UNITED STATES DEPARTMENT OF THE INTERIOR

U. S. GEOLOGICAL SURVEY

The Carbondale, Colorado, earthquake swarm of April - May, 1984

Open-File Report 88-417

by

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This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.

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ABSTRACT

During the Carbondale, Colorado, earthquake swarm ($M_L \leq 3.2$) of April - May 1984, a total of 34 earthquakes were located using regional data or local data from a temporary network installed in the epicentral area. These earthquakes were relocated with the method of Joint Hypocenter Determination (JHD) in order to better delineate the source zone of the swarm. The majority of the earthquakes occurred about 7 km south-southwest of Carbondale, at the northern terminus of the Elk Mountain anticline. The most precisely determined hypocenters of the swarm have focal depths in the 2 to 7 km range. Two composite focal mechanisms were constructed from local first-motion data. One of these mechanisms corresponds to normal faulting and the second suggests reverse faulting.

INTRODUCTION

A series of small earthquakes in the Carbondale, Colorado, area (Figure 1) began with a magnitude 2.2 (M_L) earthquake on 12 April 1984. Throughout the next four weeks, seventeen additional earthquakes ranging in magnitude from 1.9 to 3.2 (M_L) were located by the U.S. Geological Survey, National Earthquake Information Center (NEIC), using regional data from the U.S. Telemetered Network in Golden.

Nine of the earthquakes were felt in the Carbondale area. The largest of these shocks, which occurred on 14 May 1984, had a local magnitude of 3.2 and caused Modified Mercalli intensity IV effects at Carbondale. This event was also felt at Glenwood Springs, about 18 km northwest of Carbondale. Focal parameters of the May 14 earthquake determined by Wong (1986) indicate normal faulting with a minor component of strike-slip displacement (see inset in Figure 1).

The continuation of the seismic activity, including the occurrence of the M_L3.2 event on May 14, prompted us to investigate the source of the seismic activity. Accordingly, we began the installation of a nine-station temporary seismic network in the epicentral area on 16 May 1984. This network was fully operational from 17 to 31 May 1984. Seventeen additional earthquakes with duration magnitudes (M_D) from 1.3 to 2.6 were located using data from the portable network.

REGIONALLY-RECORDED EARTHQUAKES

Seventeen earthquakes in the Carbondale earthquake swarm of April-May 1984 were located by the NEIC (USGS, 1984b,c) using regional data from permanent stations in Colorado and neighboring states (Table 1). As shown by the open symbols in Figure 2, the epicentral pattern of these shocks forms a northwest-trending, elongate zone situated about 10 km southwest of Carbondale. Hypocentral depths for these solutions were fixed at 5.0 km. Location parameters for these epicenters are compiled in Table 2.

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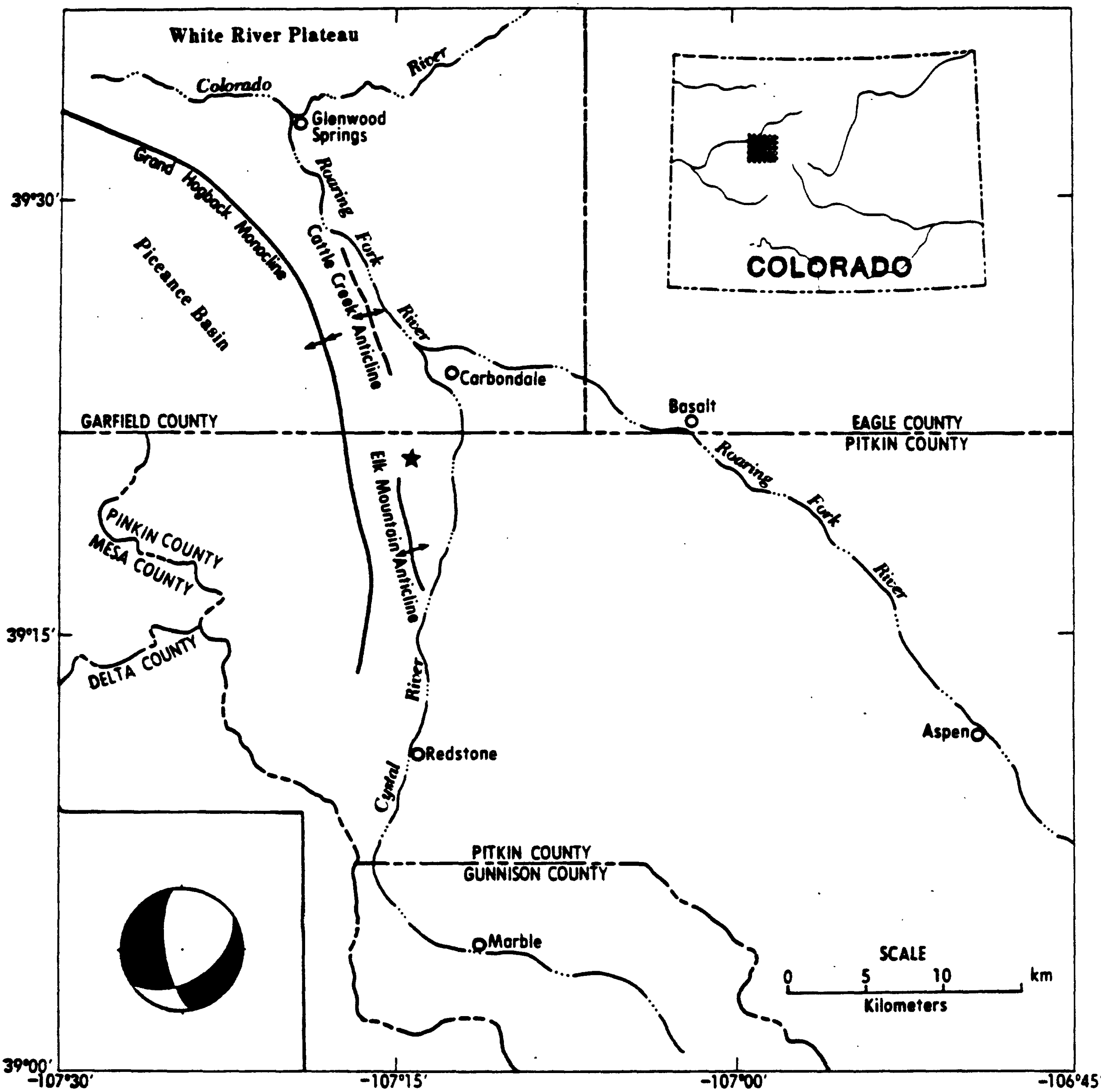


FIGURE 1.–Regional map of west-central Colorado, showing principal geographic and geologic features. Solid lines indicate axes of Grand Hogback monocline and Elk Mountain anticline (Tweto and others, 1978). Dashed line designates axis of Cattle Creek anticline, inferred from Mallory (1966). Inset shows the focal mechanism (Wong, 1986) of the 14 May 1984 Carbondale earthquake (M_L=3.2). The epicenter for this earthquake is shown as a star on the map.

Table 1: Regional stations used in the location of Carbondale earthquakes

Station Code	Station Name	Latitude (deg,min)	Longitude (deg,min)	Elevation (m)
ALQ	Albuquerque, NM	34N56.550	106W27.450	1849
BDW	Boulder, WY	42N46.572	109W34.098	2190
BKU	Beaver Lake Mtns, UT	38N32.112	113W07.608	1859
DUG	Dugway, UT	40N11.700	112W48.798	1477
GOL	Bergen Park, CO	39N42.018	105W22.266	2359
GLD	Golden, CO	39N45.036	105W13.284	1762
MSU	Marysvale, UT	38N30.798	112W10.452	2141
PV01	The Burn, CO	38N08.064	108W34.380	2182
PV02	Monogram Mesa, CO	38N12.438	108W44.232	2166
PV03	Wild Steer, CO	38N15.258	108W50.880	2007
PV04	Carpenter Flat, CO	38N23.604	108W54.324	1756
PV05	Three Step, CO	38N04.692	109W05.952	2115
PV06	Coal Canyon, CO	38N19.950	108W27.462	2213
PV07	Long Mesa, CO	38N26.280	108W38.802	2001
PV10	South La Sal, CO	38N22.578	109W02.328	2316
RMU	Rainbow Monument, UT	37N04.560	110W58.200	1536
RSSD	Black Hills, SD	44N07.224	104W02.172	2060
RW3	Ridgway 3, CO	38N15.012	107W41.220	2603
RW5	Ridgway 5, CO	38N04.800	107W49.950	2991
RW6	Ridgway 6, CO	38N12.138	107W56.028	3063

Table 2: Epicenters of regionally recorded Carbondale earthquakes determined by the NEIC (USGS, 1984b,c)

Eq. no.*	Date (ymd)	Origin time	Lat (deg)	Long (deg)	Dep (km)	Mag (ML)	Nsta	Comments
401	840412	2016 57.8#	39.298N	107.232W	5.0G	2.2	9	Felt 7 mi south of Carbondale.
402	840422	1730 56.7#	39.281N	107.190W	5.0G	3.1	10	Felt (IV) at Carbondale. Also felt in parts of Eagle County.
403	840503	1825 35.4?	39.29N	107.23W	5.0G	2.5	6	
404	840503	1828 54.1?	39.30N	107.25W	5.0G	3.0	7	Felt at Carbondale.
405	840503	1918 23.0?	39.33N	107.25W	5.0G	2.3	6	
406	840504	117 10.4?	39.33N	107.27W	5.0G	2.4	6	
407	840504	213 33.1?	39.34N	107.25W	5.0G	2.2	6	Felt at Carbondale.
408	840504	1844 37.4?	39.28N	107.20W	5.0G	2.2	5	
409	840506	200 56.6?	39.33N	107.25W	5.0G	2.1	6	Felt at Carbondale.
410	840506	212 49.7?	39.34N	107.25W	5.0G	2.3	6	Felt at Carbondale.
411	840506	213 34.4?	39.35N	107.26W	5.0G	2.6	6	Felt at Carbondale.
412	840506	251 36.9?	39.33N	107.23W	5.0G	2.2	6	Felt at Carbondale.
413	840506	417 35.5?	39.35N	107.26W	5.0G	2.5	6	
414	840506	421 37.7?	39.33N	107.24W	5.0G	2.7	6	
415	840510	120 14.9?	39.35N	107.25W	5.0G	1.9	6	
416	840510	153 51.8?	39.36N	107.30W	5.0G	2.4	6	
417	840514	1014 17.2#	39.322N	107.228W	5.0G	3.2	9	Felt (IV) at Carbondale. Also felt at Glenwood Springs.
501	840517	911 20.2#	39.337N	107.245W	5.0G	2.4	7	Felt at Carbondale.

G = depth restrained by geophysicist
\# = less reliable solution (see USGS, 1984a for details)
? = poor solution (see USGS, 1984a for details)

* Regionally-recorded earthquakes are numbered chronologically from 401 to 417 to distinguish them from locally-recorded earthquakes, which are numbered beginning with 501. Event 501, however, was located by both the regional and local networks and therefore also appears on Table 4.

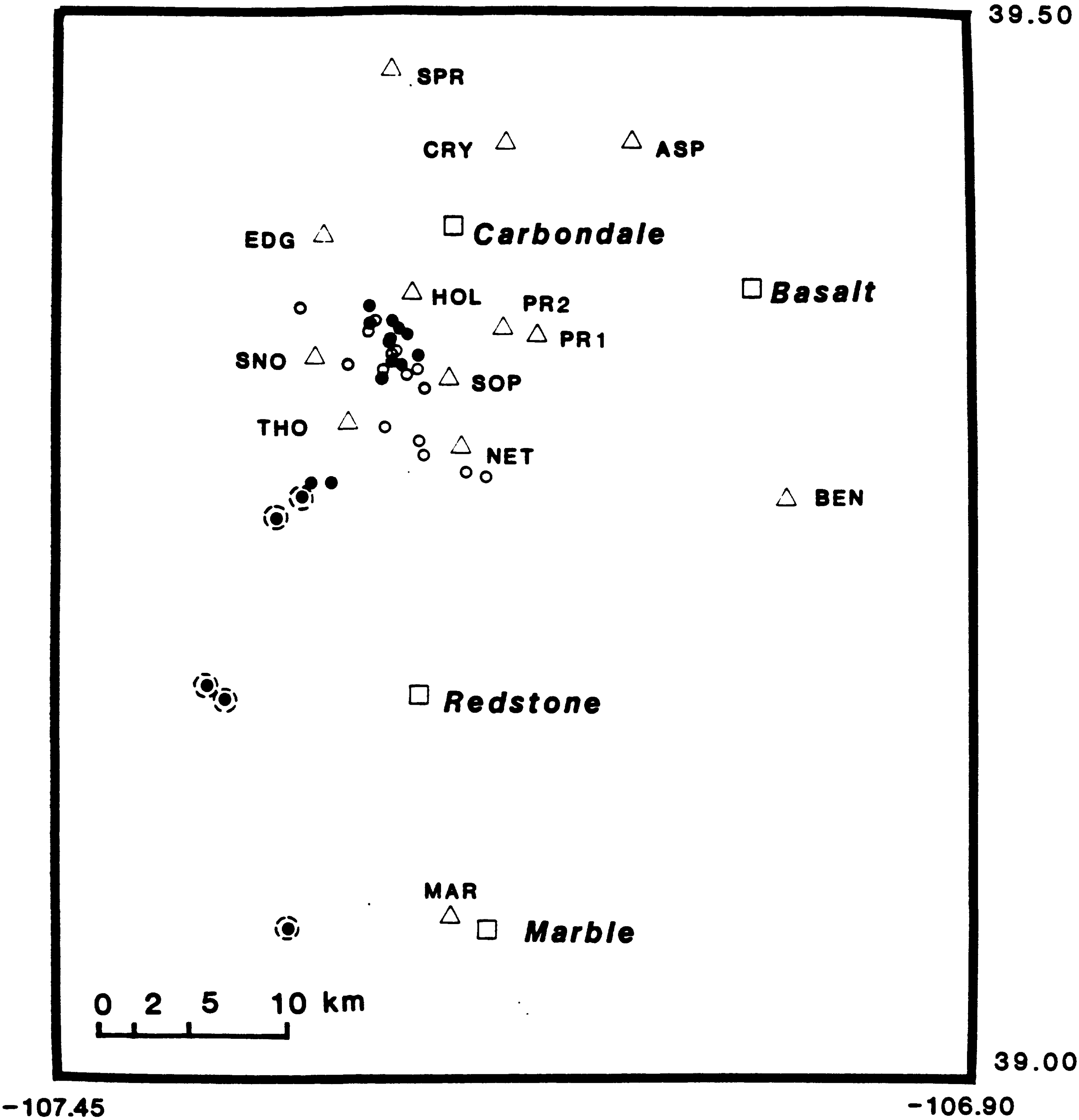


FIGURE 2.-Epicenter map of the 1984 Carbondale earthquake swarm. Open circles indicate regionally-recorded earthquakes (PDE locations). Filled circles indicate locally-recorded earthquakes (HYPOELLIPSE locations); poorly-located events are outlined with dashed circle. Triangles represent temporary seismograph stations.

INSTRUMENTATION AND DATA ANALYSIS OF LOCALLY-RECORDED EARTHQUAKES

The nine instruments deployed in our temporary network were smoked-paper recording seismographs with short-period, vertical-component seismometers; the recorders operated with a paper-speed of 60mm/min. Time corrections were made every 48 hours during record changes. Station locations and periods of operation are listed in Table 3.

Hypocenters of 17 locally-recorded earthquakes were determined with HYPOELLIPSE (Lahr, 1979) using between eight and eleven P- or S-arrival times. Of those 17 events, 12 are considered to be well-located (HYPOELLIPSE A or B quality, see Table 4). Hypocenters of three of the five remaining earthquakes are between 15 and 30 km southwest of the temporary network (Figure 2) and thus difficult to locate accurately; the other two poorly-located earthquakes were recorded by only a few stations and their hypocenters do not have good azimuthal control. We were unable to determine precise locations for the poorly-recorded events with local data alone. Fortunately additional data were read for these and other events from several stations of the NEIC regional telemetered network. These data made an important contribution to the JHD-relocation of the poorly-constrained earthquakes.

Locations were computed using the P-wave velocity model derived by Wong and Humphrey (1985), which incorporated data from a crustal structure study of the southern Rocky Mountains by Prodehl and Pakiser (1980). The model consists of three layers overlying a 7.9 km/sec half-space (Table 5). S-wave velocities were estimated by a Wadati analysis of P- and S-wave arrivals which indicated an average Vp/Vs of 1.75.

Duration magnitudes (M_D) of earthquakes located by the temporary network were estimated from the lengths of earthquake codas using the formula derived by Lee et al. (1972). Although the M_D scale was not developed for this specific area, and is thus not directly comparable to other magnitude scales, it provides a relative size estimate for the earthquakes in this study. Magnitudes of the 17 events range between 1.4 and 2.6 (M_D), and have a mean of 1.7(M_D).

JHD RELOCATIONS OF EARTHQUAKES

A two-step procedure using the Joint Hypocenter Determination (JHD) technique was applied to sixteen of the HYPOELLIPSE-located events and sixteen of the regionally-located events of the Carbondale swarm (Table 6). This JHD procedure, as described by Dewey and Spence (1979), uses a group of well-recorded earthquakes (both local and regional data where available) to estimate the variances of different seismic phases used and to compute individual station corrections for each phase. A single-event location method was then used with the JHD-computed station adjustments and variances to relocate the 32 earthquakes.

The earthquake that was best-recorded locally and regionally (Event 501, see Table 4) was selected as the JHD-calibration event and restrained at its HYPOELLIPSE-computed

Table 3: Location and operation parameters for the temporary seismograph network used to monitor the April—May 1984 Carbondale earthquake sequence

Station Code	Latitude (deg,min)	Longitude (deg,min)	Elev. (m)	Period of operation
ASP	39N26.30	107W06.10	1990	5/16-5/31
BEN	39N16.27	107W00.58	2365	5/16-5/23
CRY	39N26.33	107W10.71	2220	5/21-5/31
EDG	39N23.80	107W17.33	2142	5/22-5/31
HOL	39N22.08	107W14.13	1975	5/19-5/31
MAR	39N04.57	107W12.80	2375	5/17-5/24
NET	39N17.70	107W12.38	2045	5/16-5/24
PR1	39N20.93	107W09.63	2200	5/23-5/29
PR2	39N21.25	107W10.78	1900	5/29-5/31
SNO	39N20.23	107W17.63	2300	5/17-6/01
SOP	39N19.68	107W12.78	1930	5/16-6/01
SPR	39N28.37	107W14.83	1995	5/24-6/01
THO	39N18.42	107W16.42	2200	5/24-5/31

Table 4: HYPOELLIPSE-determined locations for the locally-recorded Carbondale earthquakes

EQ NO	DATE (YMD)	ORGN TIME (UTC)	LAT (deg)	LONG (deg)	DEPTH (km)	1 DMIN (km)	2 MAG (Md)	3 NO	4 GAP (deg)	5 RMS (sec)	6 ERZ (km)	7 AZ1 (deg)	8 ERH1 (km)	9 AZ2 (deg)	10 ERH2 (km)	11 QUA
501	840517	0911 20.68	39.355N	107.248W	4.05	4.2	2.65	8	170	0.11	2.01	-7	1.50	-97	1.09	A
502	840517	0926 55.66	39.345N	107.251W	5.74	3.8	2.15	8	154	0.09	1.35	-13	1.26	-103	0.99	A
503	840517	1548 39.26	39.352N	107.245W	5.02	3.9	1.99	8	164	0.11	1.86	-10	1.57	-100	1.20	A
506	840519	0305 38.51	39.339N	107.233W	5.72	2.1	1.98	9	91	0.11	1.52	-4	1.20	-94	1.09	A
508	840519	0733 00.38	39.336N	107.249W	5.37	3.3	1.37	9	107	0.13	1.73	-7	1.38	-97	1.23	A
511	840519	1310 24.15	39.178N	107.348W	2.95	16.3	1.40	9	241	0.09	9.49	-97	2.41	-7	0.87	C
515	840520	0343 08.57	39.328N	107.254W	5.63	3.5	2.39	9	114	0.13	1.83	-4	1.45	-94	1.32	A
522	840521	1416 54.74	39.335N	107.243W	5.32	2.7	1.44	9	98	0.11	1.51	1	1.20	-89	1.05	A
532	840522	1222 33.41	39.349N	107.239W	3.34	2.1	1.54	10	114	0.13	1.95	-49	1.04	41	1.00	A
544	840524	1207 14.57	39.362N	107.262W	5.56	2.4	1.41	11	104	0.14	2.06	-81	1.38	9	1.13	A
548	840526	0559 20.70	39.273N	107.302W	3.50	4.5	1.37	9	309	0.17	4.96	42	6.21	-48	3.05	C
550	840527	0517 12.77	39.184N	107.359W	6.93	15.5	1.77	11	331	0.10	5.51	-110	2.74	-20	2.66	C
552	840527	1657 31.82	39.279N	107.297W	3.38	3.7	1.67	10	306	0.09	2.30	42	1.83	-48	1.30	A
553	840528	1322 30.22	39.279N	107.285W	3.50	3.3	1.79	10	299	0.11	1.93	19	2.00	-71	0.99	A
556	840529	1128 40.04	39.354N	107.261W	4.83	2.7	1.30	11	96	0.13	2.66	25	1.39	-65	1.06	B
557	840529	1753 02.02	39.263N	107.318W	5.20	6.3	1.70	8	318	0.19	6.53	-128	8.13	-38	5.14	C
559	840530	2211 03.68	39.070N	107.310W	****	29.7	1.90	6	339	0.19	****	-106	14.08	-16	6.52	D
* * AVERAGES * *					4.75	6.5	1.75	9.1	121.	0.13	3.08	-29.	2.99	-55.	1.86	

1 —Distance to closest seismograph station.
2 —Local magnitude estimate based on duration (coda length) of earthquake (Lee et al., 1972).
3 —Number of observations (P and S) used to compute hypocentral solution.
4 —Largest azimuthal separation in degrees between stations as viewed from the epicenter.
5 —Root mean square errors of travel time residuals.
6-10—Error estimates based on 94% confidence ellipsoid (see Lahr, 1979, pp 31-32).
11 —A measure that is intended to indicate the general reliability of the hypocentral solution where;
A = excellent epicenter, good focal depth
B = good epicenter, fair focal depth
C = fair epicenter, poor focal depth
D = poor epicenter, poor focal depth

Table 5: Crustal velocity model used in the location of the April – May 1984 Carbondale earthquake sequence.

Layer	Depth to top of layer(km)	P–wave velocity (km/s)	S–wave velocity (km/s)
1	0	5.70	3.26
2	8.25	6.00	3.43
3	27.25	6.70	3.83
4	49.25	7.90	4.51

Table 6: JHD relocations of the 1984 Carbondale earthquake swarm

Eq. no.	Date (ymd)	Orgn Time	Lat (deg)	Long (deg)	Dep (km)	Mag (ML)	Mag (Md)
401	840412	2016 57.6	39.347N	107.222W	5.0G	2.2	
402	840422	1730 56.9	39.306N	107.198W	5.0G	3.1	
404	840503	1828 54.6	39.283N	107.185W	5.0G	3.0	
405	840503	1918 23.1	39.348N	107.248W	5.0G	2.3	
406	840504	117 9.9	39.404N	107.302W	5.0G	2.4	
407	840504	213 33.6	39.322N	107.210W	5.0G	2.2	
408	840504	1844 37.8	39.304N	107.210W	5.0G	2.2	
409	840506	200 57.1	39.320N	107.202W	5.0G	2.1	
410	840506	212 49.9	39.357N	107.249W	5.0G	2.3	
411	840506	213 34.5	39.365N	107.251W	5.0G	2.6	
412	840506	251 37.1	39.338N	107.215W	5.0G	2.2	
413	840506	417 35.6	39.357N	107.240W	5.0G	2.5	
414	840506	421 38.1	39.323N	107.208W	5.0G	2.7	
415	840510	120 15.3	39.340N	107.222W	5.0G	1.9	
416	840510	153 51.9	39.383N	107.269W	5.0G	2.4	
417	840514	1014 17.5	39.360N	107.234W	5.0G	3.2	
501	840517	911 20.6	39.355N	107.247W	4.7	2.4	2.6
502	840517	926 55.8	39.351N	107.240W	5.5		2.2
503	840517	1548 39.5	39.339N	107.238W	4.8		2.0
506	840519	3 5 38.5	39.343N	107.231W	6.2		1.9
508	840519	733 38.5	39.339N	107.249W	5.9		1.4
511	840519	1310 24.2	39.153N	107.344W	5.9		1.3
515	840519	343 8.7	39.332N	107.242W	3.4		1.4
522	840520	1416 54.7	39.339N	107.239W	5.6		2.3
532	840521	1222 33.4	39.352N	107.234W	6.5		1.4
544	840522	1207 14.8	39.356N	107.242W	3.9		1.5
548	840526	559 21.2	39.278N	107.300W	1.8G		1.3
550	840527	.517 13.2	39.159N	107.319W	3.0		1.7
552	840527	1657 32.2	39.281N	107.281W	2.3		1.6
553	840528	1322 30.7	39.294N	107.275W	3.5G		1.7
556	840529	1128 40.4	39.354N	107.248W	3.2		1.3
557	840529	1753 2.8	39.275N	107.282W	3.9		1.7

G = depth restrained by geophysicist

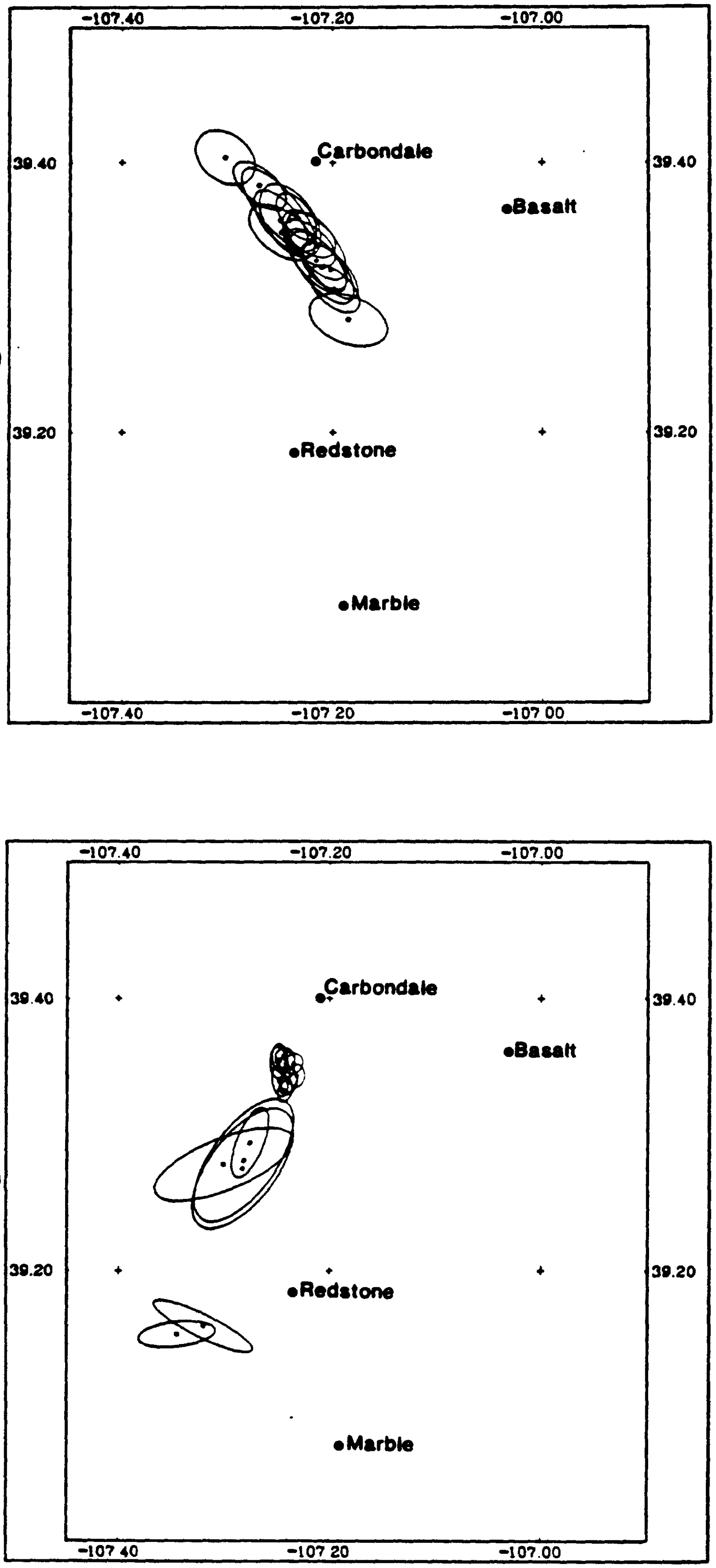
(a)
(b)


FIGURE 3.–JHD-relocated epicenters and associated 90% confidence ellipses: a)regionally-recorded events, b) locally-recorded events.

location. Consequently, the absolute positions of all recomputed epicenters will be biased by the amount of mislocation present in the epicenter of this calibration event.

Two different approaches were used to determine the depths of the locally- and regionally-recorded earthquakes. For the locally-recorded earthquakes, locations were first computed with unrestrained depth in the single-event computation. If the free-depth computation did not converge at a realistic depth, or if the hypocenter was computed to lie above the surface, the earthquake location was re-computed at the fixed HYPOELLIPSE-computed depth. For the regionally-located earthquakes, however, the depths were held fixed at 5.0 km because the large station-epicenter distances would not allow reliable depth computations.

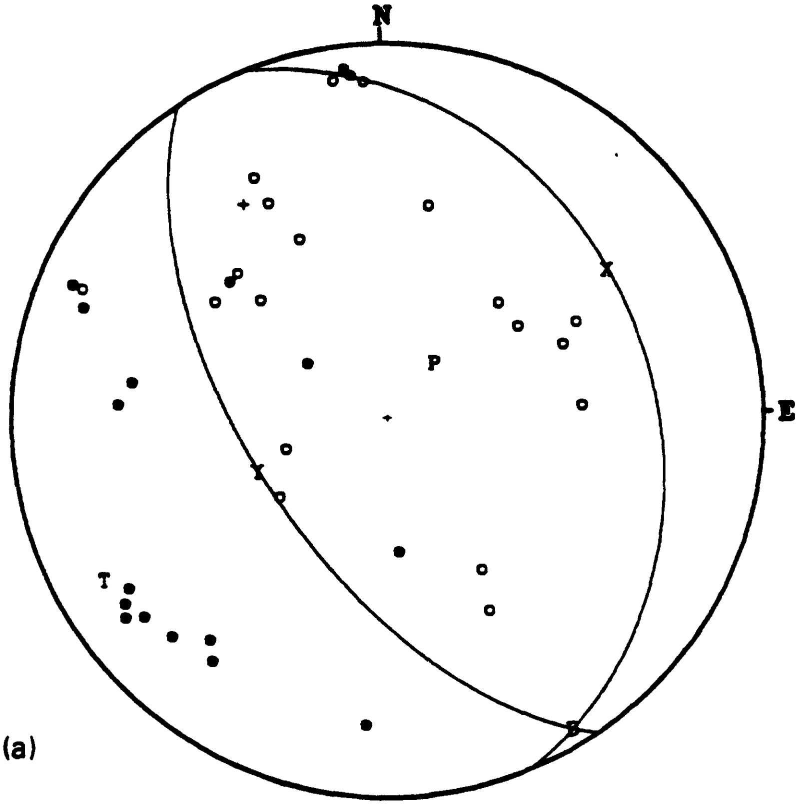
The precision of the relocated hypocenters is estimated from 90 percent confidence ellipses on pairs of hypocentral coordinates. Figure 3 shows the relocations of epicenters with their associated 90percent confidence ellipses. The effect of the relocation on the 16 regionally-recorded events (Figure 3a) was to move the epicenters systematically northeast by about 2km, roughly 7-9 km south-southwest of Carbondale. The epicentral pattern remains elongate to the northwest. However, since the 90 percent confidence ellipses are also oriented in this direction, the northwest elongation of the epicentral zone may be partly an artifact of the station distribution.

Only slight hypocentral adjustments occurred following the relocation of the majority of the locally-recorded earthquakes (Figure 3b). The 10 clustered events about 7 km south-southwest of Carbondale maintained their positions. The relocation tightened up the distribution of the four earthquakes that occurred about 15 km southwest of Carbondale, moving them northeast by about one kilometer. These four epicenters remain about 6 km south-southwest of the major cluster of earthquakes. The relocation computation had the largest effect on the two earthquakes just west of Redstone, moving them further southeast by about 4 km. Since these two epicenters were well outside of the local network, it is not surprising that the relocation process affected them more than the other locally-recorded earthquakes.

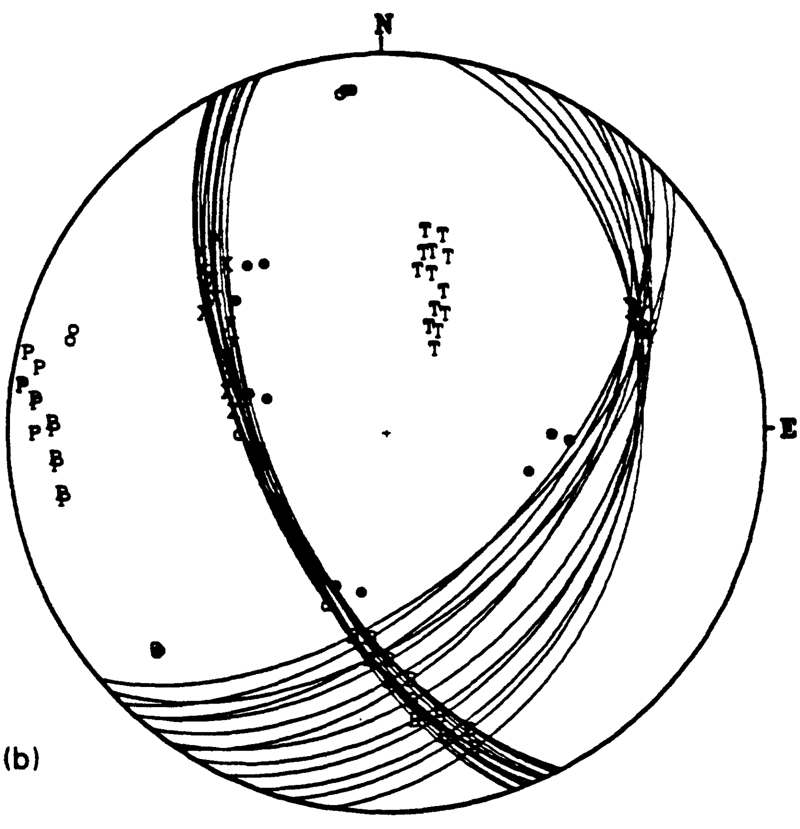
FOCAL MECHANISMS OF LOCALLY-RECORDED EARTHQUAKES

Using azimuths and take-off angles computed by HYPOELLIPSE, two composite focal mechanisms were constructed from P-wave first motion polarity data for eight well-located, locally-recorded earthquakes. The two mechanisms, presented in Figure 4, show very different orientations of the P and T axes: one indicates east-west extension, the other east-west compression. We were unable to determine a composite mechanism for the seven events outside the local station network because of the poor azimuthal distribution of first motions.

Mechanism C1 (Figure 4a), composited from five earthquakes that are aligned along the northeastern end of the earthquake zone, indicates primarily normal faulting. The



(a)



(b)

FIGURE 4.–Composite focal mechanisms (lower hemisphere equal-area projections) computed by FOCMEC (Snoke et al., 1985) at a 5 degree search grid using P-wave first-motion polarity data: a) Mechanism C1, a composite of five earthquakes with a total of 37 P-wave polarities (13% inconsistency); b) Mechanism C2, a composite of three earthquakes with a total of 21 P-wave polarities (9% inconsistency).

strike of the nodal planes closely corresponds to the strike of geologic structures in the area (Poole, 1954).

Mechanism C2 (Figure 4b) is composited from three earthquakes located one to two km south of those used in C1. Mechanism C2 indicates a reversal of P- and T-axes with respect to C1, but has one plane with a strike and dip similar to that of the southwest-dipping plane of the normal-faulting mechanism. As shown by the multiple solutions in Figure 4b, the other nodal plane is not very well-constrained, having a strike that could range from N10°E to N50°E and a dip between 30 and 60 degrees SE.

It is not unprecedented for a series of small magnitude earthquakes ($M_D < 3$) to be represented by focal mechanisms indicating both normal and reverse faulting. Similar observations have been noted in the 1985 Alpine, Wyoming, aftershock series (C.J. Langer, USGS unpublished data). Even the reversal of P- and T-axes that is seen in the Carbondale focal mechanisms has been noted by other investigators (e.g., Deschamps and King, 1982), who conclude that normal and reverse faulting can occur simultaneously without any change being made in tectonic environment.

DISCUSSION

JHD-relocated epicenters of the locally-recorded earthquakes are shown in relation to the surface geology in Figure 5. Ten of the epicenters are about 7 km south-southwest of Carbondale, just north of Thompson Creek and east of the Grand Hogback monocline. The epicenters are situated at the northern terminus of the mapped axis of the northwest-trending Elk Mountain anticline (Poole, 1954) and form a slightly elongated, 5 km by 3 km cluster. Four epicenters are located about a kilometer west of the mapped axis of the west-dipping Grand Hogback monocline (Tweto and others, 1978). These four are not considered to be in the same seismic source zone. Similarly, the two epicenters just southwest of Redstone (not shown on Figure 5) do not appear to be related to the major cluster of earthquakes. These southernmost earthquakes may be possibly related to coal mining activities in the area.

The distribution of seismicity as a function of depth is illustrated by orthogonal hypocentral cross-sections (Figure 6) that are parallel and perpendicular to the trend of mapped geologic structures in the area. The sections show a diffuse distribution between depths of 3.2 and 6.5 km. The scatter of the hypocenters within the anticline suggests that the earthquakes did not occur along a single plane, such as a bedding plane, but perhaps more closely represent a volumnar source.

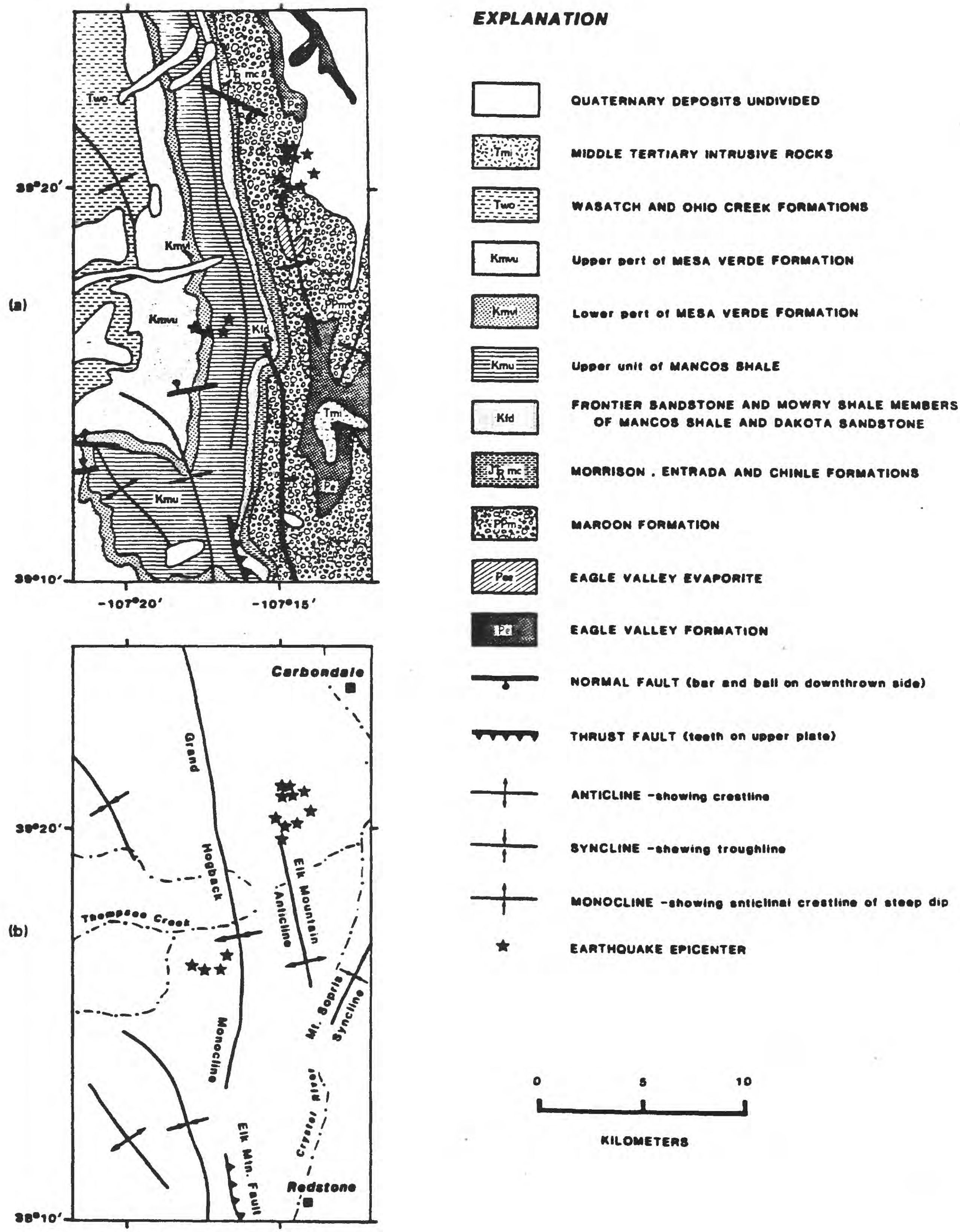


FIGURE 5.–Generalized geologic map of the Carbondale earthquake swarm area, west-central Colorado. Geology modified from Tweto and others (1978). JHD-relocated epicenters of the locally-recorded earthquakes are shown as stars.

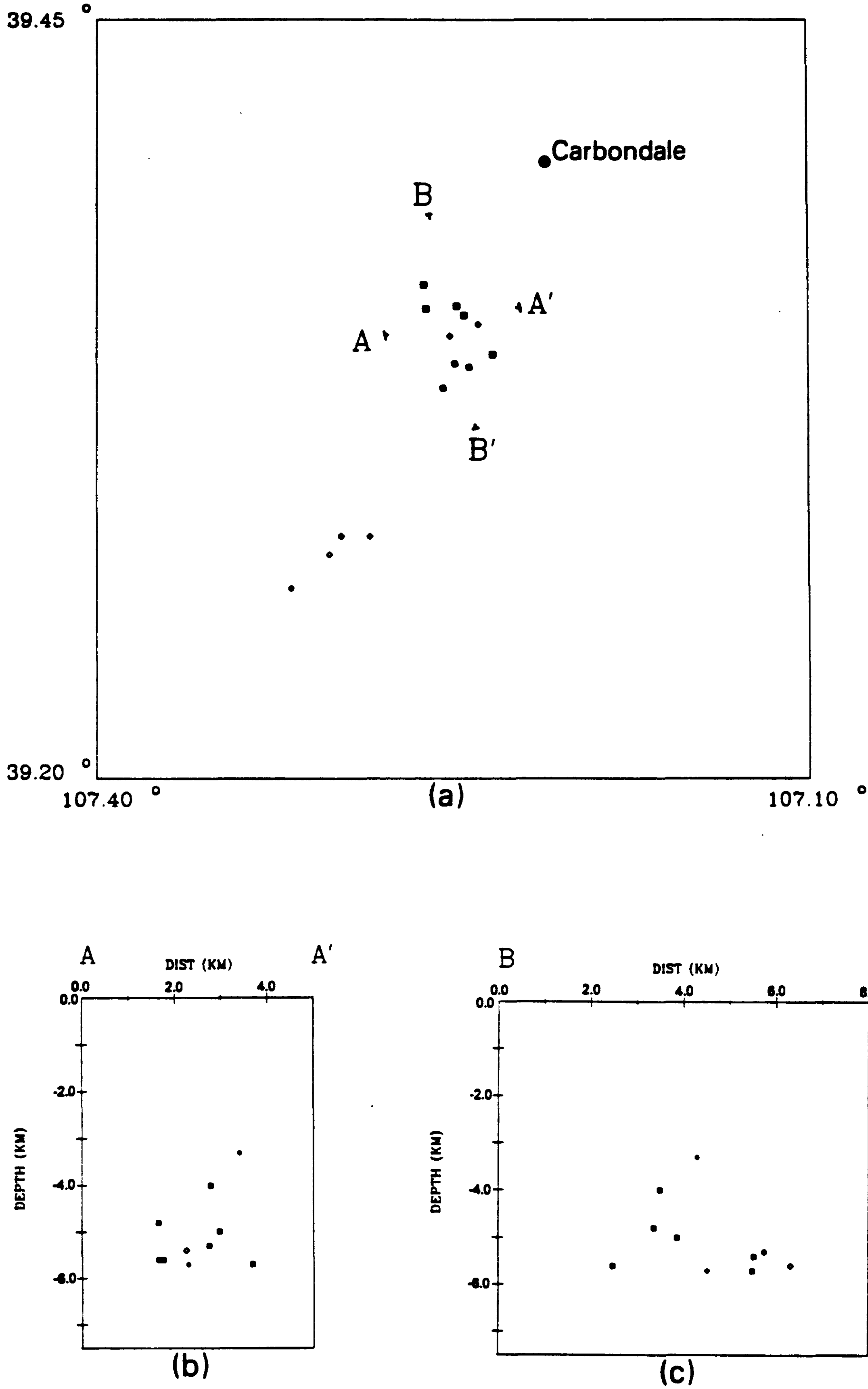


FIGURE 6.–Orthogonal cross-sections of locally-recorded earthquakes (HYPOELLIPSE locations): (a) Map showing location of cross-sections, (b) Cross-section along AA', (c) Cross-section along BB'. Solid squares indicate earthquakes used in composite focal mechanism C1. Solid circles indicate earthquakes used in composite focal mechanism C2. Open diamonds indicate earthquakes not used in either mechanism.

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APPENDIX A.–HYPOELLIPSE LOCATIONS

The computer program HYPOELLIPSE (Lahr, 1979) was used to locate 17 locally-recorded earthquakes using a layered velocity model (see Table 5). The events, which occurred between 17 May and 30 May 1984, are presented in chronological order.

```
            ____________BEGIN____________________BEGIN____________________BEGIN____________________BEGIN__________
84/ 5/17     9/11                                                                                                84/ 5/17    9/11

                                                    HORIZONTAL                                VERTICAL
                                              SE =   1.09              SE =    1.50           SE =    2.01   QUALITY = A
                                              AZ =   -97.              AZ =     -7.

 DATE     ORIGIN      LAT       LONG     DEPTH    MAG NO D3 GAP M  RMS   ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840517  911 20.68 39N21.28 107W14.87   4.05   2.65  8  8 170 1 0.11  1.5  2.0 C B|C 0.09 10 12 0.00 0.09  0  0.0  0.0  6  2.6  0.3
SE OF ORIG =  0.139         4 ITERATIONS TOTAL

(- STATION DATA -) (------- P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (---- S-WAVE TRAVEL-TIME DATA --)(--- MAGNITUDE DATA --)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
SOP    4.2 135 134 21.70IPD          1.02  1.03               0.00 1.081      22.60  1.92  1.79  0.13 0.757             501  55 2.75
SNO    4.4 244 133 21.81IPD          1.13  1.05               0.08 1.081      22.41  1.73  1.84 -0.11 0.757             501  73 2.95
NET    7.5 152 118 21.99IPD          1.31  1.50              -0.19 1.081      22.89  2.21  2.62 -0.41 0.000             501  30 2.15
ASP   15.7  54 104 23.55IPC          2.87  2.84               0.04 1.081      25.00  4.32  4.96 -0.64 0.000             501  50 2.65
BEN   22.5 114 100 24.61IPC          3.93  4.02              -0.08 1.081      26.41  5.73  7.03 -1.30 0.000             501  65 2.95
MAR   31.1 174  97 26.31IPC          5.63  5.49               0.14 1.081      27.91  7.23  9.62 -2.38 0.000             501  53 2.75

                         QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH         E     NE    SW     Z    NW    SE     N
AVE. OF END POINTS                   0.09  0.11  0.12  0.14  0.17  0.18  0.20

              NUMBER       RMS  MIN DRMS  AVE DRMS   QUALITY
                   4      0.11      0.01      0.15         D

            ____________END______________________END______________________END______________________END____________
```

```
             ___________BEGIN____________________BEGIN____________________BEGIN____________________BEGIN__________
84/ 5/17     9/26                                                                                    84/ 5/17     9/26

                                             HORIZONTAL                                  VERTICAL
                                        SE =   0.99               SE =    1.26           SE =    1.35    QUALITY = A
                                        AZ =  -103.               AZ =   -13.

 DATE    ORIGIN      LAT      LONG    DEPTH    MAG NO D3 GAP M  RMS  ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840517  926 55.66 39N20.69 107W15.08   5.74   2.15  8  7 154 1 0.09  1.3  1.3 C B|C 0.07 10 12 0.00 0.08  0  0.0  0.0  6  2.1  0.2
SE OF ORIG =  0.121        4 ITERATIONS TOTAL

(- STATION DATA -) (------- P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (----- S-WAVE TRAVEL-TIME DATA ---)(---- MAGNITUDE DATA ---)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
SNO    3.8 257 147 56.76IPD         1.10  1.20              -0.10 1.081      57.91  2.25  2.11  0.14 0.757              502  38 2.35
SOP    3.8 119 147 56.80IPD         1.14  1.21              -0.06 1.081      57.80  2.14  2.11  0.03 0.757              502  28 2.15
NET    6.8 145 130 57.09IPD         1.43  1.55              -0.12 1.081      57.69  2.03  2.72 -0.69 0.000              502  18 1.75
ASP   16.5  51 109 58.75IPD         3.09  3.07               0.02 1.081      60.05  4.39  5.38 -0.99 0.000              502  30 2.25
BEN   22.4 111 104 59.81IPD         4.15  4.05               0.10 1.081      61.01  5.35  7.10 -1.74 0.000              502  35 2.35
MAR   30.0 174 101 61.07IPD         5.41  5.36               0.05 1.081      62.82  7.16  9.38 -2.22 0.000              502  30 2.25

                         QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH         E      N     NE      Z     NW     SW     SE
AVE. OF END POINTS                  0.05   0.13   0.14   0.15   0.17   0.18   0.20

              NUMBER      RMS  MIN DRMS  AVE DRMS   QUALITY
                   5     0.09     -0.03      0.15         D

             ___________END______________________END______________________END______________________END__________
```

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            ___________BEGIN____________________BEGIN____________________BEGIN____________________BEGIN__________
84/ 5/17    15/48                                                                                       84/ 5/17    15/48

                                             HORIZONTAL                                  VERTICAL
                                        SE =   1.20               SE =    1.57           SE =    1.86   QUALITY = A
                                        AZ =  -100.               AZ =   -10.

 DATE    ORIGIN     LAT       LONG     DEPTH    MAG NO D3 GAP M  RMS  ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840517 1548 39.26 39N21.14 107W14.69  5.02   1.99  8  7 164 1 0.11  1.6  1.9 C B|C 0.10 10 12 0.00 0.10  0  0.0  0.0  6  2.0  0.2
SE OF ORIG =  0.148         4 ITERATIONS TOTAL

(- STATION DATA -) (------ P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (---- S-WAVE TRAVEL-TIME DATA --)(--- MAGNITUDE DATA --)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
SOP    3.9 134 142 40.25IPD         0.99  1.11             -0.12 1.081      41.15  1.89  1.94 -0.05 0.757          503  25 2.05
SNO    4.5 248 138 40.39IPD         1.13  1.19             -0.06 1.081      41.49  2.23  2.08  0.15 0.757          503  33 2.25
NET    7.2 152 125 40.87IPD         1.61  1.54              0.07 1.081      41.62  2.36  2.69 -0.33 0.000          503  15 1.55
ASP   15.6  52 108 42.09IPC         2.83  2.87             -0.05 1.081      42.89  3.63  5.03 -1.40 0.000          503  25 2.05
BEN   22.2 114 103 43.45IPD         4.19  3.99              0.20 1.081      45.00  5.74  6.99 -1.25 0.000          503  30 2.25
MAR   30.8 175  99 44.62IPC         5.36  5.47             -0.11 1.081      46.67  7.41  9.57 -2.16 0.000          503  23 2.05

                          QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH        E     SE     N     SW     Z     NE    NW
AVE. OF END POINTS                 0.11   0.12  0.14   0.14  0.14   0.18  0.19

              NUMBER       RMS  MIN DRMS  AVE DRMS   QUALITY
                   5      0.11     -0.06      0.15         D

            ___________END____________________END____________________END____________________END__________
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            ____________BEGIN____________________BEGIN____________________BEGIN____________________BEGIN__________
84/ 5/19    3/ 5                                                                                                   84/ 5/19    3/ 5

                                                    HORIZONTAL                                  VERTICAL
                                             SE =   1.09              SE =   1.20              SE =   1.52   QUALITY = A
                                             AZ =   -94.              AZ =    -4.

 DATE    ORIGIN      LAT       LONG     DEPTH     MAG NO D3 GAP M  RMS   ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840519  3 5 38.51 39N20.36 107W13.98   5.72    1.98  9  5  91 1 0.11   1.2  1.5 B B|B 0.28 10 14 0.00 0.09  0  0.0  0.0  7  2.0  0.2
SE OF ORIG =  0.126         3 ITERATIONS TOTAL

(- STATION DATA -) (-------- P-WAVE TRAVEL-TIME DATA AND DELAYS --------) VARI (----- S-WAVE TRAVEL-TIME DATA ---)(---- MAGNITUDE DATA ---)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
SOP    2.1 126 159 39.59IPC          1.08  1.07             0.01 1.071      40.29  1.78  1.87 -0.10 0.750            506  20 1.85
HOL    3.2 356 151 39.82IPC          1.31  1.15             0.16 1.071      40.92  2.41  2.01  0.40 0.000            506  40 2.45
SNO    5.2 267 137 39.83IPD          1.32  1.36            -0.04 1.071      40.93  2.42  2.38  0.04 0.750            506  28 2.15
NET    5.4 155 136 39.88IPD          1.37  1.38            -0.02 1.071      40.93  2.42  2.42  0.00 0.000            506  18 1.75
ASP   15.8  46 110 41.28IPC          2.77  2.94            -0.18 1.071      41.98  3.47  5.15 -1.68 0.000            506  20 1.85
BEN   20.7 111 105 42.46IPC          3.95  3.77             0.18 1.071      44.16  5.65  6.59 -0.95 0.000            506  24 2.05
MAR   29.3 177 101 43.67IPD          5.16  5.23            -0.07 1.071      47.42  8.91  9.16 -0.25 0.000            506  25 2.15

                         QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH       Z     NW     SW     NE     SE      N      E
AVE. OF END POINTS                0.42   0.60   0.70   0.71   0.75   0.78   0.80

               NUMBER       RMS  MIN DRMS  AVE DRMS   QUALITY
                    9      0.11      0.42      0.71         A

            ____________END____________________END____________________END____________________END__________
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            ___________BEGIN___________________BEGIN___________________BEGIN___________________BEGIN__________
84/ 5/19     7/33                                                                                          84/ 5/19     7/33

                                              HORIZONTAL                                  VERTICAL
                                        SE =  1.23              SE =   1.38               SE =   1.73   QUALITY = A
                                        AZ =  -97.              AZ =    -7.

 DATE     ORIGIN      LAT       LONG      DEPTH     MAG NO D3 GAP M  RMS   ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840519  733  0.38 39N20.19 107W14.96    5.37    1.37  9  4 107 1 0.13   1.4  1.7 B B|B 0.84 10 14 0.00 0.11  0  0.0  0.0  7  1.4  0.4
SE OF ORIG =  0.147           3 ITERATIONS TOTAL

(- STATION DATA -) (------- P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (---- S-WAVE TRAVEL-TIME DATA --)(--- MAGNITUDE DATA --)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
SOP    3.3 107 149  1.29IPC         0.91  1.10              -0.19 1.071      2.49  2.11  1.93  0.18 0.750            508  10 1.25
HOL    3.7  19 145  1.63IPC         1.25  1.14               0.11 1.071      2.63  2.25  2.00  0.25 0.000            508  30 2.15
SNO    3.8 271 144  1.57IPC         1.19  1.16               0.03 1.071      2.37  1.99  2.03 -0.04 0.750            508  15 1.55
NET    5.9 141 132  1.58IPC         1.20  1.40              -0.20 1.071      2.43  2.05  2.45 -0.40 0.000            508   5 0.65
ASP   17.0  48 108  3.47IPD         3.09  3.13              -0.04 1.071      5.87  5.49  5.48  0.01 0.000            508  10 1.25
BEN   21.9 109 104  4.41IPD         4.03  3.96               0.08 1.071      7.06  6.68  6.92 -0.24 0.000            508  13 1.55
MAR   29.1 174 100  5.67IPC         5.29  5.18               0.11 1.071      8.92  8.54  9.07 -0.53 0.000            508  12 1.45

                          QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH         Z     NW     NE     SW     SE     E      N
AVE. OF END POINTS                   0.40  0.58   0.68   0.70   0.70   0.74   0.78

             NUMBER      RMS  MIN DRMS  AVE DRMS   QUALITY
                  9     0.13      0.41      0.69         A

            ___________END_____________________END_____________________END_____________________END___________
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            ___________BEGIN__________________BEGIN__________________BEGIN__________________BEGIN_________
84/ 5/19    13/10                                                                                       84/ 5/19    13/10

                                             HORIZONTAL                            VERTICAL
                                        SE =  0.87              SE =   2.41        SE =   9.49   QUALITY = C
                                        AZ =   -7.              AZ =   -97.

 DATE    ORIGIN      LAT      LONG    DEPTH    MAG NO D3 GAP M  RMS   ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840519 1310 24.15 39N10.69 107W20.90   2.95   1.40  9 18 241 1 0.09   2.4  9.5 D C|D 0.40 10 13 0.00 0.08  0  0.0  0.0  6  1.4  0.4
SE OF ORIG =  0.196          5 ITERATIONS TOTAL

(- STATION DATA -) (------ P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (---- S-WAVE TRAVEL-TIME DATA --)(--- MAGNITUDE DATA --)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
MAR   16.3 134 100 27.07IPD        2.92  2.90              0.02 1.071      28.92  4.77  5.08 -0.31 0.000             511  20 1.85
NET   17.9  43  99 27.17IPD        3.02  3.17             -0.16 1.071      28.12  3.97  5.55 -1.59 0.000             511   5 0.65
SNO   18.3  15  99 27.46IPD        3.31  3.25              0.06 1.071      29.96  5.81  5.68  0.13 0.750             511  15 1.65
SOP   20.3  35  98 27.63IPD        3.48  3.60             -0.13 1.071      30.43  6.28  6.30 -0.03 0.750             511  10 1.25
HOL   23.2  25  97 28.23IPD        4.08  4.11             -0.03 1.071      29.18  5.03  7.18 -2.16 0.000             511  20 1.85
BEN   31.0  71  95 29.75IPC        5.60  5.47              0.13 1.071      32.85  8.70  9.57 -0.87 0.000             511  11 1.35
ASP   35.9  36  95 30.51EPD        6.36  6.31              0.04 1.071                                                511       5

                         QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH       SW     N     Z    NE     E    NW    SE
AVE. OF END POINTS                 0.03  0.05  0.08  0.09  0.12  0.17  0.18

              NUMBER      RMS  MIN DRMS  AVE DRMS   QUALITY
                   5     0.09     -0.01      0.11         D

            ___________END__________________END__________________END__________________END___________
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               ___________BEGIN___________________BEGIN___________________BEGIN___________________BEGIN__________
84/ 5/20     3/43                                                                                          84/ 5/20     3/43

                                          HORIZONTAL                             VERTICAL
                                   SE =   1.32          SE =   1.45         SE =   1.83    QUALITY = A
                                   AZ =   -94.          AZ =    -4.

 DATE     ORIGIN      LAT       LONG      DEPTH     MAG NO D3 GAP M  RMS   ERH   ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840520  343  8.57 39N19.68 107W15.24    5.63    2.39  9  5 114 1 0.13  1.5   1.8 B B|B 0.06 10 14 0.00 0.12  0  0.0  0.0  7  2.4  0.2
SE OF ORIG =  0.155         4 ITERATIONS TOTAL

(- STATION DATA -) (------- P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (---- S-WAVE TRAVEL-TIME DATA --)(--- MAGNITUDE DATA --)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
SOP    3.5  90 148  9.54IPD        0.97  1.17              -0.20 1.071      10.74  2.17  2.04  0.13 0.750              515  35 2.35
SNO    3.6 286 148  9.59IPC        1.02  1.17              -0.15 1.071      10.79  2.22  2.05  0.17 0.750              515  50 2.65
HOL    4.7  20 140  9.90IPD        1.33  1.29               0.04 1.071      11.95  3.38  2.26  1.13 0.000              515  50 2.65
NET    5.5 132 136  9.80IPC        1.23  1.38              -0.15 1.071      10.90  2.33  2.42 -0.09 0.000              515  25 2.05
ASP   17.9  47 107 11.92IPD        3.35  3.30               0.05 1.071      13.42  4.85  5.78 -0.92 0.000              515  30 2.25
BEN   22.0 107 104 12.63IPD        4.06  3.98               0.08 1.071      14.43  5.86  6.97 -1.11 0.000              515  45 2.65
MAR   28.2 173 101 13.73IPD        5.16  5.04               0.12 1.071      17.03  8.46  8.82 -0.36 0.000              515  45 2.65

                         QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH        Z     SE     E      N     SW     NE     NW
AVE. OF END POINTS                  -0.02  0.03  0.09   0.12  0.16   0.16   0.20

             NUMBER       RMS  MIN DRMS  AVE DRMS   QUALITY
                  6      0.13     -0.03      0.12         D

               ___________END____________________END____________________END____________________END__________
```

```
            __________BEGIN___________________BEGIN___________________BEGIN___________________BEGIN_________
84/ 5/21    14/16                                                                                   84/ 5/21    14/16

                                                 HORIZONTAL                       VERTICAL
                                            SE =  1.05          SE =   1.20        SE =   1.51   QUALITY = A
                                            AZ =  -89.          AZ =     1.

 DATE    ORIGIN      LAT      LONG    DEPTH    MAG NO D3 GAP M  RMS  ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840521 1416 54.74 39N20.10 107W14.58   5.32   1.44  9  4  98 1 0.11  1.2  1.5 B B|B 0.57 10 14 0.00 0.09  0  0.0  0.0  7  1.4  0.4
SE OF ORIG = 0.125           3 ITERATIONS TOTAL

(- STATION DATA -) (-------- P-WAVE TRAVEL-TIME DATA AND DELAYS --------) VARI (----- S-WAVE TRAVEL-TIME DATA ---)(---- MAGNITUDE DATA ---)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
SOP    2.7 107 153 55.69IPC         0.95  1.05            -0.09 1.071      56.64  1.90  1.83  0.07 0.750             522  15 1.55
HOL    3.7  10 145 55.89IPC         1.15  1.14             0.02 1.071      57.04  2.31  1.99  0.31 0.000             522  25 2.05
SNO    4.4 273 140 55.82IPC         1.08  1.21            -0.12 1.071      57.02  2.28  2.12  0.17 0.750             522  20 1.85
NET    5.5 145 134 55.89IPC         1.15  1.34            -0.18 1.071      56.89  2.15  2.34 -0.18 0.000             522   5 0.65
ASP   16.7  47 108 57.82IPC         3.08  3.08             0.01 1.071      60.92  6.18  5.39  0.80 0.000             522  12 1.45
BEN   21.3 109 104 58.72IPD         3.99  3.86             0.13 1.071      61.42  6.68  6.75 -0.07 0.000             522  12 1.45
MAR   28.9 175 100 59.96IPC         5.22  5.15             0.08 1.071      63.71  8.97  9.01 -0.03 0.000             522  12 1.45

                        QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH        Z    NW    NE    SW    SE     E     N
AVE. OF END POINTS                 0.41  0.60  0.70  0.71  0.74  0.78  0.80

             NUMBER      RMS  MIN DRMS  AVE DRMS   QUALITY
                  9     0.11      0.42      0.72         A

            __________END_____________________END_____________________END_____________________END__________
```

```
            ____________BEGIN____________________BEGIN____________________BEGIN____________________BEGIN__________
84/ 5/22    12/22                                                                                                  84/ 5/22    12/22

                                                       HORIZONTAL                               VERTICAL
                                                 SE =   1.00             SE =   1.04            SE =   1.95   QUALITY = A
                                                 AZ =    41.             AZ =   -49.

 DATE    ORIGIN     LAT      LONG     DEPTH    MAG NO D3 GAP M  RMS   ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840522 1222 33.41 39N20.95 107W14.33   3.34   1.54 10  5 114 1 0.13  1.0  1.9 B B|B 0.38 10 15 0.00 0.12  0  0.0  0.0  8  1.5  0.4
SE OF ORIG =  0.119          3 ITERATIONS TOTAL

(- STATION DATA -) (------- P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (----- S-WAVE TRAVEL-TIME DATA ---)(---- MAGNITUDE DATA ---)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
HOL    2.1   8 148 33.98IPC         0.57  0.69              -0.12 1.064      35.48  2.07  1.21  0.86 0.000             532  20 1.85
SOP    3.2 137 136 34.17IPD         0.76  0.82              -0.05 1.064      34.97  1.56  1.43  0.13 0.745             532  15 1.55
SNO    4.9 254 124 34.34IPD         0.93  1.04              -0.11 1.064      35.39  1.98  1.83  0.16 0.745             532  18 1.75
NET    6.6 155 117 34.56IPD         1.15  1.30              -0.15 1.064                                                532   5 0.65
CRY   11.2  28 107 35.42IPC         2.01  2.06              -0.04 1.064      36.92  3.51  3.60 -0.08 0.000             532  18 1.75
ASP   15.4  50 102 36.41IPD         3.00  2.77               0.24 1.064      38.41  5.00  4.84  0.16 0.000             532  22 1.95
BEN   21.6 114  99 37.14IPD         3.73  3.83              -0.10 1.064      39.89  6.48  6.70 -0.22 0.000             532  15 1.65
MAR   30.4 176  96 38.91EPC         5.50  5.36               0.14 1.064      42.41  9.00  9.39 -0.38 0.000             532  15 1.65

                        QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH        Z    NW    SE    NE     E    SW     N
AVE. OF END POINTS                 0.30  0.63  0.68  0.79  0.79  0.80  0.91

            NUMBER      RMS  MIN DRMS  AVE DRMS   QUALITY
                10     0.13      0.46      0.75         A

            ____________END______________________END______________________END______________________END____________
```

______BEGIN______BEGIN______BEGIN______BEGIN______

84/ 5/24 12/ 7 84/ 5/24 12/ 7

	HORIZONTAL			VERTICAL	
SE =	1.13	SE =	1.38	SE = 2.06	QUALITY = A
AZ =	9.	AZ =	-81.		

DATE	ORIGIN	LAT	LONG	DEPTH	MAG	NO	D3	GAP	M	RMS	ERH	ERZ	Q	SQD	ADJ	IN	NR	AVR	AAR	NM	AVXM	SDXM	NF	AVFM	SDFM
840524	12 7 14.57	39N21.71	107W15.73	5.56	1.41	11	4	104	1	0.14	1.4	2.1	B	B|B	0.06	10	18	0.00	0.11	0	0.0	0.0	9	1.4	0.4

SE OF ORIG = 0.161 4 ITERATIONS TOTAL

(- STATION DATA -) (——— P-WAVE TRAVEL-TIME DATA AND DELAYS ———) VARI (—— S-WAVE TRAVEL-TIME DATA —)(—— MAGNITUDE DATA —)

STN	DIST	AZM	AIN	PSEC PRMK	+TCOR	-O=TTOB	-TTCAL	-DELAY	-EDLY=	P-RES	P-WT	VARI THIC	SSEC	SRMK	TTOB	TTCAL	S-RES	S-WT	AMX	PR	XMAG	R	FMP	FMAG
HOL	2.4	74	157	15.75IPD		1.18	1.06			0.12	1.058		16.70		2.13	1.86	0.27	0.000			544	22		1.95
SNO	3.9	225	145	15.85IPD		1.28	1.19			0.09	1.058		16.80		2.23	2.08	0.15	0.740			544	22		1.95
EDG	4.5	329	141	15.56IPD		0.99	1.25			-0.26	1.058		16.41		1.84	2.19	-0.35	0.000			544	11		1.35
SOP	5.7	132	134	15.97IPC		1.40	1.39			0.01	1.058		16.72		2.15	2.44	-0.29	0.740			544	12		1.35
NET	8.9	147	122	16.43EPC		1.86	1.83			0.03	1.058		17.38		2.81	3.21	-0.40	0.000			544	4		0.45
PR1	8.9	99	122	16.60IPC		2.03	1.84			0.19	1.058		17.90		3.33	3.22	0.11	0.000			544	15		1.65
CRY	11.2	40	116	16.82IPC		2.25	2.19			0.06	1.058		17.97		3.40	3.83	-0.43	0.000			544	10		1.25
ASP	16.2	58	109	17.55IPC		2.98	3.01			-0.03	1.058		19.90		5.33	5.27	0.06	0.000			544	18		1.75
MAR	32.0	172	100	20.17IPD		5.60	5.70			-0.10	1.058		24.32		9.75	9.97	-0.22	0.000			544	12		1.45

QUALITY EVALUATION

	NW	SW	E	NE	Z	SE	N
DIAGONALS IN ORDER OF STRENGTH	NW	SW	E	NE	Z	SE	N
AVE. OF END POINTS	0.06	0.07	0.10	0.10	0.11	0.16	0.16

NUMBER	RMS	MIN DRMS	AVE DRMS	QUALITY
6	0.14	0.02	0.11	D

______END______END______END______END______

	HORIZONTAL			VERTICAL	
SE =	3.05	SE =	6.21	SE = 4.96	QUALITY = C
AZ =	-48.	AZ =	42.		

DATE	ORIGIN	LAT	LONG	DEPTH	MAG	NO	D3	GAP	M	RMS	ERH	ERZ	Q	SQD	ADJ	IN	NR	AVR	AAR	NM	AVXM	SDXM	NF	AVFM	SDFM
840526	559 20.70	39N16.36	107W18.14	3.50	1.37	9	12	309	1	0.17	6.2	5.0	D	D|D	0.08	11	13	0.00	0.14	0	0.0	0.0	5	1.4	0.2

SE OF ORIG = 0.525 7 ITERATIONS TOTAL

(- STATION DATA -)				(——— P-WAVE TRAVEL-TIME DATA AND DELAYS ———)									VARI	(—— S-WAVE TRAVEL-TIME DATA —)						(—— MAGNITUDE DATA —)					
STN	DIST	AZM	AIN	PSEC PRMK	+TCOR	-O=	TTOB	-TTCAL	-DELAY	-EDLY=	P-RES	P-WT	THIC	SSEC	SRMK	TTOB	TTCAL	S-RES	S-WT	AMX	PR	XMAG	R	FMP	FMAG
THO	4.5	33	128	21.71IPD			1.01	1.01			0.01	1.034		23.91	3.21	1.76	1.45	0.000				548	11	1.35	
SNO	7.2	6	116	22.08IPD			1.38	1.41			-0.02	1.034		23.03	2.33	2.46	-0.13	0.724				548	15	1.55	
HOL	12.1	29	106	23.12IPD			2.42	2.20			0.22	1.034		24.92	4.22	3.85	0.37	0.000				548	18	1.75	
EDG	13.8	5	104	22.99IPD			2.29	2.50			-0.21	1.034		23.89	3.19	4.38	-1.18	0.000				548	9	1.15	
PR1	14.9	55	103	23.16EPD			2.46	2.68			-0.22	1.034										548		5	
CRY	21.3	30	99	24.75EPC			4.05	3.79			0.26	1.034										548		5	
SPR	22.7	12	99	24.86EPC			4.16	4.03			0.13	1.034		31.86	11.16	7.06	4.10	0.000				548	10	1.25	
ASP	25.2	43	98	25.09EPC			4.39	4.47			-0.08	1.034										548		5	

QUALITY EVALUATION

	SE	SW	NE	Z	N	NW	E
DIAGONALS IN ORDER OF STRENGTH							
AVE. OF END POINTS	0.01	0.01	0.06	0.06	0.07	0.12	0.13

NUMBER	RMS	MIN DRMS	AVE DRMS	QUALITY
8	0.17	0.00	0.07	D

END END END END

BEGIN BEGIN BEGIN BEGIN

84/ 5/27 5/17 84/ 5/27 5/17

	HORIZONTAL		VERTICAL
SE =	2.66	SE = 2.74	SE = 5.51 QUALITY = C
AZ =	-20.	AZ = -110.	

DATE	ORIGIN	LAT	LONG	DEPTH	MAG	NO	D3	GAP	M	RMS	ERH	ERZ	Q	SQD	ADJ	IN	NR	AVR	AAR	NM	AVXM	SDXM	NF	AVFM	SDFM
840527	517 12.77	39N11.05	107W21.54	6.93	1.77	11	20	331	1	0.10	2.7	5.5	D	C|D	0.80	10	18	0.00	0.08	0	0.0	0.0	9	1.8	0.3

SE OF ORIG = 0.183 5 ITERATIONS TOTAL

(- STATION DATA -) (——— P-WAVE TRAVEL-TIME DATA AND DELAYS ———) VARI (—— S-WAVE TRAVEL-TIME DATA —)(—— MAGNITUDE DATA —)

STN	DIST	AZM	AIN	PSEC PRMK	+TCOR-O=TTOB	-TTCAL	-DELAY	-EDLY=	P-RES	P-WT	THIC	SSEC	SRMK	TTOB	TTCAL	S-RES	S-WT	AMX	PR	XMAG	R	FMP	FMAG
THO	15.5	28	114	15.80IPD	3.03	2.98			0.05	1.058		17.55	4.78	5.21	-0.44	0.000				550	24	2.05	
SNO	17.9	18	111	16.10IPD	3.33	3.37			-0.04	1.058		18.60	5.83	5.89	-0.06	0.740				550	30	2.25	
SOP	20.3	38	109	16.53IPD	3.76	3.77			-0.01	1.058		17.28	4.51	6.60	-2.09	0.000				550	15	1.65	
HOL	23.0	28	107	17.19IPD	4.42	4.22			0.20	1.058		20.20	7.43	7.38	0.05	0.740				550	25	2.15	
EDG	24.4	14	106	17.06IPD	4.29	4.44			-0.15	1.058		17.91	5.14	7.78	-2.64	0.000				550	10	1.35	
PR1	25.1	43	105	17.29IPD	4.52	4.56			-0.04	1.058		19.89	7.12	7.98	-0.86	0.000				550	15	1.65	
CRY	32.3	29	102	18.55IPD	5.78	5.79			-0.01	1.058		19.90	7.13	10.14	-3.01	0.000				550	11	1.45	
SPR	33.5	17	102	18.88IPD	6.11	6.00			0.11	1.058		20.33	7.56	10.49	-2.93	0.000				550	27	2.25	
ASP	35.9	38	101	19.09IPD	6.32	6.42			-0.10	1.058		21.89	9.12	11.23	-2.11	0.000				550	15	1.75	

QUALITY EVALUATION

	SW	Z	N	NE	NW	E	SE
DIAGONALS IN ORDER OF STRENGTH							
AVE. OF END POINTS	0.04	0.08	0.09	0.09	0.11	0.12	0.17

NUMBER	RMS	MIN DRMS	AVE DRMS	QUALITY
9	0.10	0.03	0.11	D

END END END END

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___________BEGIN___________________BEGIN___________________BEGIN___________________BEGIN__________
84/ 5/27    16/57                                                                                84/ 5/27    16/57

                                        HORIZONTAL                         VERTICAL
                                   SE =  1.30          SE =   1.83         SE =   2.30   QUALITY = A
                                   AZ =  -48.          AZ =    42.

 DATE    ORIGIN      LAT       LONG     DEPTH    MAG NO D3 GAP M  RMS   ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840527 1657 31.82 39N16.77 107W17.83   3.38   1.67 10  9 306 1 0.09   1.8  2.3 C B|D 0.14 10 14 0.00 0.07  0  0.0  0.0  3  1.7  0.1
SE OF ORIG =  0.168         4 ITERATIONS TOTAL

(- STATION DATA -) (------- P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (----- S-WAVE TRAVEL-TIME DATA --)(---- MAGNITUDE DATA --)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
THO    3.7  34 133 32.76IPD          0.94  0.88              0.06 1.064      36.91  5.09  1.53  3.56 0.000           552        5
SNO    6.4   3 118 33.08IPD          1.26  1.27             -0.01 1.064      33.98  2.16  2.23 -0.07 0.745           552  20 1.85
SOP    9.0  53 110 33.48IPD          1.66  1.69             -0.04 1.064      33.93  2.11  2.96 -0.86 0.000           552  15 1.55
HOL   11.2  28 107 33.95IPD          2.13  2.05              0.08 1.064      35.45  3.63  3.59  0.04 0.745           552  18 1.75
EDG   13.0   3 105 34.06IPC          2.24  2.36             -0.12 1.064                                              552        5
PR1   14.1  57 103 34.37IPD          2.55  2.54              0.01 1.064      37.92  6.10  4.45  1.65 0.000           552        5
SPR   21.9  11  99 35.88IPC          4.06  3.89              0.17 1.064      39.33  7.51  6.80  0.70 0.000           552        5
ASP   24.4  44  98 36.02EPD          4.20  4.32             -0.12 1.064                                              552        5

                         QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH      SW    E     Z     N     NE    NW    SE
AVE. OF END POINTS                 0.01  0.11  0.11  0.13  0.16  0.21  0.22

            NUMBER      RMS  MIN DRMS  AVE DRMS   QUALITY
                 8     0.09     -0.03      0.14         D

___________END___________________END___________________END___________________END___________
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             ____________BEGIN____________________BEGIN____________________BEGIN____________________BEGIN__________
84/ 5/28   13/22                                                                                          84/ 5/28   13/22

                                             HORIZONTAL                               VERTICAL
                                     SE =    0.99               SE =    2.00          SE =    1.93   QUALITY = A
                                     AZ =    -71.               AZ =     19.

 DATE    ORIGIN      LAT      LONG     DEPTH    MAG NO D3 GAP M  RMS   ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840528 1322 30.22 39N16.74 107W17.12   3.50   1.79 10  8 299 1 0.11  2.0  1.9 C B|D 0.15 11 15 0.00 0.10  0  0.0  0.0  6  1.8  0.1
SE OF ORIG =  0.172          3 ITERATIONS TOTAL

(- STATION DATA -) (------- P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (----- S-WAVE TRAVEL-TIME DATA --)(---- MAGNITUDE DATA --)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
THO    3.3  18 137 30.97IPD        0.75  0.84             -0.09 1.064     33.42  3.20  1.47  1.73 0.000             553  21 1.85
SNO    6.5 354 118 31.45IPD        1.23  1.30             -0.06 1.064     32.35  2.13  2.27 -0.14 0.745             553  22 1.95
SOP    8.3  49 113 31.72IPD        1.50  1.58             -0.08 1.064     32.92  2.70  2.76 -0.06 0.745             553  20 1.85
HOL   10.8  24 108 32.43IPD        2.21  1.99              0.22 1.064     33.98  3.76  3.48  0.28 0.000             553  20 1.85
EDG   13.1 359 105 32.60IPC        2.38  2.37              0.01 1.064     34.90  4.68  4.15  0.53 0.000             553        5
PR1   13.3  54 105 32.54IPC        2.32  2.41             -0.09 1.064     35.14  4.92  4.21  0.71 0.000             553  15 1.65
CRY   20.0  27 100 33.94EPC        3.72  3.56              0.16 1.064                                               553        5
SPR   21.8   9  99 34.15EPD        3.93  3.87              0.06 1.064     39.95  9.73  6.77  2.96 0.000             553  23 2.05

                         QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH       Z     NE    NW    SE     N    SW     E
AVE. OF END POINTS                 0.22  0.44  0.47  0.49  0.50  0.53  0.57

             NUMBER        RMS  MIN DRMS  AVE DRMS    QUALITY
                 10       0.11      0.26      0.50          B

             ____________END____________________END____________________END____________________END____________
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            _____________BEGIN_____________________BEGIN_____________________BEGIN_____________________BEGIN___________
84/ 5/29    17/53                                                                                                        84/ 5/29    17/53

                                                     HORIZONTAL                                  VERTICAL
                                                SE =   5.14             SE =   8.13             SE =   6.53   QUALITY = C
                                                AZ =   -38.             AZ =  -128.

 DATE    ORIGIN      LAT      LONG     DEPTH    MAG NO D3 GAP M  RMS   ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840529 1753  2.02 39N15.75 107W19.08   5.20   1.70  8 12 318 1 0.19  8.1  6.5 D D|D 0.34 10 11 0.00 0.17  0  0.0  0.0  5  1.7  0.2
SE OF ORIG =  0.664         4 ITERATIONS TOTAL

(- STATION DATA -) (-------- P-WAVE TRAVEL-TIME DATA AND DELAYS --------) VARI (----- S-WAVE TRAVEL-TIME DATA ---)(---- MAGNITUDE DATA ---)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
THO    6.3  38 130 63.49IPD        1.47  1.43              0.04 1.039      55.43 -6.59  2.50 -9.09 0.000              557       5
SNO    8.6  14 121 63.90IPD        1.88  1.76              0.12 1.039      65.05  3.03  3.07 -0.05 0.727              557  25 2.05
SOP   11.6  51 114 64.07IPD        2.05  2.23             -0.19 1.039                                                 557  18 1.75
HOL   13.7  31 111 64.82IPC        2.80  2.57              0.22 1.039      67.92  5.90  4.50  1.39 0.000              557  20 1.85
EDG   15.1  10 109 64.54IPD        2.52  2.80             -0.29 1.039      68.89  6.87  4.91  1.96 0.000              557  12 1.45
CRY   23.0  32 103 66.42IPD        4.40  4.13              0.26 1.039                                                 557  15 1.65
ASP   27.0  44 101 66.70EPC        4.68  4.82             -0.15 1.039                                                 557       5

                        QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH        NE     N    SW     E     Z    NW    SE
AVE. OF END POINTS                  0.04  0.04  0.04  0.05  0.05  0.07  0.10

                NUMBER       RMS  MIN DRMS  AVE DRMS   QUALITY
                     7      0.19     -0.03      0.06         D

            _____________END_______________________END_______________________END_______________________END_____________
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            ___________BEGIN____________________BEGIN____________________BEGIN____________________BEGIN_________
84/ 5/30    22/11                                                                                            84/ 5/30    22/11

                                                     HORIZONTAL                           VERTICAL
                                                SE =    6.52             SE =  14.08          SE =  99.00    QUALITY = D
                                                AZ =    -16.             AZ =  -106.

 DATE    ORIGIN      LAT       LONG     DEPTH    MAG NO D3 GAP M  RMS  ERH  ERZ Q SQD  ADJ IN NR  AVR  AAR NM AVXM SDXM NF AVFM SDFM
840530 2211  3.68 39N 4.18 107W18.59   0.10*  1.90  6 36 339 1 0.19 14.1 99.0 D D|D 0.10 10  8 0.00 0.15  0  0.0  0.0  4  1.9  0.4
SE OF ORIG = 10.000        10 ITERATIONS TOTAL

(- STATION DATA -) (------- P-WAVE TRAVEL-TIME DATA AND DELAYS -------) VARI (----- S-WAVE TRAVEL-TIME DATA ---)(---- MAGNITUDE DATA ---)
 STN  DIST AZM AIN PSEC PRMK+TCOR-O=TTOB-TTCAL-DELAY-EDLY= P-RES  P-WT THIC SSEC SRMK  TTOB TTCAL S-RES S-WT AMX PR XMAG R  FMP FMAG
SNO   29.7   3  90  8.61IPD        4.93  5.22              -0.29 1.053      12.81  9.13  9.13  0.00 0.737                 30 2.2
SOP   29.9  16  90  8.86IPD        5.18  5.24              -0.06 1.053                                                    22 1.9
EDG   36.3   3  90 10.39IPD        6.71  6.38               0.33 1.053      13.89 10.21 11.16 -0.95 0.000                 30 2.2
CRY   42.5  15  90 11.07IPC        7.39  7.46              -0.07 1.053      12.92  9.24 13.05 -3.81 0.000
ASP   44.7  24  90 11.60EPD        7.92  7.84               0.08 1.053                                                    10 1.3

                         QUALITY EVALUATION

DIAGONALS IN ORDER OF STRENGTH          E    NW    SE    NE    SW     N     Z
AVE. OF END POINTS                  -0.06 -0.04 -0.03  0.00  0.01  0.02  0.02


              NUMBER      RMS  MIN DRMS  AVE DRMS   QUALITY
                   5     0.19     -0.15     -0.01         D
```