LA-8745-PR

Progress Report

# Earthquake Catalog for Northern New Mexico

## October—December 1980

University of California

LOS ALAMOS SCIENTIFIC LABORATORY

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# EARTHQUAKE CATALOG FOR NORTHERN NEW MEXICO

# OCTOBER 1980 - DECEMBER 1980

by

D. J. Wechsler, D. J. Cash, K. H. Olsen
N. J. McFarland, and J. J. Wolff

## ABSTRACT

This report is a summary of the earthquakes in northern New Mexico located by the Los Alamos National Laboratory seismic array. Data are presented in the form of tables and epicenter maps, with a brief explanatory text.

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A seismic network capable of locating earthquakes has been maintained by the Los Alamos National Laboratory since September 1973. Summaries of recorded and earlier historical seismicity have been previously published (e.g., Slemmons, 1975; Newton et al., 1976; Northrop, 1976; Sanford et al., 1976; this catalog, 1st issue).

The present array configuration for the Los Alamos northern New Mexico seismograph stations is depicted in Fig. 1, and stations are listed along with pertinent information in Table I. Figure 1 includes some stations from the U.S. Geological Survey and Albuquerque Seismological Center seismic arrays, which are sometimes used in the computation of earthquake locations. Figure 2 is a map showing the more dense station distribution in the Jemez Mountains west of Los Alamos, around the Fenton Hill geothermal test site.

Earthquake locations have been determined using a version of HYPOINVERSE (Klein, 1978). Stations are assigned to one of three velocity models, given in Table II. Within the array (defined as an event with the largest azimuthal gap between recording stations $\leq 180^{\circ}$) precision of epicentral locations is probably on the order of 1-5 km. Other locations can be determined to within

5-15 km at best. The detection threshold is variable over the area of array coverage as well, generally increasing as one moves away from the center of the array.

Estimates of depth precision are greater than for epicentral coordinates due to the nature of the hypocenter determination problem. Within the array, depths may be estimated to ± 2-10 km, depending on the distance to the closest station; outside the array, depth uncertainty may be ±40 km. The distribution of reliable depth estimates suggests, however, that most seismic activity in northern New Mexico is shallow focus (<20 km).

Magnitudes of events are listed as local magnitudes ($M_L$), computed using the relationship

$$M_L = 2.79 \log T - 3.63 \quad , \tag{1}$$

where T is the maximum event duration in seconds observed at all network stations. The duration is measured from the first P-phase arrival to the time when the coda dissappears into the background noise. The above equation was derived by comparison of log T to magnitude values determined by the ALQ Wood-Anderson seismograph. Magnitudes for near-regional events computed using this relationship have corresponded well to those given by the USGS.

For some areas where array coverage is best, as in the Jemez area after late 1979, events as small as $M_L = -1.5$ can be detected and located. Detection threshold is generally higher over most of the area of coverage, approximately $M_L = 0.5$.

Table III is the listing of located hypocenters for October through December 1980. A negative depth indicates that the depth was constrained to the absolute value of the number listed to obtain a reliable solution for the epicenter. The quality factor (A, B, C, or D) is determined by considering the values of the RMS travel time residual and the condition number of the partial derivative matrix. It is included to give an indication of the comparative quality of the solution. Quality factors may be loosely associated with estimates of epicenter precision as follows: A ~ 1-3 km, B ~ 3-5 km, C ~ 5-15 km, and D ~ greater than 15 km.

Figure 3 is the epicenter map for the three-month period. Figure 4 is a map depicting major geologic and tectonic features. A cumulative epicenter map for all earthquakes located since September 1973 is included as Fig. 5. A duplicate tectonic map, Fig. 6, is provided for reference.

Northern New Mexico is an area of numerous and frequent mine blasting operations. An attempt has been made to eliminate all such man-caused seismic sources from this catalog. This exclusion is relatively easy for the larger, continuously operating mines and quarries, but there is a possibility that occasional small or isolated blasts could have been included in the data set. We would appreciate hearing from anyone who might have definite information about such suspicious events in particular areas.

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TABLE I

SEISMOGRAPH STATIONS

| CODE NAME | GEOGRAPHIC LOCATION | COORDINATES LATITUDE | COORDINATES LONGITUDE | ELEVATION (METERS) | VELOCITY MODEL + | SEISMOMETER | MAGNIFI-CATION* | TELEMETRY (FREQ.=MHz) | DATE INSTALLED |
|---|---|---|---|---|---|---|---|---|---|
| BRC | Barley Canyon | 35.8903 | 106.7114 | 2261 | 2 | L4-C | 512 K | 164.5/LL | 20 Nov 75 |
| CLP | Clara Peak | 36.0358 | 106.2403 | 2591 | 2 | SS-1 | 240 K | 169.0 | 7 Oct 73 |
| CZL | Cerro Azul | 36.2833 | 105.9103 | 2128 | 3 | S-13 | 672 K | 410.35 | 24 Sep 76 |
| DMPK | Dead Man's Peak | 36.4264 | 106.7757 | 2664 | 1 | S-13 | 144 K | 416.35 | 22 Nov 76 |
| EUM | Eureka Mesa | 36.0131 | 106.8439 | 2914 | 1 | L4-3D | 216 K | M/226.7 | 13 Jan 76 |
| FARG** | Farmington | 36.7780 | 108.1870 | 1801 | 1 | S-500 | — | | Oct 77 |
| FCN** | Frijoles Canyon | 35.7719 | 106.2503 | 1945 | - | L4-3D | — | LL | 7 May 73 |
| JOAQ | Joaquin L.O. | 35.7708 | 106.8411 | 2768 | 2 | SS-1 | 720 K | 410.35 | 9 Nov 79 |
| LCV*** | La Cueva | 35.8828 | 106.6742 | 2652 | 2 | L4-3D | 456 K | LL | 5 Sep 73 |
| LFC | Lake Fork Canyon | 35.8769 | 106.6647 | 2451 | 2 | Lf-C | 288 K | 169.0/LL | 4 Nov 75 |
| LFMS | Lake Fork Mesa | 35.8736 | 106.7200 | 2558 | 2 | S-500 | 576 K | 409.075 | Nov 79 |
| REDP | Redondo Peak | 35.8711 | 106.5629 | 3417 | 2 | SS-1 | 360 K | 409.35 | Oct 77 |
| LOA** | Los Alamos (TA-49, LANL) | 35.8247 | 106.2944 | 2144 | - | L4-3D | — | LL | 12 Jan 72 |
| MSA | San Antonio Mountain | 36.8692 | 106.0216 | 3322 | 3 | L4-3D | 128 K | M/226.7 | 9 Oct 75 |
| MTL | Mt. Taylor | 35.2519 | 107.5964 | 3335 | 1 | L4-3D | 272 K | M/226.7 | 15 Oct 75 |
| OTZ | Ortiz Mountain | 35.7603 | 106.1728 | 2091 | 3 | L4-C | 120 K | 166.25 | 17 Sep 76 |
| RIO** | Caja del Rio | 35.7547 | 106.1756 | 2073 | - | L4-C | — | 166.25 | 21 Feb 75 |
| SHMS | Schoolhouse Mesa | 35.8544 | 106.6906 | 2561 | 2 | S-500 | 288 K | 409.025 | Nov 79 |
| SPD | St. Peter's Dome | 35.7578 | 106.3694 | 2566 | 2 | SS-1 | 688 K | 164.75 | 18 Sep 73 |
| TMRS | Thompson Ridge | 35.8828 | 106.6375 | 2476 | 2 | S-500 | 530 K | 409.125 | Nov 79 |
| TSL | Navajo Community College | 36.3722 | 109.2436 | 2012 | 1 | SS-1 | 344 K | LL | 22 May 75 |
| TSP | Tesuque Peak | 35.7853 | 105.7814 | 3664 | 2 | SS-1 | 456 K | M/226.7 | 14 Oct 73 |
| TTP | Tetilla Peak | 35.6094 | 106.2064 | 2103 | 3 | L4-C | 114 K | 164.50 | 18 Mar 75 |
| WELC | Well C Fenton Hill | 35.9704 | 106.6243 | 2000 | 2 | S-500 | 512 K | 409. | Nov 79 |
| Q-1 | Fenton Hill Area | 35.8879 | 106.6716 | 2658 | 2 | S-13 | 153 K | M/164.5 | Jan 80 |
| Q-2 | Fenton Hill Area | 35.8783 | 106.6655 | 2599 | 2 | S-13 | 152 K | M/164.5 | Jan 80 |
| Q-3 | Fenton Hill Area | 35.8747 | 106.6686 | 2630 | 2 | S-13 | 152 K | M/164.5 | Jan 80 |
| Q-4 | Fenton Hill Area | 35.8749 | 106.6793 | 2634 | 2 | S-13 | 152 K | M/164.5 | Jan 80 |
| Q-5 | Fenton Hill Area | 35.8787 | 106.6815 | 2632 | 2 | S-13 | 152 K | M/164.5 | Jan 80 |

LL Land Line
M Microwave
* Peak Magnification at 10 Hz
** Closed
*** Fenton Hill site is 300 m south of LCV

S-500 Teledyne-Geotech
L4-C, L4-3D Mark Products
SS-1 Kinemetrics (Ranger)
S-13 Teledyne-Geotech
+ See Table II

TABLE II

VELOCITY MODELS

| APPROXIMATE GEOGRAPHICAL AREA AND REFERENCE | VELOCITY (km/s) | DEPTH (km) TO TOP OF LAYER |
|---|---|---|
| 1. Colorado Plateau (Roller, 1965) | 3.0 | 0.0 |
| | 6.2 | 2.5 |
| | 6.8 | 27.0 |
| | 7.8 | 45.0 |
| 2a. Transition Zone (Toppozada and Sanford, 1976) | 3.0 | 0.0 |
| | 6.15 | 1.0 |
| | 6.50 | 20.0 |
| | 7.9 | 41.0 |
| 2b. Jemez Local Seismicity[a] | 2.2 | 0.0 |
| | 3.0 | 0.15 |
| | 4.0 | 0.42 |
| | 6.1 | 0.72 |
| | 6.5 | 5.0 |
| | 7.9 | 41.0 |
| 3. Rio Grande Rift (Olsen et al., 1979) | 3.33 | 0.0 |
| | 6.0 | 3.2 |
| | 6.4 | 21.4 |
| | 7.6 | 33.7 |

a Model supplied by Carl A. Newton, Los Alamos National Laboratory.

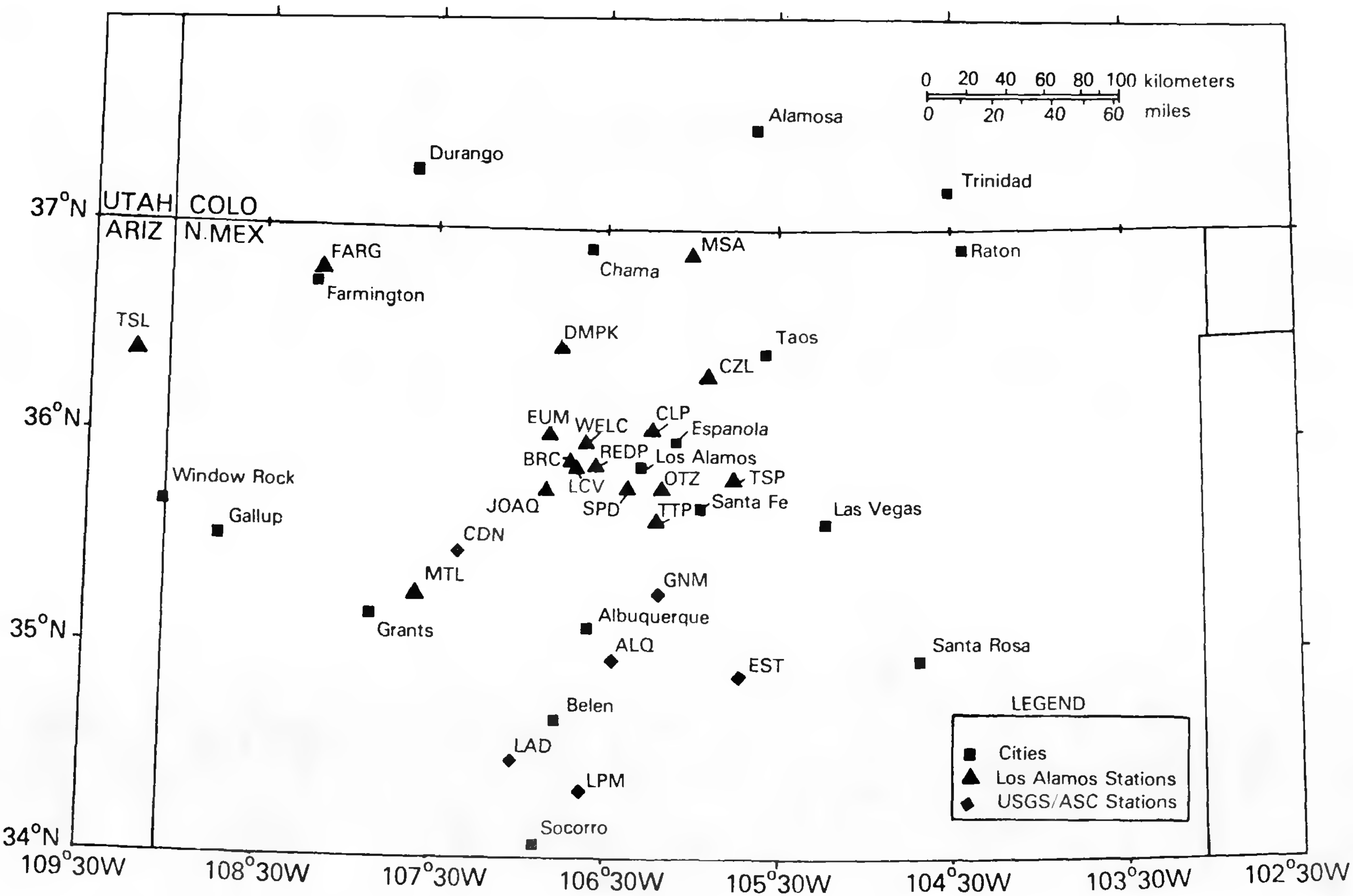


Fig. 1. Northern New Mexico seismograph stations.

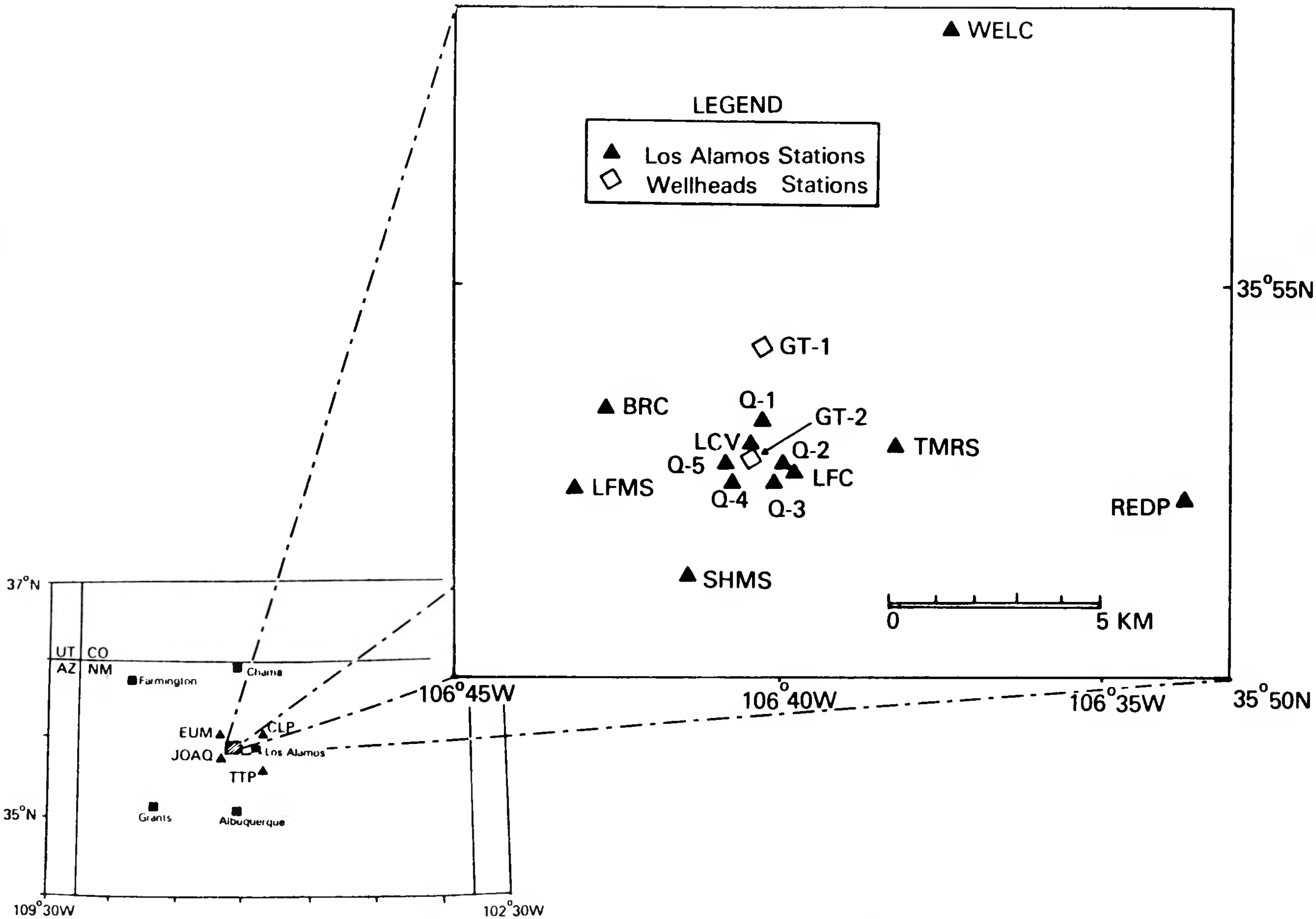


Fig. 2. Seismograph stations in the Fenton Hill, Jemez Mountains, area.

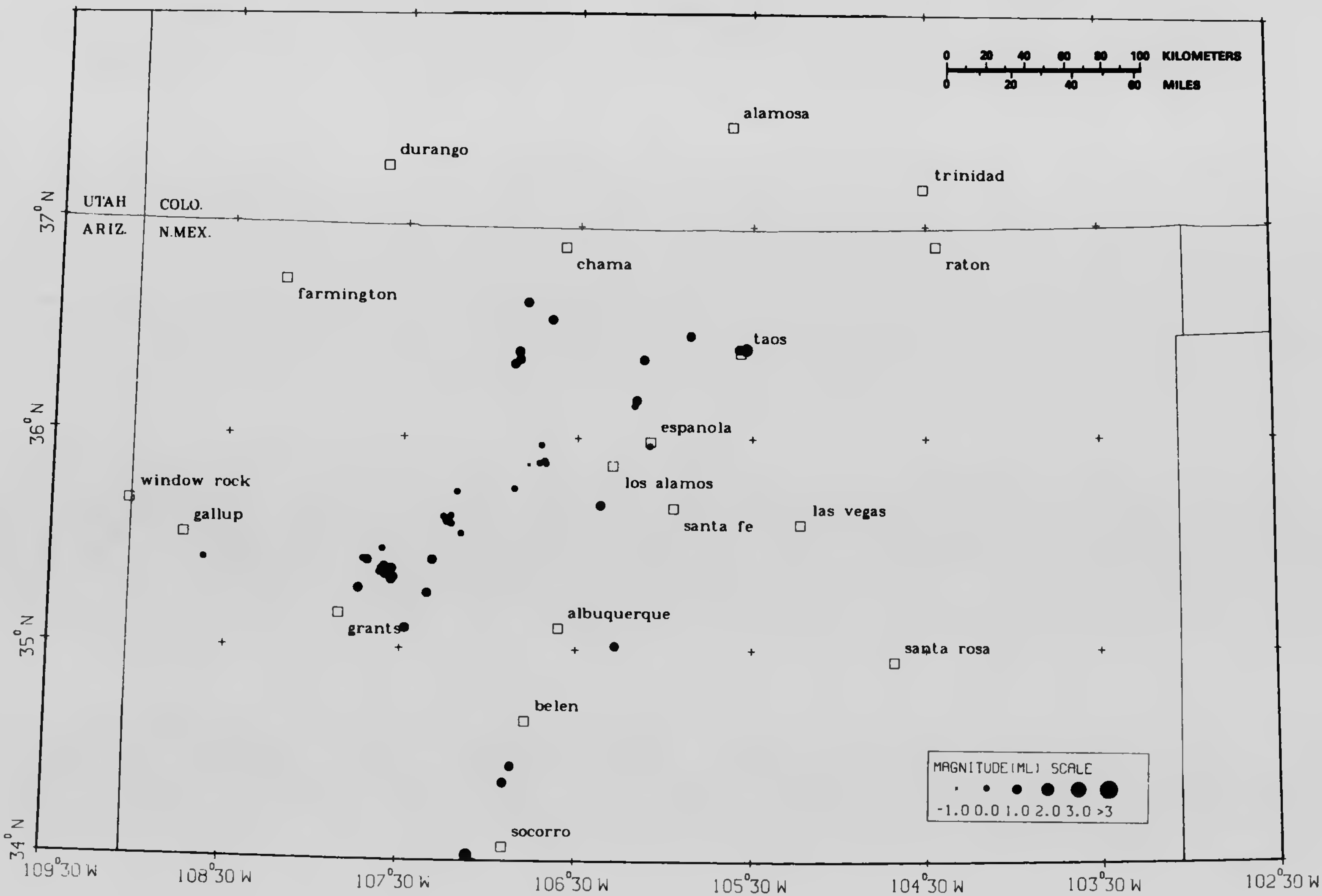


 Fig. 3. Northern New Mexico earthquakes, Oct. 1980 - Dec. 1980.

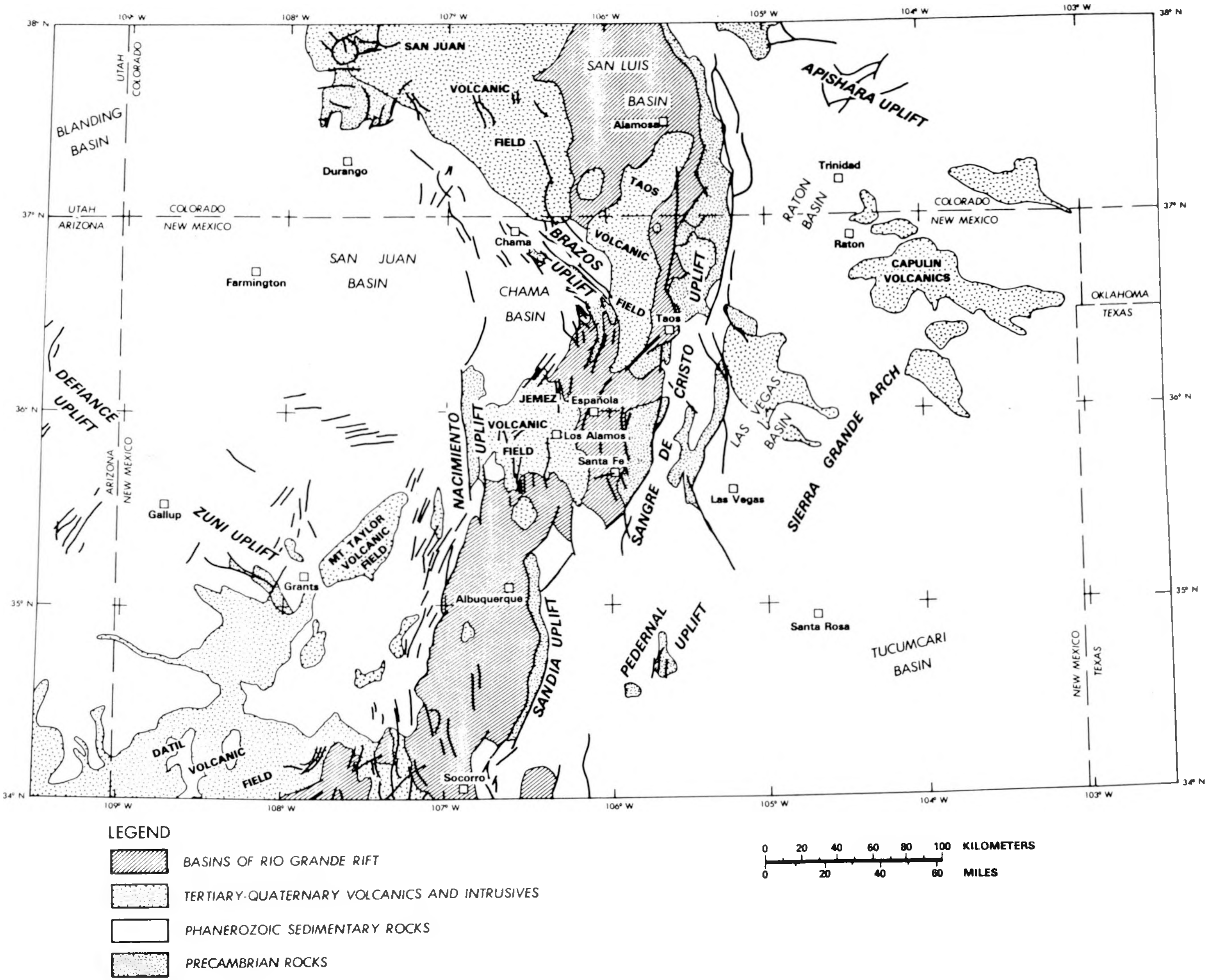


Fig. 4. Generalized geologic and tectonic map of northern New Mexico.

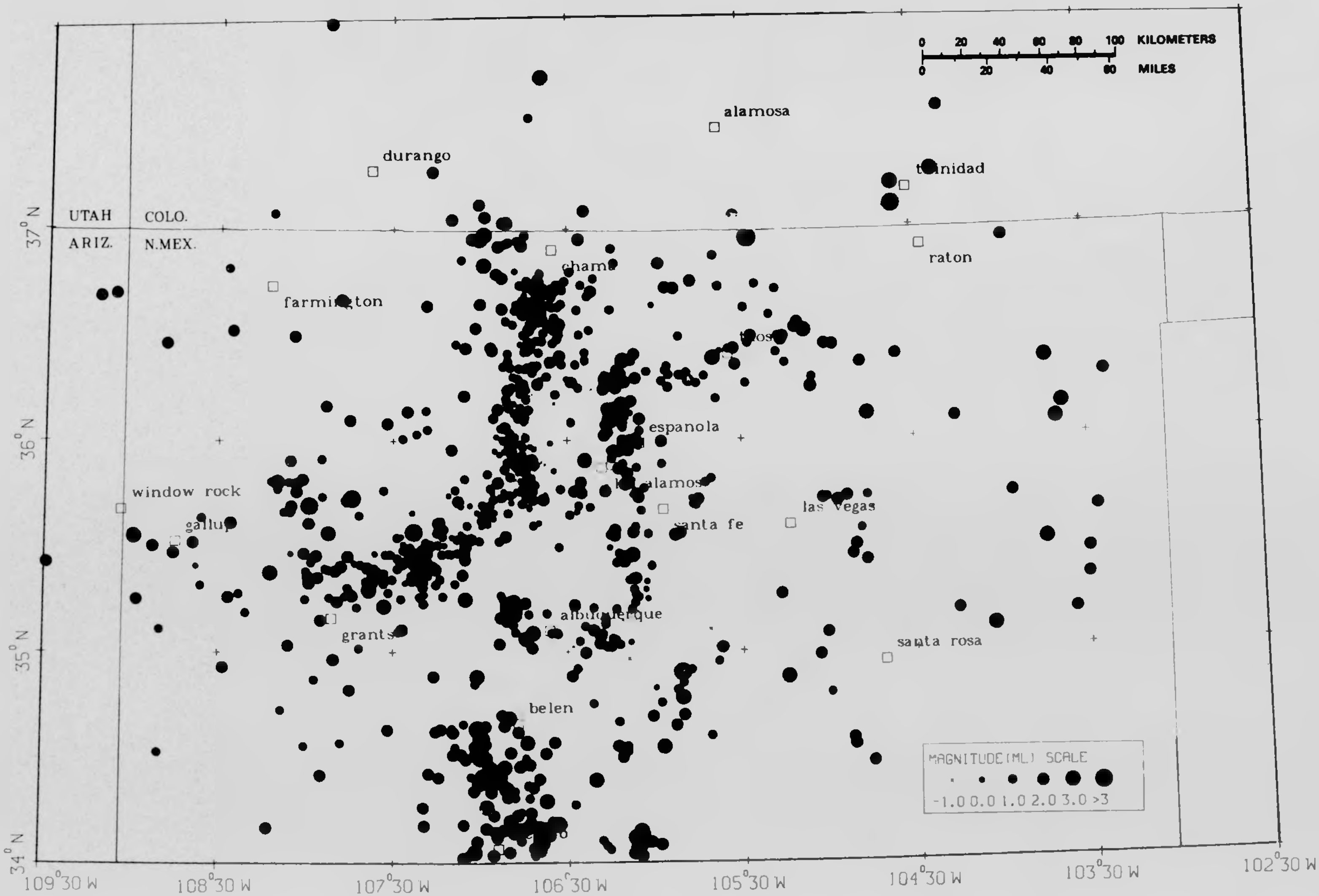


Fig. 5. Northern New Mexico earthquakes, Sept. 1973 - Dec. 1980.

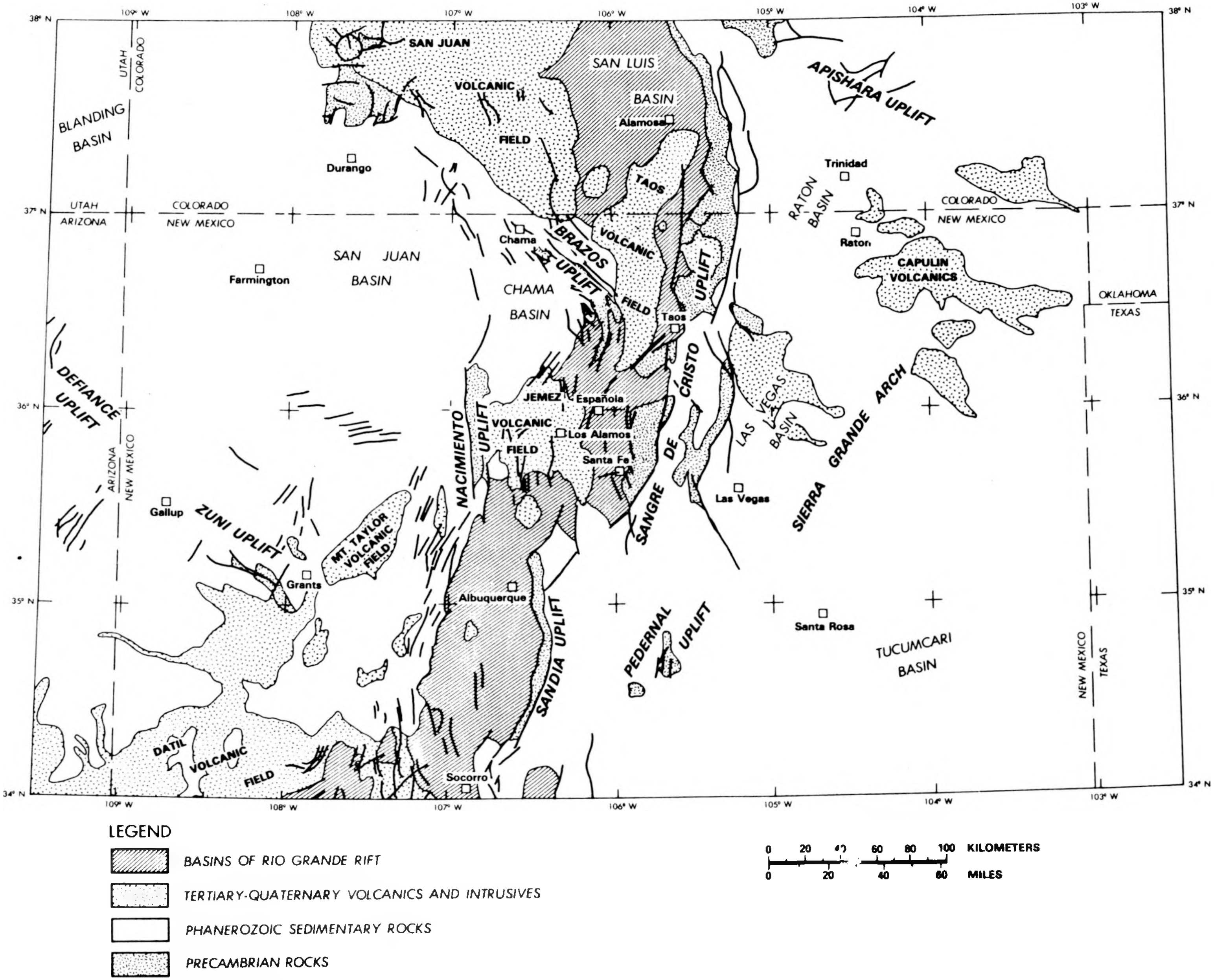


Fig. 6. Generalized geologic and tectonic map of northern New Mexico.

TABLE III

NORTHERN NEW MEXICO EARTHQUAKES, OCT.-DEC. 1980

| IDN | DATE | TIME | LAT | LONG | DEPTH | MAG | QUAL |
|---|---|---|---|---|---|---|---|
| 1 | 801007 | 1117 8.37 | 34.3681 | 106.9034 | -5.00 | .8 | B |
| 2 | 801008 | 73637.50 | 35.2803 | 107.7384 | -5.00 | .1 | B |
| 3 | 801008 | 195647.49 | 36.4873 | 105.8582 | -5.00 | .6 | B |
| 4 | 801014 | 17 041.56 | 35.3703 | 107.6098 | -5.00 | .2 | D |
| 5 | 801014 | 172645.86 | 35.3738 | 107.5513 | -5.00 | .8 | C |
| 6 | 801014 | 18 945.97 | 35.0968 | 107.4720 | -5.00 | .3 | D |
| 7 | 801016 | 82441.26 | 35.4675 | 107.6063 | -5.00 | -.6 | C |
| 8 | 801017 | 205342.20 | 35.3811 | 107.5933 | -5.00 | .3 | C |
| 9 | 801017 | 205434.99 | 35.3242 | 107.5520 | 2.90 | .2 | A |
| 10 | 801019 | 617 .42 | 36.1519 | 106.1822 | -5.00 | 0.0 | A |
| 11 | 801019 | 72428.77 | 36.1813 | 106.1652 | -5.00 | .2 | A |
| 12 | 801023 | 1417 8.76 | 34.0250 | 107.0991 | -5.00 | 1.3 | C |
| 13 | 801025 | 821 1.79 | 35.2623 | 107.3514 | -5.00 | .4 | B |
| 14 | 801025 | 194252.07 | 35.5439 | 107.1639 | -5.00 | 0.0 | B |
| 15 | 801026 | 102913.83 | 35.8929 | 106.6868 | 3.00 | -.8 | D |
| 16 | 801027 | 1133 7.38 | 35.9688 | 106.7089 | 2.00 | -.7 | B |
| 17 | 801028 | 1232 2.13 | 35.9670 | 106.0887 | -5.00 | -.4 | D |
| 18 | 801102 | 225433.11 | 35.3326 | 107.5450 | -5.00 | .4 | C |
| 19 | 801102 | 231910.98 | 35.3270 | 107.5544 | 3.10 | .1 | A |
| 20 | 801102 | 233950.96 | 35.3524 | 107.5735 | -5.00 | 0.0 | D |
| 21 | 801113 | 1949 5.20 | 35.6829 | 106.3646 | .30 | .6 | D |
| 22 | 801116 | 2132 9.21 | 35.8728 | 106.7808 | 1.10 | -1.0 | A |
| 23 | 801117 | 21 649.61 | 35.6813 | 106.3646 | 7.30 | .5 | B |
| 24 | 801118 | 132113.94 | 35.8859 | 106.7126 | 3.70 | -.6 | A |
| 25 | 801118 | 142052.55 | 35.8933 | 106.6912 | 1.10 | -.2 | A |
| 26 | 801118 | 142944.35 | 35.3451 | 107.5914 | -5.00 | .1 | C |
| 27 | 801118 | 143238.11 | 35.4147 | 107.6901 | -5.00 | .2 | C |
| 28 | 801118 | 153043.63 | 35.3580 | 107.6254 | -5.00 | 0.0 | C |
| 29 | 801118 | 163520.73 | 35.4207 | 107.7183 | -5.00 | -.6 | C |
| 30 | 801118 | 18 210.70 | 35.3328 | 107.5718 | 4.00 | -.3 | D |
| 31 | 801120 | 21124.63 | 36.6410 | 106.7957 | -5.00 | .5 | C |
| 32 | 801120 | 75959.41 | 35.3467 | 107.5931 | 3.30 | .2 | B |
| 33 | 801122 | 01628.21 | 36.3474 | 106.8662 | -5.00 | 1.0 | B |
| 34 | 801127 | 92818.39 | 36.4256 | 105.5680 | -5.00 | .5 | B |
| 35 | 801129 | 81948.91 | 36.4260 | 105.5389 | -5.00 | 1.2 | B |
| 36 | 801130 | 72030.26 | 36.5604 | 106.6557 | -5.00 | .4 | B |
| 37 | 801204 | 11 054.71 | 34.4458 | 106.8609 | -5.00 | .8 | B |
| 38 | 801211 | 12 4 2.73 | 35.6216 | 107.2642 | -5.00 | -.8 | C |
| 39 | 801213 | 657 8.40 | 35.4078 | 108.6240 | -5.00 | -.1 | D |
| 40 | 801213 | 92348.29 | 35.5904 | 107.2131 | -5.00 | -.3 | C |
| 41 | 801213 | 165144.70 | 35.6284 | 107.2245 | -5.00 | 0.0 | C |
| 42 | 801215 | 111219.82 | 35.6017 | 107.2358 | -5.00 | .5 | B |
| 43 | 801215 | 205759.56 | 35.0209 | 106.2780 | -5.00 | .1 | C |
| 44 | 801217 | 92729.72 | 35.8782 | 106.6787 | 3.00 | -.6 | A |
| 45 | 801218 | 171111.80 | 36.3736 | 106.1239 | -5.00 | .1 | A |
| 46 | 801223 | 2 256.05 | 35.7422 | 107.1897 | -5.00 | -.5 | C |
| 47 | 801223 | 318 8.42 | 35.7572 | 106.8609 | -5.00 | -.8 | B |
| 48 | 801224 | 115727.21 | 36.4079 | 106.8414 | 10.50 | .1 | B |
| 49 | 801227 | 221648.69 | 36.3805 | 106.8400 | 3.90 | .1 | B |
| 50 | 801228 | 1417 3.39 | 35.4183 | 107.3253 | -5.00 | .9 | B |

TOTAL NO. OF EPICENTERS = 50