DEPTH SEQUENCE
09/12	FCT	06:24:13.46	*	7.63	06:24:05.19	43.89	LONGITUDE=83.9175 (83D:55.05W)
09/12	PLT	06:24:16.59	7.15	10.76	06:24:05.19	55.03	STATIONS FC1, BRT SATURATED
09/12	BRT	06:24:14.58	*	8.75	06:24:05.19	50.57	HARRYVILLE EVENT

NOTES:
1. ALL DISTANCES ARE IN KILOMETERS.
2. S-P, T ARE GIVEN IN SECONDS.
3. IF AN EVENT WAS NOT LOCATED, T, DIST. ARE ARRIVED UPON AS FOLLOWS:
   T=1.37(S-P) DIST=8.0(S-P)

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LOCATED ON: 80/07/07. 14.37.26.
****

THE EVENT OCCURED ON AUG 13, 1979
AT ORIGIN TIME 5:18:56.60 +/- .247
EAST TENNESSEE MAIN EVENT
MAGNITUDE: 3.3
THE WEIGHTS ARE
WX= 1.000 WY= 1.000 WZ= 0.000 WT= 1.000
IT WAS LOCATED AT
LATITUDE 35.2200 +/- 1.908 KM. (35D,13.20M)
LONGITUDE 84.3904 +/- 1.634 KM. (84D,23.43M)
DEPTH 6.00 +/- 0.000 KM.

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ	OBS-THL
CDG	PLG	5	19	8.80	.10	72.24	200.5	-.109
CDG	SLG-PLG	0	0	8.80	.10	72.24	200.5	-.292
TVG	PLG	5	19	17.06	.10	125.03	221.9	-.575
REG	PN	5	19	31.10	.50	219.27	153.6	.711
REG	SN-PN	0	0	25.04	.50	219.27	153.6	.016
CH6	PN	5	19	31.20	.50	224.72	130.6	.148
EP1	PN	5	19	31.15	.50	221.41	129.0	.502
EP1	SN-PN	0	0	25.10	.50	221.41	129.0	-.113
ETG	PN	5	19	32.96	.50	233.93	155.6	.786
WDG	PN	5	19	33.00	.50	231.02	150.9	1.170
WDG	SN-PN	0	0	25.56	.50	231.02	150.9	-.517
TKL	PLG	5	19	9.20	.10	74.22	48.9	-.037
TKL	SLG	5	19	18.20	.10	74.22	48.9	-.348
CPG	SLG-PLG	0	0	14.80	.10	115.19	291.2	.750
HBF	PN	5	19	58.55	1.00	444.96	124.0	.651
SGS	PN	5	19	54.95	1.00	418.61	121.9	.268
JSC	PN	5	19	41.75	1.00	303.64	109.9	1.076
LHS	PN	5	19	45.40	1.00	336.31	104.0	.742
PRM	PN	5	19	31.65	1.00	223.50	124.0	.735
CHF	PN	5	19	29.95	1.00	211.05	129.5	.535

DIAGONAL ELEMENTS
1.5209 1.3424 .1695

COVARIANCE MATRIX:

12.948	5.491	-1.293
5.491	9.495	-.942
-1.293	-.942	.217

ERROR ELLIPSE IS AS FOLLOWS:
SEMIMINOR AXIS LENGTH = 1.5248 KM.
SEMIMAJOR AXIS LENGTH = 2.6873 KM.
AZIMUTH OF MAJOR AXIS = 143.7282 DEG.
AREA OF ELLIPSE = 12.8730 SQ.KM.
ECCENTRICITY = .8234

MEAN RESIDUAL : .30748 STANDARD DEVIATION : .53015
NO DEPTH COMPUTATION

LOCATED ON: 80/07/07. 14.53.39.
****

THE EVENT OCCURED ON AUG 13, 1979
AT ORIGIN TIME 5:18:56.61 +/- .163
EAST TENNESSEE MAIN EVENT
MAGNITUDE: 3.3
THE WEIGHTS ARE
WX= 1.000 WY= 1.000 WZ= 1.000 WT= 1.000
IT WAS LOCATED AT
LATITUDE 35.1808 +/- 2.043 KM. (35D;10.85M)
LONGITUDE 84.3407 +/- 1.775 KM. (84D;20.44M)
DEPTH 15.53 +/- 4.201 KM.

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ	OBS-TH.
CDG	PLG	5	19	8.80	.10	69.98	205.3	.321
CDG	SLG-PLG	0	0	8.80	.10	69.98	208.3	.097
TVG	PLG	5	19	17.06	.10	124.97	224.8	-.509
REG	PN	5	19	29.10	.50	213.40	154.2	.166
REG	SN-PN	0	0	23.64	.50	213.40	154.2	-.385
CHA	PN	5	19	29.20	.50	218.50	130.5	-.354
EP1	PN	5	19	29.15	.50	215.21	128.9	-.002
EP1	SN-PN	0	0	23.70	.50	215.21	128.9	-.385
ETG	PN	5	19	30.96	.50	228.14	156.2	.232
WDG	PN	5	19	33.00	.50	225.06	151.4	.644
WDG	SN-PN	0	0	24.16	.50	225.06	151.4	-.806
TKL	PLG	5	19	9.20	.10	73.93	44.1	.067
TKL	SLG	5	19	18.20	.10	73.93	44.1	-.094
CPO	SLG-PLG	0	0	14.80	.10	121.06	299.4	-.185
HBF	PN	5	19	56.55	1.00	438.89	128.9	.130
SGS	PN	5	19	52.95	1.00	413.54	121.7	-.264
JSC	PN	5	19	39.75	1.00	298.03	109.4	.500
LHS	PN	5	19	43.40	1.00	331.02	102.5	.127
PRM	PN	5	19	29.65	1.00	217.38	123.7	.225
CHF	PN	5	19	27.95	1.00	204.85	129.4	.061

DIAGONAL ELEMENTS
1.8783 1.6245 .1797 4.6240

COVARIANCE MATRIX:

34.072	24.079	-.416	56.131
24.079	25.713	-.143	49.822
-.416	-.143	.216	1.859
56.131	49.822	1.859	144.050

ERROR ELLIPSE IS AS FOLLOWS:
SEMIMINOR AXIS LENGTH = .8908 KM.
SEMIMAJOR AXIS LENGTH = 2.8115 KM.
AZIMUTH OF MAJOR AXIS = 139.9233 DEG.
AREA OF ELLIPSE = 7.8620 SQ.KM.
ECCENTRICITY = .9485

MEAN RESIDUAL : .00293 STANDARD DEVIATION : .35001
WOULD YOU BELIEVE IT CONVERGED
VELOCITY RATIO COMPUTATION COMPLETE

LOCATED ON: 80/07/07. 15.12.07.
****

THE EVENT OCCURED ON AUG 13, 1979
AT ORIGIN TIME 5:36:28.57 +/- .850
EAST TENNESSEE EVENT AFTERSHOCK #3
MAGNITUDE: /
THE WEIGHTS ARE
WX= 1.000 WY= 1.000 WZ= 0.000 WT= 1.000
IT WAS LOCATED AT
LATITUDE 35.2959 +/- 5.557 KM. (35D.17.75M)
LONGITUDE 84.5093 +/- 4.554 KM. (84D.30.56M)
DEPTH 1.00 +/- 0.000 KM.

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ	OBS-TH
TVG	PLG	5	36	50.05	.10	124.85	215.6	.453
TVG	SLG-PLG	0	0	15.50	.10	124.85	215.6	.275
CDG	PLG	5	36	41.90	.10	77.46	190.7	.134
CDG	SLG	5	36	50.50	.10	77.46	190.7	-1.013
TKL	PLG	5	36	42.00	.10	78.01	58.9	.144
TKL	SLG	5	36	51.00	.10	78.01	58.9	-.667
CH5	PN	5	37	10.35	.30	264.55	130.4	2.091
CH5	SN	5	37	40.00	.30	264.55	130.4	2.377
ETG	PN	5	37	5.10	.30	246.04	154.1	-.903
ETG	SN	5	37	33.00	.30	246.04	154.1	-.716

DIAGONAL ELEMENTS
1.8996 1.5406 .2509

COVARIANCE MATRIX:

116.387	99.660	3.319
99.660	93.671	3.160
3.319	3.160	.210

ERROR ELLIPSE IS AS FOLLOWS:
SEMIMINOR AXIS LENGTH = 2.9782 KM.
SEMIMAJOR AXIS LENGTH = 19.6343 KM.
AZIMUTH OF MAJOR AXIS = 138.2509 DEG.
AREA OF ELLIPSE = 183.7074 SQ.KM.
ECCENTRICITY = .9884

MEAN RESIDUAL : .21737 STANDARD DEVIATION : 1.19649
NO DEPTH COMPUTATION

LOCATED ON: 80/07/07. 15.21.32.
****

THE EVENT OCCURED ON AUG 13, 1979
AT ORIGIN TIME 5:36:29.04 +/- .776
EAST TENNESSEE EVENT AFTERSHOCK #3
MAGNITUDE: /
THE WEIGHTS ARE
WX= 1.000 WY= 1.000 WZ= 1.000 WT= 1.000
IT WAS LOCATED AT
LATITUDE 35.2475 +/- 11.458 KM. (35D;14.85M)
LONGITUDE 84.4351 +/- 9.148 KM. (84D;26.10M)
DEPTH 11.15 +/- 17.657 KM.

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ	O-C TIME
TUG	PLG	5	36	50.05	.10	124.70	219.6	+.[illegible]
TUG	SLG-PLG	0	0	15.50	.10	124.70	219.6	-.[illegible]
CDG	PLG	5	36	41.90	.10	73.84	196.7	-.[illegible]
CDG	SLG	5	36	50.50	.10	73.84	196.7	-.201
TKL	PLG	5	36	42.00	.10	75.45	52.7	+.[illegible]
TKL	SLG	5	36	51.00	.10	75.45	52.7	-.[illegible]
CHS	PN	5	37	8.35	.30	256.02	130.5	1.[illegible]
CHS	SN	5	37	36.60	.30	256.02	130.5	1.[illegible]
ETG	PN	5	37	3.10	.30	238.36	155.0	-1.[illegible]
ETG	SN	5	37	29.60	.30	238.36	155.0	-1.[illegible]

DIAGONAL ELEMENTS
3.4958 2.7712 .2392 5.7969

COVARIANCE MATRIX:

111.485	84.532	-5.468	156.390
84.532	71.018	-4.453	124.438
-5.468	-4.453	.511	-5.754
156.390	124.438	-5.754	264.558

ERROR ELLIPSE IS AS FOLLOWS:
SEMIMINOR AXIS LENGTH = 2.7592 KM.
SEMIMAJOR AXIS LENGTH = 17.7563 KM.
AZIMUTH OF MAJOR AXIS = 141.7177 DEG.
AREA OF ELLIPSE = 153.9152 SQ.KM.
ECCENTRICITY = .9879

MEAN RESIDUAL : .03733 STANDARD DEVIATION : 1.08559
WOULD YOU BELIEVE IT CONVERGED
VELOCITY RATIO COMPUTATION COMPLETE

LOCATED ON: 80/07/07. 15.47.46.
****

THE EVENT OCCURED ON AUG 15, 1979
AT ORIGIN TIME 2:27:51.72 +/- .323
EAST TENNESSEE AFTERSHOCK #6
MAGNITUDE: /
THE WEIGHTS ARE
WX= 1.000 WY= 1.000 WZ= 0.000 WT= 1.000
IT WAS LOCATED AT
LATITUDE 35.2471 +/- 2.761 KM. (35D,14.82M)
LONGITUDE 84.3891 +/- 2.230 KM. (84D,23.35M)
DEPTH 5.00 +/- 0.000 KM.

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ	OBS-THE
SMC	PLG	2	27	54.10	.50	11.05	196.9	.184
SMC	SLG-PLG	0	0	1.76	.50	11.05	196.9	-.262
REL	PLG	2	27	54.30	.50	14.49	230.9	-.184
REL	SLG-PLG	0	0	2.69	.50	14.49	230.9	.262

DIAGONAL ELEMENTS
7.4642 6.0301 .8724

COVARIANCE MATRIX:

121.782	45.875	4.030
45.875	63.633	-4.439
4.030	-4.439	1.434

ERROR ELLIPSE IS AS FOLLOWS:
SEMIMINOR AXIS LENGTH = 2.8070 KM.
SEMIMAJOR AXIS LENGTH = 5.4928 KM.
AZIMUTH OF MAJOR AXIS = 151.1828 DEG.
AREA OF ELLIPSE = 48.4383 SQ.KM.
ECCENTRICITY = .8596

MEAN RESIDUAL : -.00000 STANDARD DEVIATION : .26154
NO DEPTH COMPUTATION

LOCATED ON: 80/07/07. 16.24.55.
****

THE EVENT OCCURED ON AUG 15, 1979
AT ORIGIN TIME 8: 9:15.26 +/-   .142
EAST TENNESSEE EVENT AFTERSHOCK #7
MAGNITUDE: /
THE WEIGHTS ARE
WX= 1.000 WY= 1.000 WZ= 1.000 WT= 1.000
IT WAS LOCATED AT
LATITUDE   35.2334 +/-   .961 KM. (35D.14.01M)
LONGITUDE 84.3930 +/-   .854 KM. (84D.23.59M)
DEPTH   6.49   +/-   1.004 KM.

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ	OBS-THL
REL	PG	8	9	17.80	1.00	14.93	235.0	-.174
REL	SP1	0	0	2.25	.10	14.93	235.0	-.209
LG2	PG	8	9	17.77	1.00	14.48	57.9	-.123
LG2	SP1	0	0	2.25	.10	14.48	57.9	-.136
UGT	PG	8	9	17.22	1.00	8.84	344.2	.352
UGT	SP1	0	0	1.73	.10	8.84	344.2	.074
SMC	PG	8	9	17.35	1.00	11.80	197.5	-.050
SMC	SP1	0	0	2.10	.10	11.80	197.5	.157

DIAGONAL ELEMENTS
2.1930 1.9421 .5785 1.6773

COVARIANCE MATRIX:

24.532	13.768	-.313	6.063
13.768	19.375	-.421	4.718
-.313	-.421	.535	-2.739
6.063	4.718	-2.739	26.804

ERROR ELLIPSE IS AS FOLLOWS:
SEMIMINOR AXIS LENGTH = .7256 KM.
SEMIMAJOR AXIS LENGTH = 1.5437 KM.
AZIMUTH OF MAJOR AXIS = 140.3040 DEG.
AREA OF ELLIPSE = 3.5190 SQ.KM.
ECCENTRICITY = .8826

MEAN RESIDUAL : -.01437 STANDARD DEVIATION : .19398
WOULD YOU BELIEVE IT CONVERGED
VELOCITY RATIO COMPUTATION COMPLETE

LOCATED ON: 80/07/07. 16.33.05.
****

THE EVENT OCCURED ON AUG 26, 1979
AT ORIGIN TIME 3:40: .86 +/- .588
EAST TENNESSEE EVENT AFTERSHOCK #10
MAGNITUDE: /
THE WEIGHTS ARE
WX= 1.000 WY= 1.000 WZ= 0.000 WT= 1.000
IT WAS LOCATED AT
LATITUDE 35.4829 +/- 12.773 KM. (35D,28.97M)
LONGITUDE 84.4372 +/- 3.217 KM. (84D,26.23M)
DEPTH 6.00 +/- 0.000 KM.

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ	OBS-THE
IVY	PLG	3	40	4.45	.50	21.54	181.5	-.335
IVY	SLG-PLG	0	0	3.70	.50	21.54	181.5	.479
DRT	PLG	3	40	6.70	.50	31.10	166.5	.335
DRT	SLG-PLG	0	0	3.85	.50	31.10	166.5	-.479

DIAGONAL ELEMENTS
18.9427 4.7713 .8724

COVARIANCE MATRIX:

717.530	-71.969	-.557
-71.969	44.532	-5.861
-.557	-5.861	1.462

ERROR ELLIPSE IS AS FOLLOWS:
SEMIMINOR AXIS LENGTH = 5.0181 KM.
SEMIMAJOR AXIS LENGTH = 22.2387 KM.
AZIMUTH OF MAJOR AXIS = 6.0361 DEG.
AREA OF ELLIPSE = 350.5928 SQ.KM.
ECCENTRICITY = .9742

MEAN RESIDUAL : -.00000 STANDARD DEVIATION : .47590
NO DEPTH COMPUTATION

LOCATED ON: 80/07/07. 16.56.25.
****

THE EVENT OCCURED ON SEP 12, 1979
AT ORIGIN TIME 6:24: 4.86 +/- .354
MARYVILLE, TENNESSEE EVENT
MAGNITUDE: 3.2
THE WEIGHTS ARE
WX= 1.000 WY= 1.000 WZ= 0.000 WT= 1.000
IT WAS LOCATED AT
LATITUDE 35.5151 +/- 1.991 KM. (35D,30.90M)
LONGITUDE 83.8927 +/- 2.386 KM. (83D,53.56M)
DEPTH 5.00 +/- 0.000 KM.

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ	OBS-C
IVY	PLG	6	24	14.00	.10	55.91	242.4	-.471
IVY	SLG-PLG	0	0	6.60	.10	55.91	243.4	-.607
PLT	PLG	6	24	15.59	.10	61.01	237.6	.277
PLT	SLG-PLG	0	0	7.15	.10	61.01	237.6	-.646
FCT	PLG	6	24	13.46	.10	48.62	236.3	.194
DRT	PLG	6	24	14.85	.10	54.04	231.4	.687
GBG	PN	6	24	41.30	.40	231.95	164.2	1.032
GBG	PLG	6	24	42.30	.20	231.95	164.2	-1.267
GBG	SN	6	25	5.30	.50	231.95	164.2	-1.184
GBG	SLG	6	25	10.70	.20	231.95	164.2	-.423
CH6	PN	6	24	39.00	.40	218.66	145.0	.355
CH6	PLG	6	24	41.60	.30	218.66	145.0	.230
CH6	SLG	6	25	9.30	.30	218.66	145.0	1.911
ETG	PN	6	24	43.70	.20	251.50	168.4	1.050
ETG	PLG	6	24	46.20	.30	251.50	168.4	-.598
WDG	PN	6	24	42.90	.50	244.42	164.2	1.110
WDG	PLG	6	24	45.10	.30	244.42	164.2	-.529
EP1	PLG	6	24	39.90	.10	213.98	143.7	-.681
EP1	SLG	6	25	6.30	.20	213.88	143.7	.259
CDG	PLG	6	24	24.70	.10	122.55	215.3	-.785
CDG	SLG	6	24	40.40	.20	122.55	215.3	.900
ORT	PLG	6	24	13.30	.20	59.15	320.1	-1.700
BLA	PN	6	24	56.00	.20	366.90	58.2	-.761
CRG	PLG	6	24	37.00	.20	152.44	273.7	2.572
PRM	PN	6	24	38.20	.20	210.87	136.4	.496

DIAGONAL ELEMENTS
.7710 1.0432 .1524

COVARIANCE MATRIX:

4.570	-.134	-.679
-.134	7.293	-1.698
-.679	-1.698	.760

ERROR ELLIPSE IS AS FOLLOWS:
SEMIMINOR AXIS LENGTH = 2.2379 KM.
SEMIMAJOR AXIS LENGTH = 2.8302 KM.
AZIMUTH OF MAJOR AXIS = 87.1850 DEG.
AREA OF ELLIPSE = 19.8975 SQ.KM.
ECCENTRICITY = .6122

MEAN RESIDUAL : .02056 STANDARD DEVIATION : 1.002/2
NO DEPTH COMPUTATION

****

THE EVENT OCCURED ON SEP 12, 1979
AT ORIGIN TIME 6:24: 4.79 +/- .415
MARYVILLE, TENNESSEE EVENT
MAGNITUDE: 3.2
THE WEIGHTS ARE
WX= 1.000 WY= 1.000 WZ= 1.000 WT= 1.000
IT WAS LOCATED AT
LATITUDE 35.5287 +/- 2.113 KM. (35D,31.72M)
LONGITUDE 83.8848 +/- 2.383 KM. (83D,53.09M)
DEPTH 28.44 +/- 5.830 KM.

STATION	PHASE	HR	MIN	SEC	+OR-SEC	DIST	AZ	OBS-THE
IVY	PLG	6	24	14.00	.10	57.23	242.4	-.482
IVY	SLG-PLG	0	0	6.60	.10	57.23	242.4	-.472
PLT	PLG	6	24	15.59	.10	62.43	236.8	.250
PLT	SLG-PLG	0	0	7.15	.10	62.43	236.8	[illegible]
FCT	PLG	6	24	13.46	.10	50.06	235.3	[illegible]
DRT	PLG	6	24	14.85	.10	55.55	230.6	.645
GBG	PN	6	24	39.30	.40	233.21	164.5	.768
GBG	PLG	6	24	42.30	.20	233.21	164.5	-1.268
GBG	SN	6	25	1.90	.50	233.21	164.5	-1.548
GBG	SLG	6	25	10.70	.20	233.21	164.5	[illegible]
CH6	PN	6	24	37.00	.40	219.49	145.4	[illegible]
CH6	PLG	6	24	41.60	.30	219.49	145.4	.300
CH6	SLG	6	25	9.30	.30	219.49	145.4	2.173
ETG	PN	6	24	41.70	.20	252.84	168.7	.777
ETG	PLG	6	24	46.20	.30	252.84	168.7	-.612
WDG	PN	6	24	40.90	.50	245.69	164.5	.811
WDG	PLG	6	24	45.10	.30	245.69	164.5	-.530
EP1	PLG	6	24	39.90	.10	214.68	144.0	[illegible]
EP1	SLG	6	25	6.30	.20	214.68	144.0	.524
CDG	PLG	6	24	24.70	.10	124.20	215.1	[illegible]
CDG	SLG	6	24	40.40	.20	124.20	215.1	[illegible]
ORT	PLG	6	24	13.30	.20	58.47	318.7	[illegible]
BLA	PN	6	24	54.60	.20	345.44	58.3	[illegible]
CPO	PLG	6	24	33.90	.20	153.06	272.7	[illegible]
PRM	PN	6	24	36.20	.20	211.52	138.2	[illegible]

DIAGONAL ELEMENTS

.8295 1.0490 .1770 3.0720

COVARIANCE MATRIX:

4.513	-1.583	.327	4.270
-1.583	5.739	-.735	-1.307
.327	-.735	.174	1.280
4.270	-1.307	1.280	34.355

ERROR ELLIPSE IS AS FOLLOWS:
SEMIMINOR AXIS LENGTH = 1.9691 KM.
SEMIMAJOR AXIS LENGTH = 2.7781 KM.
AZIMUTH OF MAJOR AXIS = 55.5801 DEG.
AREA OF ELLIPSE = 17.1859 SQ.KM.
ECCENTRICITY = .7054

MEAN RESIDUAL : .01453 STANDARD DEVIATION : .9[illegible]
WOULD YOU BELIEVE IT CONVERGED
VELOCITY RATIO COMPUTATION COMPLETE