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U.S. GEOLOGICAL SURVEY

THE SOUTHERN CALIFORNIA NETWORK BULLETIN

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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 300 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 189,000 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).

EDW A short-period low-gain component was added to the already existing 3-component FBA instrument at this site.

Site name:	Edwards Air Force Base	
Latitude:	34° 52.98′ N	(34.8830°)
Longitude:	117° 59.41′ W	(117.9902)
Elevation:	795 m	(2608 ft.)
Date installed:	February 16, 1990	

Full Code	Inst.	Orientation
EDWCZ	L4	low-gain vertical

SSC Two horizontal components were added to an already existing vertical component seismometer at this site.

Site name:	Santa Cruz Island	
Latitude:	33° 59.68′ N	(34.9947°)
Longitude:	119° 37.99′ W	(119.6332°)
Elevation:	457 m	(1499 ft.)
Date installed:	August 21, 1990	

Full Code	Inst.	Orientation
SSCCE	L4	east-west
SSCCN	L4	north-south

Discontinued Stations.

Four stations have been removed since the last Bulletin was released. The removal dates are shown below. Station BOO was relocated to a microwave relay site at Edward's Airforce Base (EDW). Station IRC was relocated to a nearby site because of telemetry convenience (now called IR2 with the location 34° 23.26′ N 118° 23.90′ W and 610m elevation. Station LAV was removed because it was located in a creek area that was subject to frequent washouts. Construction near station SYS has led to abundant ground noise. LAV and SYS will be relocated in 1991.

Table 1. Discontinued stations

Code	Date Discontinued
BOO	February 5, 1990
IRC	February 19, 1990
LAV	October 10, 1990
SYS	May 2, 1990

TERRAscope Broad-Band Stations.

There are now 6 broad-band dial-up stations operating in southern California, and most recently one in northern California. Each one can transfer 3-component data from a selected event in a compressed binary file using KERMIT. Software has been written by Joe Steim of Quanterra Inc. (and modified by others) to decompress the binary data and write an ASCII file or files with the digital seismogram data and an event header. The following is a general description pertaining to all the stations now in operation, with a table describing the different parameters unique to each instrument.

▪ Table 2. Broad-Band Station Locations

Code	Name	Lat.	Lon.	Elev.(m)	Modem #	Baud
GSC	Goldstone Lake, CA	35.3017	116.8050	990	619-386-1408	19200
ISA	Lake Isabella, CA	35.6633	118.4733	835	619-379-8208	19200
PAS	Pasadena, CA	34.1483	118.1717	308	818-796-6415	9600
					818-449-9792	19200
PFO	Pinyon Flat Observ., CA	33.6116	116.4586	1288	619-349-3513	19200
SBC	Santa Barbara, CA	34.4417	119.7133	90	805-569-1283	19200
SVD	Seven Oaks Dam, CA	34.1045	117.0975	600	714-794-9288	19200
	(Stanford's)	37.4035	122.1752	158	415-493-4008	19200

STS-1 Instruments: GSC, ISA, PAS, PFO, SBC

Quanterra Very Broad Band Seismograph
Streckeisen AG, STS-1/VBB Very Broad Band Seismometers
digitized with 24-bit resolution at 20 samples/sec
apparent natural period of 360 sec with damping 0.707 of critical

Kinemetrics FBA-23 Strong Motion Accelerometers
digitized with 16-bit resolution at 100 samples/sec

STS-2 Instruments: SVD, (Stanford's)

Quanterra Very Broad Band Seismograph
Streckeisen AG, STS-2/VBB Very Broad Band Seismometers
digitized with 24-bit resolution at 80 samples/sec
apparent natural period of 120 sec with damping 0.707 of critical

Guralp CMG5 Strong Motion Accelerometers
digitized with 24-bit resolution at 80 samples/sec
(Stanford's is an FBA-23, 24-bit, 80sps)

Components:Z : + up vertical   N : + north   E : + east

▪ Table 3. Broad-Band Data Streams

Station	LG 100sps	VSP 80sps	VBB 20sps	LP 1sps	VLP 0.1sps	ULP 0.01sps
GSC	3330	—	9.88×10^8	3.95×10^9	1.58×10^{10}	—
ISA	3330	—	9.88×10^8	3.95×10^9	1.58×10^{10}	—
PAS	3738	—	1.04×10^9	4.16×10^9	1.66×10^{10}	—
PFO	3330	—	9.88×10^8	3.95×10^9	1.58×10^{10}	—
SBC	3330	—	9.88×10^8	3.95×10^9	1.58×10^{10}	—
SVD	53608	5.99×10^8	5.99×10^8	5.99×10^8	2.39×10^9	2.39×10^9

LG value is counts/m/sec^2. All others are counts/m/sec.

LG and VBB are event detected.
LP is derived from the VBB data stream with a cutoff period = 2.7 sec.
VLP is derived from the LP data stream with a cutoff period = 27 sec.
ULP is derived from VLP data stream with a cutoff period = 270 sec.

▪ Table 4. Broad-Band Instrument Constants

Station Component	Serial No.	Generator Constant	Sensitivity of Mass Position to Acceleration
GSC			
vert.	78909	2294 v-sec/m	78.0 v/gal
N/S	39021	2332 v-sec/m	79.4 v/gal
E/W	39022	2422 v-sec/m	82.4 v/gal
ISA			
vert.	78910	2358 v-sec/m	80.2 v/gal
N/S	39025	2340 v-sec/m	78.0 v/gal
E/W	39026	2290 v-sec/m	79.8 v/gal
PAS			
vert.	18220	2166 v-sec/m	72.4 v/gal
N/S	98405	2140 v-sec/m	71.8 v/gal
E/W	98404	2132 v-sec/m	71.4 v/gal
PFO			
vert.	38515	2430 v-sec/m	82.4 v/gal
N/S	48538	2434 v-sec/m	81.6 v/gal
E/W	48537	2378 v-sec/m	79.8 v/gal
SBC			
vert.	78901	2570 v-sec/m	87.2 v/gal
N/S	39024	2278 v-sec/m	77.4 v/gal
E/W	39023	2296 v-sec/m	77.6 v/gal
SVD			
vert.	—	1500 v-sec/m	—
N/S	—	1500 v-sec/m	—
E/W	—	1500 v-sec/m	—

Notes: Between 11/21/88 and 7/09/90 the north-south and vertical feedback boxes on the PAS instrument were switched. They are presently in the correct position. See the section entitled *PAS IRIS-TERRAscope Station Calibration* in the 1988 Network Bulletin for more information (Wald *et al.*, 1990).

Sensor comparisons for TERRAscope stations.

In order to check polarities, gain settings and frequency responses of the TERRAscope stations, we often examine data recorded on different sensors at the same site. All of the

The example in Figure 1 compares the VBB channel (20 samples per second) of the Streckeisen-1 broadband sensor and the Kinemetrics FBA-23 force balance accelerometer LG channel (100 samples per second) at station PAS. The earthquake is the Montebello event of June 12, 1989 (M_L 4.4) located 13 km south of the station. The ground velocities were bandpass filtered between 0.1 and 5 hz. Generally, there is a good match in shape and amplitude between the seismograms recorded by the two types of sensors. One difference is that the amplitude of the north/south component of the VBB channel is smaller than the LG channel by about 20% and the amplitude of the vertical component of the VBB channel is slightly larger than the LG channel. This is probably due to the swapping of vertical and north/south feedback boxes connected to the Streckeisen-1, that occurred on November 21, 1988 (described in the section on PAS IRIS-TERRAscope Station Calibration in the January-December 1988 Network Bulletin). Note that the feedback boxes were switched back on July 9, 1990, so that now the amplitude match between the VBB and LG channels is consistent.

This example shows that the relative response between the Streckeisen-1 and the FBA is fairly well known. To check the absolute calibration, a tilt test of the FBA sensor was done recently in October of 1990. The results indicated that it is operating within 2 % of its reported values.

Figure 2 is a nuclear explosion on October 12, 1990 (m_b 5.5) at the Nevada Test Site, located 200 km north-northeast of station GSC. The comparison is between compares the VBB channel (20 samples per second) of the Streckeisen-1 broadband sensor and the Kinemetrics FBA-23 force balance accelerometer LG channel (100 samples per second) at station GSC. The ground velocities are bandpass filtered between 0.1 and 5 hz. This station shows a better match in the amplitudes between the Streckeisen-1 and FBA sensors than PAS (for reasons just explained). In this example, the higher noise level on the LG channel is due to the lack of resolution for small amplitude signals. The maximum recorded amplitudes were only 15 to 30 counts.

The example in Figure 3 shows a comparison of the PAS Streckeisen-1 with the Streckeisen-2 sensor which was temporarily operating at PAS. The Streckeisen-2 sensor is now installed at station SVD. The LP channel (1 sample per second) for the two types of Streckeisen sensors are compared. The earthquake is a teleseism (M_S 6.0) from the Aleutians on November 21, 1990, located 42 degrees to the northwest. The data is not filtered. There is a fairly good agreement in waveform and amplitude between the two sensors, although the ampltiude of the north/south component of the Streckeisen-2 is a little large. The long-period ($>$ 100 sec) noise level on the horizontal components appears worse on the Streckeisen-2 than for the Streckeisen-1. However, the difference in noise level may be due more to the installation than the sensor characteristics. The Streckeisen-1 is installed in an evacuated jar to reduce atmospheric pressure effects, while for the temporary installation of the Streckeisen-2, the sensor was placed on the pier without any environmental shielding.

NETWORK OPERATIONS

Status of Processing.

The status of each month of catalog data since the advent of digital recording is described in Table 5. 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 to finalize the most recent eight years of data. As a result, almost all months in 1983 – 1990 have been finalized. The effort will now be shifted to reloading and finalizing older data.

▪ Table 5. 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	F	F	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	F	F	F	F	F	F	F	F	F
1990	F	F	F	F	F	F	F	F	F	F	F	F
1991	P	P	P									

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

Network Magnitude Re-Calibrations

During the fourth quarter of 1989, significant changes were made in the magnifications at a number of stations. These changes can be expected to affect the magnitude calibration, so these calibrations were redone using earthquakes from late 1989 and 1990.

The primary magnitude type used for local earthquakes by the Southern California Seismographic Network is the local magnitude M_L, defined by Richter (1935). When an event is legibly recorded on three or more Wood-Anderson instruments, the M_L is taken to be its magnitude. At the present time, we still use the original photographically

Since station gains do change and new stations are added, the calibration and the magnitudes are recomputed quarterly, but the original calibration was still being used for the preliminary estimates. After all the recent gain modifications, it was clearly time for a new suite of standard earthquakes. The new group consisted of all the events within the Southern California Seismographic Network above M_L 2.5 in October 1989 through June 1990, which had at least five Wood-Anderson amplitudes, a list totaling 179 earthquakes. The results appear in Appendix C. The old and the new **A** values are given, along with the number of events used to determine them, the difference (old minus new).

A network data base documents all known station gain changes. For those stations in the original calibration, we should be able to predict what the new gain would be. This expected difference is the last column in Appendix C. In fact, the predictions were not very accurate. This may mean that a significant number of changes made since 1981 do not appear in the data base. Appendix D shows variations with time, from the quarterly recalibrations, of the **A** values at selected stations. Clearly, there have been changes at various times in the station gains, for instance, at station OLY in the third quarter of 1989.

A further urgent reason for a new calibration is that the calibrations had previously been referenced only by channel number on the A/D converter and not by station name. The new MicroVAX on-line software followed a different indexing convention, so that all magnitude estimates were being made using the adjacent channel's calibration. The software has since been modified to reference the calibrations by station and component name, rather than channel number.

Surprisingly, the magnitudes of the calibration events did not change much (0.1 to 0.2, in most cases), even when the wrong station's calibration was being used. Probably, the large number of readings used to produce the magnitude causedrandom errors to average out. Thus, preliminary magnitudes from the Microvax on-line system are not grossly in error. They seem to be overestimated by about 0.1 due to the station gain changes.

$\underline{M_L}$

The same 179 earthquakes were also used to re-estimate station corrections for the Wood-Anderson instruments. Other such recomputations have been done in the past with larger numbers of earthquakes, for example by Hutton and Boore (1987). However, another repeat would bring to light any major instrumental changes or problems. Appendix E shows the results, include comparison with the station corrections used by Richter (1958) and by Hutton and Boore (1987). This set of corrections should, for the most part, not be affected by the station gain and discriminator changes, since all but Isabella (ISA) and Glamis (GLA) are recorded photographically.

All the corrections agree fairly well with those used in the past, except for Cottonwood (CWC), where they differ by 0.5 to 0.6. The magnification of the two CWC Wood-Anderson's has recently been about one third of what it was in the past, suggesting some sort of instrumental problem. Because there is little other change from the calibration previously used, which is based on many more readings, we have not revised the calibration used in Network data processing.

Note that all of these Wood-Anderson determinations produce the logarithm of the gain relative to the median M_L estimate for each earthquake, or in the case of Hutton and Boore, the logarithm of the gain relative to Palomar East-West (PLME). It says nothing recorded torsion seismometers for this, except at Isabella (ISA) and Glamis (GLA), where the Wood-Anderson response is electronically simulated. Caltech currently operates eight two component Wood-Anderson instruments. M_L is available for most earthquakes above about magnitude 2.5, about 5% of the total that we record.

In the future, we expect to rely more on synthetic Wood-Anderson records computed from the TERRAscope broad-band instruments. Several of these stations have recently been installed, but only Pasadena has recorded enough local earthquakes to determine a reliable station correction. Magnitude calibration for TERRAscope stations will be considered in a later Bulletin.

For earthquakes which are too small to be read on the Wood-Andersons, we have two options. The option which applies to the most earthquakes by far is the coda-amplitude magnitude procedure (MCA) (Johnson, 1979), an automatic feature of the off-line data processing. About 55% of the events recorded get coda magnitudes. The other option is a peak- amplitude magnitude (M_H) computed by the same procedure as M_L, but with the short-period vertical instruments recorded on helicorder drums. This procedure applies only to events with no other magnitude and which are large enough to be recorded on the drums; the total is less than 1%. The rest of the events, all small, have no magnitude assigned.

For those few events that are too large to be readable on the Wood-Andersons, we now have the option of using synthetic Wood-Anderson responses computed from low-gain short period instruments scattered throughout the Network. Jim Mori has written software for the on-line recording systems which computes these magnitudes in near real-time. For many of the larger events (46 in the past year), the low-gain instruments supplement the photographic and electronic Wood-Andersons to produce more reliable local magnitudes. Recalibration of each procedure is discussed below.

MCA

The process of estimating coda-amplitude magnitude is described by Johnson (1979). To summarize, 2-sec averages of rectified amplitude are computed for the on-scale portion of the S-wave coda, and a power law function

$$a(t) = a_o \, t^{-q}$$

is fit to them. For purposes of routine magnitude determination, **q** is 1.8. **t** is the time measured from the P onset. Although this definition makes little theoretical sense, it is consistent with usual definitions of coda duration and it happens to minimize hypocentral distance dependence of the decay rate. $\mathbf{a}_o$ is the amplitude the coda would have 1 second after the P onset if it existed then.

As in the case of local magnitude M_L , $\mathbf{a}_o$ is related to the size of the earthquake through the instrument gain and various geologic factors. In this case, however, there is no discernable distance dependence, presumably becuase of the definition of time from the P-onset instead of the S-onset. The calibration is made by accumulating values of $A=\log(a_o)-M_L$ for earthquakes for which local magnitude is known from Wood-Anderson amplitudes. The initial calibration of each station was based on about 500 events with consistent M_L's, recorded in 1981 and 1982.

about the actual gain of the Wood-Anderson instrument, about which there has been some questions of late (Uhrhammer and Collins, 1990).

M_H

Occasionally, we still compute magnitudes from amplitudes read off the helicorder drums. In general, it is assumed that response of the short-period instrumentation used is close enough to that of a Wood-Anderson that the same distance correction applies. An empirical gain correction is estimated by comparing individual station magnitude estimates with the M_L. These assumptions are rather doubtful, so this magnitude, called M_H for helicorder magnitude, is only used when M_L and M_{CA} are not available. Both the gain changes and the discriminator changes would be expected to affect the station corrections. Furthermore, there have been many years of undocumented changes with these stations since the calibrations were last determined. The results are presented in the second part of Appendix E. Although there is much individual variation, the median change is only 0.08.

Low-Gain M_L

As mentioned above, Mori's low-gain magnitudes must also be calibrated in terms of M_L. Mori did this for the automatic version of his software (as described in Wald *et al.*, 1990). The automatic software selects the largest amplitude, P wave, S wave or electronic glitch. Criteria are applied to the peak amplitudes to eliminate any data which are clipped or below the noise level. The general procedure for M_L , however, has been to use S-wave amplitudes only. For the purposes of final magnitude assignment, therefore, we manually eliminated the P waves and the glitches from the data set. Appendix F is the result. It is clear that, as long as S waves are used exclusively, there is little difference between including Nevada Test Site blasts and not including them. Many of the stations were read only for a very few earthquakes, so it would be advantageous to recalculate this calibration at a later date with more data. Mori's results, which are based on a different set of earthquakes, without the S wave only restriction, are also listed. In most cases, they agree fairly well.

The station corrections are especially important for stations located in sedimentary basins, for example GSA, GVR, CLI. In these cases the corrections are in the -0.4 to -0.5 range, meaning that the amplitudes are a factor of 2 to 3 larger than they would otherwise be. M_L's for the 46 calibration earthquakes were recomputed using the photographic and electronic Wood-Andersons and the synthetic ones. Only three magnitudes changed by more than 0.2.

Phase Data On-line.

The event files (or .MEM files) that contain the phase data for each event for all finalized months are now kept on-line on the MOJAVE node. They may be viewed or copied. The complete pathname of their location is:

MOJAVE::DUB0:[MEMS.'yr-mth']

For example, the .MEM files for all events that occurred in January of 1990 would be in MOJAVE::DUB0:[MEMS.90JAN]. Information on how to use the .MEM files for analysis can be found in Open-File Report 89-479 entitled *LEAPing Into CUSP: Local*

Earthquake Analysis Programs for CUSP Data (Wald and Jones, 1989), or by contacting the Pasadena USGS Office or the Caltech Seismo. Lab.

PICKLE - A New Real-Time Picker.

Beginning in February of 1990 a new software P-picking program came on line. The program, called PICKLE, was designed as a module of the CUSP real-time data aquisition system running on the network VAX 3200 computer. PICKLE is activated by the CUSP trigger recognition program SPIDER (Given *et al.*, 1986). Once activated PICKLE examines the seismograms of triggered stations while they are still in computer memory. The picker is based on the algorithm developed by Allen (1978) and allows variation of several parameters to adjust and tailor phase recognition. When enough picks have been made to satisfy a user-specified parameter the event is located using HYPOINVERSE (Klein, 1989). Finally, the resulting location passes to a program that checks the solution against preset alarm criteria. Different alarm levels will trigger different responses (e.g., send location information via electronic mail, digital pagers, etc.)

During the prototype phase PICKLE has located about 20 to 30 events per day. Because it operates on the waveforms directly in memory, it is quite fast, averaging 20 to 30 seconds from event trigger to completion of the P-picking job. Rather than wait for picks at all stations in the network, PICKLE will release the event when it has satisfied a parameter that dictates the minimum number of picks. This value is currently set at 15. An event will also be released if a certain period of time, currently 30 seconds, has passed since the trigger began. Most of the elapsed time taken by an event is spent waiting for good quality P phases to arrive at a sufficient number of stations. As a result, PICKLE actually picks larger events faster because the minimum picks criterion is met more quickly. During the time PICKLE is active it uses less than 1% of the CPU capacity of the computer.

PICKLE offers several advantages over earlier pickers; it is flexible, it requires no new hardware, it yields locations in less than a minute, and it can examine seismograms from all network sites. It also ties automated picks to seismograms recorded by CUSP for routine processing. This allows review and editing of picks using network data analysis tools. More work needs to be done before PICKLE will evolve into a solid part of the network real-time system. For example, it is difficult to calculate a good magnitude without sacrificing location speed. In any case, magnitude determinations are problematic in a high-gain, short period network. Also, discriminating multiple events and some types of noise present challanges to the programmer.

Weekly Earthquake Reports.

Since January of 1990, the Southern California Seismographic Network has been issuing a weekly Earthquake Report, aimed mostly at a nonscientific audience but useful perhaps to scientists as well. A map and a description of the week's activity is included. We also try to address some of the questions that reporters typically ask.

The report covers from Thursday to Wednesday, inclusive, and is generally available by noon on Thursday. The Earthquake Report is distributed in the following ways:

1) by FAX to emergency services and agencies with time critical requirements, Thursday afternoon

2) by FAX to other users Thursday night
3) to the the ca.earthquakes news group on Usenet
4) by hardcopies, which may be picked up at the Caltech Public Affairs Office.

There is no mailing list. The FAX list consists of members of academia, members of the press, and several government agencies. We currently have room for more on the overnight FAX list; first come, first served. To request having your name or organization added to the FAX list contact Dr. Kate Hutton at (818) 356-6959. The FAX number you give must be for a FAX machine that is on 24 hours.

RESEARCH NOTES

The February 28, 1990 Upland Earthquake. The following is the abstract from a paper written by Hauksson and Jones (1991) entitled *The 1988 and 1990 Upland Earthquakes: Left-Lateral Faulting Adjacent to the Central Transverse Ranges*, J. Geophys. R., in press.

Two earthquakes (M_L=4.6 and M_L=5.2) occurred at almost the same location in Upland, southern California in June 1988 and February 1990 and had similar strike-slip focal mechanisms with left-lateral motion on a northeast-striking plane. The focal mechanisms and aftershock locations showed that the causative fault was the San Jose fault, an 18-km-long concealed fault that splays west-southwest from the frontal fault of the central Transverse Ranges. Left-lateral strike- slip faults adjacent to the frontal faults may play an important role in the deformation of the Transverse Ranges and the Los Angeles basin as suggested by these Upland earthquakes, the left-lateral strike-slip 1988 (M_L=4.9) Pasadena earthquake on the Raymond fault, 30 km to the west of Upland, and scattered background seismicity along other active left- lateral faults. These faults may transfer slip away from part of the frontal fault toward the south. Alternatively these faults could represent secondary faulting related to the termination of the northwest-striking right-lateral strike-slip faults to the south of the range front. The 1988 and 1990 Upland earthquakes ruptured abutting or possibly overlapping segments of the San Jose fault. The edges of the overlapping aftershock zones, which are sharply defined, together with background seismicity, outline a 14-km-long aseismic segment of the San Jose fault. The 1988 mainshock originated at 9.5 km depth and caused aftershocks between 5 and 12 km. In contrast the 1990 mainshock focus occurred at the top of its aftershock zone, at 5 km, and caused aftershocks down to 13 km depth. These deep aftershocks tapered off within two weeks. The rate of occurrence of aftershocks in magnitude-time space was the same for both sequences. The principal stress orientations reflected in the focal mechanisms of the aftershocks is identical to that determined from background activity and did not change with time during the aftershock sequence. The constant stress orientation suggests that the 1988 and 1990 events did not completely release all the stored slip on that segment of the fault. Presence of 14 km of unbroken fault, abrupt temporal termination of deep aftershocks, and the constant stress orientation suggest that a future moderate-sized earthquake (M_L=6.0–6.5) on the San Jose fault may have a rupture length of at least 14 km and possibly 18 km.

Imperial Valley – Region 1.

This region experienced several swarms during the year, which is typical of the Brawley Seismic Zone. Obsidian Butte, located in the Brawley Seismic Zone, had some activity in late March. On June 21 another small swarm occurred in the same area including events of M_L 3.9, 3.3 and 3.6. Activity picked up again in early July with the largest event in the swarm being an M_L 3.2. More small swarms occurred in western Imperial Valley and Obsidian Butte in late July and early August, but no events exceeded M_L 3.0.

On May 17 an M_L 3.5 occurred 14 km WNW of El Centro, followed 2.5 hours later by an M_L 3.2 in the same location. Both events were felt in the Imperial Valley area. They were located at the southeastern end of the Superstition Hills fault; however, they are not considered aftershocks of the November 24, 1987 M_S 6.6 Superstition Hills earthquake.

An M_L 4.0 hit south of the Mexican border on March 31.

South San Jacinto – Region 2.

The southern branches of the San Jacinto fault experienced normal seismic activity once again after relative quiesence in 1989 and a sudden spurt of activity in December of that year. Four $M_L \geq 3.0$ earthquakes were part of a swarm near the Buck Ridge fault segment of the San Jacinto fault during February. The N70°W fault plane of these events (Figure 6, Number 2) is consistent with the Buck Ridge fault if it dips NE at 60–70°. On August 5 an M_L 3.6 earthquake occurred 8 km NNW of Borrego Springs near the Anza Gap on the San Jacinto fault. It was followed one minute later by an M_L 2.7 aftershock. A sequence of events were located on the Clark branch of the San Jacinto fault on August 30. Among the 50 earthquakes in this sequence, the largest ones were an M_L 3.9 followed 2.5 hours later by an M_L 4.2. These two largest events had strike-slip focal mechanisms (Figure 6, Numbers 24,25).

San Diego – Region 4.

The prolific aftershock sequence of the July 1986 Oceanside earthquake produced yet another event of M_L 4.0 on April 4 that was felt in Orange County and San Diego. Several smaller aftershocks followed. Other offshore events in this region included an M_L 3.7 off the coast of northern Mexico on May 1 and an M_L 3.2 in the same area on September 8.

Los Angeles Coast – Region 5.

The Los Angeles area experienced a number of small earthquakes in 1990. On January 17 an M_L 3.6 occurred near the Newport-Inglewood fault zone, however the mechanism was an east-striking thrust (Figure 6, Number 5), indicating that it was not actually on the Newport-Inglewood fault itself. Similar mechanisms have previously been reported in this area. An M_L 3.0, felt in the Los Angeles area on March 8, was located in Highland Park north of downtown Los Angeles. The Huntington Beach area experienced a small cluster of five events that occurred over a period of three days at the end of April. An M_L 3.0 event occurred south of Malibu on October 8 that was felt in west Los Angeles. It was followed 1 minute later by an M_L 2.7 and then an M_L 1.9 the next day. The Costa Mesa area was the site of an M_L 3.6 earthquake on October 18 that was felt throughout Orange County and southern Los Angeles County, and caused minor damage in Costa Mesa. The focal mechanism showed a combination strike-slip/normal motion on a north-south fault (Figure 6, Number 26).

Accessing GOPHER Files on the Seismo. Lab. SUN.

The Caltech Seismo Lab. is acquiring data from the broad-band TERRAscope stations for both southern California RTP-triggered events and IRIS-triggered teleseismic events. These data, acquired by the GOPHER software package, are available via anonymous **ftp** via Internet. The following information is needed to gain access to the GOPHER data:

host:	seismo.gps.caltech.edu
IP address:	131.215.65.1
userid:	anonymous
password:	your actual name or internet address
data directory:	pub/gopher

The gopher subdirectory contains: IRIS.catalog, IRIS, RTP.catalog, and RTP. These directory names refer to the source of the event notification. The IRIS and RTP subdirectories contain further monthly subdirectories named in numeric **yymm** format. The actual binary event and log files for events are in these monthly directories. The naming convention for these files is:

yymmddhhmmss.station.stream.format.version (data file)

yymmddhhmmss.station.log.version (log file)

where yymmddhhmmss : is the time of the event in GMT

station : is the 3 character station code

stream : is the type of data stream (i.e. VBB, LP, etc.)

format : is the format of the file. Currently it is K for Kermit binary

version : is currently 0

log : is the keyword "log"

SYNOPSIS OF SEISMICITY

A total of 9,765 earthquakes and 1,513 blasts were cataloged for 1990 (Figure 4). Of the cataloged events, 123 were greater than or equal to M_L 3.0 (Appendix A, Figure 5). The largest earthquake in 1990 had an M_L of 5.2 and was located in Upland. Focal mechanisms for 37 events ($M_L \geq 3.5$) are shown in Figure 6.

For the following discussion southern California has been divided into eleven subregions (Figure 7). These regions are arbitrary, but useful for discussing characteristics of seismicity in a manageable context. Figures 8a and 8b summarize the activity of each sub-region over the past four years. A separate discussion section follows for those regions with notable activity.

Other activity in 1990 included events smaller than M_L 3.0 in the Montebello area, Brea, Culver City, Santa Monica Bay, Alhambra, downtown Los Angeles, Redondo Beach, and west of Palos Verdes. The rate of microseismicity has decreased from the high rate of 1985-1989 and is now at the pre-1985 rate.

North Elsinore – Region 6.

The largest earthquake of the year in southern California occurred on February 28 near Upland. It was an M_L 5.2 with a strike-slip focal-mechanism with left-lateral motion on a northeast-striking plane. The causative fault appears to be the San Jose fault. See the article entitled *The February 28, 1990 Upland Earthquake* in the Research Notes section.

An M_L 2.2 aftershock of the October 1, 1987 Whittier Narrows earthquake (M_L 5.9) occurred in March, and two small events of M_L 1.7 and 2.1 went unnoticed in the Ontario area on June 12.

San Bernardino – Region 7.

An M_L 3.6 hit 11 km NE of Lake Arrowhead on April 3 that was widely felt in the Inland Empire. It had a strike-slip mechanism which is common for that area (Figure 6, Number 11). In mid-September a small swarm of ten events occurred 15 km west of Big Bear. Then 8 km southwest of Big Bear an M_L 3.7 occurred, followed by an M_L 1.9 aftershock on December 17. The intersection of the Banning and San Jacinto faults was the site of an M_L 3.7 on June 16. Later in the year, on September 2 an M_L 3.2 occurred 27 km east of San Bernardino that was felt in Big Bear and Idylwild.

The Lucerne Valley was very seismically active with several swarms in 1990. At the end of May there was a sequence of events including an M_L 3.4 followed by an M_L 2.5 the next day. The activity continued into June, and then was relatively quiet until November when an M_L 3.5 occurred. December brought some swarm activity again.

A small sequence of earthquakes happened August 4-5 near North Palm Springs, all less than M_L 2.5. The Palm Springs area had more activity in early November with an M_L 3.4 on November 7 near the San Jacinto fault that was widely felt in the area. Also, a sequence of 36 events was located in the Bullion Mountains 34 km NNE of Twentynine Palms in early November. The Niland area and Joshua Tree National Monument were also sites of small swarms in November.

The Indio area was very active with an M_L 3.8 on April 6 that was felt in Indio and Palm Springs, followed by several events greater than M_L 3.0 over the next few days. All events had normal faulting on a north-south fault which is typical of the region east of the Coachella Valley (Figure 6, Number 17). An M_L 3.6 occurred in the area on April 18, and was proceeded by an M_L 3.3 on April 24. Seismic activity in this area continued to be high through June.

The Yuha Desert, 37 km west of Calexico, had a small sequence in mid-November that included an M_L 3.0.

North Mojave – Region 8.

An M_L 3.6 was located in the northern Mojave desert on March 17 that went virtually unnoticed due to the sparse population in that area.

South Sierra Nevada – Region 9.

On August 3 an M_L 3.1 occurred at the southern end of the Owens Valley, and an M_L 3.0 was located just over the California-Nevada border northeast of Shoshone on October 14.

Kern County – Region 10.

The southeastern Sierra Nevada experienced a swarm in January which included an M_L 3.9 as the largest event on January 11. The swarm was located about 10 km north of the Garlock fault. The focal mechanisms of the larger events show primarily strike-slip motion perhaps with an oblique-reverse component, although the mechanism is not well-constrained (Figure 6, Numbers 3,4,6).

In mid-November a small cluster of events shook the area 13 km WSW of Castaic Lake. The largest two events were an M_L 3.3 and an M_L 2.5 which were both felt in the area. An M_L 3.7 hit 15 km east of Bakersfield on December 18. The focal mechanism showed a combination of strike-slip and normal motion on an east-west fault (Figure 6, Number 27) which is consistent with the trend of a fault zone east of Bakersfield. Several small aftershocks followed.

Santa Barbara – Region 11.

An M_L 3.1 occurred 79 km WNW of Santa Barbara on May 2 that was felt in Santa Barbara, Santa Maria, and Lompoc. Further north along the coast 6 km south of Pt. Conception an M_L 3.2 occurred on May 26. A sequence of five earthquakes was located offshore near Santa Rosa Island July 12-13. The two largest events were both M_L 3.3, one on July 12 and the other on July 13.

10-Year Seismicity

The seismicity for the 10-year period from January 1981 through December 1990 is shown in Figure 9.

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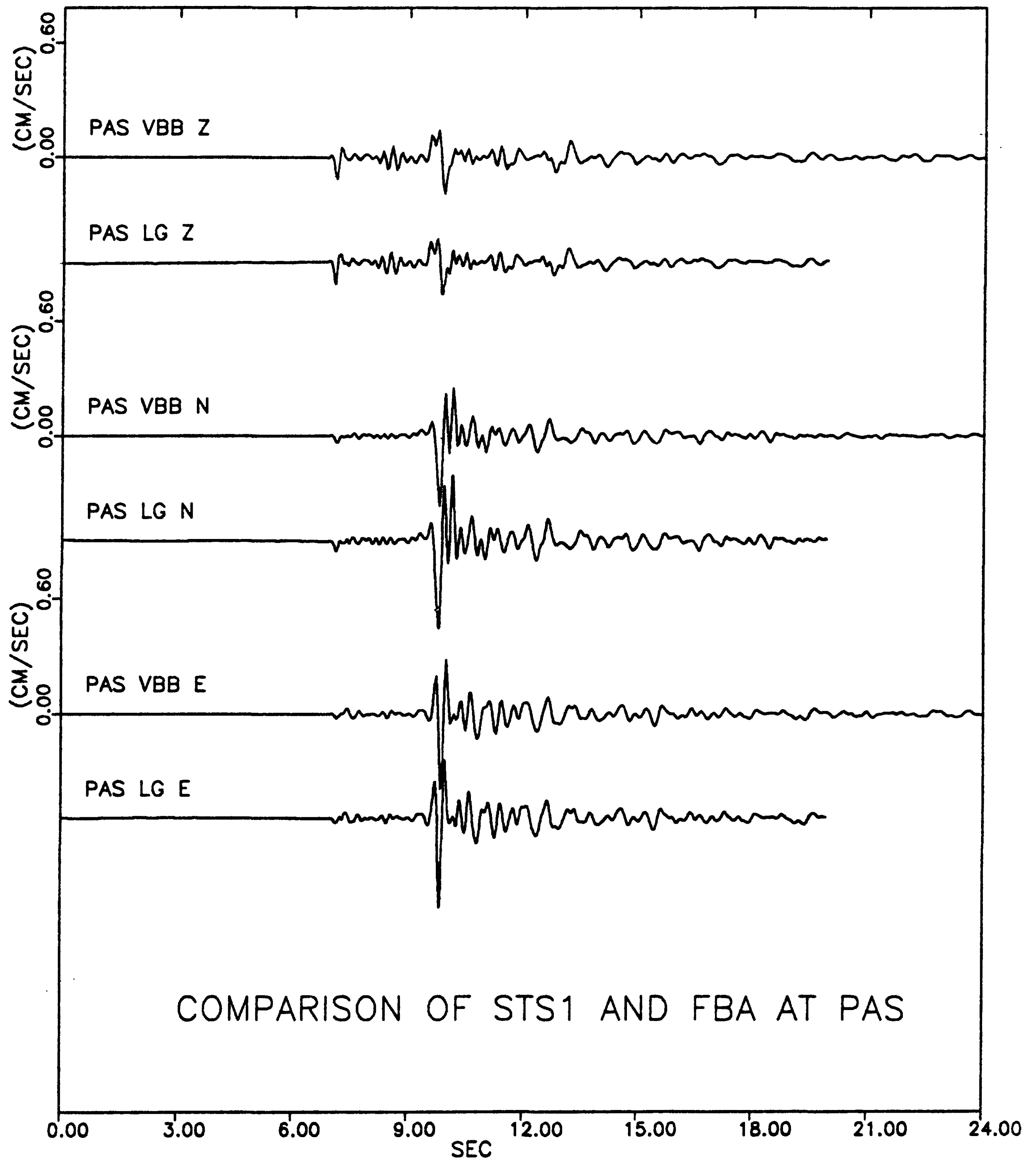

Figure 1. Streckeisen-1 (VBB channel) and FBA (LG channel) at PAS. This example compares the VBB channel (20 samples per second) of the Streckeisen-1 with the LG channel (FBA at 100 samples per second). The earthquake is the Montebello event of June 12, 1989 (M_L4.4) located 13 km south of the stations. The ground velocities were bandpass filtered between 0.1 and 5 hz.

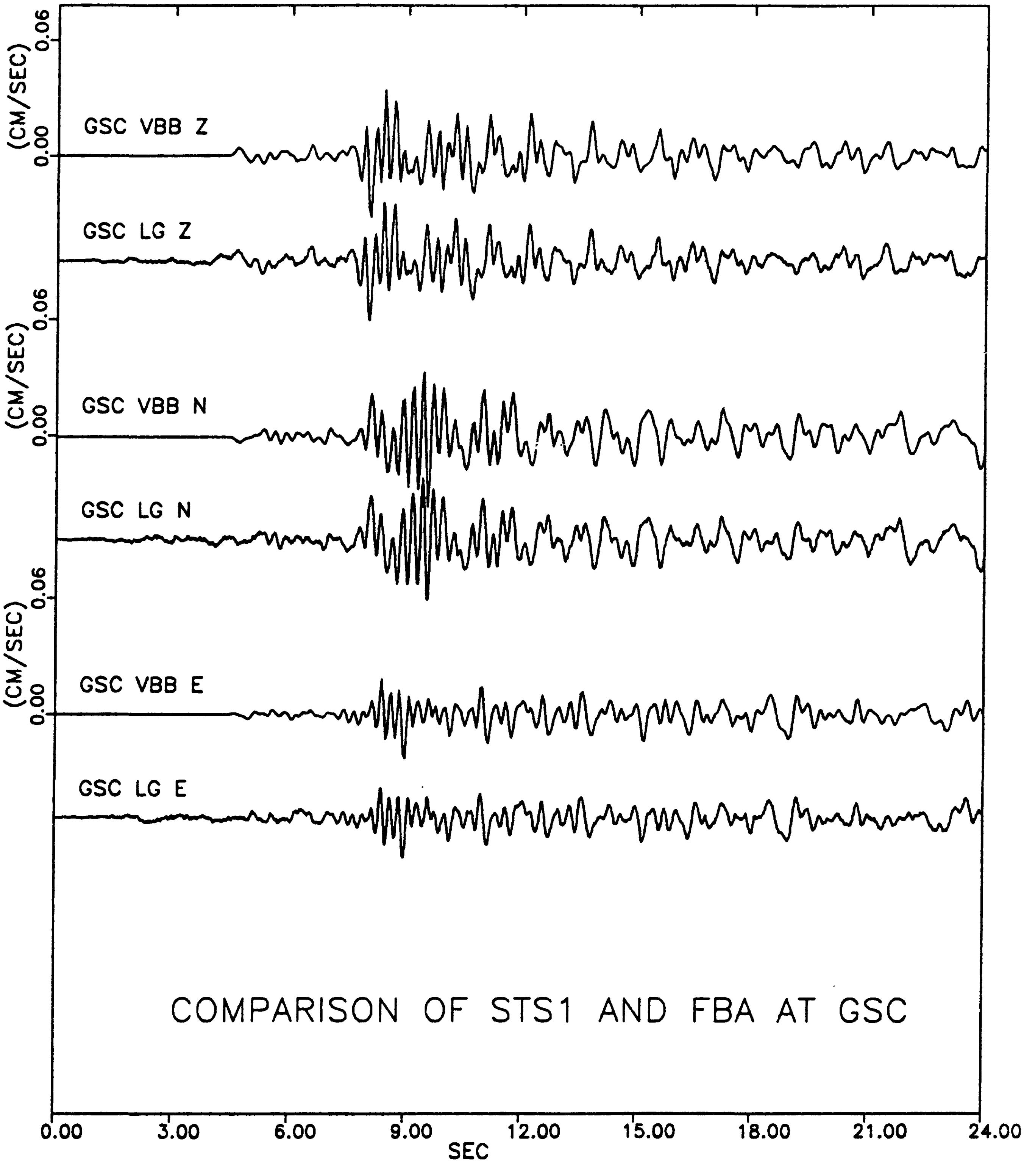

Figure 2. Streckeisen-1 (VBB channel) and FBA (LG channel) at GSC. This example is for a nuclear explosion on October 12, 1990 (m_b5.5) at the Nevada Test Site, located 200 km north-northeast of the station.

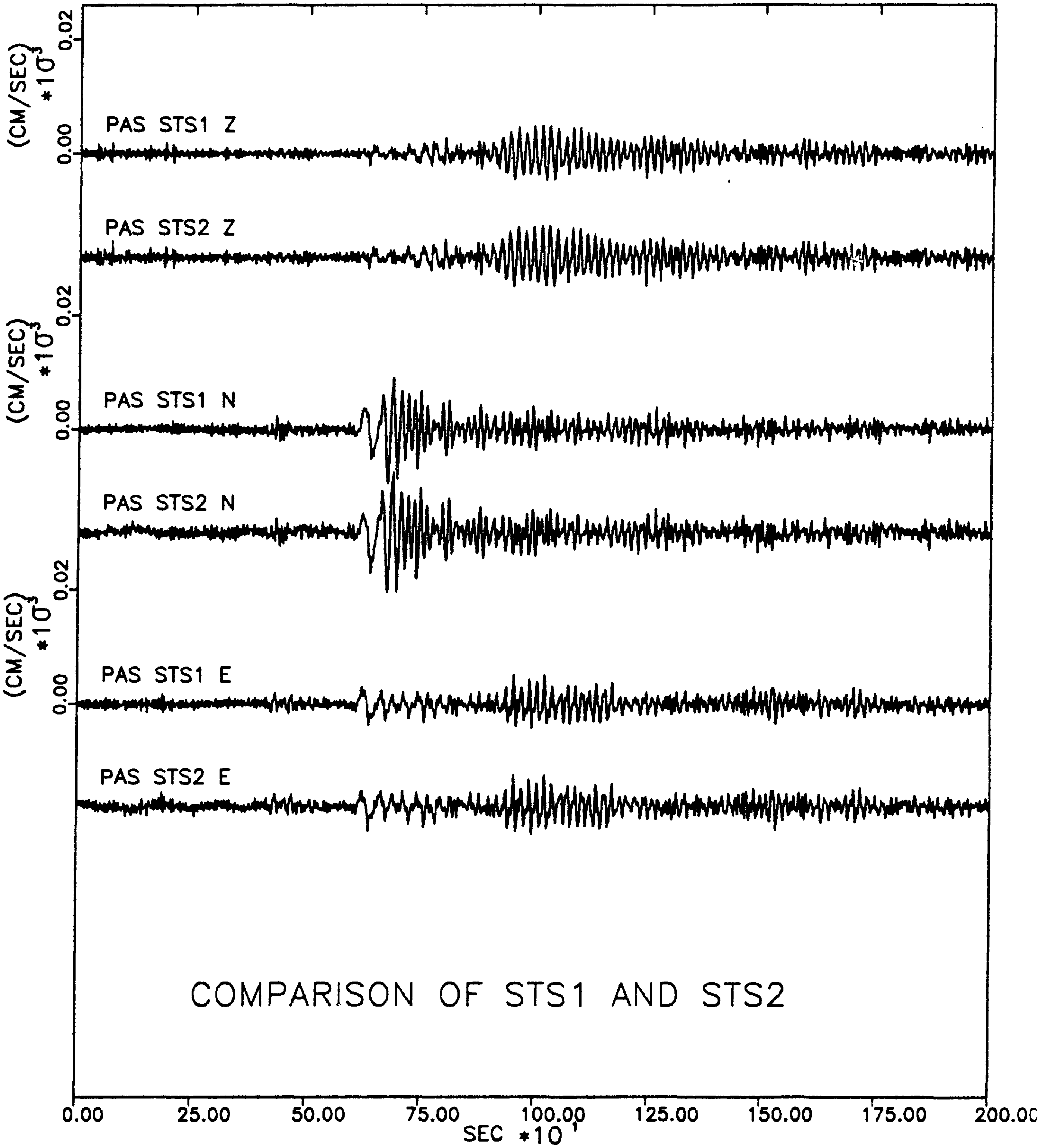

Figure 3. Streckeisen-1 and Streckeisen-2 at PAS. This example compares the LP channel (1 sample per second) for the two types of Streckeisen sensors. The earthquake is a teleseism (M_s6.0) from the Aleutians on November 21, 1990, located 42 degrees to the northwest.

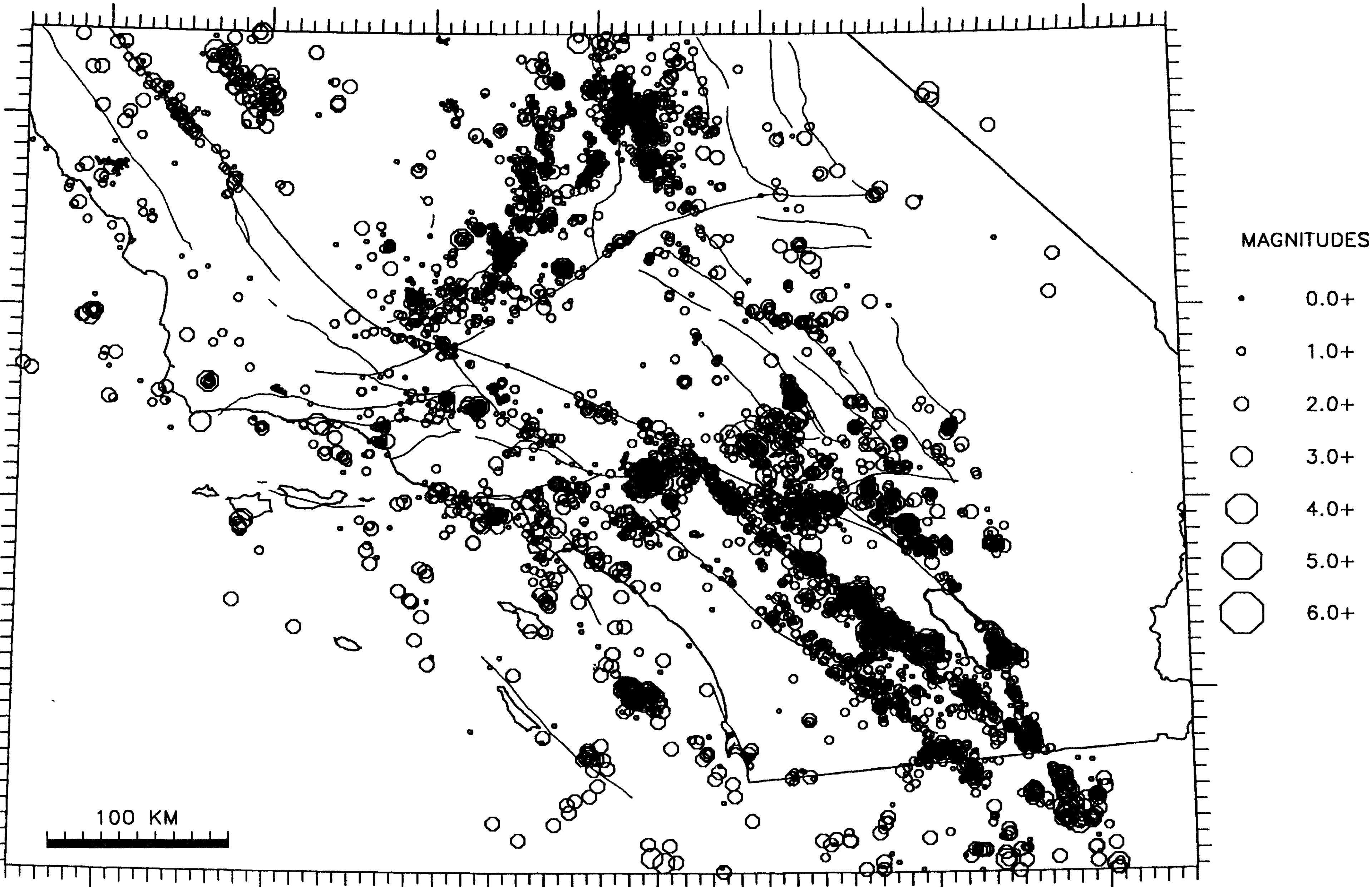

Figure 4. Map of all located earthquakes in southern California for the period of January through December 1990.

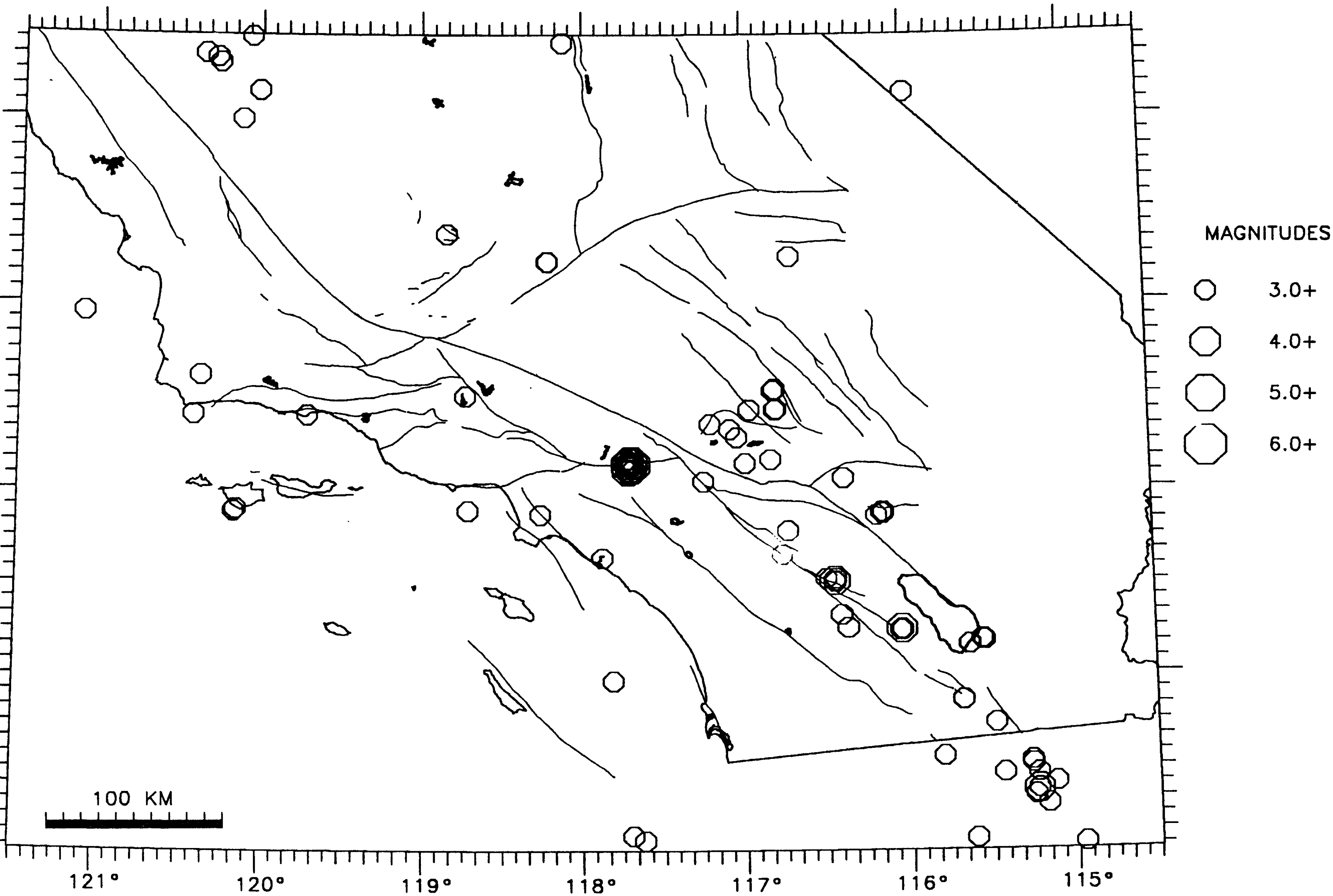

Figure 5. Map of located earthquakes of magnitude 3.0 and larger in southern California for the period of January through December 1990.

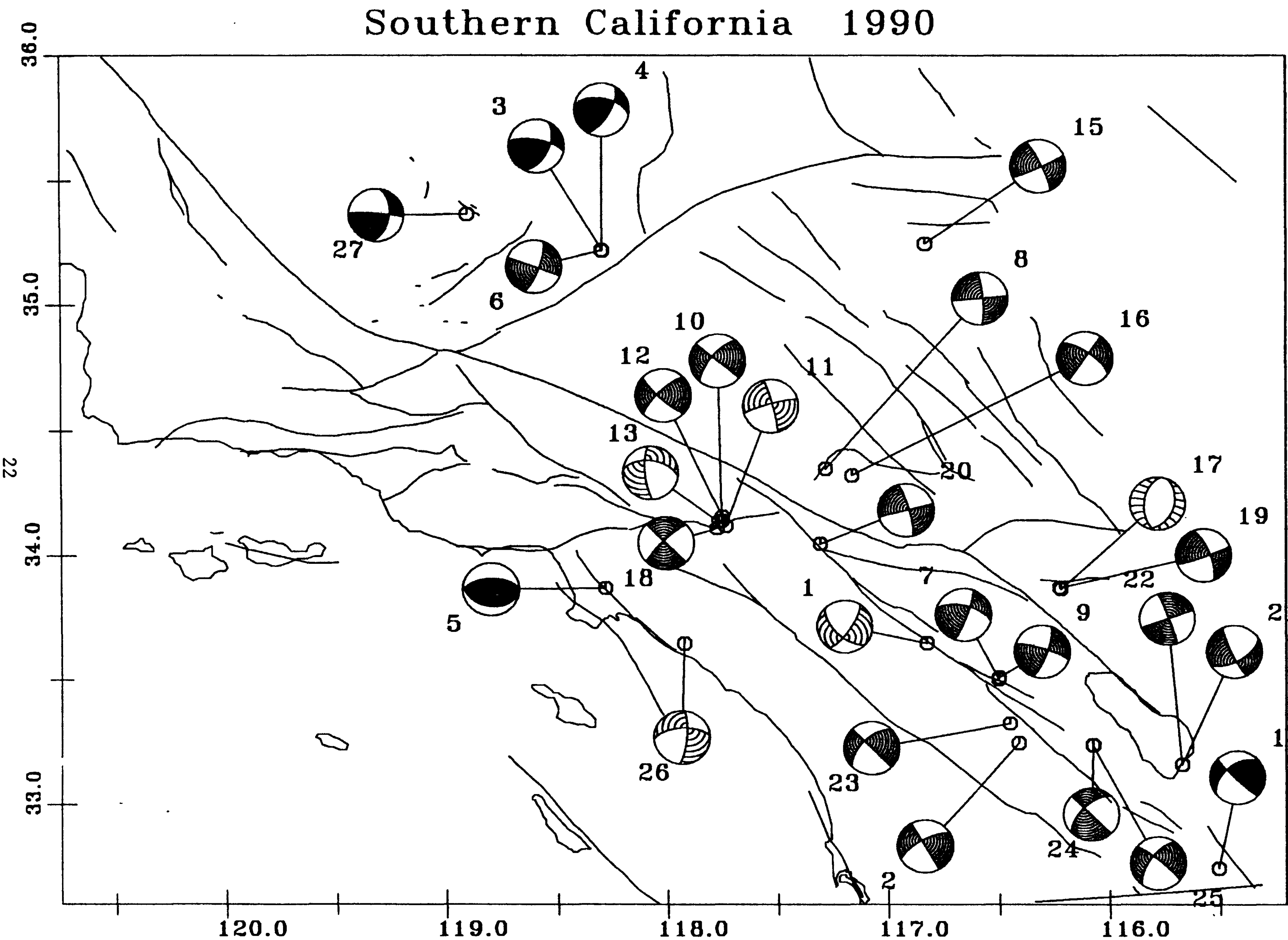

Figure 6. Lower hemisphere focal mechanisms for selected events for the period January through December 1990. Event numbers correspond to numbers in FM column of Appendix A and column 1 of Appendix B.

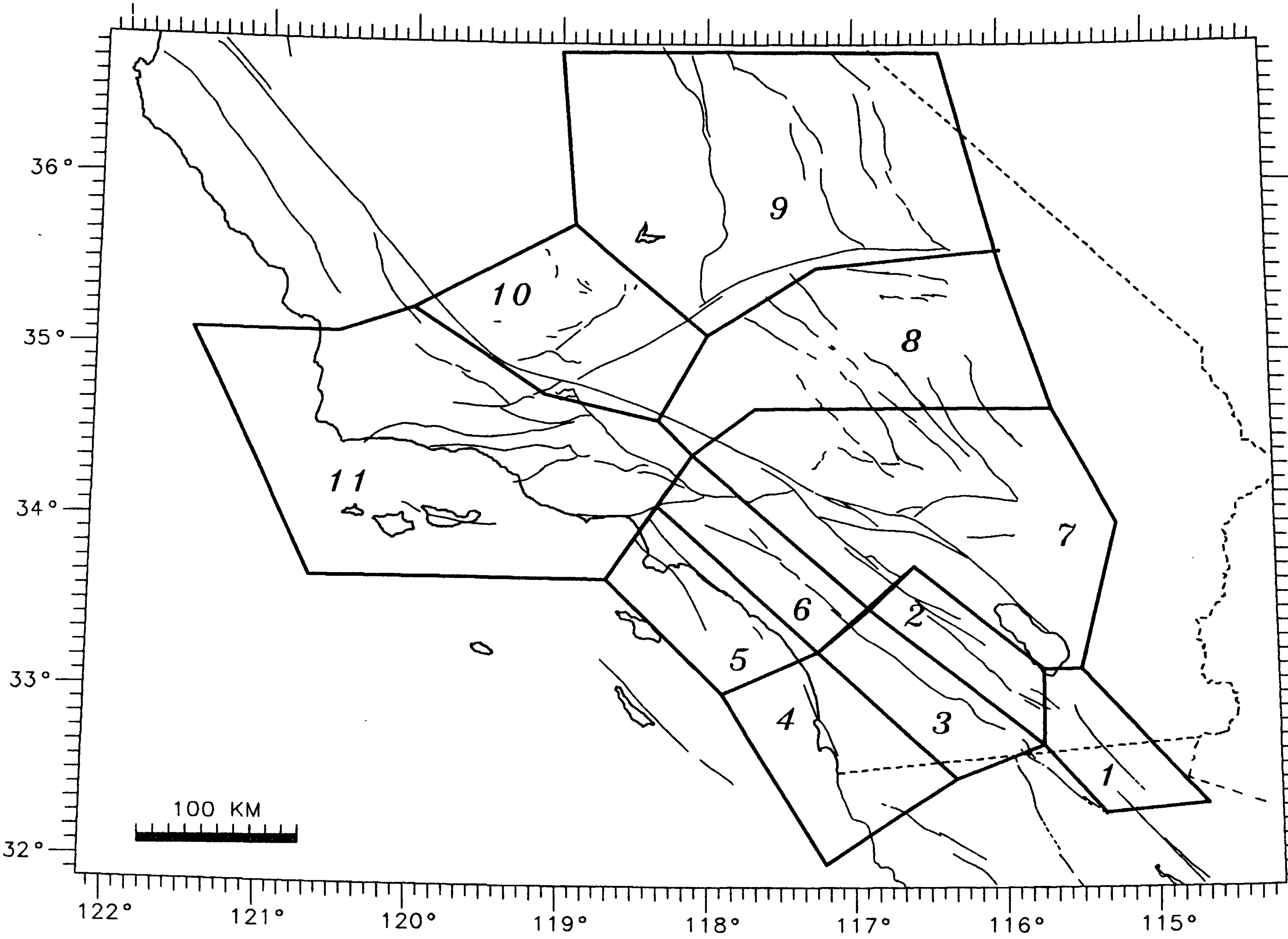

Figure 7. Map of sub-regions used in Figures 8a and 8b. The geographic name of each sub-region, as used in the text, can be found in the headings of Figures 8a and 8b.

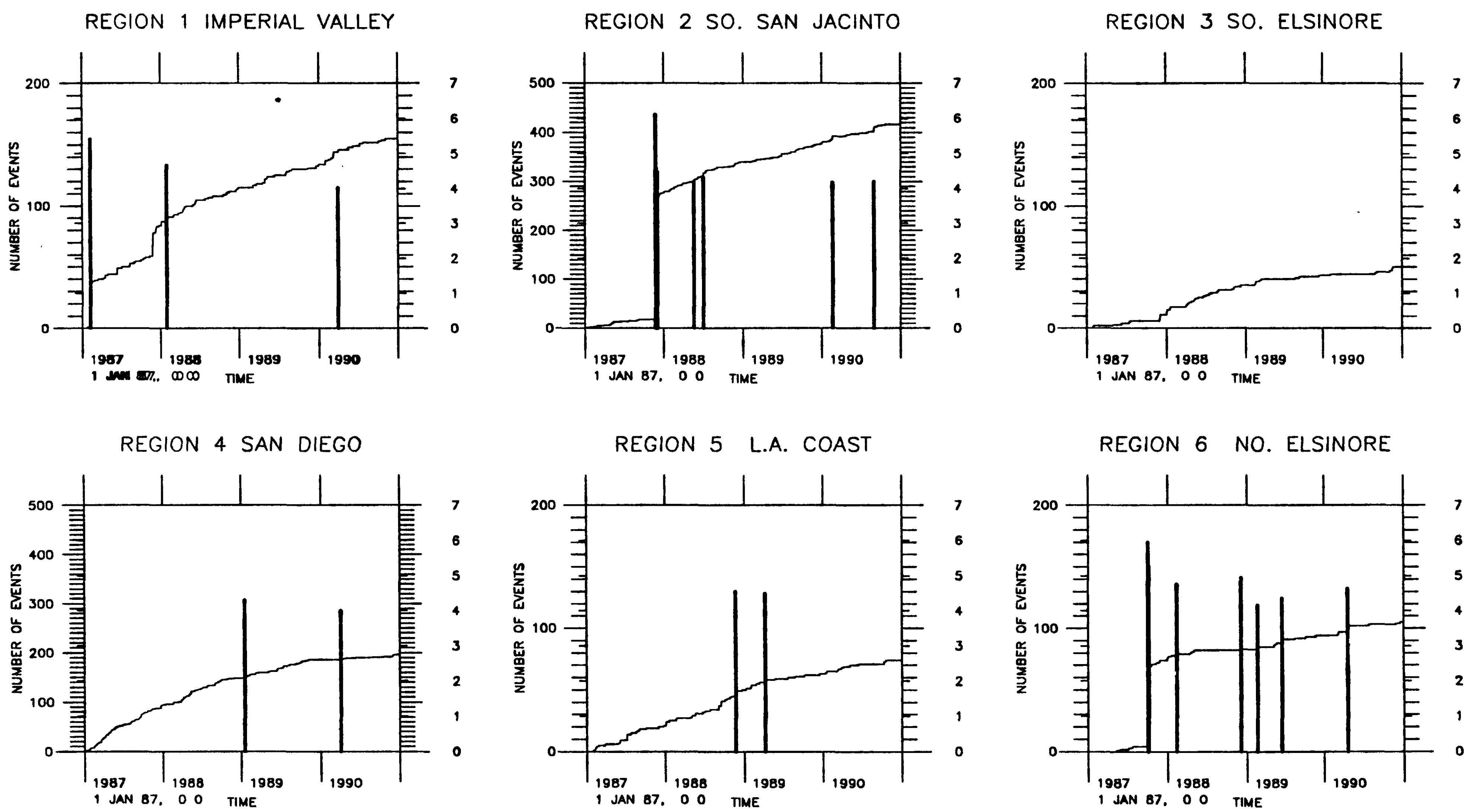

Figure 8a. Cumulative number of events ($M_L \geq 2.5$) in sub-regions 1 through 6 over the four year period ending December 1990. The boundaries of the sub-regions are shown in Figure 7. Vertical bars represent time and magnitude (scale on right) of large events ($M_L \geq 4.0$). Note that the vertical scales of the plots may not be the same.

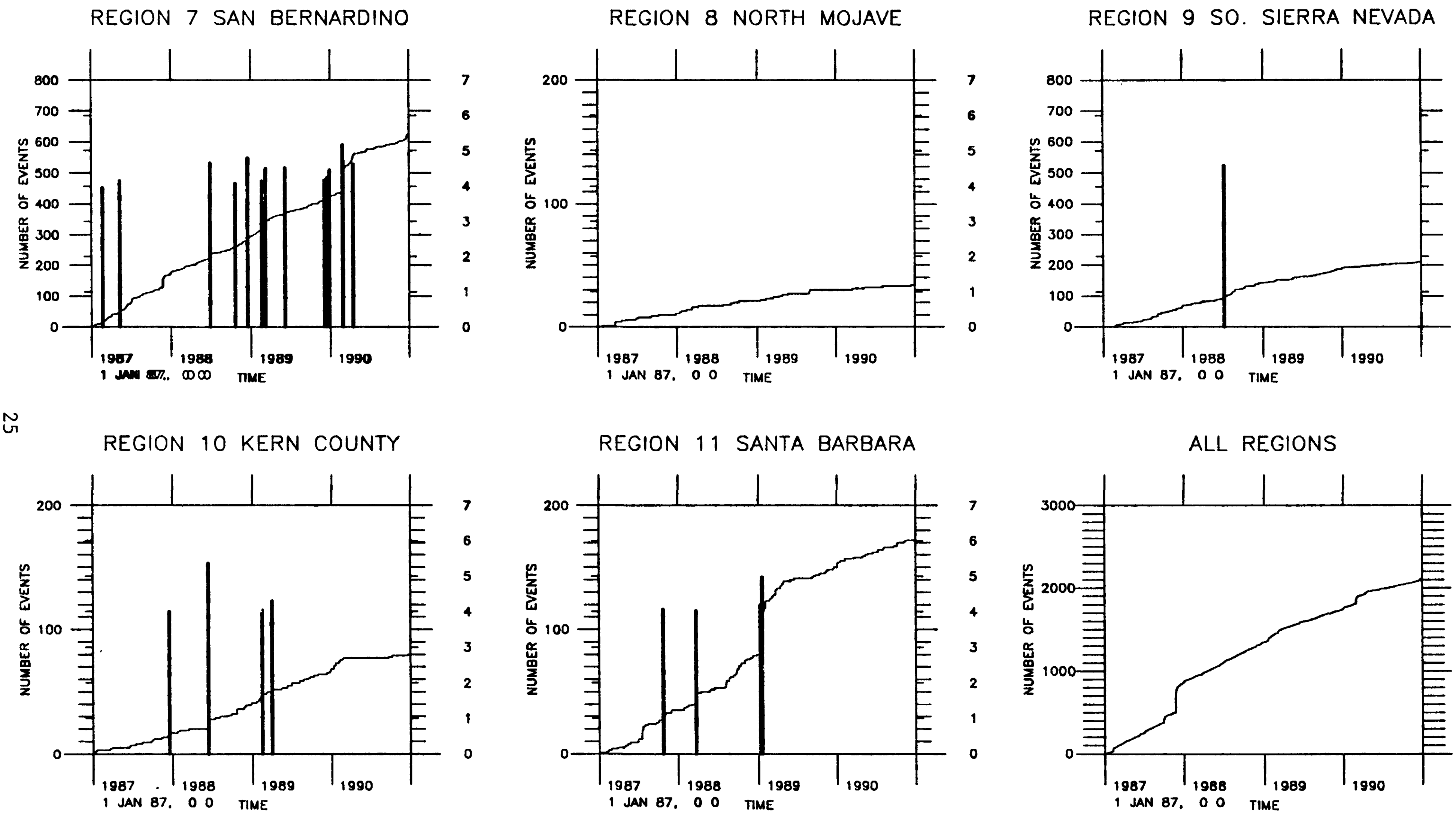

Figure 8b. Cumulative number of events ($M_L \geq 2.5$) in sub-regions 7 through 11 and for all sub-regions over the four year period ending December 1990. The boundaries of the sub-regions are shown in Figure 7. Vertical bars represent time and magnitude (scale on right) of large events ($M_L \geq 4.0$). Note that the vertical scales of the plots may not be the same.

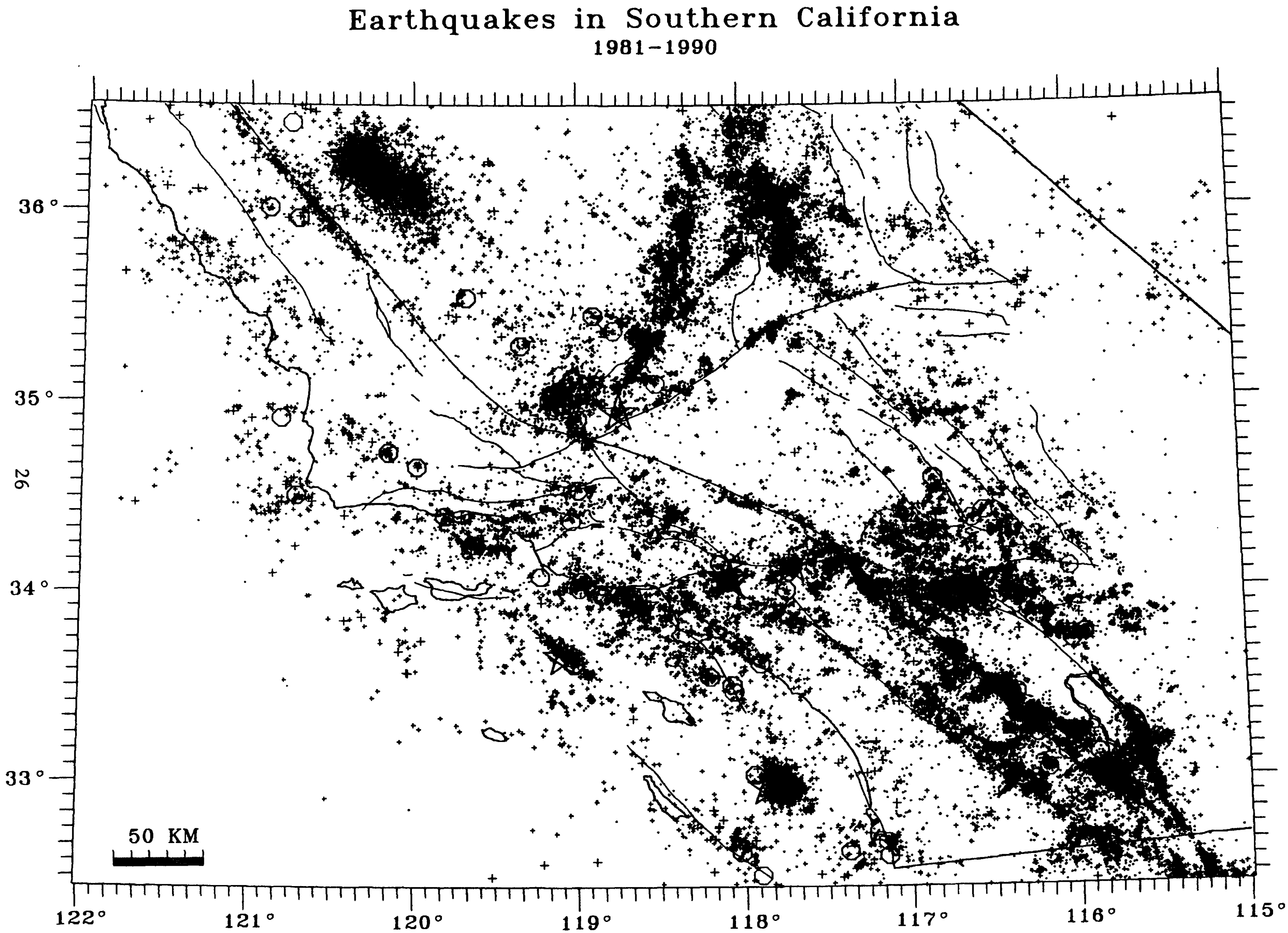

Figure 9. The 10-year siesmicity over the period January 1981 – December 1990.

APPENDIX A.

SIGNIFICANT SOUTHERN CALIFORNIA EARTHQUAKES

All events of $M_L \geq 3.0$ for the period January to December 1990. 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 6.

DATE			TIME	SEC	LAT	LON	Z	Q	M	TYP	RMS	NPH	CUSPID	FM
1990	JAN	1	22:59	43.36	32.5613	-115.8054	4.19	A	3.3	M_L	0.12	43	1049099	
1990	JAN	2	9:50	53.18	33.6530	-116.7699	13.41	A	3.5	M_L	0.09	102	1049144	1
1990	JAN	3	11:54	27.43	33.2549	-116.3745	9.30	A	3.6	M_L	0.09	76	1049214	2
1990	JAN	11	1:22	10.30	35.2250	-118.2151	3.58	A	3.9	M_L	0.13	106	1049754	3
1990	JAN	11	23:08	57.98	35.2253	-118.2189	3.44	A	3.6	M_L	0.14	87	1049832	4
1990	JAN	12	9:10	23.19	36.4593	-120.7487	6.00	C	4.0	M_L	0.25	36	1049870	
1990	JAN	12	19:50	56.60	36.3386	-120.3650	6.00	C	3.4	M_L	0.17	20	1049901	
1990	JAN	16	7:20	18.05	34.4037	-119.7015	10.23	A	3.3	M_L	0.09	20	140535	
1990	JAN	17	23:27	18.03	33.8713	-118.2626	14.00	A	3.6	M_L	0.19	85	1050259	5
1990	JAN	19	12:39	17.95	35.2260	-118.2203	3.60	A	3.8	M_L	0.13	88	1050342	6
1990	JAN	21	12:32	42.52	36.1414	-120.0217	6.00	C	3.4	M_L	0.31	20	1050510	
1990	JAN	31	4:09	24.59	32.4683	-115.2373	6.00	C	3.0	M_L	0.33	24	1051199	
1990	FEB	5	:51	1.93	33.5032	-116.4500	9.28	A	3.6	M_L	0.13	63	1051515	7
1990	FEB	6	18:14	7.90	34.9476	-121.0949	6.00	C	3.6	M_L	0.30	22	1051655	
1990	FEB	17	3:46	3.54	34.3536	-117.2088	4.52	A	3.5	M_L	0.14	82	1052544	8
1990	FEB	18	15:52	59.94	33.5089	-116.4520	9.16	A	4.2	M_L	0.13	87	1052624	9
1990	FEB	18	15:54	55.55	33.5097	-116.4545	8.83	A	3.3	M_L	0.12	47	140721	
1990	FEB	18	21:47	27.41	33.5222	-116.4460	11.40	A	3.1	M_L	0.12	49	1052658	
1990	FEB	22	5:32	50.44	33.1927	-115.5562	1.00	C	3.0	M_L	0.12	36	1052987	
1990	FEB	26	8:05	25.06	32.3810	-115.2382	6.00	C	3.0	M_L	0.37	29	1053372	
1990	FEB	28	20:37	24.17	34.1385	-117.7042	6.49	A	3.7	M_L	0.11	113	675971	
1990	FEB	28	23:43	36.70	34.1381	-117.7028	5.31	A	5.2	M_L	0.14	116	1053635	10
1990	FEB	28	23:46	54.11	34.1333	-117.7167	6.00	C	3.1	M_L	0.10	3	141026	
1990	MAR	1	: 2	8.97	34.1336	-117.7086	5.04	A	3.2	M_L	0.20	54	1053639	
1990	MAR	1	: 3	21.20	34.1522	-117.7023	8.56	A	3.3	M_L	0.18	38	140819	
1990	MAR	1	: 6	29.91	34.1381	-117.6974	5.29	A	3.4	M_L	0.11	97	1053640	
1990	MAR	1	:11	10.77	34.1272	-117.7083	5.09	A	3.3	M_L	0.10	62	1053641	
1990	MAR	1	:34	57.15	34.1267	-117.7013	4.37	A	4.0	M_L	0.13	82	1053648	
1990	MAR	1	1:35	48.94	34.1306	-117.7144	5.48	A	3.3	M_L	0.16	92	141721	
1990	MAR	1	1:39	56.87	34.1325	-117.7164	9.57	A	3.6	M_L	0.14	104	1053662	
1990	MAR	1	1:41	43.70	34.1516	-117.7060	10.20	A	3.1	M_L	0.11	54	676005	
1990	MAR	1	1:41	47.38	34.1565	-117.6945	6.00	C	3.2	M_L	0.21	6	141061	
1990	MAR	1	2:00	22.57	34.1297	-117.6967	4.42	A	3.1	M_L	0.16	75	141724	
1990	MAR	1	3:08	45.20	34.1305	-117.6985	4.76	A	3.3	M_L	0.11	93	1053677	
1990	MAR	1	3:23	3.03	34.1525	-117.7201	11.43	A	4.7	M_L	0.13	151	676027	
1990	MAR	1	3:31	14.98	34.1485	-117.7238	11.33	A	3.2	M_L	0.10	124	1053680	
1990	MAR	1	5:46	18.89	34.1347	-117.7172	9.62	A	3.0	M_L	0.13	80	1053704	
1990	MAR	1	12:11	20.80	34.1440	-117.7096	11.46	A	3.0	M_L	0.14	60	1053752	
1990	MAR	1	20:32	14.17	34.1265	-117.7019	4.52	A	3.3	M_L	0.11	62	1053824	
1990	MAR	1	20:55	30.59	34.1312	-117.7032	4.88	A	3.4	M_L	0.11	71	1053826	

DATE	TIME	SEC	LAT	LON	Z	Q	M	TYP	RMS	NPH	CUSPID	FM
1990 MAR 1	23:27	9.02	34.1521	-117.6926	7.16	A	3.2	M_L	0.06	32	1053840	
1990 MAR 2	: 0	12.24	34.1559	-117.7037	9.82	A	3.2	M_L	0.10	96	676179	
1990 MAR 2	17:26	25.48	34.1450	-117.6947	5.61	A	4.7	M_L	0.16	161	1053953	
1990 MAR 2	20:26	45.72	34.1474	-117.7016	8.39	A	3.1	M_L	0.14	81	1053990	
1990 MAR 3	3:48	31.70	34.1634	-116.8344	13.60	A	3.0	M_L	0.10	73	1054058	
1990 MAR 4	16:45	15.76	34.1158	-117.6838	4.12	A	3.6	M_L	0.14	103	1054199	11
1990 MAR 6	18:01	49.15	34.1558	-117.6995	9.75	A	3.6	M_L	0.13	81	1054407	12
1990 MAR 8	6:25	17.97	34.1313	-117.7182	8.37	A	3.7	M_L	0.15	120	1054657	13
1990 MAR 10	18:40	42.45	32.7387	-115.4865	12.45	A	3.5	M_L	0.23	45	1054912	14
1990 MAR 12	11:26	11.00	34.1268	-117.6996	4.54	A	3.4	M_L	0.10	69	1055047	
1990 MAR 12	11:29	36.21	34.1263	-117.7001	3.95	A	3.0	M_L	0.12	56	1055048	
1990 MAR 17	23:01	36.34	35.2485	-116.7080	11.36	A	3.6	M_L	0.07	56	1055738	15
1990 MAR 18	13:56	38.12	34.1460	-117.7110	8.68	A	3.3	M_L	0.14	92	1055771	
1990 MAR 31	22:59	48.03	32.3792	-115.2392	6.00	C	4.0	M_L	0.44	35	1056416	
1990 APR 4	2:13	39.83	34.3259	-117.0885	5.51	C	3.7	M_{CA}	0.10	99	1056583	16
1990 APR 4	8:54	39.39	32.9698	-117.8138	6.00	C	4.0	M_{CA}	0.47	91	1056608	
1990 APR 4	23:47	44.13	33.8619	-116.1952	5.42	A	3.2	M_{CA}	0.09	59	1056639	
1990 APR 7	1:07	5.13	33.8709	-116.1563	4.67	A	3.8	M_{CA}	0.09	54	1056778	17
1990 APR 12	1:12	55.68	33.8807	-116.1537	4.23	A	3.3	M_{CA}	0.10	58	1057012	
1990 APR 12	2:45	56.41	33.8799	-116.1496	2.03	A	3.1	M_{CA}	0.13	78	1057025	
1990 APR 14	11:14	11.85	33.8729	-116.1598	4.59	A	3.3	M_{CA}	0.09	59	1057180	
1990 APR 16	8:21	29.09	34.1059	-117.7243	3.81	A	3.2	M_{CA}	0.11	102	1057255	
1990 APR 17	8:47	32.22	34.1633	-117.7331	11.94	A	3.3	M_{CA}	0.11	123	1057290	
1990 APR 17	22:32	27.29	34.1057	-117.7216	3.59	A	4.6	M_L	0.16	112	1057313	18
1990 APR 18	14:26	5.83	33.8792	-116.1635	4.51	A	3.0	M_{CA}	0.10	56	1057364	
1990 APR 18	14:32	49.11	33.8773	-116.1651	4.67	A	3.6	M_{CA}	0.10	58	1057365	19
1990 APR 20	3:24	46.24	34.1155	-117.7203	3.54	A	3.4	M_{CA}	0.11	95	1057490	
1990 APR 23	9:30	16.49	34.0627	-116.3905	3.50	A	3.0	M_{CA}	0.06	61	1057623	
1990 APR 24	11:27	19.52	33.8792	-116.1590	4.54	A	3.3	M_{CA}	0.08	58	1057675	
1990 MAY 1	8:41	2.64	32.1112	-117.6309	6.00	D	3.7	M_{CA}	0.51	30	1057974	
1990 MAY 1	17:24	25.38	34.6140	-120.3706	9.15	C	3.1	M_{CA}	0.10	28	1058009	
1990 MAY 16	17:18	14.55	36.2913	-120.2735	6.00	C	3.2	M_{CA}	0.14	17	1058753	
1990 MAY 17	17:02	40.76	32.8613	-115.6844	6.95	A	3.5	M_{CA}	0.20	37	1058798	
1990 MAY 17	19:32	41.29	32.8627	-115.6804	7.05	A	3.2	M_{CA}	0.20	36	1058808	
1990 MAY 19	17:55	58.41	36.3203	-120.2910	6.00	C	3.2	M_{CA}	0.29	51	1058874	
1990 MAY 26	7:28	11.50	34.4060	-120.4132	0.93	A	3.2	M_{CA}	0.17	44	1059151	
1990 MAY 31	17:39	19.70	34.4299	-116.9656	3.55	A	3.4	M_{CA}	0.10	86	1059340	
1990 JUN 4	2:16	38.93	36.4303	-120.0758	6.00	C	3.4	M_{CA}	0.25	23	1059467	
1990 JUN 17	6:08	5.41	34.0464	-117.2542	15.02	A	3.7	M_L	0.12	147	2000429	20
1990 JUN 21	10:47	21.87	33.1645	-115.6346	1.00	C	3.9	M_L	0.20	46	141990	21

APPENDIX A. (continued)

DATE			TIME	SEC	LAT	LON	Z	Q	M	TYP	RMS	NPH	CUSPID	FM
1990	JUN	21	10:51	15.02	33.1615	-115.6373	1.00	C	3.3	M_L	0.12	38	2000607	
1990	JUN	21	11:08	45.93	33.1611	-115.6402	1.00	C	3.6	M_L	0.12	37	2000610	22
1990	JUN	30	23:46	53.72	32.3000	-115.1807	6.00	C	3.0	M_{CA}	0.37	23	1059765	
1990	JUL	9	10:30	35.01	32.5193	-115.2706	9.60	A	3.1	M_{CA}	0.15	19	1060073	
1990	JUL	9	10:54	54.43	32.5351	-115.2736	14.52	A	3.5	M_L	0.19	28	1060075	
1990	JUL	13	6:27	8.33	33.8888	-120.1618	6.00	C	3.3	M_{CA}	0.31	34	2001214	
1990	JUL	13	23:37	9.32	33.9000	-120.1496	6.00	C	3.3	M_{CA}	0.32	35	2001248	
1990	JUL	19	19:09	50.89	32.1185	-115.6165	6.00	C	3.2	M_{CA}	0.34	20	2001437	
1990	JUL	20	8:40	32.77	34.1706	-117.7278	5.23	A	3.2	M_{CA}	0.12	93	2001466	
1990	AUG	1	4:03	24.39	33.1873	-115.5580	1.00	C	3.0	M_{CA}	0.12	29	1060819	
1990	AUG	1	4:17	4.48	33.1902	-115.5624	2.48	A	3.2	M_{CA}	0.16	31	1060820	
1990	AUG	1	5:31	23.96	33.1834	-115.5488	1.00	C	3.0	M_{CA}	0.14	27	1060823	
1990	AUG	3	10:02	50.31	36.3987	-118.1225	6.00	C	3.1	M_{CA}	0.10	37	1061156	
1990	AUG	5	21:27	3.79	33.3248	-116.4141	5.21	A	3.6	M_{CA}	0.07	57	1061283	23
1990	AUG	31	1:05	49.03	33.2438	-116.0452	8.78	A	3.9	M_L	0.14	48	2003772	24
1990	AUG	31	1:23	32.22	33.2454	-116.0497	8.10	A	3.0	M_{CA}	0.13	37	2003775	
1990	AUG	31	3:24	53.95	33.2448	-116.0479	6.06	C	3.0	M_{CA}	0.16	39	2003782	
1990	AUG	31	3:38	0.01	33.2471	-116.0492	8.11	A	4.2	M_L	0.15	55	2003785	25
1990	AUG	31	3:56	18.90	33.2417	-116.0581	3.00	A	3.1	M_{CA}	0.20	37	2003787	
1990	AUG	31	4:24	28.25	33.2479	-116.0500	7.47	A	3.3	M_{CA}	0.15	48	2003792	
1990	SEP	2	10:20	35.34	34.1435	-116.9949	14.07	A	3.2	M_{CA}	0.08	82	2003986	
1990	SEP	8	22:32	14.08	32.1367	-117.6998	6.00	D	3.2	M_{CA}	0.46	22	2004489	
1990	SEP	15	19:01	41.17	34.2832	-117.0452	2.36	A	3.2	M_{CA}	0.10	80	2004813	
1990	OCT	5	3:17	54.85	32.4683	-115.4436	16.31	C	3.1	M_{CA}	0.27	31	1062210	
1990	OCT	9	4:02	26.14	33.8897	-118.7134	13.87	A	3.2	M_L	0.18	56	1062428	
1990	OCT	14	19:43	41.04	36.1301	-115.9742	6.00	D	3.0	M_{CA}	0.38	23	2006319	
1990	OCT	18	8:30	15.01	32.4163	-115.1295	6.00	C	3.1	M_{CA}	0.24	19	2006496	
1990	OCT	18	17:21	56.06	33.6373	-117.8780	3.24	A	3.6	M_{CA}	0.20	118	2006524	26
1990	OCT	25	3:00	50.00	33.5214	-116.5039	16.37	A	3.2	M_{CA}	0.11	68	143450	
1990	NOV	5	3:51	47.82	32.3488	-115.2576	6.00	C	3.1	M_{CA}	0.30	17	1062577	
1990	NOV	7	11:07	52.88	33.7812	-116.7331	10.37	A	3.4	M_{CA}	0.10	107	1062723	
1990	NOV	9	7:11	19.88	34.4276	-116.8087	3.74	A	3.5	M_L	0.10	97	1062836	
1990	NOV	9	7:12	27.38	34.4323	-116.8008	2.99	A	3.0	M_{CA}	0.10	54	143774	
1990	NOV	17	14:34	29.20	34.5024	-118.7306	7.95	A	3.4	M_L	0.14	70	2007634	
1990	DEC	1	7:39	40.43	32.0899	-114.9596	6.00	C	3.0	M_{CA}	0.56	14	2008291	
1990	DEC	10	2:34	9.09	35.9903	-120.1263	6.00	C	3.1	M_{CA}	0.24	24	2008654	
1990	DEC	13	18:59	58.00	33.1920	-115.5564	0.25	A	3.1	M_{CA}	0.15	42	2008907	
1990	DEC	14	14:22	33.11	36.5657	-117.9348	6.00	C	3.0	M_{CA}	0.15	37	2008930	
1990	DEC	18	16:56	43.09	35.3742	-118.8458	6.56	A	3.7	M_{CA}	0.17	105	688784	27
1990	DEC	19	19:04	47.34	34.5302	-116.8204	1.00	C	3.0	M_{CA}	0.12	83	2009163	

APPENDIX A. (continued)

DATE	TIME	SEC	LAT	LON	Z	Q	M	TYP	RMS	NPH	CUSPID	FM
1990 DEC 20	13:48	57.98	34.5356	-116.8117	1.00	C	3.0	M_{CA}	0.11	111	2009187	
1990 DEC 20	16:15	53.46	34.5397	-116.8085	1.00	C	3.2	M_{CA}	0.09	83	2009194	
1990 DEC 21	9:04	13.61	34.5324	-116.8137	1.00	C	3.1	M_{CA}	0.11	98	2009254	

APPENDIX B.

FOCAL MECHANISMS FOR M≥3.5 EARTHQUAKES IN 1990

Focal solution parameters are rounded to the nearest degree.

No.	Date			Latitude		Longitude		M_L	Strike	Dip	Strike	Dip	Rake
1	90	1	2	33	38.91	116	46.79	3.5	135	60	35	73	-160
2	90	1	3	33	14.86	116	22.84	3.6	240	70	150	90	0
3	90	1	11	35	13.25	118	13.10	3.9	280	70	26	53	140
4	90	1	11	35	13.29	118	13.26	3.6	30	65	281	54	40
5	90	1	17	33	52.26	118	14.76	3.6	100	35	268	56	100
6	90	1	19	35	13.32	118	13.43	3.8	20	75	290	90	0
7	90	2	5	33	30.24	16	27.58	3.6	20	80	284	61	30
8	90	2	17	34	20.97	117	12.82	3.5	355	80	265	90	0
9	90	2	18	33	30.67	116	27.42	4.2	20	75	287	80	10
10	90	2	28	34	8.48	117	42.01	5.2	220	70	130	90	0
11	90	3	4	34	7.24	117	41.03	3.6	345	83	254	82	-172
12	90	3	6	34	9.54	117	41.87	3.6	225	75	132	80	10
13	90	3	8	34	8.27	117	42.93	3.7	175	75	277	52	-40
14	90	3	10	32	44.65	115	29.99	3.5	134	84	230	50	140
15	90	3	17	35	14.92	116	42.60	3.6	65	85	334	80	10
16	90	4	4	34	19.39	117	5.54	3.7	215	90	305	70	340
17	90	4	7	33	52.09	116	9.34	3.8	20	40	187	51	-80
18	90	4	17	34	6.71	117	43.40	4.6	495	90	225	80	530
19	90	4	18	33	52.41	116	9.73	3.6	70	85	338	70	20
20	90	6	17	34	2.96	117	15.03	3.7	255	90	345	80	350
21	90	6	21	33	9.77	115	38.40	3.9	60	60	155	81	-10
22	90	6	21	33	9.67	115	38.48	3.6	340	85	250	90	180
23	90	8	5	33	19.57	116	25.02	3.6	225	60	135	90	0
24	90	8	31	33	14.34	116	2.51	3.9	495	90	225	60	510
25	90	8	31	33	14.36	116	2.70	4.2	215	65	309	81	-10
26	90	10	18	33	38.80	117	53.43	3.6	5	75	267	61	-150
27	90	12	18	35	22.06	118	50.54	3.7	274	84	9	50	140

APPENDIX C. (continued)

Station	New No.	A	Old No.	A	Diff.	D.B.
COA V	70	1.38	51	1.21	0.17	-0.12
COK V	94	1.31	70	1.43	-0.12	-0.36
COY V	138	2.04	325	1.90	0.14	-0.10
COY Z	39	0.13	40	-0.26	0.39	-0.09
CPE V	131	1.10	72	0.73	0.37	-0.17
CPM V	117	1.65	271	1.90	-0.25	0.06
CPM Z	51	0.06				0.00
CRG V	78	1.51	232	2.03	-0.52	-0.33
CRR V	120	1.93	203	1.78	0.15	-0.03
CSP V	148	1.53	229	1.27	0.26	
CTW V	52	1.81	115	1.60	0.21	-0.10
CTW Z	41	0.06				-0.06
DB2 V	144	1.66	356	1.97	-0.31	-0.72
DBM V	136	1.65	499	1.83	-0.18	-0.10
DHB V	35	0.41				
DTP V	41	1.58	357	1.64	-0.06	-0.07
ECF V	94	1.42	66	1.86	-0.44	0.00
EDW Z	5	0.17				
EDW I	1	-0.16				
ELM V	104	1.46	186	1.71	-0.25	-0.13
ELR V	91	0.99	60	1.01	-0.02	-0.13
ELS V	149	1.62	287	2.01	-0.39	-0.32
EMS V	50	1.36	48	1.28	0.08	-0.14
ERP V	72	1.21	61	1.24	-0.03	0.04
EWC V	128	1.25	230	1.44	-0.19	-0.10
EWC Z	56	-0.06	34	-0.07	0.01	0.06
EWC E	121	1.06	170	1.74	-0.68	0.04
EWC N	121	1.11	176	1.75	-0.64	0.04
FAL V	11	1.93				
FIL V	100	1.47	136	1.48	-0.01	0.02
FLA V	17	0.22				
FLA M	49	0.23				
FLS V	135	1.44	284	1.80	-0.36	-0.26
FMA V	11	0.59				
FOX V	70	0.97	279	1.51	-0.54	-0.38
FRG V	24	1.49	24	2.00	-0.51	-0.52
FRI V	35	1.32	200	1.34	-0.02	
FRK V	121	1.34	183	1.48	-0.14	-0.10
FTC V	31	0.39	147	1.28	-0.89	-0.74
GAV V	133	1.20	249	1.02	0.18	-0.10
GAV Z	71	-0.03	33	0.00	-0.03	-0.10
GFP V	70	0.68				
GFP Z	11	0.40				
GFP E	23	-0.13				
GLA V	95	1.74	91	2.12	-0.38	

APPENDIX C.

OLD AND NEW CALIBRATIONS USED FOR CODA DURATION MAGNITUDES

The last column is the difference predicted from entries in the station history data base. The fourth letter (or number) in the station code refers to the component. V = high gain vertical; Z = low gain vertical; N = high gain north-south; E = high gain east-west; I = vertical force balance accelerometer (FBA); J = north-south FBA; K = east-west FBA; 1 = vertical broad-band; 2 = north-south broadband; 3 = east-west broad-band.

Station	New No.	A	Old No.	A	Diff.	D.B.
ABL V	88	1.28	345	1.54	-0.26	-0.14
ADL V	123	1.24	81	1.38	-0.14	-0.44
AMS V	7	1.42	136	1.40	0.02	-0.10
ARV V	80	1.62	281	1.53	0.09	-0.06
BAR V	143	1.53	227	1.80	-0.27	-0.03
BAT V	121	1.57	4	1.83	-0.26	-0.13
BC2 V	102	1.51	190	1.72	-0.21	-0.09
BCH V	69	1.43	272	1.82	-0.39	-0.13
BLK V	144	1.87	346	1.98	-0.11	0.09
BLU V	4	0.28	152	1.57	-1.29	
BLU Z	4	-0.25	10	0.03	-0.28	
BMT V	134	1.65	490	1.69	-0.04	0.09
BNP V	49	1.51	144	1.96	-0.45	
BON V	3	1.33	33	1.07	0.26	-0.14
BOO V	40	1.08	218	1.17	-0.09	-0.09
BRA Z	18	-0.01				
BRA I	5	0.42				
BRA K	3	1.37				
BRG V	141	2.15	239	1.61	0.54	-0.06
BRT V	127	1.27	83	1.06	0.21	-0.12
BTL V	116	1.51	424	1.70	-0.19	-0.16
CAH V	2	0.31	359	1.54	-1.23	
CAL V	134	1.62	310	1.89	-0.27	-0.38
CAV V	137	1.92	253	2.16	-0.24	-0.41
CBK V	142	2.07	178	1.90	0.17	-0.12
CFL V	113	1.77	471	1.72	0.05	
CFT V	130	1.04	78	0.65	0.39	-0.16
CH2 V	41	1.56	126	1.34	0.22	0.11
CIS V	113	1.23	186	1.32	-0.09	
CIW V	89	1.36	24	1.16	0.20	
CJV V	123	1.20	320	1.30	-0.10	-0.04
CLC V	110	1.82	175	1.64	0.18	
CLI V	39	1.04	31	1.12	-0.08	-0.77
CLI E	54	0.86				
CLI N	54	1.02				
CLM V	1	-0.02				
CLM Z	1	-0.03				
CLM E	1	0.11				
CLM N	1	0.07				
CO2 V	128	1.89	215	2.11	-0.22	-0.42

APPENDIX C. (continued)

Station	New No.	A	Old No.	A	Diff.	D.B.
GLA E	42	0.63	7	0.51	0.12	
GLA N	41	0.55	6	0.23	0.32	
GRP V	224	1.87		0.02		
GSA Z	34	-0.19				
GSA E	46	0.02				
GSA N	45	0.03				
GSA A	8	-0.16				
GSA B	2	0.19				
GSC V	132	1.88	238	1.24	0.64	
GVR V	88	0.68				-0.26
GVR E	62	0.17				0.04
GVR N	63	0.21				0.04
GVR I	7	-0.14				0.57
GVR J	7	-0.23				0.57
GVR K	7	-0.31				0.57
HAY V	86	1.03	75	0.96	0.07	
HDG V					0.00	
HOD V	143	1.68	401	2.05	-0.37	-0.55
HOT V	120	1.85	288	1.70	0.05	-0.06
HYS V	142	1.63	304	1.58	0.05	-0.12
IKP V	88	1.20	143	1.15	0.05	-0.20
IND V	141	1.59	243	1.57	0.02	-0.17
ING V	42	0.77	32	0.50	0.27	-0.09
INS V	21	1.47	197	2.05	-0.58	-0.07
IRC V	23	1.12	144	1.10	0.02	
IRN V						-0.04
IRS V	31	0.97	35	0.94	0.03	-0.12
ISA V	90	1.28	342	1.38	-0.10	-0.72
ISA E	8	-0.02	17	-0.16	0.14	-0.10
ISA N	3	-0.65	22	-0.19	-0.46	-0.14
JAS V	11	1.22	165	1.87	-0.65	
JAW V	97	1.40				-0.34
JFS V	90	1.51	242	1.54	-0.03	-0.10
JNH V	147	1.61	489	1.55	0.06	-0.36
JTR V			1			
JUL V	123	1.76	310	2.04	-0.28	0.16
KEE V	115	2.00	262	1.65	0.35	-0.14
KYP V			203	1.54		-0.10
LAN V	1	-0.29	222	1.30	-1.59	
LAQ V	64	1.40	110	1.64	-0.24	-0.10
LAV V	126	1.73	285	2.18	-0.45	-0.55
LCL V	5	-0.64				
LED V						0.00
LEO V	106	1.53	222	1.84	-0.31	-0.04
LHU V	120	1.79	314	1.70	0.09	0.06

APPENDIX C. (continued)

Station	New No.	A	Old No.	A	Diff.	D.B.
LJB V	146	1.84	433	1.66	0.18	-0.09
LJB Z	30	-0.21	7	-0.03	-0.18	-0.04
LJB E	112	0.89	351	1.64	-0.75	0.06
LJB N	124	0.91	340	1.70	-0.79	0.06
LLN V	141	1.79	61	0.79	1.00	0.06
LNA V	2	-0.76				
LOK V	101	1.42	330	1.30	0.12	0.02
LOM V	10	0.07				
LRM V	119	1.43	361	1.40	0.03	-0.12
LRR V	137	1.52	116	1.69	-0.17	-0.06
LTC V	78	1.36	173	1.77	-0.41	-0.38
LTM V			43	1.98		
LUC V	123	1.23				
MAR V	92	1.65	324	2.12	-0.47	-0.17
MDA V	68	1.54	242	1.65	-0.11	-0.34
MEC V	136	1.90				-0.40
MIR V	25	1.05	208	1.42	-0.37	-0.12
MLL V	125	1.09	78	1.10	-0.01	0.04
MNP V	39	1.87				
MRV V			197	1.88		
MTC Z	8	0.84				
MTU V	29	1.47				
MWC V	139	1.14	215	1.20	-0.06	-0.12
NW2 V	34	0.77	62	0.60	0.17	-0.14
OLY V	138	1.31	352	1.91	-0.60	-0.24
ORK V	10	0.73				-0.54
PAD V	27	1.64	127	1.55	0.09	
PAR V			142	1.68		
PAS V	108	0.85	194	0.93	-0.08	
PAS E	44	0.01	22	0.34	-0.33	
PAS 1	73	0.49				
PAS 2	79	0.51				
PAS 3	90	0.70				
PCF V	101	0.76				0.06
PCR V			209	1.66		
PEC V	143	1.50	365	1.40	0.10	
PEM V	122	1.58	298	1.45	0.13	-0.14
PEM Z	42	0.10	26	0.13	-0.03	-0.06
PGC V			5	0.87		
PGW V			14	1.15		
PHC V	17	1.11				
PIV V			35	1.89		
PKM V	80	1.45	242	1.98	-0.53	-0.08
PLE V	79	1.20	236	1.76	-0.56	-0.02
PLM V	144	1.74	293	1.38	0.36	

Station	New No.	A	Old No.	A	Diff.	D.B.
PLS V	1	0.88				
PLT V	47	1.22	53	1.49	-0.27	-0.14
PMC V	31	1.30				
PMC V			55	0.39		
PMC Z	14	0.58	132	1.89	-1.31	
PMC E	10	0.58	42	0.64	-0.06	
PMC N	14	0.94	66	0.48	0.46	
PMG V	20	1.04				
PNM V			44	1.80		0.00
POB V	148	1.90	395	2.10	-0.20	0.06
POB Z	92	0.39	28	0.27	0.12	0.02
PPB V	25	1.13				
PPR V			89	1.51		
PPT V			144	1.83		
PRC V			144	1.76		
PRC N			45	0.46		
PRI V	29	1.31	186	1.75	-0.44	
PSA V			102	1.63		
PSH V	31	1.15	163	1.78	-0.63	
PSM V	26	1.37	154	1.89	-0.52	
PSP V	119	1.04	309	1.66	-0.62	-0.02
PTD V	81	0.98	89	1.35	-0.37	-0.70
PTQ V	21	1.14				
PTR V	24	1.26	130	1.54	-0.28	
PVP Z	31	1.16				
PVR V	86	0.77	70	0.99	-0.22	-0.14
PYR V	111	1.59	269	1.45	0.14	
QAL V	64	0.92	231	1.52	-0.60	-0.38
RAY V	146	1.77	350	1.89	-0.12	-0.11
RAY Z	52	0.03	45	0.01	0.02	-0.12
RCH V			23	1.31		
RCP V	24	-0.16				
RMR V	123	1.54	294	1.51	0.03	-0.19
RUN V	80	1.88	87	1.56	0.32	0.04
RVR V	142	1.20	246	1.13	0.07	
RVS V			30	2.05		
RYS V	98	1.49	293	1.94	-0.45	-0.16
SAD V	1	-0.88	188	1.80	-2.68	-0.07
SAT V	24	0.56				
SAT M	58	0.52				
SBB V	152	1.47	328	1.68	-0.21	-0.11
SBI V			24	1.22		
SBK V	88	0.95	68	1.04	-0.09	-0.17
SBP Z	49	0.05				
SBP I	12	0.90				

APPENDIX C. (continued)

Station	New No.	A	Old No.	A	Diff.	D.B.
SBP J	7	0.71				
SBP K	5	0.73				
SC1 V	3	0.00				
SCC V	68	1.33	167	1.88	-0.55	-0.04
SCD V	78	1.29	168	1.77	-0.48	-0.04
SCI V	68	0.86	7	1.20	-0.34	
SCY V	33	1.13	131	0.93	0.20	
SDL V			205	1.69		
SDW V	151	1.46	360	1.67	-0.21	0.46
SGL V	123	1.88	171	2.03	-0.15	-0.39
SHH V	1	-1.48	19	2.13	-3.61	-0.14
SIL V	124	1.36	305	1.79	-0.43	-0.33
SIL Z	43	0.02	54	0.36	-0.34	-0.12
SIM V	45	1.17				
SIP V						0.06
SLC V	69	1.22	223	1.99	-0.77	1.41
SLG V	83	1.29	144	1.73	-0.44	-0.30
SLP V	42	1.03	134	1.49	-0.46	-0.41
SLT V	3	-0.13	118	1.51	-1.64	
SME V	151	1.71	355	1.39	0.32	-0.10
SMO V	136	1.17	241	1.46	-0.29	-0.09
SNC V	127	1.73	395	1.61	0.12	
SND V						-0.04
SNR V	22	0.72	28	0.90	-0.18	-0.12
SNR E	54	0.98	27	1.15	-0.17	-0.14
SNS V	63	1.31	113	1.13	0.18	-0.17
SPC V			15	1.18		
SPM V			137	2.28		0.00
SRT V	89	1.41	277	1.76	-0.35	-0.26
SS2 V	123	1.03	131	1.39	-0.36	0.07
SSC V	60	1.38	200	1.55	-0.17	0.06
SSM V	7	1.05	47	1.17	-0.12	-0.02
SSN V	49	1.18				
STT V	117	1.39	159	1.57	-0.18	0.09
SUN V	140	1.63	439	1.90	-0.27	0.02
SUP V	106	1.77	177	1.88	-0.11	-0.38
SWM V	1	-0.71	216	1.57	-2.28	-0.54
SYP V	79	1.48	224	1.35	0.13	-0.15
SYS V	133	1.57	198	1.62	-0.05	-0.12
TAB V	61	1.35				
TAB Z	27	-0.30				
TCC V	50	1.00	10	0.79	0.21	-0.26
TEJ V	75	1.36	418	1.85	-0.49	-0.72
THC V	23	1.04	232	1.18	-0.14	-0.08
TJR V	121	1.75	275	2.03	-0.28	-0.44

APPENDIX C. (continued)

Station	New No.	A	Old No.	A	Diff.	D.B.
TMB V	80	1.43	357	1.76	-0.33	-0.13
TOW V	112	1.85	235	1.80	0.05	-0.12
TPC V	124	1.53	78	1.34	0.19	-0.51
TPO V	109	1.70	407	1.89	-0.19	-0.04
TPR M	59	1.01				
TTM V			37	1.96		
TWL V	92	1.11	30	0.61	0.50	
U13 V			15	0.99		
U6 V			42	0.94		
U8 V			25	0.75		
UPL V	15	0.47				
UPL Z	9	-0.07				
UPL E	10	0.11				
UPL N	6	-0.21				
UPL I	2	-0.19				
UPL J	1	1.01				
UPL K	2	-0.19				
VG2 V	138	1.16	277	1.43	-0.27	0.04
VPD V	97	0.62	49	0.39	0.23	
VST V	123	0.99	159	1.30	-0.31	
WAS V	84	1.32	290	1.68	-0.36	0.02
WBM V	93	1.22	286	1.66	-0.44	-0.42
WBS V	117	1.62	429	1.77	-0.15	-0.12
WCH V	98	1.48	397	1.41	0.07	0.06
WCO V			78	1.95		
WCP V			286	2.49		
WCS V	97	1.53	380	1.81	-0.28	-0.04
WCX V			397	1.55		
WHF V	82	1.70	298	1.85	-0.15	0.06
WHS V			319	1.96		
WHV V	115	1.60	448	1.60	0.00	-0.13
WIS V	60	0.81	36	1.06	-0.25	-0.12
WIS E	23	0.82				
WJP V	114	1.42	373	1.42	0.00	
WKT V			381	1.30		0.00
WLH V	83	1.51	59	1.74	-0.23	-0.14
WLK V			32	0.94		
WMF V	95	1.65	318	1.99	-0.34	-0.24
WNM V	94	1.44	257	1.57	-0.13	0.06
WOF V	93	1.40	357	1.60	-0.20	
WOR V	94	1.27	355	1.61	-0.34	0.06
WRC V	66	2.00	346	1.99	0.01	-0.09
WRV V	86	1.53	223	1.93	-0.40	-0.10
WSC V	52	1.62	323	1.86	-0.24	-0.07
WSH V	130	1.92	413	1.78	0.14	0.02

APPENDIX D.

TIME HISTORY, BY QUARTER YEAR, OF "A" USED IN FINAL MCA COMPUTATIONS FOR SELECTED STATIONS

Quarter	BAR	BMT	BRG	DB2	IND	OLY
84Q1	1.82	1.64	2.07	1.94	1.75	1.94
84Q2	1.80	1.74	2.23	2.01	1.51	1.87
84Q3	1.77	1.70	2.19	1.92	1.52	1.94
84Q4	1.00	1.71	2.34		1.55	2.16
85Q1	1.29	1.66	2.33		1.66	1.95
85Q2	1.51	1.70	2.18		1.43	1.84
85Q3	1.56	1.83	2.25		1.45	1.97
85Q4	1.60	1.75	2.43	1.93	1.55	2.01
86Q1	1.54	1.78	2.61	2.01	1.59	1.92
86Q2	1.61	1.58	2.44	1.86	1.53	1.79
86Q3	1.60	1.58	2.19	1.85	1.53	1.82 shift 1 pin
86Q4	1.69	1.59	2.19	1.88	1.59	1.84
87Q1	1.64	1.49	2.23	1.80	1.50	1.39
87Q2	1.62	1.45	2.18	1.94	1.67	1.80
87Q3	1.60	1.62	2.19	1.55	1.66	1.83
87Q4	1.65	1.79	2.23	1.74	1.66	1.87
88Q2	1.57	1.67	2.19	2.05	1.53	1.90
88Q3	1.74	1.66	2.06	2.15	1.59	1.89
88Q4	1.66	1.76	2.12	2.26	1.66	1.93
89Q1	1.82	1.79	2.27	2.40	1.66	2.00
89Q2	1.72	1.64	2.17	2.13	1.45	1.92
89Q3	1.48	1.65	2.12	1.80	1.37	1.39
89Q4	1.44	1.73	2.08	1.68	1.41	1.33
90Q1	1.54	1.67	2.15	1.74	1.56	1.29
90Q2	1.46	1.61	2.10	1.62	1.63	1.29
NEW	1.53	1.65	2.15	1.66	1.59	1.31

APPENDIX E.

NEW AND OLD STATION CORRECTIONS FOR USE WITH PHOTOGRAPHIC AND HELICORDER RECORDS

Wood-Anderson Responses

Instr.	No.	Corr.	Old	Diff.	H&B	Diff.
CWC E	24	-0.50	0.0	-0.5	0.06	-0.57
CWC N	18	-0.51	0.0	-0.5	0.09	-0.60
GLA E	97	-0.26	-0.2	-0.1	-0.36	0.10
GLA N	95	-0.22	-0.2	0.0	-0.21	-0.01
ISA E	49	0.48	0.2	0.3	0.22	0.26
ISA N	49	0.62	0.2	0.4	0.26	0.36
PAS E	111	0.28	0.1	0.2	0.09	0.19
PAS N	94	0.31	0.1	0.2	0.05	0.26
PLM E	143	-0.08	0.0	-0.1	-0.10	0.02
PLM N	157	-0.10	0.0	-0.1	-0.11	0.01
RVR E	117	-0.09	0.1	-0.2	0.05	-0.14
RVR N	118	0.06	0.1	0.0	0.17	-0.11
SBC E	77	-0.03	-0.1	0.1	-0.21	0.18
SBC N	90	-0.11	-0.1	0.0	-0.22	0.11
TIN E	56	-0.30	-0.2	-0.1	-0.30	0.00
TIN N	58	-0.35	-0.2	-0.2	-0.29	-0.06
		means		-0.05		-0.02

Helicorder Responses

Instr.	No.	Corr.	Old	Diff.
BAR Z	125	-1.33	-1.4	0.0
CIS Z	123	-1.14	-1.4	0.3
CLC Z	95	-1.77	-1.3	-0.5
CPE Z	137	-0.89	-1.1	0.2
CWC Z	9	-1.06	-1.2	0.1
GLA Z	105	-1.40	-1.7	0.2
GSC Z	96	-1.47	-1.5	-0.2
HAY Z	88	-0.92	-0.8	-0.2
IKP Z	126	-1.00	-1.0	0.0
ISA Z	133	-1.04	-1.4	0.3
MWC Z	149	-0.90	-1.2	0.3
PAS Z	147	-0.61	-0.8	0.2
PLM Z	85	-1.47	-1.3	-0.2
RVR Z	136	-0.92	-1.0	0.1
SBB Z	110	-1.34	-1.6	0.2
SCI Z	107	-0.28	-0.9	0.7
SYP Z	108	-1.16	-1.2	0.0
TIN Z	43	-1.28	-1.3	0.0
TPC Z	83	-1.26	-1.1	-0.2
		mean		0.08

APPENDIX F.

STATION CORRECTIONS FOR USE WITH SYNTHETIC WOOD-ANDERSON RECORDS FROM LOW-GAIN SHORT-PERIOD INSTRUMENTS

The following station corrections are shown with and without using underground nuclear explosions in the calibration. The last column is Mori's station correction.

	w/ No.	nukes Corr.	w/out No.	nukes Corr.	Mori
BLU Z	2	0.25	2	0.25	0.28
BRA Z	10	0.37	10	0.37	0.39
CLI E	14	-0.22	12	-0.18	-0.60
CLI N	16	-0.31	14	-0.29	-0.60
CLM E	12	-0.20	11	-0.23	0.00
CLM N	11	-0.23	11	-0.23	0.00
CLM Z	9	-0.06	9	-0.06	0.00
COY Z	21	0.27	21	0.27	0.23
CPM Z	24	0.11	19	0.12	0.06
CTW Z	19	0.07	17	0.08	-0.03
EDW Z	13	0.24	13	0.24	0.20
EWC E	28	0.22	19	0.18	0.10
EWC N	23	0.08	18	0.07	0.10
EWC Z	21	0.28	21	0.28	0.20
GAV Z	25	0.30	22	0.32	0.21
GSA E	34	-0.36	28	-0.35	-0.25
GSA N	34	-0.35	29	-0.34	-0.25
GSA Z	26	0.02			0.04
GVR E	28	-0.37	25	-0.37	-0.40
GVR N	27	-0.41	25	-0.41	-0.40
LJB E	26	0.14	22	0.12	0.08
LJB N	22	0.11	19	0.08	0.08
LJB Z	23	0.25	22	0.24	0.28
PEM Z	27	0.10	21	0.08	0.01
PMC Z	7	-0.22	6	-0.16	-0.20
POB Z	23	0.07	22	0.06	0.17
RAY Z	21	0.25	20	0.27	0.18
SBP Z	15	0.82	15	0.82	0.80
SCI E	5	0.19	5	0.19	0.00
SCI N	5	0.22	5	0.22	0.00
SCI Z	7	-0.46	7	-0.46	
SIL Z	26	0.26	23	0.26	0.13
TAB Z	16	0.06	14	0.07	0.00
UPL E	17	-0.54	14	-0.60	-0.30
UPL N	13	-0.31	13	-0.31	0.00
UPL Z	11	0.24	11	0.24	0.20