U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

# THE SOUTHERN CALIFORNIA NETWORK BULLETIN

## JANUARY – DECEMBER, 1989

by

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## INTRODUCTION

The California Institute of Technology together with the Pasadena Office of the U.S. Geological Survey operates a network of approximately 280 remote seismometers in southern California. Signals from these sites are telemetered to the central processing site at the Caltech Seismological Laboratory in Pasadena. These signals are continuously monitored by computers that detect and record thousands of earthquakes each year. Phase arrival times for these events are picked by human analysts and archived along with digital seismograms. All data aquisition, processing and archiving is achieved using the CUSP system. These data are used to compile the *Southern California Catalog of Earthquakes*; a list beginning in 1932 that currently contains more than 180,000 events. This data set is critical to the evaluation of earthquake hazard in California and to the advancement of geoscience as a whole.

This and previous Network Bulletins are intended to serve several purposes. The most important goal is to make Network data more accessible to current and potential users. It is also important to document the details of Network operation, because only with a full understanding of the process by which the data are produced can researchers use the data responsibly.

## NETWORK CONFIGURATION

**New Stations.** Several new sites have been added since publication of the last Network Bulletin. As in past Bulletins, reports of network changes are not restricted to those that occurred during the reporting period but are as current as possible. An explanation of the conventions used for full station codes can be found in Given *et al.* (1987).

Plans are still underway to telemeter TIN and CWC, two long established sites in Owen's Valley. One or more new sites may also be added in that area.

Site preparation is complete for the new broad-band, high dynamic range site planned for the vicinity of the new Seven Oaks dam being contructed north of Redlands by the U. S. Army Corps of Engineers. Its design will be very similar to the new Streckeisen that has been installed in Pasadena. It will be located in an abandoned water shaft near power plant #2 in the Santa Ana riverbed. The installation date has been delayed due to a delay in the delivery of parts. The completion date is now fall, 1990.

<u>CLM</u> The instrument at this site was designed to be a portable station that can be easily moved to another site when needed (See the discussion on Network Portable Sites). The instrument was installed at this location in order to provide a close station to record aftershocks of the February 28, 1990 $M_L$ 5.5 Upland earthquake. This is a temporary station.

| | | |
|---|---|---|
| Site name: | Claremont | |
| Latitude: | 34° 5.78′ N | ( 34.0963°) |
| Longitude: | 117° 43.33′ W | (117.7222 ) |
| Elevation: | 351 m | (1151 ft.) |
| Date installed: | April 30, 1990 | |

| Full Code | Inst. | Orientation |
|---|---|---|
| CLMCV | L4 | vertical |
| CLMCZ | L4 | vertical low-gain |
| CLMCE | L4 | east/west |
| CLMCN | L4 | north/south |
| CLMCI | FBA | vertical |
| CLMCJ | FBA | north/south |
| CLMCK | FBA | east/west |

IR2 The station IRC (Iron Canyon) was moved to the southeast due to the convenience of the telemetry drop, and since the move was significant, the site code has been changed.

| | | |
|---|---|---|
| Site name: | Iron Canyon | |
| Latitude: | 34° 23.26′ N | ( 34.3877°) |
| Longitude: | 118° 23.90′ W | (118.3983°) |
| Elevation: | 610 m | (2001 ft.) |
| Date installed: | February 19, 1990 | |

| Full Code | Inst. | Orientation |
|---|---|---|
| IR2CV | L4 | vertical |

PLS This is a permanent site that fills the hole in the network that was left when the COQ (Corona Quarry) station was removed. It was also located here in order to occupy the microwave relay site already at this location. The microwave relay stations receive and relay microwave signals from other stations. Eventually all microwave sites will be accompanied by a seismic instrument.

| | | |
|---|---|---|
| Site name: | Pleasants Peak | |
| Latitude: | 33° 47.33′ N | ( 33.7888°) |
| Longitude: | 117° 36.48′ W | (117.6080°) |
| Elevation: | 1177 m | (3861 ft.) |
| Date installed: | May 23, 1990 | |

| Full Code | Inst. | Orientation |
|---|---|---|
| PLSCV | L4 | vertical |
| PLSCZ | L4 | vertical low-gain |
| PLSCN | L4 | north/south |
| PLSCE | L4 | east/west |
| PLSCI | FBA | vertical |
| PLSCJ | FBA | north/south |
| PLSCK | FBA | east/west |

SCI Two horizontal components were added to this vertical component station in order to provide better depth control for offshore events. Santa Cruz will also be equipped with horizontal components in the future.

| | | |
|---|---|---|
| Site name: | San Clemente Island | |
| Latitude: | 32° 58.80′ N | ( 32.9800°) |
| Longitude: | 118° 32.80′ W | (118.5467°) |
| Elevation: | 219 m | (718 ft.) |
| Date installed: | June 13, 1990 | |

| Full Code | Inst. | Orientation |
|---|---|---|
| SCICN | L4 | north/south |
| SCICE | L4 | east/west |

UPL An instrument was installed at this location in order to provide a close station to record aftershocks of the February 28, 1990 $M_L$ 5.5 Upland earthquake. The instrument at this site, like CLM, was designed to be a portable station.

| | | |
|---|---|---|
| Site name: | Upland | |
| Latitude: | 34° 8.96′ N | ( 34.1493°) |
| Longitude: | 117° 41.92′ W | (117.6987°) |
| Elevation: | 555 m | (1820 ft.) |
| Date installed: | March 20, 1990 | |

| Full Code | Inst. | Orientation |
|---|---|---|
| UPLCV | L4 | vertical |
| UPLCZ | L4 | vertical low-gain |
| UPLCN | L4 | north/south |
| UPLCE | L4 | east/west |
| UPLCI | FBA | vertical |
| UPLCJ | FBA | north/south |
| UPLCK | FBA | east/west |

**Discontinued Stations.** Only one station has been removed since the last Bulletin was released. The removal date is shown below. SYS was removed due to heavy construction in the vicinity of the site. Relocation is forthcoming.

**■ Table 1. Discontinued stations**

| Code | Date Discontinued |
|---|---|
| SYS | May 2, 1990 |

**Network Portable Sites.** The technicians at the Pasadena office have created two "portable" stations that can quickly and easily be moved to a site when they are needed, for close recording of increased seismic activity in a particular area. These stations are put together inside a large heavy gage truck toolbox with a 3-component L4 seismometer and 3-component FBA at one end, and the electronics package at the other. The ground at the chosen site is leveled and then sand is placed under the station in order to provide adequate coupling to the ground and also to aid in draining moisture away from the station. The only other parts required to complete the station are the tub with the transmitter and battery, and the mast and antenna for sending the signal.

The plan is to construct more of these portable stations in the future so that there is a plentiful supply of them to place in the field when they are needed.

## NETWORK OPERATIONS

**Status of Processing.** The status of each month of catalog data since the advent of digital recording is described in Table 2. Events for months marked preliminary (**P**) have been timed but have not yet run the gauntlet of quality checking, addition of helicorder amplitudes and rearchiving necessary to become final (**F**). For months marked "pinked" (**Pnk**), larger events ($\approx$ 3.0) have only been timed crudely on a few stations and smaller events are absent. A period in 1980–1981 has actually been timed and digital seismograms are available, but the "pinked" version is still used for any purpose requiring good magnitudes or completeness for large earthquakes; some events and magnitudes are missing otherwise. An increased effort has been made in the last year months to finalize the most recent eight years of data. As a result, almost all months in 1983 – 1988 have been finalized. The effort will now be shifted to reloading and finalizing older data.

## ▪ Table 2. Processing Status of Network Data

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1977 | P | P | P | P | P | P | P | P | P | P | P | P |
| 1978 | F | F | F | F | F | F | F | F | F | F | F | F |
| 1979 | P | P | P | P | P | P | P | P | P | P | P | P |
| 1980 | P | P | P | P | Pnk | Pnk | Pnk | Pnk | Pnk | Pnk | Pnk | Pnk |
| 1981 | Pnk | Pnk | P | P | P | P | P | P | P | P | P | P |
| 1982 | P | P | P | P | P | P | P | P | P | P | P | P |
| 1983 | P | P | P | Pnk | Pnk | Pnk | Pnk | P | P | F | F | F |
| 1984 | F | F | F | F | F | F | F | F | F | F | F | F |
| 1985 | F | F | F | F | F | F | F | F | F | F | F | F |
| 1986 | F | F | F | F | F | F | P | F | F | F | F | F |
| 1987 | F | F | F | F | F | F | F | F | F | F | F | F |
| 1988 | F | F | F | F | F | F | F | F | F | F | F | F |
| 1989 | F | F | F | P | P | P | P | P | P | P | P | P |
| 1990 | P | P | P | P | P | P | | | | | | |

F = final, Pnk = "pinked", P = preliminary

**Network Connections to the Seismological Lab.** The Caltech/USGS seismic processing computers are now networked to the rest of the scientific world. Our local Ethernet backbone has been linked through a Cisco gateway to the CITnet and thence to Internet. Network communications are controlled by MultiNet software from TGV, Inc. This software supports all TCP/IP services including TELNET, FTP and RLOGIN. It also allows DECnet communications with USGS computers all over the country. MultiNet has been installed on the Caltech VAX/750, node name BOMBAY, which is the area router for our local network and the primary off-line data processing computer. Our Internet domain specification is *gps.caltech.edu*.

Mail addressed to users on BOMBAY should be in this form:

*user-id*@bombay.gps.caltech.edu (131.215.66.2)

Mail addressed to users on INDIO, the USGS research VAX/750, should be in this form:

"indio::user-id"@bombay.gps.caltech.edu

Appendix C provides electronic mail addresses of the users on the BOMBAY and INDIO systems.

**RTP Messages to GOPHER at Caltech.** GOPHER, the software written by Steve Malone at the University of Washington, is presently running at the University of Washington. It "triggers" on NEIC messages and retrieves broad-band data for significant events around the world from the dial-up instruments operating at Harvard, Massachusetts; Pasadena, California; Albuquerque, New Mexico; Cathedral Caves, Missouri; and Kipapa, Hawaii. The Caltech Seismology Laboratory has received the GOPHER software, and it will be running on the SUN system with several modifications as soon as a dedicated modem is delivered.

In order to provide easily accessible data quickly for local and regional events of interest in southern California in addition to significant events world-wide, the GOPHER program at Caltech has been modified to accept and trigger on RTP messages. The RTP (real-time picker), which "triggers" on local and regional events, sends messages to GOPHER, which in turn will retrieve the broad-band data for these events from the dial-up TERRAscope stations being installed and the USGS broad-band stations in southern California. The stations from which data will be retrieved for each event will depend on the magnitude of the event and the distance between the earthquake location and each station.

As soon as this process is running and the bugs have been worked out, information on how to access the data files will be provided (probably in the next Network Bulletin).

## RESEARCH NOTES

**Conversion of CUSP data to Unix System in SAC format.** It is now possible to convert southern Califorinia network data in the form of CUSP FREEZE (.MEM) and ARKIVE (.GRM) files to SAC format. The SAC software (Seismic Analysis Codes) was developed by Lawrence Livermore National Lab and is copyrighted by the University of California. An updated version of this software now resides on the Unix based Sun computers at Caltech.

The software for the conversion was developed by Rob Clayton, Craig Jones, David Wald and Bruce Worden. MEM files are read from FREEZE tapes on the Sun and converted to a binary header file using a program called *memtobin.c*. A second code, *wed.c*, reads this binary header file and the corresponding GRM file from the ARKIVE tape and combines the header and the waveform data for each station. The output from *wed.c* consists of a separate binary file in SAC format for every station. For teleseisms, the earthquake source information (location, origin time and magnitude) is read from a file called *eqinfo* residing in the working directory. This information is used to determine station distance, azimuth and back-azimuth, and these parameters are also written into the SAC header.

The information in the SAC header is similar to that in the CUSP MEM files. However, in SAC, the header is of fixed length (158 32-bit words) and contains floating point, integer, logical and character fields. It is followed by a single data section containing the dependent variable. Details of the SAC format and software use can be found in the SAC users manual.

SAC format allows direct use of the SAC software which provides interactive plotting, phase picking, filtering and signal stacking of seismic data. In addition, the capability of creating SAC macro files allows more automated general purpose seismic analysis.

## SYNOPSIS OF SEISMICITY

A total of 10,074 earthquakes and 2,919 blasts were cataloged for 1989 (Figure 1). Of the cataloged events, 130 were greater than or equal to $M_L$ 3.0 (Appendix A). The largest earthquake in 1989 had an $M_L$ of 5.0 and was located off the coast of Malibu within the Torrance-Wilmington fold and thrust belt (Hauksson and Saldivar, 1989). Focal mechanisms for 25 events ($M_L \geq 3.5$) are shown in Figure 3.

For the following discussion southern California has been divided into eleven sub-regions (Figure 4). These regions are arbitrary, but useful for discussing characteristics of seismicity in a manageable context. Figures 5a and 5b summarize the activity of each sub-region over the past four years. A separate discussion section follows for those regions with notable activity.

**Imperial Valley – Region 1.** Several earthquake swarms occurred in the vicinity of Obsidian Butte at the south end of the Salton Sea in 1989. Such swarms are common in the Brawley Seismic Zone (the broad band of seismicity that connects the north end of the Imperial fault to the south end of the San Andreas fault). The entire zone experienced vigorous seismic activity in 1989. Most earthquakes in the Brawley Seismic Zone are thrust events on east-west planes; however, on February 16 an unusual $M_L$ 3.5 normal event with a north-south strike occurred.

In March the level of seismic activity increased, producing three $M_L > 4.0$ events and 11 events between $M_L$ 3 and 4. The largest earthquake of the sequence in March was an $M_L$ 4.3. Relocations of the events using Imperial Valley velocity models from Fuis (1982) revealed a northeast-striking lineation that appeared to be shallow (3-5 km), although the depths were not well-constrained. The mechanisms included strike-slip, reverse, and normal faulting and did not depend on depth.

Seismicity continued at a more moderate level from April through June, followed by slightly decreased activity until October when the level increased again through the end of the year (Figure 5a).

**South San Jacinto – Region 2.** The southern San Jacinto fault experienced three sequences of events in December after almost a year of unexceptional activity. The northern San Jacinto fault also experienced two sequences of seismic activity (see the San Bernardino discussion, Region 7). The first sequence started on December 2 with an $M_L$ 4.2 earthquake near the northern end of the Anza segment (Figure 3, Number 24). The mainshock showed right-lateral strike-slip movement, and was preceded by an $M_L$ 2.8 foreshock and followed by several aftershocks. The second sequence on this portion of the San Jacinto fault occurred on December 22 and was located 3 km to the southeast of the first sequence. The largest event in this sequence was an $M_L$ 3.4. The next sequence started on December 31 and included an $M_L$ 2.9 foreshock preceding a normal faulting $M_L$ 3.2 mainshock followed by aftershocks. This sequence was located in the middle of the Anza segment, between the Clark and Buck Ridge faults. All the events in these sequences were compatible with a north-striking maximum horizontal stress.

**San Diego – Region 4.** The aftershock rate from the $M_L$ 5.3 Oceanside mainshock in July of 1986 continued to decay in 1989 with only 5 events $\geq M_L$ 3.0. The largest earthquake was an $M_L$ 4.2 on January 15 (Figure 3, Number 1).

**Los Angeles Coast – Region 5.** The increased rate of earthquake activity in the Los Angeles area continued through most of 1989. An $M_L$ 3.1 earthquake occurred at the northern end of the Palos Verdes fault and a cluster of smaller events ($\leq M_L$ 2.7) occurred on the Newport-Inglewood fault in January. High seismicity continued in the Los Angeles basin throughout February, March, and April with the Newport-Inglewood fault producing an $M_L$ 4.5 earthquake on April 7 (Figure 2, Number 22). It was located 1-2km south of the March 1933 epicenter ($M_L$ 6.3) and had a pure right-lateral strike-slip mechanism. It was felt widely in the Los Angeles area but had no felt aftershocks.

On June 12 two earthquakes occurred in the Montebello area of Los Angeles, an $M_L$ 4.4 followed 25 minutes later by an $M_L$ 4.1 (Figure 3, Numbers 18 and 23). Ten aftershocks were recorded over the following two weeks. In addition, three aftershocks of the 2 December 1988 Pasadena earthquake occurred on the Raymond fault in the five days after the Montebello event. Small earthquakes continued in the Los Angeles basin through the rest of the year with none larger than $M_L$ 3.0.

**North Elsinore – Region 6.** A strike-slip event of $M_L$ 3.2 was located at the north end of the Chino fault in February. On May 7 there was an $M_L$ 3.5 located apparently on the Whittier fault near Chino.

**San Bernardino – Region 7.** The area around the southern San Andreas fault was very active during 1989 (Figure 6). Numerous small earthquakes ($\leq M_L$ 2.0) were located just east of the Coachella Valley segment of the fault in February. Another small swarm of earthquakes (the largest was $M_L$ 2.7) occurred near Indio in March on a northeast-striking fault intersecting the San Andreas fault. All the events were shallow (approximately 2 km depth). In April an $M_L$ 3.0 occurred at the site of the March swarm and exhibited normal faulting on a northeast-striking plane. Another swarm east of the Coachella Valley occurred in May, but with no events greater than $M_L$ 3.0. There were three small events ($M_L$ 2.0, 1.8, 1.5) in an unusual but not unprecedented location just east of the San Andreas fault north of Bombay Beach in June.

An $M_L$ 4.5 earthquake occurred in the southern Mojave desert on June 4 near the Lenwood fault about 50 km west-northwest of the 1979 Homestead Valley earthquakes. The mechanism was left-lateral strike-slip on a north-south plane. Six aftershocks were recorded in June. An $M_L$ 3.0 reverse-slip event was located near the San Andreas fault south of Wrightwood in August near the site of the 1970 Lytle Creek earthquake ($M_L$ 5.4) which had the same mechanism. Another earthquake occurred at this site in September; an $M_L$ 3.6 reverse-slip event on an east-striking plane 1 km from the surface trace of the San Andreas.

December was by far the most seismically active month for this area. A small swarm began in the southern Mojave desert on December 24 and continued through the end of the year. There was also a cluster of 17 earthquakes located near Mecca Beach in the first week of December, and an $M_L$ 4.0 was recorded about 10 km east of the San Andreas fault near Indio on December 18. Its right-lateral strike-slip motion on a north-south plane was compatible with small north-striking faults east of the San Andreas in the Indio Hills.

In addition, there were several sequences of earthquakes on the San Jacinto fault (see the South San Jacinto fault discussion, Region 2). The first sequence on the northern portion of the San Jacinto fault zone started on December 6 with an $M_L$ 3.4 thrust event followed by several aftershocks. The thrust event on a north-northwest striking plane was an unusual mechanism suggesting a rotated maximum horizontal stress compared with other earthquakes of the region. The second sequence was a foreshock-mainshock-aftershock sequence that occurred on December 27-28 11 km north-northwest of the city of San Bernardino. These events were associated with a north-striking normal fault located between the San Jacinto and San Andreas faults.

The events were distributed along several segments of the San Jacinto fault, and excluding these 1989 events, there has been only one other $M_L>4$ earthquake north of the Anza Gap since 1983. However, previous $M_L$ 6 earthquakes on the San Jacinto fault have not been preceded by noticeable increases in the level of $M_L$ 3 events, so it was concluded that the high level of activity observed was unusual but not anomalous.

**South Sierra Nevada – Region 9.** In November the Garlock fault was the site of an unusual $M_L$ 3.2 event. It was preceded by fifteen events in the same location within the fifteen hours before the event. All 49 first motions recorded for the main shock were compressional and well-distributed on the focal sphere, suggesting an artificial source. However, the depth was determined as 4.7 km with the nearest station at 15 km, and the waveforms of all the events showed clear S waves and no pronounced long-period (which might also suggest an artifical event). Without further research, these events cannot be adequately identified, but they have been tentatively classified as earthquakes.

**Santa Barbara – Region 11.** The largest earthquake in southern California in 1989 occurred on January 19. It was an $M_L$ 5.0 earthquake occurred off the coast of Malibu (Figure 3, Number 2). It was felt widely in the Los Angeles area and caused some minor damage. The largest aftershock was an $M_L$ 3.8 event fifteen hours after the mainshock (Figure 3, Number 3). The mainshock had an almost pure thrust mechanism on a west-northwest striking plane and was located within the Torrance-Wilmington fold and thrust belt in Santa Monica bay as defined by Hauksson and Saldivar (1989). Aftershocks continued throughout the year with a normal decay. This was the third $M_L$ 5.0 or greater event to occur in Santa Monica Bay since 1930. The previous two events were an $M_L$ 5.2 in 1930 and an $M_L$ 5.0 in 1979.

An unrelated $M_L$ 3.8 event in February occurred 20 km west of the Malibu mainshock with an oblique thrust mechanism on a west striking plane Figure 3, Number 6). It, too, was felt throughout the Los Angeles area.

An $M_L$ 3.1 earthquake was located in the Santa Monica mountains in March with a left-lateral strike-slip mechanism parallel to the Santa Monica fault. This is an unusual location since earthquakes rarely occur north of the Malibu-Santa Monica-Raymond fault.

## REFERENCES


Fuis, Gary S., Mooney, Walter D., Healey, John H., McMechan George A., and William J. Lutter, 1982, Crustal Structure of the Imperial Valley region, in The Imperial Valley, California, Earthquake of October 15, 1979, *U. S. Geological Survey Prof. Paper 1254*, p. 25.

Given, D. D., Hutton, L. K., and L. M. Jones, 1987, The Southern California Network Bulletin, July - December, 1986: *U. S. Geological Survey Open-File Report 87–488*, 40 pp.

Hauksson, Egill and Geoffrey V. Saldivar, 1989, Seismicity and active compressional tectonics in Santa Monica Bay, southern California, *J. Geophys. Res. 94*, p. 9591.

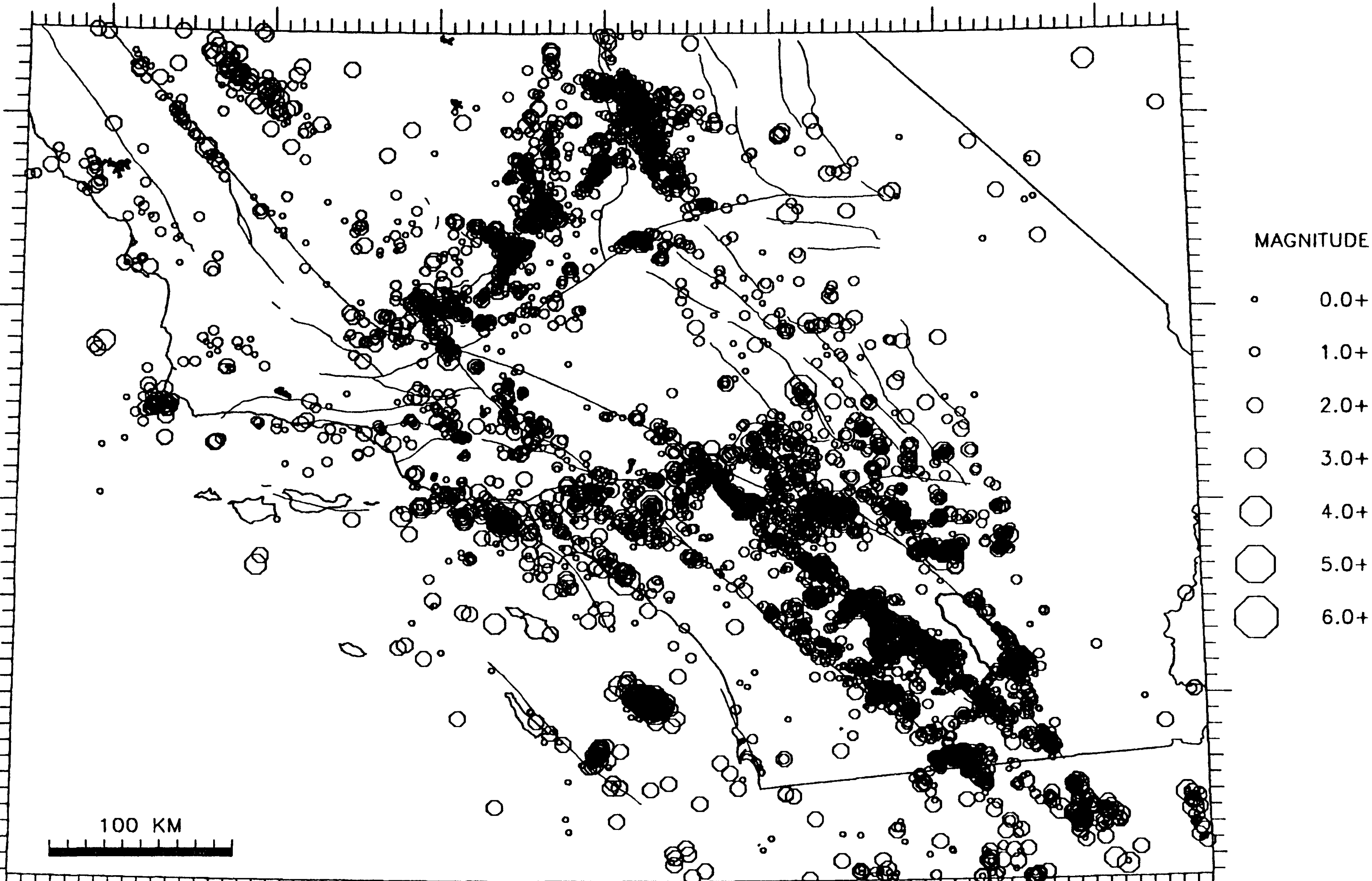


Figure 1. Map of all located earthquakes in southern California for the period of January through December 1989.

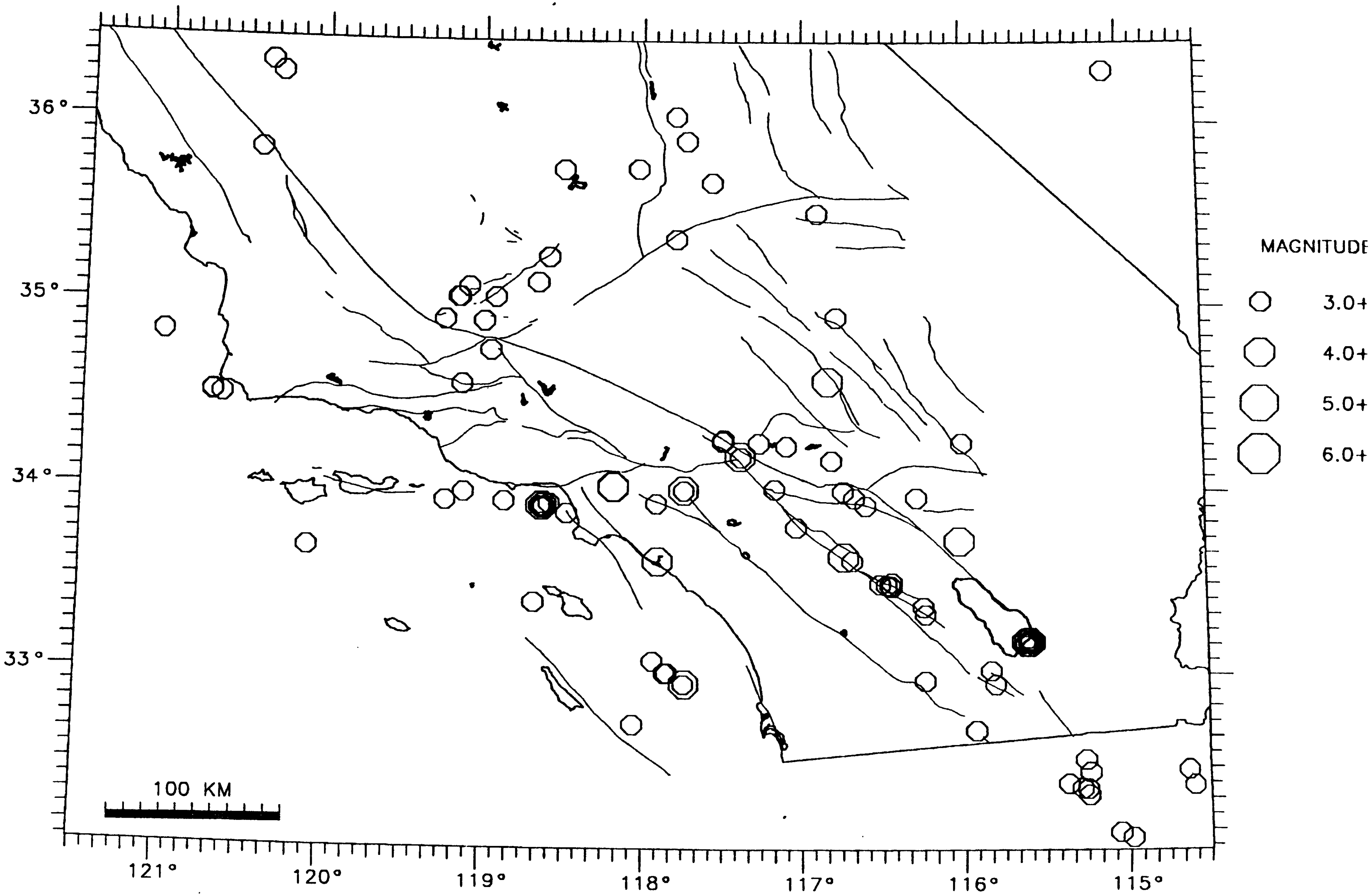


Figure 2. Map of located earthquakes of magnitude 3.0 and larger in southern California for the period of January through December 1989.

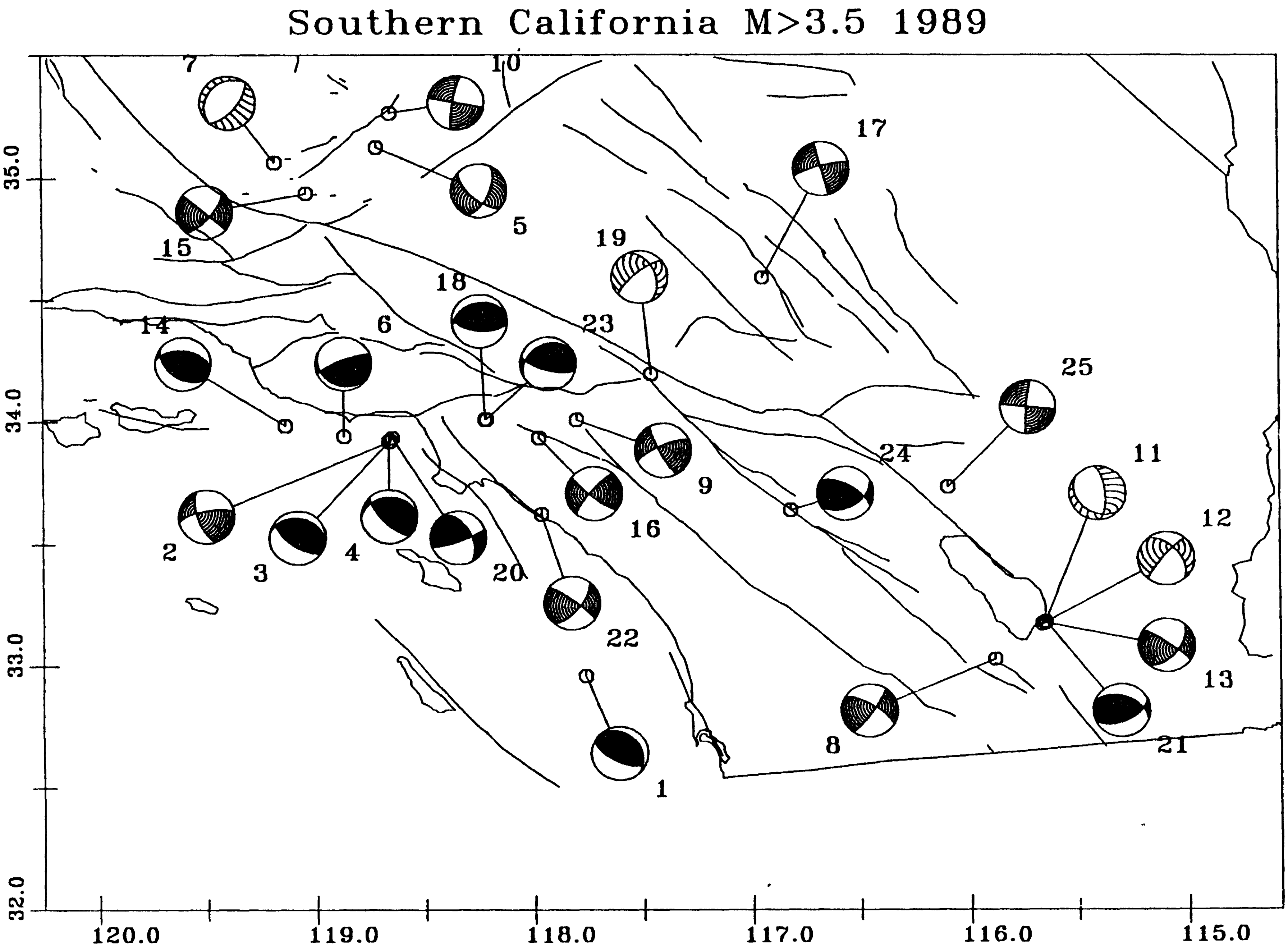


Figure 3. Lower hemisphere focal mechanisms for selected events for the period January through December 1989. Event numbers correspond to numbers in FM column of Appendix A and column 1 of Appendix B.

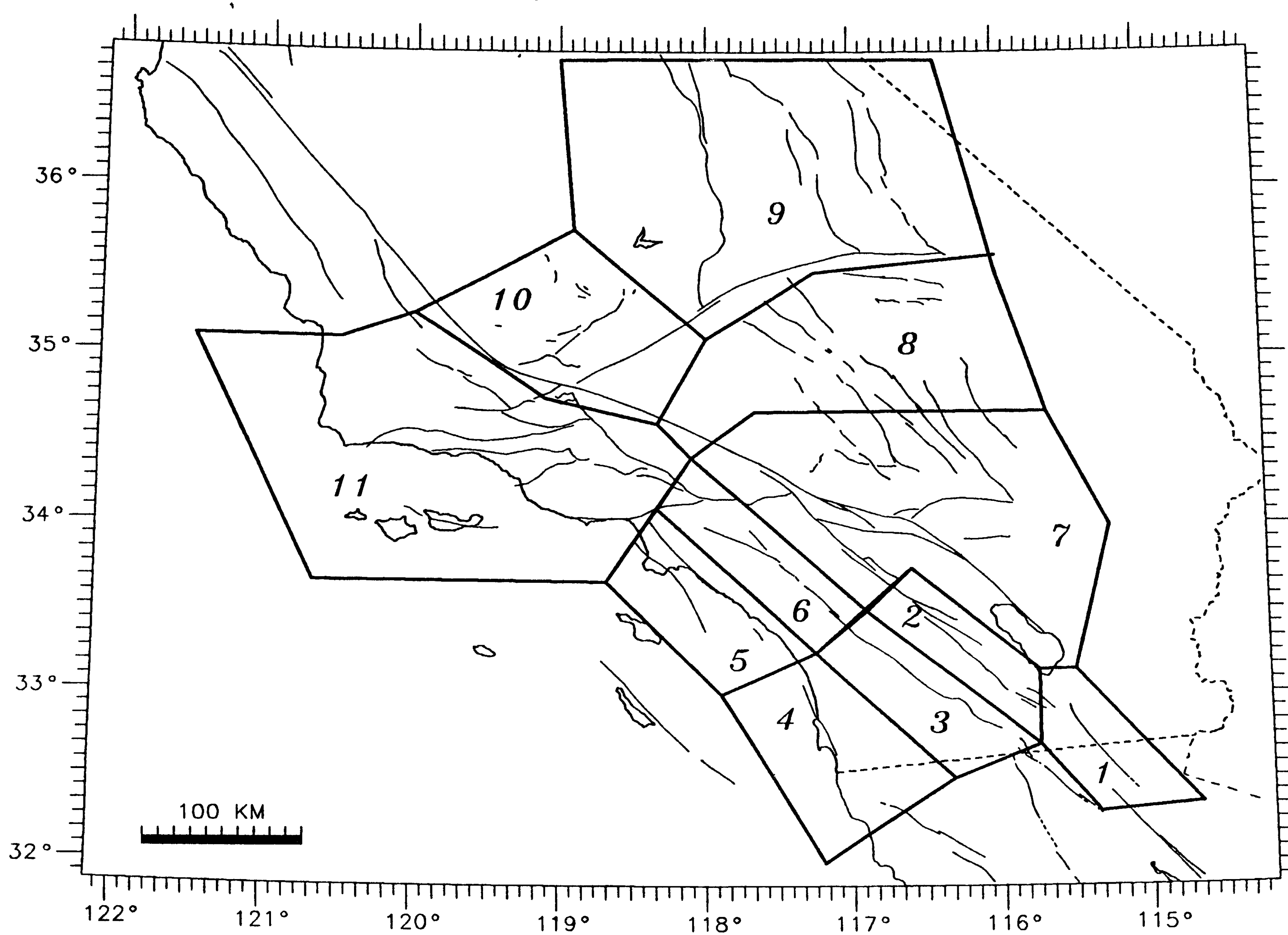


Figure 4. Map of sub-regions used in Figures 5a and 5b. The geographic name of each sub-region, as used in the text, can be found in the headings of Figures 5a and 5b.

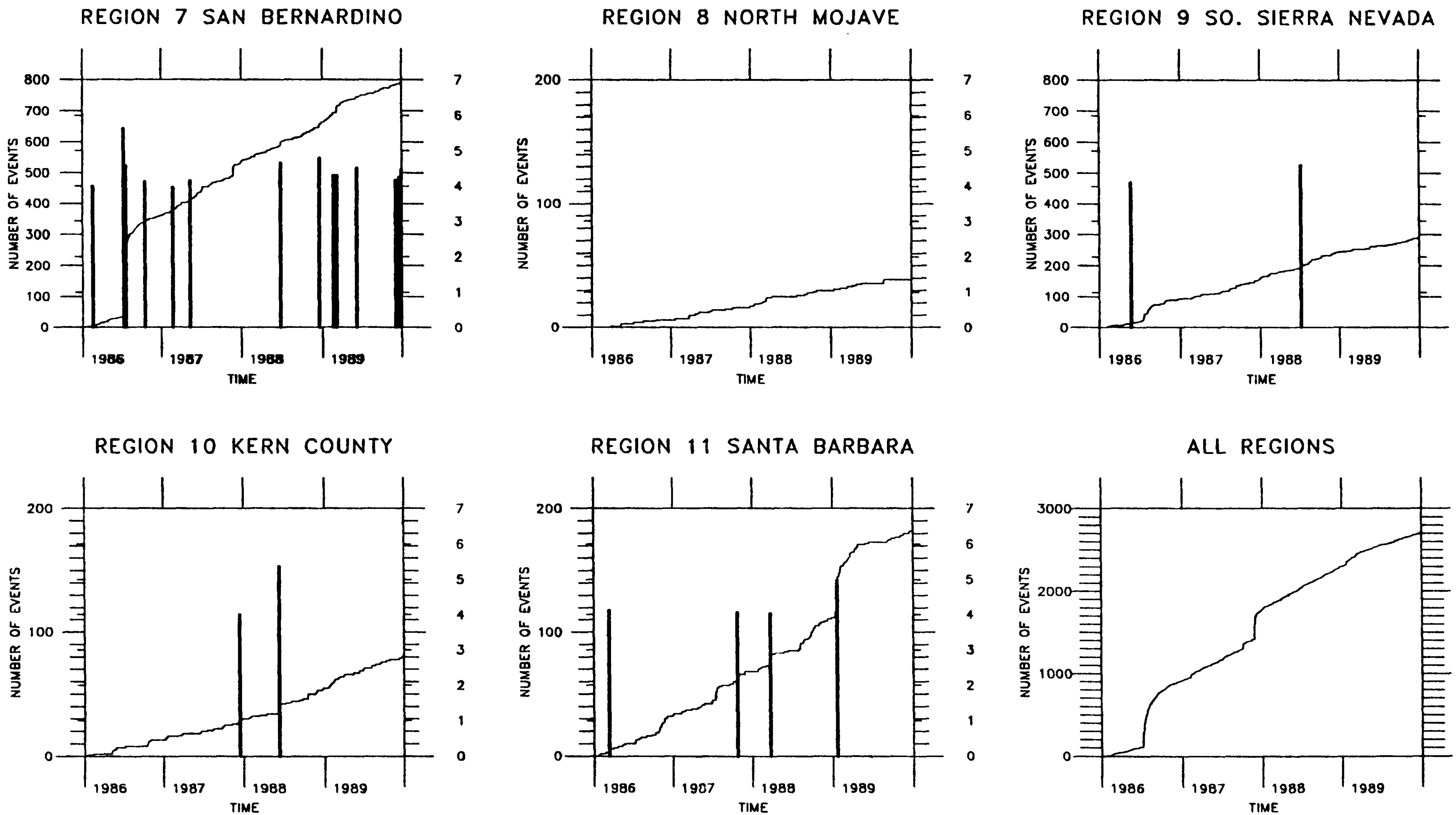


Figure 5b. Cumulative number of events ($M_L \geq 2.5$) in sub-regions 7 through 11 and for all sub-regions over the four year period ending December 1989. The boundaries of the sub-regions are shown in Figure 7. Vertical bars represent time and magnitude (scale on right) of large events ($M_L \geq 4.0$). Note that the vertical scales of the plots may not be the same.

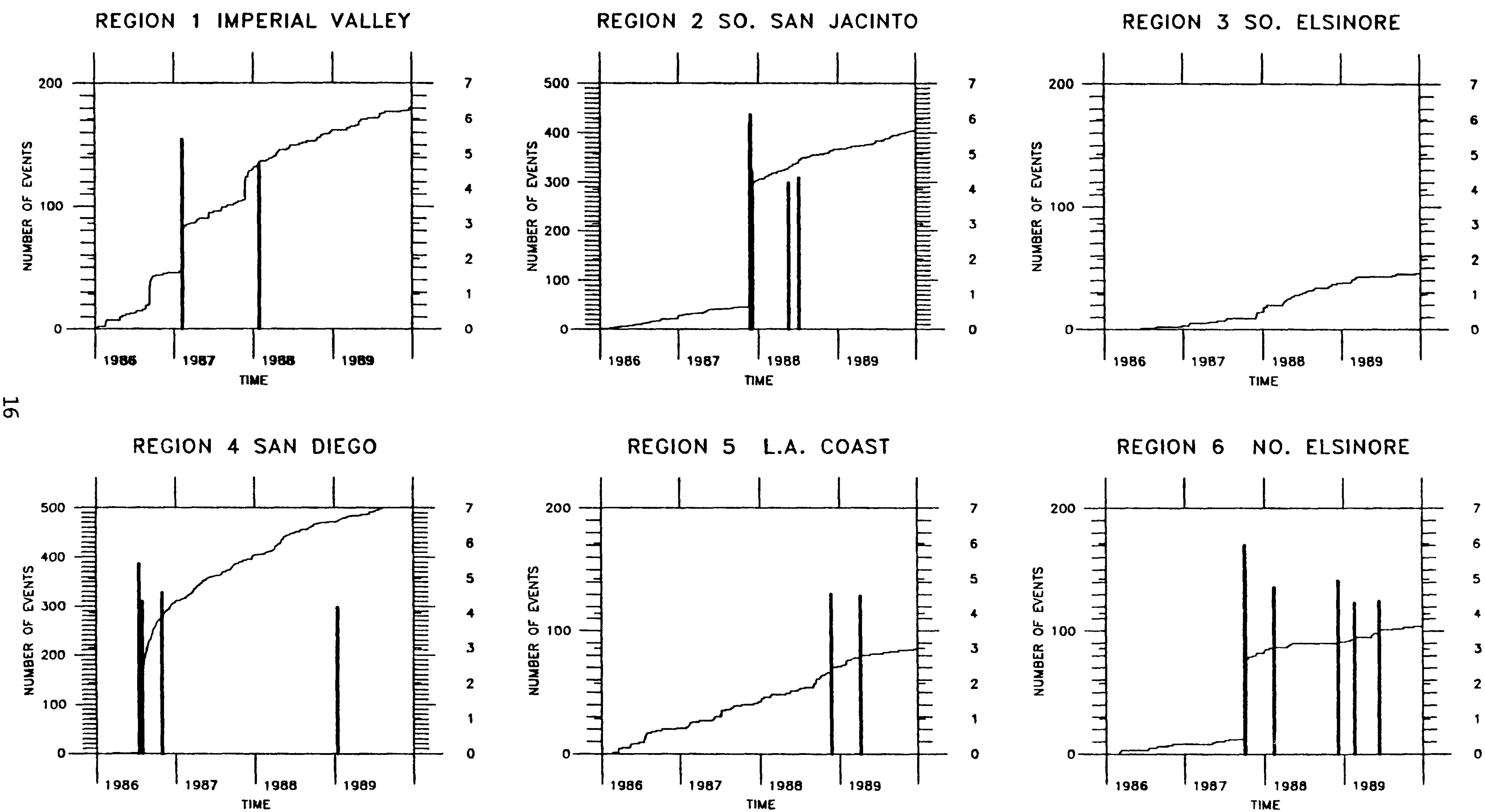


Figure 5a. Cumulative number of events ($M_L \geq 2.5$) in sub-regions 1 through 6 over the four year period ending December 1989. The boundaries of the sub-regions are shown in Figure 4. Vertical bars represent time and magnitude (scale on right) of large events ($M_L \geq 4.0$). Note that the vertical scales of the plots may not be the same.

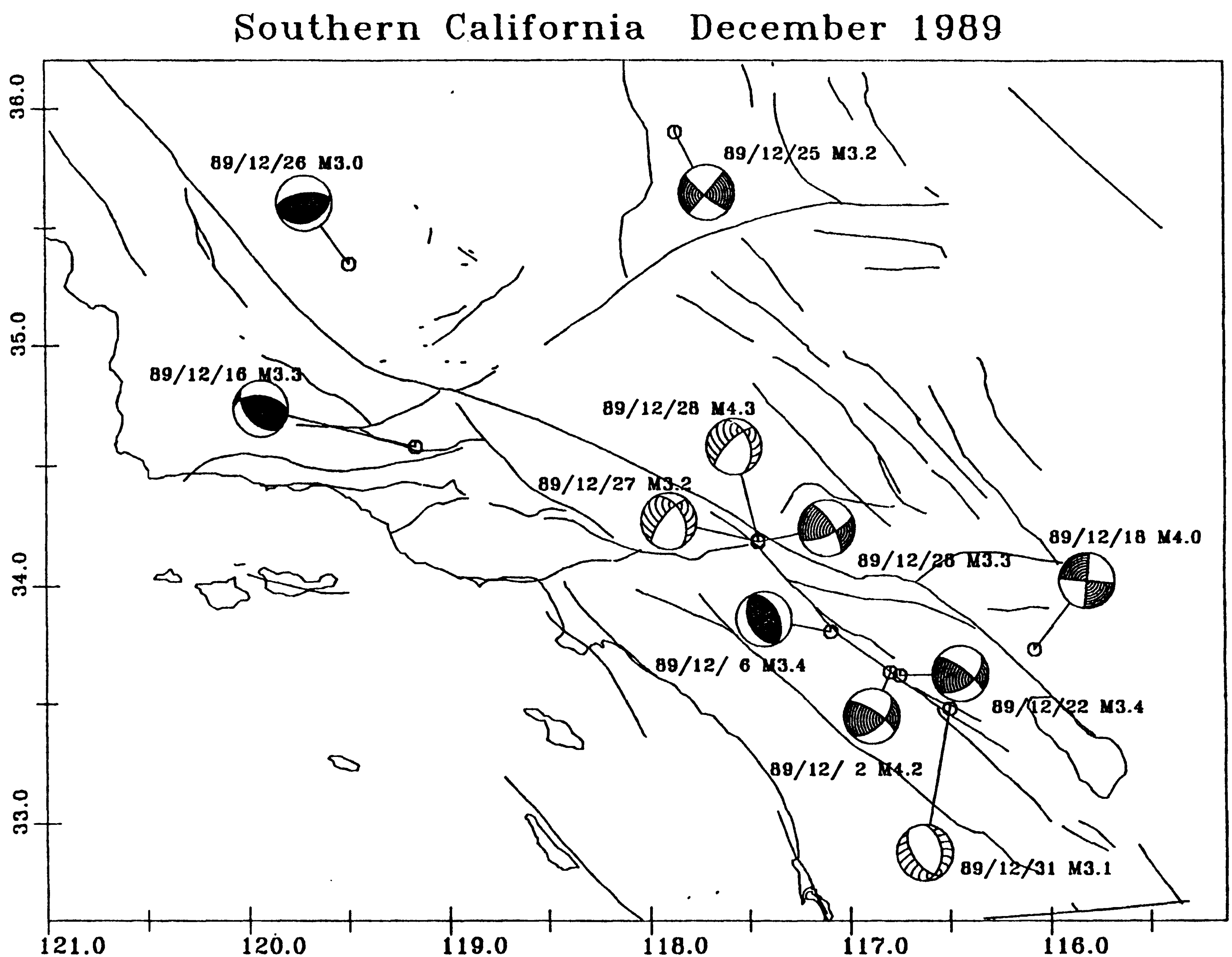


Figure 6. Map of significant earthquake activity and focal mechanisms in the San Jacinto fault zone area for December 1989.

## APPENDIX A.

## SIGNIFICANT SOUTHERN CALIFORNIA EARTHQUAKES

All events of $M_L \geq 3.0$ for the period January to December 1989. Times are GMT, RMS is the root-mean-squared of the location error, NPH is the number of phases picked. The CUSPID is the unique number assigned to the event by the CUSP system. FM denotes the number of the accompanying focal mechanism in Figure 3.

| DATE | TIME | SEC | LAT | LON | Z | Q | M | TYP | RMS | NPH | CUSPID | FM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989 JAN 5 | 21:32 | 13.85 | 34.2636 | -116.0035 | 3.26 | A | 3.3 | $M_{CA}$ | 0.10 | 68 | 1017186 | |
| 1989 JAN 9 | 5:08 | 21.52 | 36.2868 | -115.0850 | 6.00 | C | 3.3 | $M_{CA}$ | 0.27 | 44 | 1017460 | |
| 1989 JAN 10 | :34 | 39.67 | 34.5066 | -120.6882 | 6.00 | C | 3.0 | $M_{CA}$ | 0.15 | 15 | 1017515 | |
| 1989 JAN 10 | 17:21 | 22.93 | 34.4994 | -120.6278 | 6.00 | C | 3.1 | $M_{CA}$ | 0.10 | 15 | 1017546 | |
| 1989 JAN 11 | 9:32 | 31.79 | 33.9696 | -116.2912 | 3.36 | A | 3.1 | $M_{CA}$ | 0.07 | 57 | 1017637 | |
| 1989 JAN 11 | 23:34 | 24.94 | 33.1820 | -115.5954 | 0.94 | A | 3.2 | $M_{CA}$ | 0.18 | 31 | 1017719 | |
| 1989 JAN 15 | 15:39 | 55.15 | 32.9475 | -117.7362 | 6.00 | C | 4.2 | $M_{CA}$ | 0.30 | 51 | 1018298 | 1 |
| 1989 JAN 19 | 6:53 | 28.84 | 33.9187 | -118.6274 | 11.85 | A | 5.0 | $M_L$ | 0.17 | 163 | 1018595 | 2 |
| 1989 JAN 19 | 6:59 | 37.25 | 33.9047 | -118.6221 | 11.78 | A | 3.0 | $M_{CA}$ | 0.13 | 35 | 1018596 | |
| 1989 JAN 19 | 7:00 | 53.27 | 33.9171 | -118.6185 | 11.59 | A | 3.1 | $M_{CA}$ | 0.13 | 43 | 138795 | |
| 1989 JAN 19 | 7:02 | 47.31 | 33.9149 | -118.6383 | 11.25 | A | 3.1 | $M_{CA}$ | 0.12 | 38 | 138796 | |
| 1989 JAN 19 | 7:44 | 21.97 | 33.9127 | -118.6317 | 11.39 | A | 3.0 | $M_{CA}$ | 0.10 | 42 | 1018605 | |
| 1989 JAN 19 | 8:10 | 5.67 | 33.9191 | -118.6199 | 11.72 | A | 3.2 | $M_{CA}$ | 0.14 | 46 | 1018609 | |
| 1989 JAN 19 | 10:25 | 8.54 | 33.9163 | -118.6130 | 11.42 | A | 3.3 | $M_{CA}$ | 0.14 | 54 | 1018629 | |
| 1989 JAN 19 | 14:48 | 1.19 | 33.9205 | -118.6162 | 10.83 | A | 3.1 | $M_{CA}$ | 0.14 | 53 | 138809 | |
| 1989 JAN 19 | 22:01 | 57.93 | 33.9186 | -118.6356 | 11.96 | A | 3.8 | $M_{CA}$ | 0.16 | 121 | 1018717 | 3 |
| 1989 JAN 19 | 22:09 | 41.70 | 33.9188 | -118.6406 | 11.57 | A | 3.5 | $M_{CA}$ | 0.14 | 58 | 1018718 | 4 |
| 1989 JAN 20 | 3:25 | 22.01 | 33.9098 | -118.6197 | 10.78 | A | 3.0 | $M_{CA}$ | 0.13 | 46 | 1018768 | |
| 1989 JAN 21 | 2:26 | 19.65 | 35.1250 | -118.6594 | 11.06 | A | 3.5 | $M_{CA}$ | 0.20 | 110 | 1018896 | 5 |
| 1989 JAN 23 | 14:29 | 13.45 | 33.9694 | -116.2904 | 3.38 | A | 3.2 | $M_{CA}$ | 0.08 | 59 | 1019066 | |
| 1989 JAN 29 | 2:30 | 19.62 | 33.0066 | -117.8441 | 6.00 | C | 3.2 | $M_{CA}$ | 0.33 | 28 | 1019640 | |
| 1989 JAN 30 | 18:29 | 41.32 | 33.8789 | -118.4711 | 3.22 | A | 3.1 | $M_{CA}$ | 0.17 | 59 | 1019757 | |
| 1989 JAN 31 | :38 | 33.06 | 35.0982 | -119.0878 | 28.63 | A | 3.4 | $M_{CA}$ | 0.20 | 72 | 1019808 | |
| 1989 JAN 31 | 18:22 | 39.77 | 34.1714 | -116.8160 | 11.26 | A | 3.4 | $M_{CA}$ | 0.09 | 68 | 653813 | |
| 1989 FEB 1 | 11:22 | 0.03 | 36.0371 | -117.7924 | 0.01 | A | 3.0 | $M_{CA}$ | 0.06 | 35 | 138900 | |
| 1989 FEB 2 | 4:51 | 54.48 | 33.9421 | -118.8563 | 8.35 | A | 3.8 | $M_{CA}$ | 0.12 | 95 | 1020059 | 6 |
| 1989 FEB 3 | 6:52 | 8.40 | 34.9199 | -119.2376 | 14.09 | A | 3.0 | $M_{CA}$ | 0.09 | 55 | 1020135 | |
| 1989 FEB 3 | 23:48 | 46.74 | 33.1810 | -115.6001 | 1.01 | A | 3.4 | $M_H$ | 0.20 | 32 | 1020181 | |
| 1989 FEB 5 | 21:51 | 12.64 | 32.4854 | -114.6296 | 0.00 | B | 3.2 | $M_{CA}$ | 0.06 | 10 | 1020311 | |
| 1989 FEB 5 | 22:05 | 15.90 | 32.4014 | -114.5998 | 6.00 | C | 3.2 | $M_{CA}$ | 0.11 | 8 | 1020316 | |
| 1989 FEB 10 | 3:56 | 19.92 | 33.0032 | -117.8577 | 6.00 | C | 3.4 | $M_{CA}$ | 0.36 | 34 | 1020661 | |
| 1989 FEB 14 | 15:43 | 54.65 | 35.0431 | -119.1559 | 13.84 | A | 3.9 | $M_L$ | 0.17 | 61 | 1020974 | 7 |
| 1989 FEB 15 | 13:50 | 41.48 | 33.0233 | -115.8340 | 1.80 | A | 3.6 | $M_{CA}$ | 0.17 | 47 | 1021076 | 8 |
| 1989 FEB 16 | 13:51 | 12.06 | 34.0059 | -117.7365 | 3.31 | A | 3.2 | $M_{CA}$ | 0.15 | 75 | 1021155 | |
| 1989 FEB 16 | 19:17 | 7.77 | 33.1712 | -115.5961 | 0.50 | A | 3.5 | $M_{CA}$ | 0.16 | 31 | 1021168 | |
| 1989 FEB 17 | 6:10 | 28.35 | 35.0430 | -119.1427 | 14.02 | A | 3.1 | $M_{CA}$ | 0.15 | 38 | 1021227 | |
| 1989 FEB 18 | 7:17 | 4.85 | 34.0064 | -117.7384 | 3.28 | A | 4.3 | $M_L$ | 0.18 | 144 | 1021313 | 9 |
| 1989 FEB 20 | 19:33 | 58.46 | 32.1224 | -114.9858 | 6.00 | D | 3.2 | $M_{CA}$ | 0.37 | 12 | 1021488 | |
| 1989 FEB 24 | 15:52 | 33.34 | 33.0725 | -117.9321 | 6.00 | C | 3.2 | $M_{CA}$ | 0.34 | 25 | 1021901 | |
| 1989 FEB 25 | 1:00 | 19.02 | 33.9315 | -118.6251 | 10.57 | A | 3.7 | $M_{CA}$ | 0.16 | 96 | 655118 | 20 |

| DATE | | | TIME | SEC | LAT | LON | Z | Q | M | TYP | RMS | NPH | CUSPID | FM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989 | MAR | 3 | 16:43 | 14.32 | 33.3729 | -116.2514 | 11.44 | A | 3.2 | $M_{CA}$ | 0.13 | 53 | 1022596 | |
| 1989 | MAR | 3 | 16:46 | 16.59 | 35.2658 | -118.5936 | 6.46 | A | 3.8 | $M_{CA}$ | 0.09 | 81 | 1022597 | 10 |
| 1989 | MAR | 4 | 5:34 | 16.43 | 32.9683 | -116.2435 | 9.73 | A | 3.2 | $M_{CA}$ | 0.10 | 46 | 1022693 | |
| 1989 | MAR | 6 | 22:16 | 47.63 | 33.1814 | -115.5987 | 1.03 | A | 4.3 | $M_L$ | 0.22 | 37 | 1022950 | 11 |
| 1989 | MAR | 6 | 22:20 | 38.62 | 33.1753 | -115.6201 | 0.87 | A | 3.3 | $M_{CA}$ | 0.12 | 31 | 1022951 | |
| 1989 | MAR | 6 | 22:22 | 0.30 | 33.1612 | -115.6184 | 0.24 | A | 3.1 | $M_{CA}$ | 0.14 | 26 | 1022952 | |
| 1989 | MAR | 6 | 22:45 | 55.01 | 33.1705 | -115.6244 | 3.00 | A | 3.4 | $M_{CA}$ | 0.15 | 27 | 1022954 | |
| 1989 | MAR | 6 | 22:57 | 34.27 | 33.2046 | -115.6005 | 0.00 | A | 3.2 | $M_{CA}$ | 0.19 | 37 | 1022957 | |
| 1989 | MAR | 6 | 22:58 | 32.52 | 33.1810 | -115.5961 | 1.25 | A | 3.6 | $M_{CA}$ | 0.24 | 40 | 655773 | |
| 1989 | MAR | 6 | 23:11 | 5.17 | 33.1950 | -115.5941 | 0.92 | A | 3.1 | $M_{CA}$ | 0.13 | 40 | 139064 | |
| 1989 | MAR | 7 | :24 | 58.15 | 33.1808 | -115.6113 | 2.81 | A | 4.1 | $M_L$ | 0.16 | 50 | 1022967 | 12 |
| 1989 | MAR | 7 | 1:47 | 27.60 | 33.1779 | -115.6149 | 1.58 | A | 3.4 | $M_{CA}$ | 0.16 | 45 | 1022975 | |
| 1989 | MAR | 7 | 7:43 | 44.12 | 33.1818 | -115.5939 | 0.50 | A | 4.2 | $M_L$ | 0.19 | 51 | 1022992 | 13 |
| 1989 | MAR | 12 | 9:54 | 14.58 | 33.1855 | -115.5861 | 1.00 | C | 3.0 | $M_{CA}$ | 0.19 | 24 | 1023580 | |
| 1989 | MAR | 15 | 13:27 | 44.82 | 35.5104 | -116.9010 | 8.46 | B | 3.3 | $M_{CA}$ | 0.12 | 49 | 1023826 | |
| 1989 | MAR | 16 | :20 | 53.78 | 32.1495 | -115.0585 | 6.00 | C | 3.1 | $M_{CA}$ | 0.34 | 17 | 1023897 | |
| 1989 | MAR | 21 | 1:02 | 56.27 | 32.5421 | -115.2616 | 6.00 | C | 3.3 | $M_{CA}$ | 0.35 | 26 | 1024353 | |
| 1989 | MAR | 21 | 12:04 | 51.55 | 33.9899 | -119.1104 | 3.17 | A | 3.8 | $M_{CA}$ | 0.17 | 121 | 1024420 | 14 |
| 1989 | MAR | 24 | 22:25 | 25.64 | 33.1835 | -115.5990 | 0.81 | A | 3.3 | $M_{CA}$ | 0.14 | 24 | 1024814 | |
| 1989 | MAR | 24 | 22:28 | 10.09 | 33.1812 | -115.5938 | 1.00 | C | 3.2 | $M_{CA}$ | 0.14 | 20 | 1024815 | |
| 1989 | MAR | 24 | 23:16 | 49.32 | 33.1838 | -115.5847 | 0.86 | A | 3.6 | $M_{CA}$ | 0.15 | 51 | 657094 | 21 |
| 1989 | MAR | 24 | 23:18 | 1.97 | 33.1883 | -115.5918 | 0.44 | A | 3.0 | $M_{CA}$ | 0.16 | 10 | 139203 | |
| 1989 | MAR | 26 | 13:22 | 39.04 | 32.9480 | -115.8092 | 3.83 | A | 3.1 | $M_{CA}$ | 0.24 | 55 | 1024922 | |
| 1989 | MAR | 29 | 9:29 | 49.53 | 34.9139 | -118.9923 | 14.29 | A | 3.7 | $M_H$ | 0.16 | 115 | 1025141 | 15 |
| 1989 | APR | 7 | 20:07 | 30.30 | 33.6189 | -117.9020 | 12.85 | A | 4.5 | $M_L$ | 0.24 | 141 | 657729 | 22 |
| 1989 | APR | 9 | 7:29 | 3.69 | 34.2477 | -117.0967 | 7.95 | A | 3.2 | $M_{CA}$ | 0.15 | 74 | 1026129 | |
| 1989 | APR | 14 | 6:45 | 53.86 | 36.6427 | -121.2725 | 6.00 | D | 3.1 | $M_{CA}$ | 0.26 | 11 | 1026632 | |
| 1989 | APR | 18 | 18:15 | 35.73 | 33.6853 | -120.0837 | 6.00 | C | 3.0 | $M_{CA}$ | 0.13 | 26 | 1027052 | |
| 1989 | APR | 26 | 14:47 | 12.42 | 34.5121 | -120.6871 | 1.00 | C | 3.1 | $M_{CA}$ | 0.05 | 18 | 1027699 | |
| 1989 | APR | 26 | 22:10 | 31.85 | 33.9318 | -118.5793 | 10.54 | A | 3.4 | $M_{CA}$ | 0.15 | 80 | 1027759 | |
| 1989 | MAY | 2 | 13:37 | 14.44 | 32.7269 | -118.0573 | 6.00 | C | 3.3 | $M_{CA}$ | 0.36 | 32 | 1028231 | |
| 1989 | MAY | 5 | 14:11 | 55.16 | 32.9455 | -117.7402 | 6.00 | C | 3.4 | $M_{CA}$ | 0.27 | 30 | 1028486 | |
| 1989 | MAY | 7 | 6:07 | 47.59 | 33.9344 | -117.9116 | 4.27 | A | 3.5 | $M_L$ | 0.17 | 88 | 1028638 | 16 |
| 1989 | MAY | 8 | 15:25 | 40.91 | 32.3509 | -115.2479 | 6.00 | C | 3.3 | $M_{CA}$ | 0.20 | 20 | 1028750 | |
| 1989 | MAY | 13 | 2:02 | 33.29 | 35.0422 | -118.9215 | 11.91 | A | 3.3 | $M_{CA}$ | 0.17 | 73 | 1029243 | |
| 1989 | MAY | 22 | 2:49 | 31.39 | 34.9425 | -116.7837 | 3.36 | A | 3.0 | $M_{CA}$ | 0.10 | 50 | 1030099 | |
| 1989 | MAY | 25 | 12:40 | 10.21 | 35.8389 | -120.4217 | 11.87 | A | 3.8 | $M_{CA}$ | 0.09 | 45 | 1030432 | |
| 1989 | JUN | 1 | 9:33 | 51.27 | 34.0139 | -117.1709 | 12.13 | A | 3.5 | $M_{CA}$ | 0.09 | 106 | 139487 | |
| 1989 | JUN | 1 | 14:23 | 22.39 | 34.2637 | -117.2707 | 4.36 | A | 3.0 | $M_{CA}$ | 0.09 | 42 | 1031205 | |
| 1989 | JUN | 4 | 21:33 | 59.72 | 34.5967 | -116.8385 | 1.94 | A | 4.5 | $M_L$ | 0.09 | 121 | 1031507 | 17 |
| 1989 | JUN | 8 | 21:42 | 53.02 | 35.2648 | -118.5909 | 7.59 | A | 3.0 | $M_{CA}$ | 0.08 | 76 | 139497 | |
| 1989 | JUN | 11 | :51 | 26.74 | 36.2513 | -120.3024 | 6.00 | C | 3.1 | $M_{CA}$ | 0.22 | 21 | 1032019 | |
| 1989 | JUN | 11 | 17:22 | 46.54 | 32.4108 | -115.3700 | 6.00 | C | 3.0 | $M_{CA}$ | 0.28 | 29 | 1032054 | |
| 1989 | JUN | 12 | 16:57 | 18.50 | 34.0274 | -118.1798 | 15.57 | A | 4.4 | $M_L$ | 0.17 | 141 | 1032113 | 18 |
| 1989 | JUN | 12 | 17:22 | 25.52 | 34.0216 | -118.1784 | 15.52 | A | 4.1 | $M_L$ | 0.19 | 137 | 661481 | 23 |

**APPENDIX A. (continued)**

| DATE | TIME | SEC | LAT | LON | Z | Q | M | TYP | RMS | NPH | CUSPID | FM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1989 JUN 16 | 7:00 | 47.53 | 34.8282 | -121.0070 | 6.00 | C | 3.3 | $M_{CA}$ | 0.35 | 26 | 1032440 | |
| 1989 JUN 28 | :20 | 15.35 | 33.4929 | -116.4786 | 15.63 | A | 3.1 | $M_{CA}$ | 0.14 | 51 | 662348 | |
| 1989 JUL 11 | 8:02 | 17.50 | 32.0181 | -115.5458 | 6.00 | C | 3.4 | $M_{CA}$ | 0.50 | 30 | 1034433 | |
| 1989 JUL 19 | 23:46 | 22.89 | 33.9663 | -116.6746 | 10.56 | A | 3.0 | $M_{CA}$ | 0.08 | 58 | 1035144 | |
| 1989 AUG 2 | 21:35 | 53.40 | 32.4743 | -115.2366 | 6.00 | C | 3.2 | $M_{CA}$ | 0.35 | 32 | 1036543 | |
| 1989 AUG 9 | 13:42 | 11.27 | 33.4982 | -116.5189 | 7.08 | A | 3.3 | $M_{CA}$ | 0.11 | 55 | 1037206 | |
| 1989 AUG 12 | 20:19 | 10.05 | 34.2717 | -117.4939 | 12.28 | A | 3.0 | $M_{CA}$ | 0.10 | 62 | 1037559 | |
| 1989 AUG 25 | 15:20 | 13.70 | 36.6395 | -121.2591 | 6.00 | D | 3.1 | $M_{CA}$ | 0.12 | 11 | 1038948 | |
| 1989 AUG 30 | 18:39 | 8.04 | 33.9259 | -116.6036 | 12.50 | A | 3.1 | $M_{CA}$ | 0.08 | 67 | 1039539 | |
| 1989 AUG 31 | 17:30 | 55.04 | 35.7502 | -118.0311 | 5.14 | A | 3.1 | $M_{CA}$ | 0.07 | 47 | 1039619 | |
| 1989 SEP 2 | 5:39 | 35.66 | 33.5079 | -116.4445 | 9.29 | A | 3.2 | $M_{CA}$ | 0.12 | 47 | 1039805 | |
| 1989 SEP 4 | 17:53 | 41.03 | 33.3326 | -116.2383 | 10.33 | A | 3.2 | $M_{CA}$ | 0.11 | 48 | 1040045 | |
| 1989 SEP 9 | 8:49 | 39.42 | 32.6998 | -115.9304 | 1.73 | A | 3.1 | $M_{CA}$ | 0.10 | 47 | 1040522 | |
| 1989 SEP 13 | 1:25 | 29.21 | 34.7554 | -118.9493 | 12.11 | A | 3.1 | $M_{CA}$ | 0.16 | 54 | 1040896 | |
| 1989 SEP 15 | 13:20 | 5.41 | 34.2819 | -117.4876 | 11.16 | A | 3.5 | $M_{CA}$ | 0.21 | 110 | 667854 | |
| 1989 SEP 17 | 22:33 | 44.00 | 35.7446 | -118.5026 | 6.89 | A | 3.1 | $M_{CA}$ | 0.03 | 11 | 1041362 | |
| 1989 SEP 18 | 22:10 | 54.46 | 35.6773 | -117.5615 | 2.75 | A | 3.1 | $M_{CA}$ | 0.16 | 38 | 1041434 | |
| 1989 SEP 28 | 15:42 | 36.69 | 36.6339 | -121.1924 | 6.00 | D | 3.0 | $M_{CA}$ | 0.26 | 11 | 1042433 | |
| 1989 SEP 30 | 9:21 | 3.50 | 36.5150 | -120.4778 | 6.00 | C | 3.6 | $M_{CA}$ | 0.19 | 13 | 1042618 | |
| 1989 OCT 1 | 22:08 | 36.00 | 36.5755 | -121.1990 | 6.00 | D | 3.1 | $M_{CA}$ | 0.37 | 14 | 1042728 | |
| 1989 OCT 8 | 17:58 | 27.33 | 33.4912 | -116.4570 | 6.92 | A | 3.1 | $M_{CA}$ | 0.13 | 57 | 1043470 | |
| 1989 OCT 18 | 1:45 | 57.92 | 36.9272 | -121.7807 | 20.00 | D | 3.2 | $M_{CA}$ | 0.59 | 17 | 669695 | |
| 1989 OCT 18 | 21:52 | 53.66 | 36.3099 | -120.3698 | 6.00 | C | 3.1 | $M_{CA}$ | 0.13 | 20 | 1044348 | |
| 1989 OCT 19 | 18:30 | 27.32 | 33.0093 | -117.8557 | 6.00 | C | 3.1 | $M_{CA}$ | 0.31 | 28 | 1044448 | |
| 1989 NOV 4 | 3:09 | 19.87 | 35.3671 | -117.7877 | 5.49 | C | 3.2 | $M_{CA}$ | 0.15 | 49 | 1045289 | |
| 1989 NOV 4 | 23:34 | 44.20 | 33.9438 | -119.2239 | 1.00 | C | 3.1 | $M_{CA}$ | 0.16 | 38 | 1045351 | |
| 1989 NOV 6 | 3:40 | 48.09 | 33.1798 | -115.5922 | 0.74 | A | 3.2 | $M_{CA}$ | 0.17 | 33 | 1045442 | |
| 1989 NOV 10 | 6:40 | 42.86 | 32.3871 | -115.2870 | 6.00 | C | 3.3 | $M_{CA}$ | 0.41 | 30 | 1045830 | |
| 1989 NOV 11 | 8:35 | 15.52 | 33.3905 | -118.6718 | 7.45 | A | 3.0 | $M_{CA}$ | 0.10 | 43 | 1045900 | |
| 1989 NOV 12 | 17:13 | 31.43 | 34.0024 | -116.7425 | 14.09 | A | 3.0 | $M_{CA}$ | 0.09 | 60 | 1046004 | |
| 1989 DEC 1 | 11:16 | 51.36 | 36.6502 | -121.3169 | 6.00 | D | 3.1 | $M_{CA}$ | 0.62 | 18 | 1047243 | |
| 1989 DEC 1 | 11:26 | 23.03 | 36.6640 | -121.3461 | 6.00 | D | 3.1 | $M_{CA}$ | 0.50 | 14 | 1047245 | |
| 1989 DEC 1 | 12:37 | 43.20 | 36.6710 | -121.4460 | 6.00 | D | 3.6 | $M_{CA}$ | 0.73 | 19 | 1047247 | |
| 1989 DEC 2 | 23:16 | 47.86 | 33.6457 | -116.7416 | 14.47 | A | 4.2 | $M_L$ | 0.11 | 125 | 671917 | 24 |
| 1989 DEC 6 | 19:15 | 23.50 | 33.8070 | -117.0354 | 15.33 | A | 3.4 | $M_{CA}$ | 0.08 | 51 | 1047586 | |
| 1989 DEC 16 | 15:21 | 53.90 | 34.5712 | -119.1255 | 5.02 | A | 3.3 | $M_{CA}$ | 0.16 | 51 | 672496 | |
| 1989 DEC 18 | 6:27 | 4.51 | 33.7338 | -116.0238 | 9.93 | A | 4.2 | $M_L$ | 0.12 | 68 | 672565 | 25 |
| 1989 DEC 22 | 3:03 | 25.54 | 33.6240 | -116.6878 | 14.08 | A | 3.4 | $M_{CA}$ | 0.10 | 67 | 140444 | |
| 1989 DEC 23 | 16:37 | 45.97 | 36.4561 | -120.3697 | 6.00 | C | 3.5 | $M_{CA}$ | 0.20 | 22 | 1048512 | |
| 1989 DEC 25 | 3:21 | 35.67 | 35.9042 | -117.7243 | 8.29 | A | 3.3 | $M_L$ | 0.10 | 49 | 1048597 | |
| 1989 DEC 27 | 22:10 | 47.67 | 34.1889 | -117.3823 | 14.32 | A | 3.1 | $M_{CA}$ | 0.11 | 74 | 140475 | |
| 1989 DEC 28 | 9:41 | 8.20 | 34.1924 | -117.3864 | 14.58 | A | 4.5 | $M_L$ | 0.14 | 144 | 140477 | 19 |
| 1989 DEC 28 | 10:00 | 44.42 | 34.1868 | -117.3828 | 14.27 | A | 3.1 | $M_{CA}$ | 0.12 | 90 | 140478 | |
| 1989 DEC 30 | 2:46 | 17.45 | 32.3846 | -115.2554 | 6.00 | C | 3.5 | $M_{CA}$ | 0.35 | 23 | 1048884 | |
| 1989 DEC 31 | 12:53 | 51.49 | 33.4836 | -116.4443 | 8.49 | A | 3.0 | $M_{CA}$ | 0.13 | 71 | 1048984 | |

# APPENDIX B.

## LIST OF EVENTS FOR WHICH FOCAL MECHANISMS ARE PLOTTED IN FIGURE 3

Focal solution parameters are rounded to the nearest degree.

| No. | Date | | | Latitude | | Longitude | | $M_L$ | Strike | Dip | Strike | Dip | Rake |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 89 | 1 | 15 | 32 | 57.54 | 117 | 44.08 | 4.2 | 116 | 65 | 318 | 27 | 80 |
| 2 | 89 | 1 | 19 | 33 | 55.23 | 118 | 37.18 | 5.0 | 160 | 65 | 259 | 72 | 160 |
| 3 | 89 | 1 | 19 | 33 | 55.23 | 118 | 37.66 | 3.8 | 126 | 65 | 282 | 27 | 100 |
| 4 | 89 | 1 | 19 | 33 | 55.10 | 118 | 37.66 | 3.5 | 135 | 70 | 268 | 28 | 110 |
| 5 | 89 | 1 | 21 | 35 | 7.50 | 118 | 39.55 | 3.5 | 25 | 60 | 131 | 64 | -30 |
| 6 | 89 | 2 | 2 | 33 | 56.36 | 118 | 50.32 | 3.8 | 120 | 20 | 248 | 77 | 140 |
| 7 | 89 | 2 | 14 | 35 | 3.81 | 119 | 8.41 | 3.9 | 40 | 65 | 220 | 25 | -90 |
| 8 | 89 | 2 | 15 | 33 | 1.73 | 115 | 50.20 | 3.6 | 35 | 80 | 301 | 70 | 20 |
| 9 | 89 | 2 | 18 | 34 | 0.34 | 117 | 44.56 | 4.3 | 246 | 75 | 152 | 80 | 10 |
| 10 | 89 | 3 | 3 | 35 | 15.80 | 118 | 35.55 | 3.8 | 460 | 90 | 190 | 80 | 530 |
| 11 | 89 | 3 | 6 | 33 | 10.59 | 115 | 35.63 | 4.3 | 130 | 30 | 354 | 68 | -130 |
| 12 | 89 | 3 | 7 | 33 | 10.35 | 115 | 36.41 | 4.1 | 220 | 80 | 318 | 51 | -40 |
| 13 | 89 | 3 | 7 | 33 | 10.70 | 115 | 35.67 | 4.2 | 40 | 55 | 304 | 82 | 10 |
| 14 | 89 | 3 | 21 | 33 | 58.95 | 119 | 6.66 | 3.8 | 125 | 45 | 278 | 48 | 110 |
| 15 | 89 | 3 | 29 | 34 | 56.28 | 118 | 59.80 | 3.7 | 40 | 70 | 310 | 90 | 0 |
| 16 | 89 | 5 | 7 | 33 | 56.00 | 117 | 55.25 | 4.5 | 220 | 80 | 128 | 80 | 10 |
| 17 | 89 | 6 | 4 | 34 | 35.49 | 116 | 50.76 | 3.5 | 255 | 80 | 165 | 90 | 0 |
| 18 | 89 | 6 | 12 | 34 | 0.51 | 118 | 10.47 | 4.4 | 95 | 60 | 256 | 32 | 100 |
| 19 | 89 | 12 | 28 | 34 | 11.67 | 117 | 23.23 | 4.5 | 230 | 75 | 337 | 42 | -50 |
| 20 | 89 | 2 | 25 | 33 | 55.97 | 118 | 36.71 | 3.7 | 70 | 80 | 332 | 51 | 40 |
| 21 | 89 | 3 | 24 | 33 | 11.01 | 115 | 35.40 | 3.6 | 65 | 55 | 290 | 45 | 60 |
| 22 | 89 | 4 | 7 | 33 | 37.39 | 117 | 55.17 | 4.5 | 40 | 65 | 306 | 81 | 10 |
| 23 | 89 | 6 | 12 | 34 | 0.51 | 118 | 10.09 | 4.1 | 105 | 70 | 238 | 28 | 110 |
| 24 | 89 | 12 | 2 | 33 | 38.34 | 116 | 45.11 | 4.2 | 60 | 45 | 299 | 63 | 40 |
| 25 | 89 | 12 | 18 | 33 | 44.04 | 116 | 1.11 | 4.2 | 185 | 85 | 95 | 90 | 180 |

# APPENDIX C.

## ELECTRONIC MAIL ADDRESSES

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|---|---|
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