The 1999 Southern California Seismic Network Bulletin

Lisa A. Wald and Stan Schwarz

U.S. Geological Survey

INTRODUCTION

The Pasadena office of the U.S. Geological Survey (USGS), together with the Caltech Seismological Laboratory, operates a network of more than 350 remote seismometers in southern California called the Southern California Seismic Network (SCSN). SCSN is part of TriNet, a cooperative project between the USGS, Caltech, and the California Division of Mines and Geology (CDMG). The TriNet project is halfway completed and is upgrading the existing network to digital, adding new stations, and developing real-time and earthquake-alert capabilities. Signals from the SCSN sites are telemetered to a central processing location at the Caltech Seismological Lab in Pasadena. Computers that detect and record thousands of earthquakes each year continuously monitor these signals. Phase arrival times for these events are picked by analysts and are archived along with digital seismograms. Data acquisition, processing, and archiving are achieved using the Caltech/USGS Seismic Processing (CUSP) system (Dollar, 1989). These data have been compiled into the SCSN Catalog of Earthquakes, a list beginning in 1932 that currently contains more than 356,300 events. Waveform, phase, and catalog data are archived by the Southern California Earthquake Center Data Center (SCEC_DC). This data set is critical to the evaluation of earthquake hazards in California and to the advancement of geoscience as a whole.

This and previous SCSN Bulletins are intended to serve several purposes, the most important of which is to make Network data more accessible to current and potential users. The Bulletins also document important details of Network operation so that researchers can use the data with a full understanding of the process by which they are collected.

NEW STATIONS

The list of fifteen new stations added through 31 December 1999 is in Table 1. A list of all currently operating TriNet stations (all three TriNet agencies) may be found at http://www.trinet.org/trinetmap/trinetmap.html, and a list of currently operating SCSN/TriNet stations only is at http://www.trinet.org/statist.html. Figure 1 shows the locations of all the current SCSN analog and digital stations. The "ST2" type instruments are Streckheisen STS-2 broadband seismometers with an FBA-23; the "SQU" types are Guralp CMG-40T instruments with the FBA-23; and the "EPI" types are Guralp CMG-40T instruments with Episensor strong-motion instruments.

DISCONTINUED STATIONS

Five stations were discontinued in 1999. The removal dates are shown in Table 2. Some were removed because they were replaced with digital instruments at nearby sites.

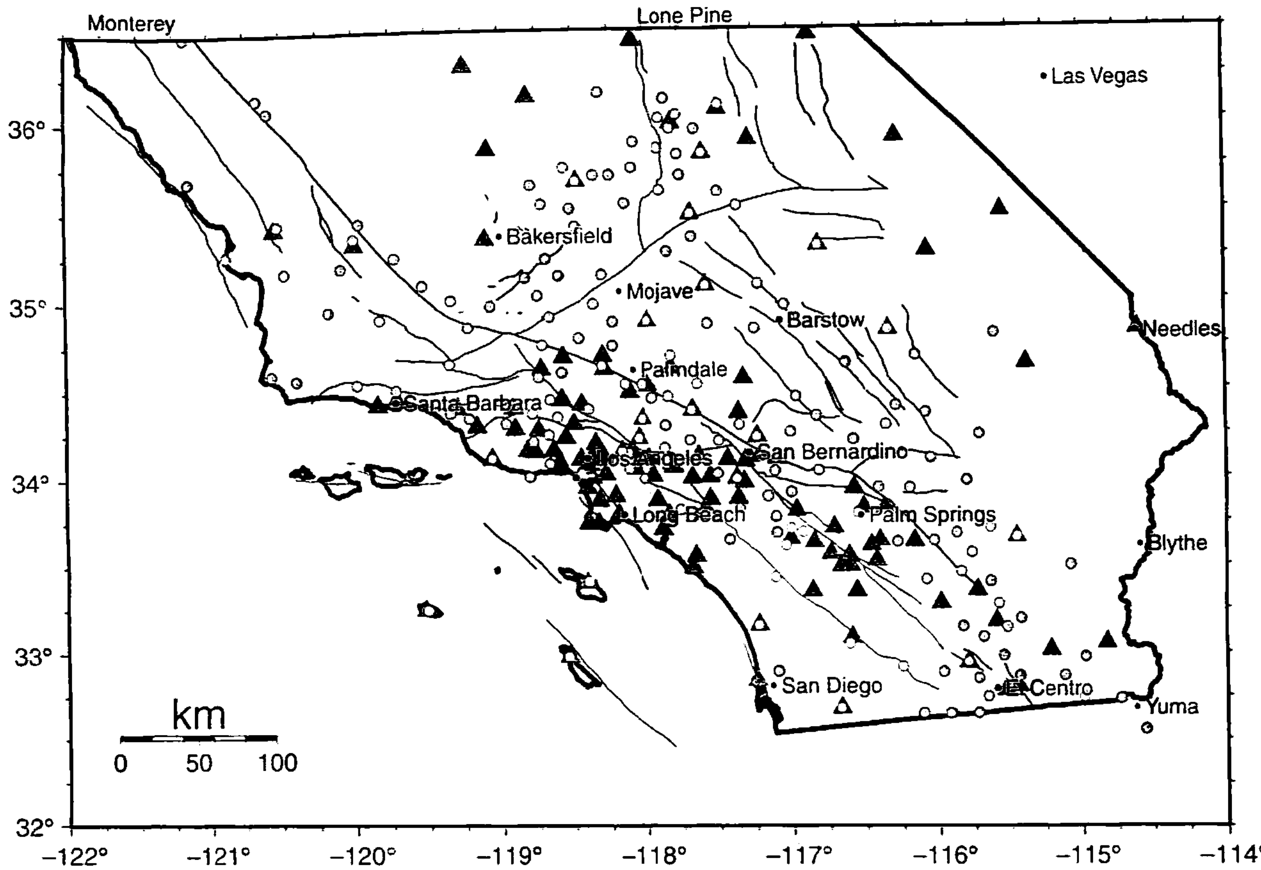
PROCESSING STATUS OF NETWORK DATA

The processing status for each month of the catalog since the advent of digital recording is described in Table 3. Events for months marked P (preliminary) have been located but have not yet run the gauntlet of quality-checking, adjustment and checking of magnitudes, and rearchiving necessary to become final (F with shading). For months marked PNK (pinked), large events (~M 3.0) have only been crudely timed on a few stations, while smaller events are absent. The event information was recorded on pink index cards, thus they are called "pinked" until the data have been completely located and checked for quality. The 1977 and 1979 events occurred before the current seismic processing system was in place, and these data are still in the process of being hand-entered into the computer. The early 1980's gaps exist because of the abundant Mammoth events during that time. A period in 1980–1981 has actually been timed and digital seismograms are available, but the "pinked" version is still used for research requiring the best magnitudes or completeness estimates for large events. Several months in 1992–1994 (from the Joshua Tree/Landers sequence) and 1996 (from the Northridge sequence) (marked P) are nearly finalized and are in need only of magnitude calibrations. The Hector Mine earthquake produced a new backlog of events that are still being processed.

1999 SEISMICITY HIGHLIGHTS

A total of 12,373 earthquakes and 993 blasts were catalogued for 1999 (Figure 2). Of the catalogued events, 393 were greater than or equal to M_L = 3.0 (Appendix A). The largest earthquake within the SCSN network in 1999 was the M 7.1 Hector Mine earthquake on 16 October. Focal mechanisms for twenty-one selected events ($M_L \geq 4.0$) are shown in Figure 3.

TriNet/SCSN Stations - December 1999



▲ **Figure 1.** Southern California Seismographic Network, January 1999. Triangles represent digital stations; circles are analog stations.

TABLE 1
New Stations Added to SCSN in 1999

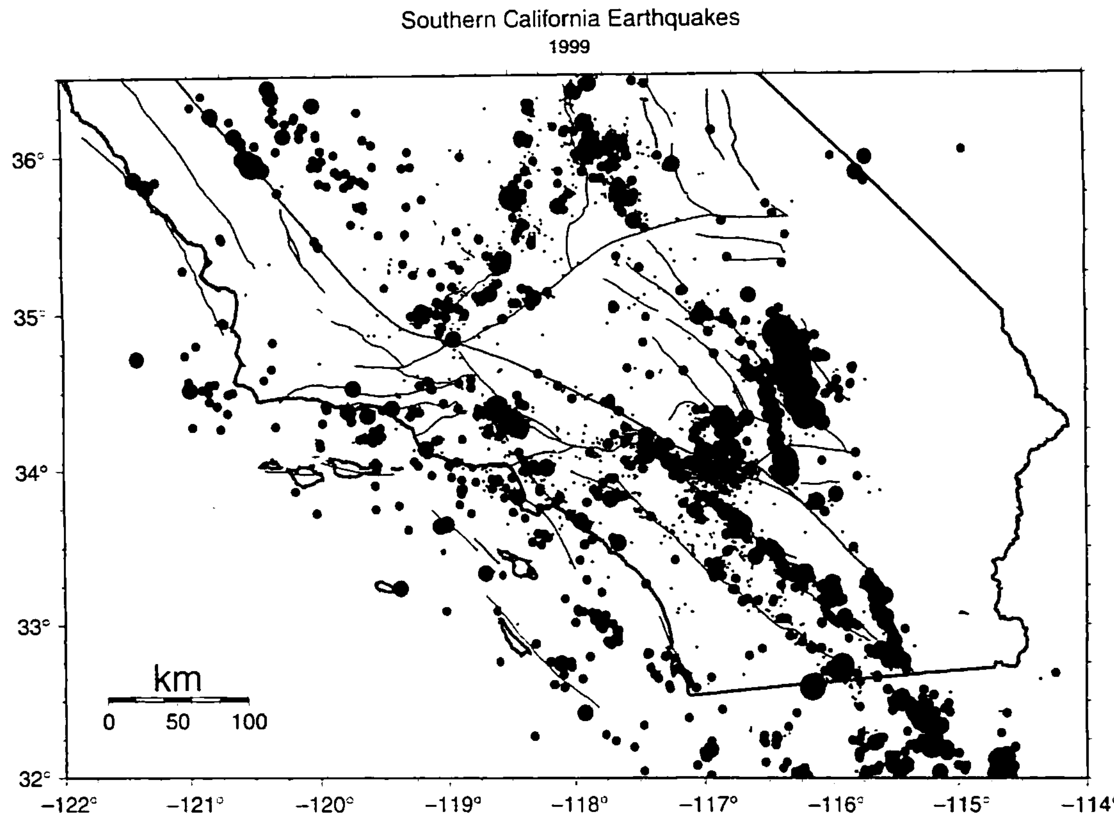
Code	Site Name	Lat (N)	Lon (E)	Elev (m)	Instr	Install Date
CHF	Chilao Flat Ranger Station	34.33°	−118.03°	1547	ST2	1999/01/29
THX	Thermal Airport	33.63°	−116.16°	−44	SQU	1999/01/30
SLA	Slate Mountain	35.89°	−117.28°	1160	EPI	1999/03/09
OAT	Oat Mountain	34.34°	−118.61°	1089	STA	1999/03/11
SCZ	Santa Cruz Island	34.00°	−119.64°	383	EPI	1999/03/12
BTC	Brunts Corner	33.01°	−115.22°	7	SQU	1999/04/02
MTL	Mount Lukens	34.27°	−118.24°	441	ST2	1999/04/20
SDD	Saddleback	33.55°	−117.61°	61	EPI	1999/05/03
STS	State Street	33.79°	−118.20°	−27	SQU	1999/05/20
PLC	Palm Springs City Hall	33.82°	−116.51°	96	SQU	1999/05/25
SAL	Salton City	33.28°	−115.99°	−22	SQU	1999/05/25
RSS	Riverside Surface	33.97°	−117.33°	306	SQU	1999/05/27
LGU	Laguna Peak	34.11°	−119.07°	351	SQU	1999/06/10
BAK	Cal State Bakersfield	35.34°	−119.10°	83	SQU	1999/06/29
GOR	Green Oak Ranch	34.16°	−117.23°	46	SQU	1999/06/29

TABLE 2 Discontinued Stations in the SCSN in 1999			
Code	**Site Name**	**Date Terminated**	**Comments**
LCL	Los Cerritos Museum	1999/02/12	
FMA	Fort MacArthur	1999/02/12	
EW2	East Wide Canyon	1999/02/18	Vertical components remain
SSC	Santa Cruz Island	1999/03/10	Damaged; replaced by digital
MTL	Mount Lukens	1999/05/26	Too noisy

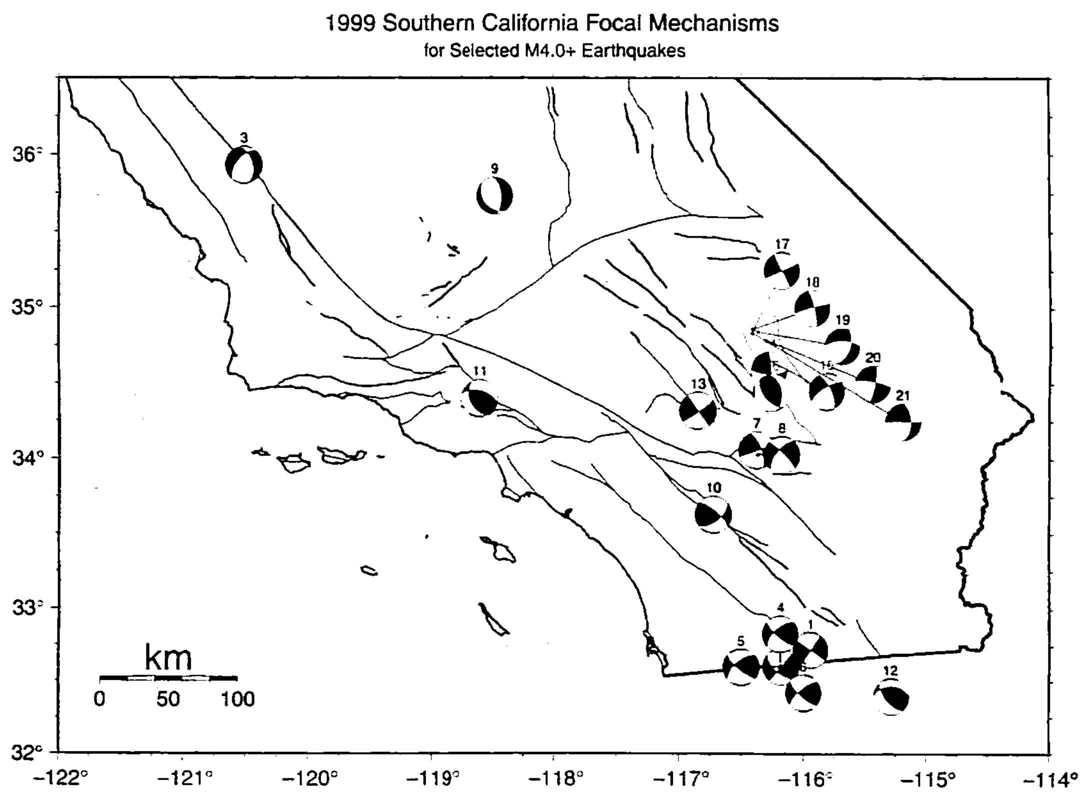
TABLE 3
Processing Status of Network Data

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1932-1974	PREDIGITAL RECORDING—COMPLETE FOR $M \geq 3.0$											
1975	F	F	F	F	F	F	F	F	F	F	F	F
1976	F	F	F	F	F	F	F	F	F	F	F	F
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	PNK	PNK	PNK	PNK	PNK	PNK	PNK	PNK	PNK	PNK	PNK	PNK
1981	PNK	PNK	P	P	P	P	F	F	F	F	F	F
1982	F	F	F	F	F	F	F	F	F	F	F	F
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	F	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	F	F	F	F	F	F	F	F	F	F	F	F
1992	F	F	F	P	P	P	P	P	P	P	P	P
1993	F	F	F	F	F	F	F	F	F	F	F	F
1994	P	P	P	F	F	F	F	F	F	F	F	F
1995	F	F	F	F	F	F	F	F	F	F	F	F
1996	F	F	F	F	F	F	F	F	F	F	F	F
1997	F	F	F	F	F	F	F	F	F	F	F	F
1998	F	F	F	F	F	F	F	F	F	F	F	F
1999	F	F	F	F	F	F	F	F	F	F	P	P
2000	F	P										

F: Final; P: Preliminary; PNK: Pinked

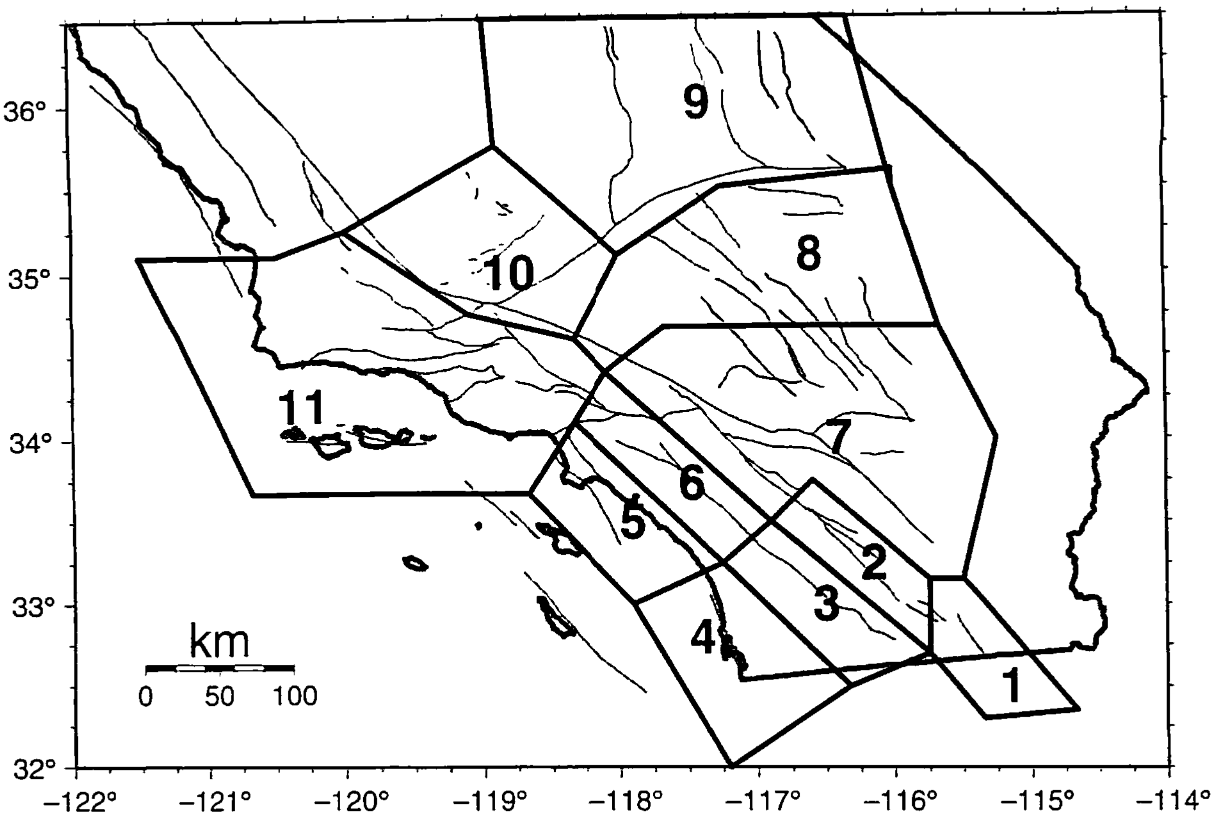


▲ **Figure 2.** All located earthquakes in southern California for the period of January–December 1999.



▲ **Figure 3.** Lower hemisphere focal mechanisms for selected M 4.0+ events for the period January–December 1999. Event numbers correspond to numbers in FM column of Appendix A.

Seismicity Summary Regions



▲ **Figure 4.** Boundaries of subregions used in summary of seismicity. 1 = Imperial Valley, 2 = South San Jacinto, 3 = South Elsinore, 4 = San Diego, 5 = Los Angeles, 6 = North Elsinore, 7 = San Bernardino/South Mojave, 8 = North Mojave, 9 = South Sierra Nevada, 10 = Kern County, 11 = San Fernando/Santa Barbara.

For the following discussion, southern California has been divided into eleven subregions (Figure 4). These regions are arbitrary but useful for discussing characteristics of seismicity in a manageable context. Figure 5 summarizes the activity of each subregion over the past ten years. A separate discussion section follows for those regions with notable activity. Earthquakes of M 3.5 or greater, or those of any size that were felt, are discussed. The discussions include all earthquakes recorded by SCSN that occurred between latitudes 32.0°N and 36.5°N and longitudes 114°W and 122°W. We also mention some interesting and/or large events near but outside this region; these are typically events in the Owens Valley (north of Coso) or to the south in Mexico. Figure 6 shows all earthquakes of magnitude 3 and greater.

Imperial Valley—Region 1

This area and the adjacent area just south of the California/Mexico border had a lot of seismic activity in 1999. The Cerro Prieto geothermal area had an M 3.5 in February and an M 4.9 on 1 June. It became very active later in August with a prolific swarm. The largest events in the swarm are summarized in Table 4.

Elsewhere in the region, closer to the southern end of the Salton Sea, there were seven significant events or swarms during the year, as summarized in Table 5.

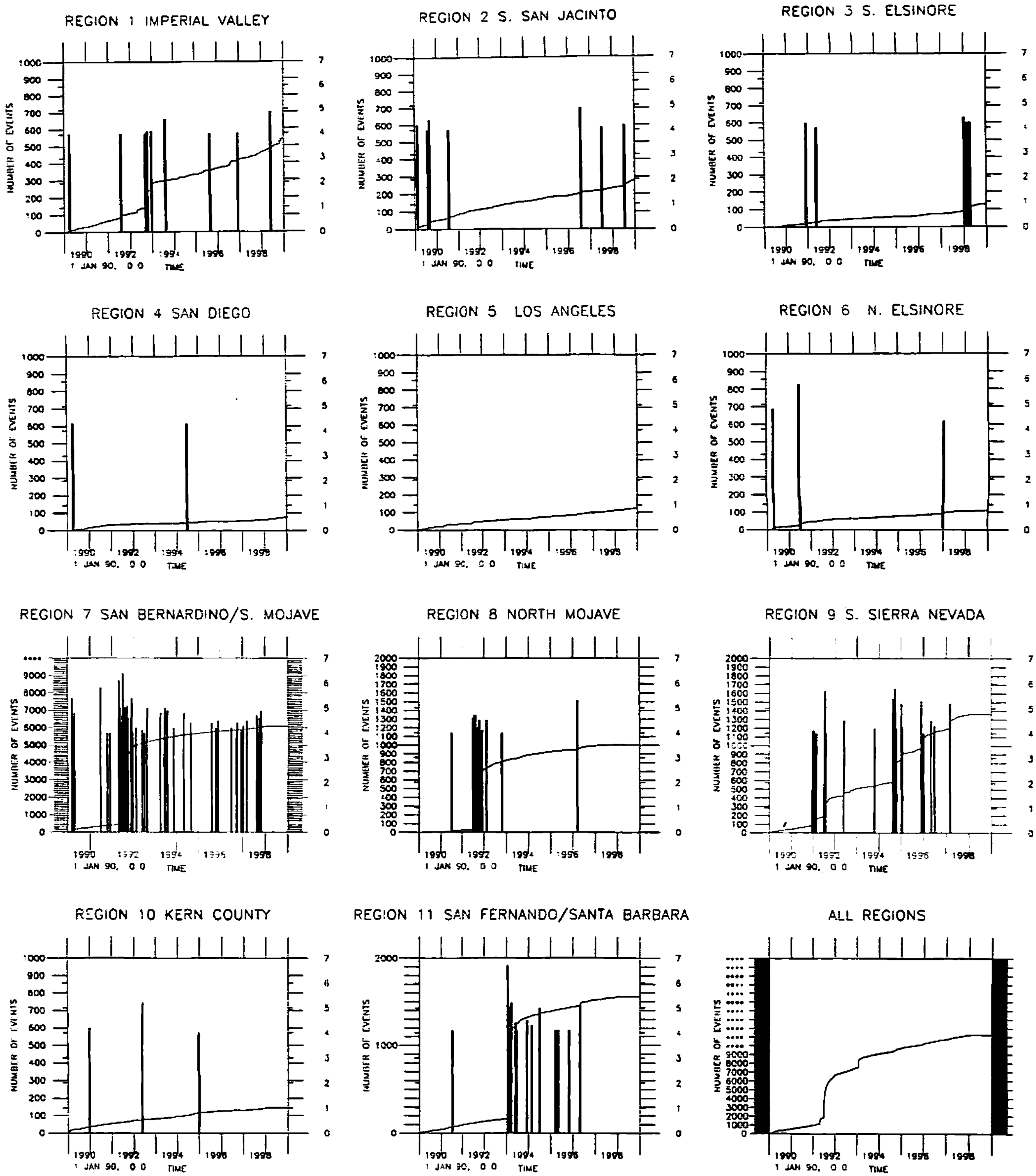
Swarms are common in these areas since they are in the Brawley Seismic Zone, which connects the north end of the Imperial Fault with the south end of the San Andreas Fault at Bombay Beach.

South San Jacinto —Region 2

Most of the activity in this region was from a swarm near Ocotillo early in the year. This is a common area for swarms. Outside the Ocotillo area, there was an M 4.2 (Figure 3, #10) that rattled the area near Anza on 19 July and was felt in Temecula and Palm Springs. Salton City experienced an M 3.5 on 10 August and a small six-hour swarm on 3 October that produced quite a few felt events as summarized in Table 6.

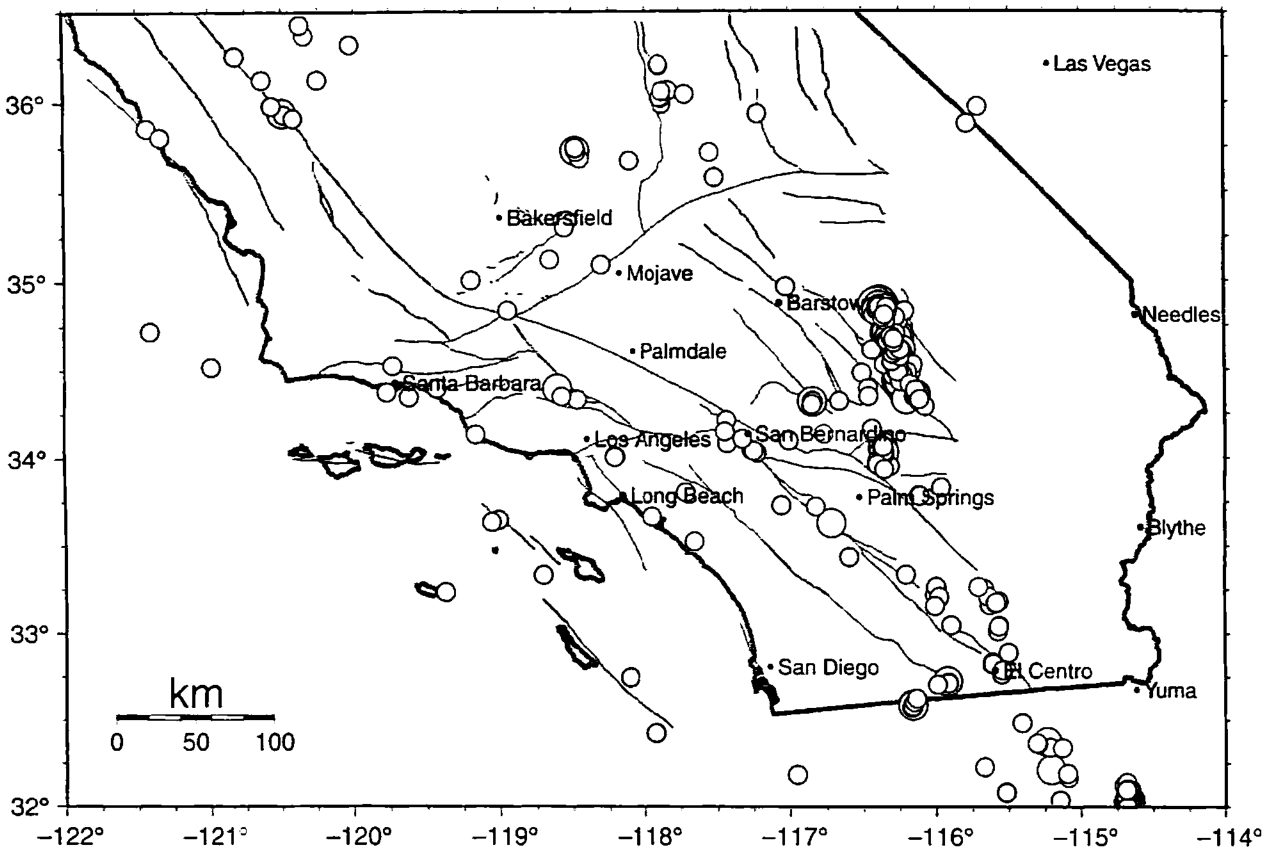
South Elsinore—Region 3

An M 3.4 occurred on 27 March near Perris and was felt in Hemet and Corona.



▲ ***Figure 5.*** Cumulative number of events ($M_L \geq 2.5$) in all subregions over the ten-year period ending December 1999. The boundaries of the subregions 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.

Southern California Earthquakes M3.0+
1999



▲ **Figure 6.** 1999 magnitude 3.0+ earthquakes. Includes earthquakes discussed in the "Earthquake Highlights" section and labeled towns for reference.

TABLE 4
Cerro Prieto Swarm Events

Magnitude	Date	Magnitude	Date
3.5	8/8	3.7	8/27
3.7	8/12	3.5	8/29
3.6, 3.5	8/21	4.8	9/10
4.7	8/24	3.6	10/3
3.5	8/25	4.0	10/18

TABLE 5
Brawley Seismic Zone Events

Location	Magnitude	Date
near Brawley	2.5,3.1	7/13
near El Centro	3.7, 3.9	7/23
near Obsidian Butte	swarm, 3.3, 3.1	4/14
"	3.5	11/18
"	3.5	11/24

TABLE 6
Salton City Swarm Events

Magnitude	Date	Magnitude	Date
3.8, 4.4 (Figure 3, #1)	1/13	4.0 (Figure 3, #5)	4/6
4.2, 3.5 (Figure 3, #2)	2/18	3.6, 4.2 (Figure 3, #6)	4/18
4.3 (Figure 3, #4)	3/13	3.7	9/3

San Diego—Region 4

There were no significant events to report in this region.

Los Angeles—Region 5

Numerous small events were felt in the Los Angeles area, and a few other events occurred along the nearby coast. On 22 January an M 2.4 was felt under Baldwin Hills. An M 3.4 followed by a few small aftershocks occurred in Frazier Park on 19 February. A few days later on the 25th Baldwin Hills had a small M 2.1. In Loma Linda an M 3.8 was felt on 22 March. An M 3.4 near Fountain Valley on 13 April was felt throughout Orange County. Baldwin Hills had another M 2.1 that was felt on 18 April. Then on 30 May an M 3.5 followed fifteen minutes later by an M 3.1, both in East Los Angeles, were felt throughout the Los Angeles Basin. 16 June brought a succession of events near the Los Angeles Civic Center, all within six hours, that were widely felt: *M* 3.2, *M* 3.0, *M* 2.2, *M* 2.1, and another *M* 2.1. East Los Angeles got hit again with an *M* 3.8 on 29 June.

An *M* 2.4 was felt near Manhattan Beach on 8 September, and the Hollywood Hills experienced an *M* 3.3 and an *M* 3.1 on 30 November. An *M* 3.9 and a few small aftershocks near Yorba Linda were widely felt in Los Angeles and Orange Counties on 7 December. San Clemente Island had an *M* 3.7 with a small aftershock on 3 May, and an *M* 3.6 hit San Juan Capistrano on 9 August.

North Elsinore—Region 6
There were no significant events to report in this region.

San Bernardino/South Mojave—Region 7
This region produced most of the earthquakes in southern California in 1999, including the M_w 7.1 Hector Mine earthquake in the Mojave Desert on 16 October. That earthquake is discussed in a separate section in this report.

There were continuing aftershocks of the Joshua Tree/Landers/Big Bear sequence; the most notable ones are listed in Table 7.

A lone *M* 3.9 occurred on the Garlock Fault on 1 July near Mojave and was felt in Tehachapi. In the San Bernardino and surrounding area there were several felt earthquakes. On 21 April an *M* 3.9 near Mt. San Gorgonio was felt in Riverside and San Bernardino. 27 July brought an *M* 3.1 near Devore Creek that was felt in the area. It was then relatively quiet until December, when there was an *M* 3.9 on the 13th near Yucaipa and an *M* 3.3 on the 30th near San Bernardino on the San Jacinto Fault.

A little further west in Fontana there were also several felt events throughout the year. There was an *M* 3.6 on 30 January, an *M* 2.6 on 1 February, an *M* 3.1 in the same place on 23 October, and another *M* 3.1 on 1 December.

North Mojave—Region 8
There were aftershocks in the southern part of this region from the 16 October Hector Mine earthquake. See the separate section in this report for a discussion of that earthquake sequence.

South Sierra Nevada—Region 9
An *M* 4.4 (Figure 3, #9) hit on 11 July near the town of Lake Isabella. It was followed by an *M* 3.7, an *M* 3.4, and thirteen *M* 2.0+ aftershocks. This was the beginning of a swarm that continued into August with another felt *M* 3.2 on 15 August.

A Coso swarm produced activity in the second half of January, and then another swarm took place near Coso Junction that started on 12 September and lasted through about the 22nd. An *M* 3.6 on 15 September was the largest event in the swarm.

TABLE 7
Joshua Tree/Landers/Big Bear Aftershocks

Location	Magnitude	Date
Big Bear City	3.4	1/24
"	4.2 (Figure 3, #13)	9/20
"	2.5	9/27
Desert Hot Springs	3.5	3/4
"	3.1	4/24
"	3.2	9/11
Yucca Valley	3.1	4/2
"	3.1	6/14
Joshua Tree	3.7	5/1
"	3.6	5/4
"	4.9, 3.5, 3.9, 3.8, 4.2 (Figure 3, #7, #8)	5/14
"	3.7	6/3

There was also an *M* 4.0 on 26 October near Olancha which was both preceded and followed by several smaller events in September and October.

Kern County—Region 10
An *M* 3.5 shook the area near Wheeler Ridge on 1 January, and an *M* 3.6 occurred near Tehachapi on 12 June.

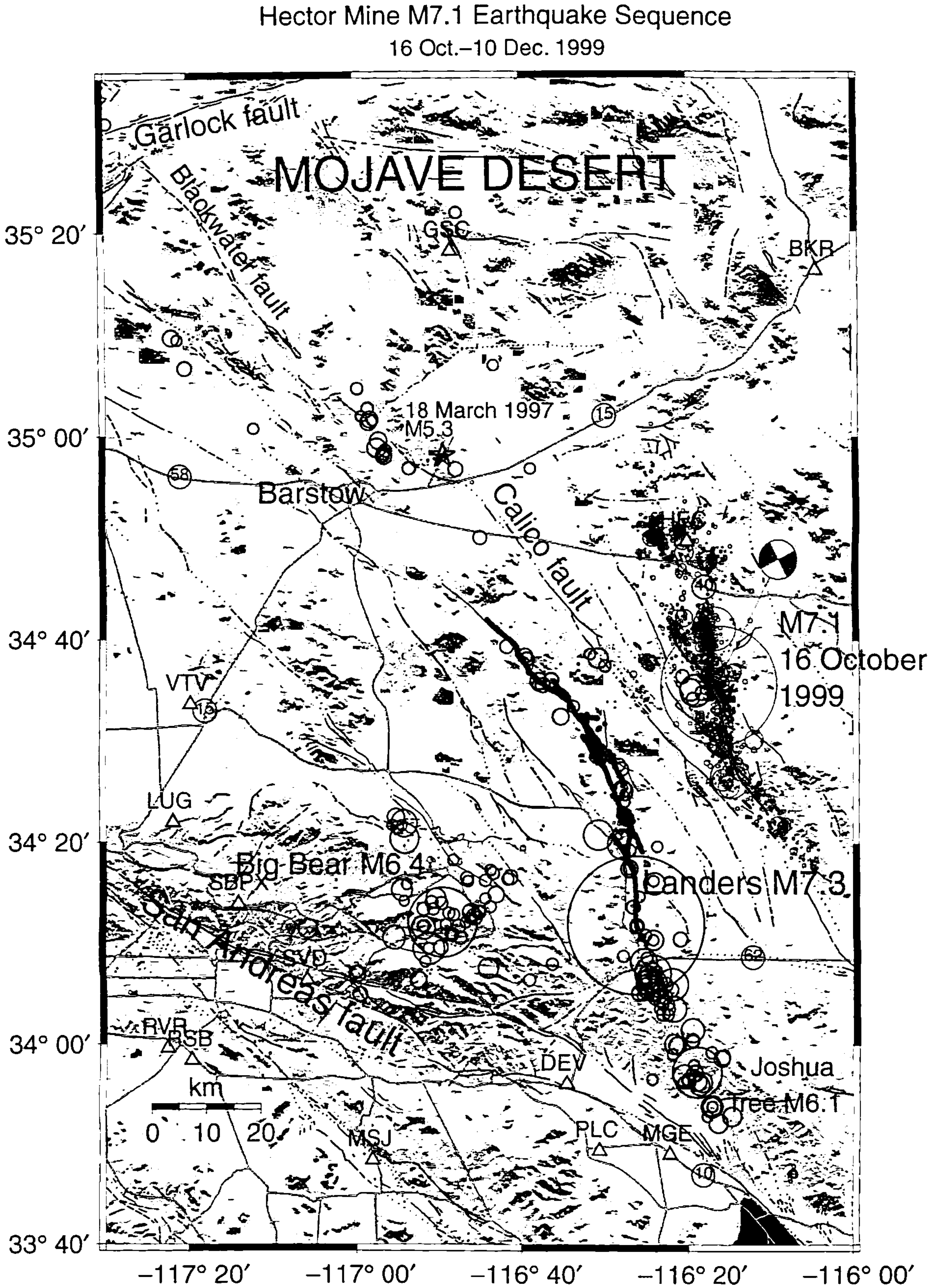
San Fernando/Santa Barbara—Region 11
The Port Hueneme area felt several small earthquakes early in the year, including an *M* 2.5 on 12 January, an *M* 2.7 on 18 January, and an *M* 3.2 on 20 January. A small series of events out in the Santa Barbara Channel were felt in late January through early February. An *M* 3.7 occurred near San Nicholas Island on 16 July.

Moving inland, an *M* 3.2 shook downtown Santa Barbara on 14 August, and an *M* 3.4 was felt in Carpenteria on 6 October. Further east, notable Northridge aftershocks included an *M* 3.0 on 8 March and an *M* 3.6 on 11 April. An *M* 4.0 (Figure 3, #11) aftershock hit on 22 July, and a smaller *M* 2.9 on 25 September.

16 OCTOBER 1999 HECTOR MINE EARTHQUAKE

The M_w 7.1 Hector Mine, California earthquake occurred at 9:46 GMT on 10/16/1999 (Figure 7). The event caused minimal damage because it was located in a remote, sparsely populated part of the Mojave Desert, approximately 4[illegible] miles east-southeast of Barstow, with epicentral coordinates 34.59°N 116.27°W and a hypocentral depth of 5 ± 3 km. Twelve foreshocks, *M* 1.9–3.8, preceded the main shock during the previous twelve hours. All of these events were located close to the hypocenter of the main shock.

The Hector Mine earthquake occurred within the eastern California shear zone (ECSZ). By virtue of its remo



▲ **Figure 7.** 16 October 1999 Hector Mine earthquake sequence. Shown are the main shock and aftershocks (circles), the focal mechanism of the main shock, the Hector Mine surface rupture, and the 1992 Landers surface rupture. Triangles are TriNet stations. (Courtesy of Egill Hauksson.)

location, the societal impact of the Hector Mine earthquake was, fortunately, minimal in spite of the event's appreciable size. The ECSZ is characterized by high seismicity, a high tectonic strain rate, and a broad, distributed zone of north-northwest-trending faults (Dokka and Travis, 1990; Sauber *et al.*, 1986; Sauber *et al.*, 1994; Sieh *et al.*, 1993). Data regarding the slip rates of faults within the ECSZ suggest that on the order of 15% of the Pacific-North American plate motion occurs along this zone (Sauber *et al.*, 1986; Wesnousky, 1986). Most of the faults in the ECSZ have low slip rates and long repeat times for major earthquakes, on the order of several thousands to tens of thousands of years. The occurrence of the Hector Mine earthquake within seven years and only about 30 km east of the 1992 M_w 7.3 Landers earthquake suggests that the closely spaced surface faults in the ECSZ are mechanically related.

The Hector Mine event involved rupture on two previously mapped fault zones—the Bullion Fault and an unnamed, more northerly-trending fault that is informally referred to in this paper as the Lavic Lake Fault (Dibblee, 1966, 1967a,b). Traces of the Bullion Fault exhibit evidence of Holocene displacement and were zoned as active in 1988 under California's Alquist-Priolo Earthquake Fault Zoning Act (Hart and Bryant, 1997). The pattern of rupture along more than one named fault was also observed from the 1992 Landers earthquake (Hauksson *et al.*, 1993; Sieh *et al.*, 1993).

Much of the fault zone that produced the Hector Mine earthquake had been buried by relatively young stream deposits, and the fault scarps in bedrock have a subdued morphology. It appears that these faults have not experienced significant offset for perhaps 10,000 years or more (Hart, 1987). Planned future investigations will refine the age of the last event on these faults. The portion of the Lavic Lake Fault that ruptured between the northern end of the Bullion Mountains and Lavic Lake had not previously been mapped. However, our field investigations have identified ancient, subdued fault scarps along portions of the 1999 rupture zone in this area. It thus appears that the entire segment of the Lavic Lake Fault that was involved in the 1999 event had ruptured in the past. As is typical for most faults within the eastern California shear zone, the rate of movement along the Lavic Lake Fault may be quite slow (< 1 mm/yr) and should produce earthquakes only infrequently. This event is a reminder that in areas with low-slip-rate faults, it is erroneous to consider such faults as inactive solely because they have not produced an earthquake during Holocene time.

Additionally, the Hector Mine earthquake is noteworthy for a couple of other reasons. First, it clearly produced triggered seismicity over much of southern California, from the rupture zone toward the south-southwest in particular. Second, the event may provide new data and insight into recently developed paradigms concerning earthquake interactions and the role of static stress changes.

Questions such as these will, of course, be the subject of extensive detailed analyses in years to come. Fortunately, the Hector Mine sequence will provide one of the best data sets obtained to date for a significant earthquake in the United States. Because it occurred when major upgrades to both the regional seismic network (TriNet) and the regional geodetic network (SCIGN) were well underway, the Earth science community will have abundant high-quality data with which to explore the important and interesting questions that have been raised.

Note: This summary was prepared by Susan Hough of the USGS Pasadena office with compiled information from the scientists at the USGS, SCEC, and CDMG.

NETWORK PROJECT NOTES

Staff Changes

There have been a number of staff changes during the last year. Jim Mori left the office in late January to take a professorship at Kyoto University in Japan. With his departure, Lucy Jones took over as Scientist-in-Charge of the Pasadena office. In late 1999 two additional staff members were added to our team. Alan Yong is on a student contract and will be helping with Network issues. Jocelyn Davies will be doing administrative and other support duties.

Ned Field, from the University of Southern California, was hired as a geophysicist to fill the position left empty by Jim Mori's departure. He began working in the office in February.

Outreach and Education Program

A more formal Outreach and Education program was initiated in 1999 with Lisa Wald as the program manager. The program will encompass Web site development and management, as well as other activities relating to public outreach, with an emphasis on K–12 education.

The focus in 2000 will be on redesigning the Pasadena office Web site and participating as a member of the Earthquake Hazards Program Web Team with the creation of an Earthquake Hazards Program Web site. Also, a workshop will be conducted to instruct teachers how to teach their students about earthquakes using hands-on activities.

WEB NOTES

Pasadena Office Web Site

As mentioned previously, the Pasadena office Web site will be redesigned this year. The goal is to integrate the overall look of the Web site with the new Earthquake Hazard Program Web site that is under development. The Menlo Park and Pasadena Webmasters will be working together to coordinate both their sites with the new Hazards Program Web site.

An additional URL was registered to the Pasadena office Web site to eliminate the confusion caused by the dash in the old URL. The old URL will continue to function, but the new one is preferred. It is http://pasadena.wr.usgs.gov.

The Squid Server, or Web Servers, Earthquakes, and the Slashdot Effect

Introduction

The Internet is quickly becoming the medium of choice for dissemination of earthquake information to the public. As a result, the USGS Pasadena office Web server is subject to tremendous surges in traffic volume any time an earthquake is felt in southern California. This phenomenon is akin to the "Slashdot effect", which is named for the popular "News for Nerds" Web site at slashdot.org. Their readership numbers in the hundreds of thousands, and any site mentioned on Slashdot experiences a sudden, huge surge of traffic that lasts for several days. The Slashdot effect has brought down many servers. This is very similar to our experience following the 16 October 1999 Hector Mine earthquake. The server was completely overwhelmed within fifteen minutes of the event and was rendered unresponsive by the flood of traffic. This experience prompted our efforts to find ways to increase our Web server capacity.

Figure 8 gives a more detailed look at the period immediately following the Hector Mine earthquake. Note that the hit rate begins increasing immediately and increased by almost three orders of magnitude within ten minutes. The peak hit rate of 67/sec was reached at about fifteen minutes after the event. During the peak traffic periods, the server was essentially unresponsive. The average data rate during peak periods was about 4 Mb/sec. A rough estimate based on the relationship between the hit rate and the data rate indicates that the peak data rate was probably around 7 Mb/s. The server was at that time on a 10 Mb/sec link to the 100 Mb Caltech network, so its Ethernet was essentially saturated. In addition, the server's CPU was 100% busy. Since the server was saturated, it is likely that the actual number of requests received was higher than that recorded in the logs. The logs record only requests that were serviced, so we really do not know how many requests were lost that morning.

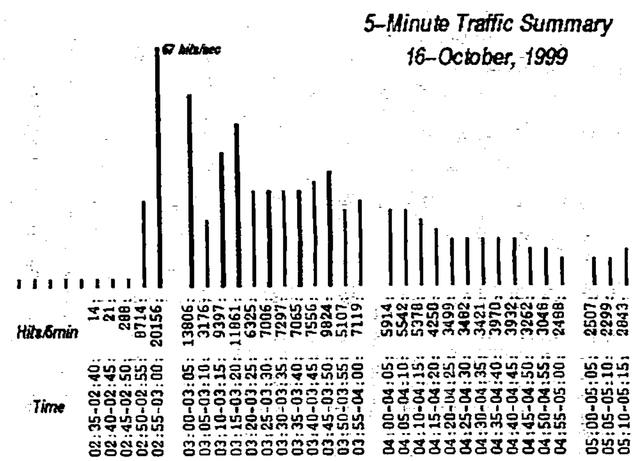
Increasing Web Server Capacity

In the aftermath of the Hector Mine event, we began looking for ways to increase our Web server capacity. After some research, three options presented themselves:

1. Off-site hosting with a commercial Web hosting service
2. Setting up multiple mirrored servers with an address-translation front-end
3. A reverse-proxy server to distribute hits to multiple servers

Option One:

The first option came from a suggestion that an off-site provider might be willing to host some of our pages on their servers. They have a global network of servers that is capable of handing very large traffic loads. The downside of this is due to the nature of the information we are serving. The most popular pages requested after an earthquake are the



▲ **Figure 8.** Web traffic summary on the ehzsouth server after the 16 October M_w 7.1 Hector Mine earthquake. The peak hit rate was reached at about fifteen minutes after the earthquake. This was before the front-end Squid server was added.

Community Internet Intensity Map, the ShakeMap, and the Map of Recent Earthquakes.

These are all necessarily dynamic pages. The Community Internet Intensity Map is updated at five-minute intervals after an event. The other two maps are updated after every significant earthquake. During a major sequence, this can translate into updates every two to five minutes. This would make it very difficult to propagate updated versions of the maps to an off-site provider in real time. Because of this difficulty, this option was shelved.

Option Two:

The second option was to set up several servers on the local LAN, each with a full copy of the Web pages, and a Coyote Point Equalizer as a front end to distribute requests to the servers. In this scenario, it would still be necessary to propagate updated files to the various servers, but this would not be as big a problem as in the first option, as the servers would all be on the local USGS LAN. The major downside of this option is the $4,000 cost of the base-model Equalizer product, plus the cost of setting up additional Web servers.

Option Three:

The third option was suggested by an article from *Web Techniques* titled "Load Balancing Your Web Site: Practical Approaches for Distributing HTTP Traffic" (Engelschall, 1998). In this article, the author discusses several approaches to distributing load to a Web site, finishing with a discussion of using Apache as a reverse-proxy server. The idea is to use a stripped-down Apache server to intercept incoming http requests and then to dole them out to a farm of back-end servers which actually serve up the data. By not having to do any disk I/O, the front-end server can be made to run very fast. This was the option that we finally decided to try, since it seemed to be the easiest and most cost-effective to implement.

The Design Goal

At the time, a design goal was set of increasing our Web server capacity by an order of magnitude. This was chosen because the current server was able to half-fill its 10 Mb/sec Ethernet connection after Hector Mine. The Caltech network runs at 100 Mb from our building to the Gigabit campus backbone. If our improved server could fill the 100 Mb link, it would be doing about as much as it could without requiring major revisions in the USGS connection to the Caltech network.

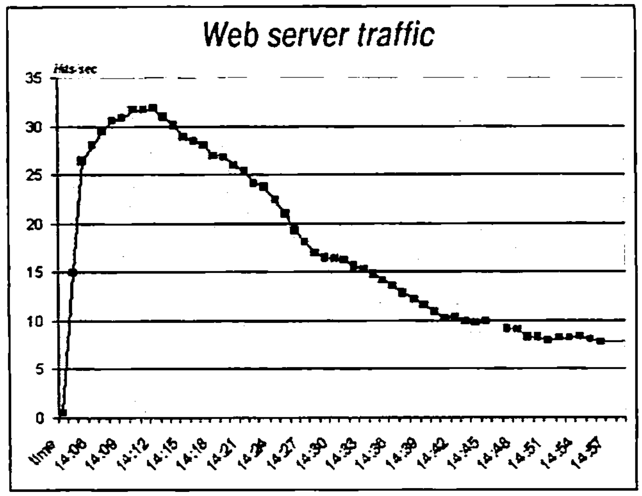
A Fourth Option Presents Itself

While searching the Internet for practical information and experiences in setting up an Apache reverse-proxy server, we encountered scores of people who advised that, while this option works well, a caching reverse-proxy known as Squid was a superior choice. Squid is primarily intended to be a proxy server for ISP's and other networks to use as a way of speeding up access to popular Web sites for users on their local networks. It works by intercepting outbound http requests and then caching the files that come back from the remote servers. It can then serve repeated requests for the same pages locally, thus providing faster service. Reading the Squid documentation revealed that it has what is called an http-accelerator mode. This is essentially a reverse-proxy mode with caching. In this, a Squid is set up to receive all incoming requests for Web service. It forwards the requests to one or more back-end servers, and it caches the data returned so that it can use it to service future requests. It caches data both in memory and on disk, and it can serve requests much faster than a conventional http server.

From Pie-in-the-sky to Proof-of-concept

As a test, we set up a Squid server. It is an AMD K6-2/400 PC with 384 Mb of RAM and a 9 Gb fast-wide SCSI disk. It is running *FreeBSD* 3.3 and *Squid* 2.2-Stable4. This was set up to be a front end for the USGS Pasadena Web server. Testing was done using a set of seven Sun workstations running the Apache *Benchmark* program. Each workstation was instructed to request a set of six files between 100 and 10,000 times. In this manner, we were able to subject the Squid server to 350,000–400,000 hits per hour for six hours in order to simulate a sustained load about twice as large as the Hector Mine peak and ten times the average load experienced on 16 October. The server performed well. A maximum hit rate of 367/sec was achieved in this round of testing. The data rate reported by the cache manager was about 64 Mb/sec, which is beyond the 40 Mb/sec we had hoped for. This was possible due to setting the FastEthernet interface to run full duplex, which raises the practical saturation limit to around 80–90 Mb/sec. The Squid server was observed to be CPU-bound at this level of traffic, indicating that we had reached the limit of its ability to handle packets. Still, the server was responsive at all times during this test.

The Squid server went live on 23 November. On 30 November, there were two earthquakes, magnitude 3.2 and



▲ **Figure 9.** Web traffic summary on the Squid server after the 7 December M3.9 Los Angeles earthquake. This is after the front-end Squid server was added. The hit rate is a factor of 10 higher than the main server (see Figure 10).

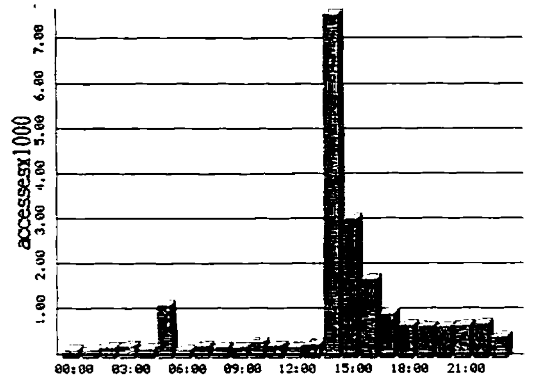
3.1, about fifteen minutes apart, centered under West L.A. The first event was at 10:27 PST, and the Web server experienced a traffic spike within ten minutes. During the day, the server normally experiences a hit rate of about 0.4/sec. During this traffic spike, it jumped to 19.8/sec. The Squid server handled this traffic easily. At the same time, other servers in the Seismo Lab were slowed to a crawl. The spike in traffic was brief, but even at peak activity our server was responsive at all times.

On 7 December, there was an M3.9 earthquake centered about 50 km (30 miles) southeast of Los Angeles, near densely populated areas of Orange County and Riverside. This event occurred at 13:58 PST, and the hit rate on the server was increasing within two minutes. Figure 9 shows the hit rate reported by the internal cache manager in the Squid server. Note that the hit rate went from 0.5/sec to 15/sec within two minutes of the earthquake and peaked at just under 32/sec at about fifteen minutes. The peak rate was about half that recorded after Hector Mine. During this time, the Squid server was responsive.

The daily graph for activity on the back-end Web server (Figure 10) shows that the peak activity is between 14:00 and 15:00, when the server processed 7,682 hits. A look at the comparable report for the Squid server shows that during this same time it handled 58,449 hits, which is almost a factor of 10 difference. This correlates well with the Squid server's internal statistics, which indicate that it has about a 90% hit rate for cached items. This indicates that the load on the main server has been reduced considerably.

Conclusion

It would appear from the combination of testing and the real experience of the 30 November and 7 December events that the configuration of the Squid server as a front end for our regular office server has performed well. With a bit of luck,



▲ **Figure 10.** Web traffic summary on the ehzsouth server after the 7 December *M* 3.9 Los Angeles earthquake (accesses × 1,000). This is after the front-end Squid server was added. The Squid server considerably reduced the load on the main server.

we will be much better able to handle the traffic generated by the next big earthquake in Los Angeles.

FOR FURTHER INFORMATION

To order back publications of the Southern California Seismic Network Bulletins for 1985–1996, contact the USGS at Books and Open-File Reports Section, Branch of Distribution, U.S. Geological Survey, Box 25425, Federal Center, Denver, Colorado, 80225 or call (303) 236-7476. Network Bulletins are published only in *Seismological Research Letters* starting with the 1997 Bulletin. Network Bulletins for 1990 through the present can also be seen at http://pasadena.wr.usgs.gov/lisa/NETBULLS. Archived SCSN data and information about getting an account on the SCEC Data Center can be obtained at http://www.scecdc.scec.org.

ACKNOWLEDGMENTS

The Summary of Seismicity section was written using information in the TriNet Earthquake Commentary (online at http://www.trinet.org/eqreports/eqreports.html). Thanks to Nancy King and Doug Given for internal reviews.

REFERENCES

Dibblee, T. W., Jr. (1966). *Geologic Map of the Lavic Quadrangle, San Bernardino County, California*, U.S. Geological Survey Miscellaneous Geologic Investigations Map I-472, map scale 1:62,500.

Dibblee, T. W., Jr. (1967a). *Geologic Map of the Deadman Lake Quadrangle, San Bernardino County, California*, U.S. Geological Survey Miscellaneous Geologic Investigations Map I-488, map scale 1:62,500.

Dibblee, T. W., Jr. (1967b). *Geologic Map of the Emerson Lake Quadrangle, San Bernardino County, California*, U.S. Geological Survey Miscellaneous Geologic Investigations Map I-490, map scale 1:62,500.

Dokka, R. K. and C. J. Travis (1990). Late Cenozoic strike-slip faulting in the Mojave Desert, California, *Tectonics* 9, 311–340.

Dollar, R. S. (1989). *Realtime CUSP: Automated Earthquake Detection System for Large Networks*, U.S. Geological Survey Open-File Report 89-320, 3 pp.

Engelschall, R. S. (1998). Load balancing your Web site: Practical approaches for distributing HTTP traffic, *Web Techniques* 5.

Hart, E. W. (1987). *Pisgah, Bullion, and Related Faults, San Bernardino County, California*, California Division of Mines and Geology Fault Evaluation Report FER-188, 19 pp. (unpublished).

Hart, E. W. and Bryant, W. A. (1997). *Fault-rupture Hazard Zones in California*, Department of Conservation, Division of Mines and Geology Special Publication 42, 38 pp.

Hauksson, E., L. M. Jones, K. Hutton, and D. Eberhart-Phillips (1993). The 1992 Landers earthquake sequence: Seismological observations, *J. Geophys. Res.* 98, 19,835–19,858.

Sauber, J.,W. Thatcher, and S. C. Solomon (1986). Geodetic measurement of deformation in the central Mojave desert, California, *J. Geophys. Res.* 91, 2,683–2,693.

Sauber, J.,W. Thatcher, S. C. Solomon, and M. Lisowski (1994). Geodetic slip rate for the eastern California shear zone and the recurrence time of Mojave Desert earthquakes, *Nature* 367, 264–266.

Sieh, K., L. Jones, E. Hauksson, K. Hudnut, D. Eberhart-Phillips, T. Heaton, S. Hough, K. Hutton, H. Kanamori, A. Lilje, S. Lindvall, S. F. McGill, J. Mori, C. Rubin, J. A. Spotila, J. Stock, H. K. Thio, J. Treiman, B. Wernicke, and J. Zachariasen (1993). Nearfield investigations of the Landers earthquake sequence, April to July 1992, *Science* 260, 171–176.

Wesnousky, S. (1986). Earthquakes, Quaternary faults, and seismic hazard in California, *J. Geophys. Res.* 91, 2,587–2,631.

Earthquake Hazards Team
U.S. Geological Survey
525 South Wilson Avenue
Pasadena, CA 91106

APPENDIX A

Significant Southern California Earthquakes

All events of $M_L \geq 3.0$ for the period January to December 1999. Times are GMT, Q is the overall quality of the location. M is the magnitude, Z is the depth in km, PH is the number of phases picked. RMS is the root mean square of the arrival times (in seconds). ID is the unique number assigned to the event by the CUSP system, and FM denotes the number of the accompanying focal mechanism in Figure 3. These events have not been finalized; therefore their magnitudes may not be of highest accuracy. In most cases, if the magnitude is incorrect, it is larger than indicated.

Date	Time	Location	Q	M	Z	PH	RMS	ID	FM
1999/1/1	12:21:58.46	35°0.63′ –119°11.75′	A	3.5	9.46	68	0.35	9074844	
1999/1/1	19:31:29.59	32°49.49′ –115°37.17′	A	3.2	14.91	49	0.34	9074854	
1999/1/1	19:32:03.27	32°50.19′ –115°37.00′	A	3.2	10.05	23	0.20	9074863	
1999/1/1	19:51:24.77	32°49.60′ –115°36.82′	A	3.3	14.57	50	0.31	9074860	
1999/1/3	05:37:42.60	36°4.02′ –117°50.19′	A	3.1	2.53	53	0.13	9074985	
1999/1/9	19:40:19.55	32°10.14′ –115°5.36′	D	3.0	6.00	9	0.28	9075530	
1999/1/13	07:10:42.68	33°26.27′ –116°36.01′	A	3.0	1.19	17	0.21	9075766	
1999/1/13	10:02:05.43	32°43.11′ –115°55.26′	A	3.8	9.35	59	0.34	9075784	
1999/1/13	13:20:56.02	32°43.61′ –115°55.57′	A	4.4	2.58	61	0.39	9075803	1
1999/1/13	13:23:57.43	32°42.79′ –115°55.19′	B	3.1	5.50	28	0.31	9075807	
1999/1/14	06:44:13.43	33°39.00′ –119°0.86′	C	3.4	6.00	90	0.31	9075894	
1999/1/19	22:25:31.73	36°3.98′ –117°49.92′	A	3.3	3.06	65	0.17	9076345	
1999/1/20	00:53:56.24	36°3.65′ –117°49.86′	A	3.6	3.01	53	0.15	9076380	
1999/1/20	18:10:12.47	34°8.27′ –119°10.21′	A	3.2	2.38	31	0.34	9076478	
1999/1/21	20:04:35.76	32°25.41′ –117°55.55′	D	3.1	6.00	11	0.62	9076561	
1999/1/21	22:49:07.59	36°3.77′ –117°49.74′	A	3.1	3.51	41	0.11	9076580	
1999/1/22	23:50:49.64	35°20.50′ –118°34.02′	B	3.1	6.56	73	0.21	9076634	
1999/1/24	23:58:51.71	34°19.00′ –116°50.61′	A	3.4	5.03	113	0.25	9076749	
1999/1/30	23:24:04.47	34°5.16′ –117°26.04′	A	3.6	3.19	133	0.23	9077185	
1999/1/31	07:55:53.10	35°20.55′ –118°32.38′	A	3.0	0.01	67	0.21	9077222	
1999/2/2	03:53:03.66	36°2.69′ –117°42.90′	A	3.2	0.96	50	0.15	9077342	
1999/2/2	14:36:51.33	32°2.28′ –115°8.82′	D	3.1	6.00	15	0.39	9077357	
1999/2/4	13:02:10.84	35°20.54′ –118°32.38′	A	3.1	0.01	71	0.20	9077576	
1999/2/19	03:08:32.16	32°35.51′ –116°9.92′	A	4.2	3.38	70	0.37	9078694	2
1999/2/19	03:22:38.34	32°36.20′ –116°9.21′	A	3.5	6.00	42	0.34	9078698	
1999/2/19	16:27:51.00	33°12.02′ –115°59.21′	C	3.5	6.00	72	0.29	9078766	
1999/2/19	16:58:55.14	34°50.30′ –118°56.80′	A	3.4	13.30	74	0.27	9078772	
1999/2/24	21:0:18.36	33°43.50′ –116°49.69′	A	3.1	16.98	22	0.11	9079155	
1999/2/26	15:25:57.37	35°56.53′ –120°29.95′	A	4.1	12.76	37	0.35	9079311	3
1999/2/26	19:32:19.58	32°11.11′ –116°57.29′	C	3.3	6.00	27	0.33	9079323	
1999/2/27	22:31:54.97	32°11.43′ –115°5.76′	D	3.5	6.00	16	0.41	9079420	
1999/3/4	19:34:17.12	35°34.92′ –117°30.78′	A	3.0	9.81	42	0.16	9079768	
1999/3/5	00:18:49.99	35°56.07′ –120°29.10′	B	3.4	12.12	35	0.37	9079808	
1999/3/5	06:13:02.94	33°58.09′ –116°21.13′	A	3.5	7.87	85	0.17	9079844	
1999/3/8	12:09:20.76	34°20.10′ –118°28.42′	A	3.0	9.61	101	0.30	9080086	
1999/3/11	15:11:23.70	34°19.71′ –116°50.75′	A	3.1	5.10	99	0.21	9080321	
1999/3/13	13:31:20.40	32°35.27′ –116°10.01′	A	4.2	6.81	81	0.36	9080531	4
1999/3/14	16:49:37.72	32°20.59′ –115°13.32′	C	3.0	6.00	18	0.43	9080643	
1999/3/15	16:24:47.43	33°38.28′ –119°3.60′	C	3.1	6.00	60	0.31	9080722	

Date	Time	Location	Q	M	Z	PH	RMS	ID	FM
1999/3/18	23:37:45.65	36°7.64′ –120°38.17′	D	3.5	6.00	15	0.29	9081094	
1999/3/19	09:48:00.14	32°42.38′ –115°59.67′	B	3.5	3.19	8	0.18	9081116	
1999/3/21	13:53:33.07	35°41.31′ –118°27.03′	A	3.1	3.96	53	0.17	9081335	
1999/3/22	08:31:29.33	34°1.98′ –117°13.54′	A	3.8	16.72	139	0.28	9081410	
1999/3/28	00:12:06.49	33°44.02′ –117°3.64′	A	3.4	11.62	108	0.34	9081930	
1999/4/1	00:49:37.28	32°34.55′ –116°9.85′	C	3.1	5.69	25	0.21	9082219	
1999/4/1	00:54:23.52	32°35.37′ –116°9.94′	A	3.1	5.39	32	0.27	9082239	
1999/4/3	04:06:15.18	34°8.64′ –116°25.99′	A	3.1	3.03	78	0.20	9082400	
1999/4/7	06:26:40.12	32°35.59′ –116°9.78′	A	4.0	8.49	63	0.31	9082683	5
1999/4/11	09:09:19.57	34°21.09′ –118°34.81′	A	3.6	2.26	125	0.30	9083105	
1999/4/11	17:21:10.76	34°19.16′ –116°50.48′	A	3.1	7.25	83	0.18	9083137	
1999/4/13	18:22:54.30	33°40.14′ –117°57.27′	A	3.4	10.93	100	0.29	9083372	
1999/4/13	23:39:58.09	33°58.99′ –116°24.14′	A	3.4	3.09	92	0.22	9083436	
1999/4/15	03:51:53.25	33°9.93′ –115°38.45′	A	3.3	0.77	47	0.31	9083580	
1999/4/15	03:59:02.77	33°9.91′ –115°38.34′	A	3.1	1.56	38	0.31	9083589	
1999/4/15	23:03:33.40	34°50.14′ –116°12.87′	A	3.0	7.73	29	0.15	9083710	
1999/4/16	09:58:51.21	36°22.33′ –120°20.65′	C	3.1	6.00	11	0.29	9083761	
1999/4/16	15:53:51.58	34°29.05′ –116°30.67′	A	3.2	3.31	83	0.20	9083778	
1999/4/17	20:41:37.40	36°15.48′ –120°49.29′	B	3.2	3.06	19	0.34	9083931	
1999/4/18	14:33:14.18	32°35.28′ –116°9.89′	A	3.5	8.75	71	0.38	9084016	
1999/4/18	15:53:01.05	32°35.22′ –116°9.78′	A	4.2	7.79	98	0.32	9084040	6
1999/4/21	13:36:37.16	32°4.93′ –115°30.98′	C	3.4	6.00	30	0.46	9084245	
1999/4/21	17:28:18.01	34°8.27′ –116°46.13′	A	3.9	10.88	124	0.20	9084273	
1999/4/24	17:42:17.82	33°59.11′ –116°24.29′	A	3.1	3.76	78	0.22	9084570	
1999/4/30	10:09:50.37	33°0.87′ –115°34.94′	A	3.0	9.17	43	0.25	9085105	
1999/5/2	01:07:59.36	33°57.33′ –116°19.12′	A	3.7	7.61	91	0.27	9085336	
1999/5/3	16:18:58.76	32°44.74′ –118°6.67′	C	3.7	6.00	33	0.44	9085494	
1999/5/5	02:17:46.91	34°4.17′ –116°22.30′	A	3.6	1.75	83	0.23	9085734	
1999/5/14	07:54:03.19	34°3.74′ –116°21.98′	A	4.9	1.85	134	0.25	9086596	7
1999/5/14	07:56:07.88	34°3.38′ –116°22.26′	A	3.4	0.21	21	0.24	3317352	
1999/5/14	07:58:19.56	34°1.82′ –116°22.30′	A	3.1	0.00	27	0.20	3317369	
1999/5/14	07:59:42.65	34°3.79′ –116°22.43′	A	3.5	0.01	65	0.20	3317354	
1999/5/14	08:01:48.82	34°4.09′ –116°22.25′	A	3.1	0.01	39	0.15	3317399	
1999/5/14	08:09:11.30	34°1.33′ –116°21.31′	A	3.1	0.01	44	0.21	3317357	
1999/5/14	08:10:44.24	34°2.12′ –116°22.03′	A	3.0	0.75	46	0.18	3317358	
1999/5/14	08:18:34.05	34°4.60′ –116°22.31′	A	3.5	1.98	64	0.21	9086688	
1999/5/14	08:22:07.15	34°1.75′ –116°21.35′	A	3.9	1.36	82	0.32	9086693	
1999/5/14	08:40:33.23	34°2.33′ –116°21.69′	A	3.4	1.80	62	0.20	7129392	
1999/5/14	08:51:42.31	34°2.04′ –116°21.85′	A	3.8	0.03	62	0.26	7129394	
1999/5/14	09:19:13.80	34°1.78′ –116°21.34′	A	3.1	0.01	38	0.14	7129529	
1999/5/14	09:31:57.03	34°2.18′ –116°21.60′	A	3.4	0.00	57	0.27	7129510	
1999/5/14	09:58:40.38	34°3.84′ –116°22.07′	A	3.1	0.02	67	0.17	7129519	
1999/5/14	10:29:33.13	34°4.05′ –116°21.81′	A	3.2	1.10	72	0.25	9086741	
1999/5/14	10:52:35.21	34°2.03′ –116°21.57′	A	4.2	1.74	80	0.22	3317364	8
1999/5/14	10:54:03.46	34°2.13′ –116°21.63′	B	3.0	0.12	29	0.26	3317349	
1999/5/14	19:38:35.80	34°20.98′ –119°37.46′	A	3.2	13.08	46	0.39	9086891	

Date	Time	Location	Q	M	Z	PH	RMS	ID	FM
1999/5/24	04:59:03.86	34°43.28′ −121 25.02′	D	3.2	6.00	12	0.43	9088895	
1999/5/26	12:37:09.49	33°11.25′ −115°34.63′	A	3.0	0.87	42	0.33	9089223	
1999/5/30	12:15:45.81	34°0.58′ −118°12.51′	A	3.5	6.75	84	0.28	9089885	
1999/5/30	12:20:38.31	34°0.84′ −118°12.87′	A	3.1	4.48	110	0.31	9089890	
1999/6/1	12:40:03.78	35°58.42′ −115°42.82′	D	3.3	6.00	23	0.47	9090196	
1999/6/1	15:18:02.63	32°22.46′ −115°14.53′	C	4.9	6.00	40	0.47	9090222	
1999/6/1	17:58:53.76	35°52.87′ −115°47.35′	C	3.3	6.00	31	0.32	9090326	
1999/6/3	16:33:07.01	34°4.00′ −116°21.93′	A	3.7	1.79	92	0.21	9090571	
1999/6/12	15:48:35.46	33°57.94′ −116°24.42′	A	3.1	8.53	95	0.19	9091618	
1999/6/13	05:15:30.52	35°18.29′ −118°33.45′	C	3.6	5.68	77	0.20	9091706	
1999/6/13	14:57:57.23	36°19.23′ −120°1.55′	D	3.2	6.00	12	0.19	9091757	
1999/6/15	05:15:37.39	34°10.00′ −116°26.47′	A	3.1	9.57	79	0.19	9091960	
1999/6/17	00:21:18.29	34°58.33′ −117°1.43′	A	3.1	7.43	69	0.18	9092308	
1999/6/17	01:11:08.26	34°0.67′ −118°12.79′	A	3.2	6.14	81	0.29	9092333	
1999/6/22	00:02:16.75	33°15.83′ −116°0.25′	A	3.1	3.31	65	0.19	9092902	
1999/6/25	04:33:08.69	33°13.49′ −116°0.77′	A	3.1	5.62	67	0.25	9093372	
1999/6/28	07:48:08.00	33°20.10′ −118°42.42′	C	3.3	6.00	6	0.01	9093727	
1999/6/29	01:37:28.21	32°34.44′ −116°10.31′	A	3.2	2.24	55	0.31	9093882	
1999/6/29	06:06:02.82	32°34.85′ −116°10.03′	A	3.1	3.26	42	0.26	9093932	
1999/6/29	12:55:00.82	34°0.47′ −118°12.97′	A	3.8	8.04	126	0.35	9093975	
1999/7/1	12:43:07.89	35°5.76′ −118°18.35′	A	3.9	6.90	96	0.22	9094270	
1999/7/11	18:20:46.81	35°43.84′ −118°28.75′	A	4.4	4.71	56	0.13	9095528	9
1999/7/11	18:22:11.89	35°43.97′ −118°28.69′	A	3.7	3.50	64	0.19	3318651	
1999/7/11	18:29:55.92	35°44.16′ −118°28.69′	A	3.4	4.34	68	0.16	3318658	
1999/7/11	22:16:41.52	32°36.36′ −116°9.22′	A	3.4	6.84	66	0.33	9095583	
1999/7/14	07:57:58.24	32°53.58′ −115°30.50′	A	3.1	11.95	36	0.28	9095945	
1999/7/14	16:46:54.78	35°59.34′ −117°52.64′	A	3.2	3.53	34	0.09	9095980	
1999/7/15	04:02:56.29	35°43.49′ −118°28.40′	A	3.1	4.71	44	0.16	9096044	
1999/7/16	19:15:11.10	33°14.37′ −119°22.61′	A	3.7	21.11	52	0.19	9096329	
1999/7/16	22:51:27.76	34°31.20′ −120°59.52′	C	3.4	6.00	24	0.36	9096361	
1999/7/17	06:39:07.90	35°54.85′ −120°25.31′	C	3.2	12.39	20	0.41	9096392	
1999/7/19	01:50:55.51	36°25.90′ −120°22.17′	C	3.3	6.00	18	0.44	9096559	
1999/7/19	22:09:27.49	33°37.94′ −116°43.11′	A	4.2	14.00	147	0.22	9096656	10
1999/7/22	09:57:24.04	34°23.81′ −118°36.55′	A	4.0	11.62	168	0.32	9096972	11
1999/7/24	01:13:22.79	32°46.67′ −115°32.83′	A	3.7	15.55	58	0.31	9097165	
1999/7/24	02:01:26.02	32°46.08′ −115°33.34′	A	3.9	15.42	49	0.33	9097184	
1999/7/24	02:02:36.17	32°47.35′ −115°32.98′	A	3.0	11.50	20	0.19	9097185	
1999/7/28	05:38:08.01	34°13.06′ −117°26.21′	A	3.1	14.00	98	0.23	9097822	
1999/8/6	02:34:00.38	32°1.87′ −114 42.60′	D	3.3	6.00	16	0.43	9099444	
1999/8/6	02:39:12.94	32°7.35′ −114 42.32′	D	3.2	6.00	14	0.26	9099439	
1999/8/6	13:43:49.58	32°2.60′ −114 40.42′	D	3.2	6.00	11	0.33	9099491	
1999/8/6	17:48:40.53	32°4.33′ −114 39.71′	D	3.3	6.00	18	0.44	9099512	
1999/8/8	22:34:02.84	32°4.24′ −114 39.51′	D	3.5	6.00	10	0.40	9099831	
1999/8/9	12:56:33.09	33°15.81′ −116°0.06′	A	3.3	4.08	76	0.23	9099900	
1999/8/10	06:33:00.03	33°31.60′ −117°39.59′	A	3.6	11.31	111	0.27	9099968	
1999/8/10	18:44:21.52	33°16.14′ −116°0.24′	A	3.5	3.07	96	0.29	9100018	

Date	Time	Location	Q	M	Z	PH	RMS	ID	FM
1999/8/11	18:11:26.16	32°3.79′ −114 40.21′	D	3.1	6.00	9	0.27	9100125	
1999/8/12	20:16:03.21	32°4.26′ −114 38.76′	D	3.4	6.00	9	0.31	9100248	
1999/8/12	20:21:18.52	32°3.84′ −114 39.89′	D	3.7	6.00	11	0.28	9100260	
1999/8/12	23:47:06.06	32°2.91′ −114 37.68′	D	3.0	6.00	8	0.26	9100285	
1999/8/13	03:16:39.38	32°3.21′ −114 38.78′	D	3.0	6.00	13	0.22	9100347	
1999/8/13	17:10:17.57	35°43.33′ −117°32.77′	B	3.0	5.98	66	0.16	9100668	
1999/8/13	17:37:11.87	32°3.26′ −114 38.25′	D	3.0	6.00	7	0.22	9100658	
1999/8/15	04:47:32.52	34°31.57′ −119°44.06′	A	3.2	1.08	50	0.35	9100879	
1999/8/15	23:25:28.03	35°44.54′ −118°28.88′	A	3.2	4.86	46	0.14	9101021	
1999/8/17	03:47:02.62	32°1.87′ −114 38.46′	D	3.3	6.00	12	0.20	9101196	
1999/8/17	10:16:51.26	32°3.74′ −114 39.58′	D	3.1	6.00	13	0.25	9101241	
1999/8/17	19:29:52.99	32°2.54′ −114 37.89′	D	3.1	6.00	8	0.29	9101306	
1999/8/17	19:55:27.61	32°4.38′ −114 40.75′	D	3.0	6.00	7	0.25	9101342	
1999/8/18	00:41:35.02	32°1.89′ −114 37.43′	D	3.2	6.00	10	0.33	9101372	
1999/8/18	07:50:05.64	34°23.75′ −116°28.12′	A	3.1	4.02	84	0.15	9101425	
1999/8/21	11:25:15.54	32°2.87′ −114 41.51′	D	3.6	6.00	13	0.34	9102013	
1999/8/21	22:22:08.87	32°3.23′ −114 41.51′	D	3.3	6.00	11	0.35	9102078	
1999/8/22	00:38:41.35	32°2.92′ −114 42.07′	D	3.5	6.00	17	0.47	9102096	
1999/8/22	05:16:43.25	32°1.24′ −114 40.70′	C	3.0	6.00	18	0.45	9102119	
1999/8/22	18:50:16.48	32°3.25′ −114 41.31′	C	3.0	6.00	14	0.29	9102193	
1999/8/23	03:24:53.91	32°2.03′ −114 40.18′	D	3.1	6.00	9	0.39	9102228	
1999/8/24	13:17:00.17	32°0.44′ −114 39.20′	D	3.1	6.00	7	0.28	9102415	
1999/8/24	16:14:27.81	32°0.08′ −114 42.43′	D	3.7	6.00	16	0.41	9102459	
1999/8/25	00:25:32.30	32°1.77′ −114 39.86′	D	3.4	6.00	10	0.28	9102543	
1999/8/25	07:04:15.82	32°3.54′ −114 41.87′	D	3.2	6.00	13	0.32	9102583	
1999/8/25	18:41:02.48	32°1.23′ −114 42.51′	D	3.5	6.00	15	0.36	9102671	
1999/8/25	20:27:13.25	32°6.04′ −114 39.33′	D	3.1	6.00	7	0.22	9102713	
1999/8/26	08:12:36.84	32°4.40′ −114 41.21′	C	3.0	6.00	15	0.33	9102767	
1999/8/26	18:12:12.47	32°1.85′ −114 38.76′	D	3.0	6.00	8	0.17	9102815	
1999/8/26	18:17:55.80	32°1.96′ −114 39.54′	D	3.2	6.00	9	0.18	9102839	
1999/8/27	23:31:14.23	32°2.12′ −114 42.29′	D	3.7	6.00	14	0.36	9103026	
1999/8/28	00:14:24.21	32°2.87′ −114 41.47′	C	3.0	6.00	9	0.28	9103020	
1999/8/29	19:07:13.15	32°2.47′ −114 39.96′	C	3.1	6.00	14	0.39	9103263	
1999/8/29	19:11:24.87	32°4.09′ −114 40.39′	D	3.3	6.00	11	0.26	9103268	
1999/8/29	19:17:11.59	32°3.95′ −114 40.38′	D	3.5	6.00	10	0.26	9103275	
1999/8/29	19:42:38.20	32°8.49′ −114 41.06′	D	3.0	6.00	7	0.35	9103256	
1999/8/30	22:16:44.54	32°1.99′ −114 41.29′	D	3.4	6.00	7	0.28	9103387	
1999/8/30	22:28:06.59	32°6.18′ −114 40.79′	D	3.3	6.00	7	0.24	9103389	
1999/8/30	22:43:26.37	32°3.92′ −114 41.58′	D	3.1	6.00	10	0.40	9103390	
1999/8/31	00:20:50.44	32°6.00′ −114 40.23′	D	3.2	6.00	6	0.14	9103397	
1999/9/3	06:35:15.96	35°44.83′ −118°28.84′	A	3.0	3.95	62	0.17	9103780	
1999/9/3	21:10:42.79	32°37.52′ −116°8.17′	A	3.7	12.27	63	0.29	9103860	
1999/9/6	01:28:37.41	32°0.04′ −114 40.84′	D	3.0	6.00	10	0.37	9104013	
1999/9/7	10:19:25.07	35°51.58′ −121 25.85′	D	3.1	6.00	12	0.27	9104112	
1999/9/7	16:42:09.07	33°20.32′ −116°12.56′	A	3.4	17.35	82	0.26	9104164	
1999/9/10	13:40:01.24	32°12.80′ −115°12.52′	C	4.9	6.00	38	0.59	*9104506*	*12*

Date	Time	Location	Q	M	Z	PH	RMS	ID	FM
1999/9/11	16:43:01.32	32°5.93′ −114 41.16′	D	3.1	6.00	12	0.32	9104651	
1999/9/12	01:21:20.52	33°56.21′ −116°21.54′	A	3.2	9.44	77	0.28	9104691	
1999/9/14	11:57:14.92	36°1.43′ −117°52.83′	A	3.2	4.81	48	0.11	9104930	
1999/9/16	03:02:44.50	36°1.33′ −117°53.02′	A	3.6	4.04	53	0.13	9105143	
1999/9/16	17:39:49.54	36°1.52′ −117°52.80′	A	3.1	5.18	47	0.11	9105210	
1999/9/16	17:39:57.94	36°1.51′ −117°53.55′	A	3.1	3.62	22	0.18	9105217	
1999/9/20	07:02:49.18	34°19.34′ −116°50.75′	A	4.2	2.82	141	0.22	9105672	13
1999/9/21	15:42:47.70	35°48.53′ −121 20.27′	D	3.7	9.10	13	0.36	9105809	
1999/9/24	03:42:52.87	36°12.39′ −117°53.86′	A	3.3	1.07	41	0.16	9106025	
1999/9/25	01:18:24.90	36°12.05′ −117°53.74′	A	3.0	2.47	32	0.12	9106131	
1999/10/1	01:29:41.98	36°12.36′ −117°54.05′	A	3.3	0.00	55	0.21	9106756	
1999/10/3	10:14:50.52	32°13.82′ −115°40.16′	C	3.6	6.00	19	0.18	9106985	
1999/10/3	11:04:30.72	36°12.52′ −117°53.86′	A	3.0	0.86	47	0.17	9107003	
1999/10/3	11:54:06.19	33°2.96′ −115°54.11′	A	3.4	1.36	58	0.35	9107010	
1999/10/6	05:06:28.63	36°7.62′ −120°15.04′	C	3.0	6.00	11	0.36	9107350	
1999/10/6	20:15:58.25	34°23.85′ −119°26.10′	A	3.4	13.22	69	0.46	9107408	
1999/10/13	04:56:10.24	33°12.67′ −115°58.88′	A	3.0	10.00	69	0.25	9108304	
1999/10/13	19:35:57.06	35°58.87′ −120°34.31′	C	3.2	0.01	14	0.20	9108363	
1999/10/15	14:22:43.53	34°35.43′ −116°16.47′	A	3.0	0.01	29	0.15	9108537	
1999/10/16	02:41:04.72	34°35.61′ −116°16.39′	A	3.8	0.01	68	0.16	9108606	
1999/10/16	09:46:44.13	34°35.64′ −116°16.25′	A	7.1	0.01	55	0.17	9108652	14
1999/10/16	09:51:48.29	34°26.33′ −116°15.71′	A	4.9	0.00	50	0.19	3320846	
1999/10/16	09:52:53.97	34°30.11′ −116°12.17′	C	4.7	6.00	22	0.29	3320847	
1999/10/16	09:59:35.05	34°41.21′ −116°16.81′	B	5.8	9.73	45	0.20	3320848	15
1999/10/16	10:02:39.82	34°35.06′ −116°15.71′	A	4.5	0.01	42	0.23	3320849	
1999/10/16	10:07:29.71	34°48.67′ −116°18.04′	B	4.3	0.01	53	0.33	9108646	
1999/10/16	10:08:04.37	34°42.36′ −116°20.46′	A	4.6	1.64	38	0.20	9108676	
1999/10/16	10:09:54.62	34°40.25′ −116°17.50′	B	4.0	1.82	45	0.30	3320876	
1999/10/16	10:10:33.31	34°35.61′ −116°16.68′	D	3.2	0.00	12	0.18	9108780	
1999/10/16	10:10:48.88	34°37.75′ −116°16.61′	A	4.3	0.05	20	0.10	9108699	
1999/10/16	10:20:52.66	34°21.77′ −116°8.91′	A	4.8	0.00	56	0.19	9108709	
1999/10/16	10:21:20.97	34°32.38′ −116°15.96′	B	4.4	0.88	33	0.24	3321286	
1999/10/16	10:22:47.63	33°50.09′ −115°58.09′	C	3.7	11.17	18	0.17	9108728	
1999/10/16	10:49:50.43	33°15.34′ −115°40.41′	A	3.6	2.30	32	0.25	9108673	
1999/10/16	11:05:26.71	34°28.03′ −116°17.71′	B	3.1	0.00	17	0.19	9108743	
1999/10/16	11:06:38.38	34°34.99′ −116°16.95′	A	4.2	0.01	53	0.20	9108750	
1999/10/16	11:07:23.30	34°36.19′ −116°17.66′	B	3.9	0.01	26	0.25	9108859	
1999/10/16	11:20:38.17	34°35.26′ −116°17.41′	A	3.8	1.58	24	0.15	9108765	
1999/10/16	11:21:13.42	34°27.26′ −116°14.81′	B	3.5	0.01	20	0.18	3321290	
1999/10/16	11:21:38.72	34°29.73′ −116°15.19′	A	3.9	0.01	49	0.20	9108894	
1999/10/16	11:24:33.55	34°36.32′ −116°16.60′	C	3.7	6.00	25	0.20	9108736	
1999/10/16	11:26:04.80	34°48.76′ −116°20.44′	B	4.7	0.01	33	0.22	9108775	
1999/10/16	11:47:43.91	34°40.86′ −116°20.81′	B	3.6	1.19	46	0.25	9108760	
1999/10/16	11:49:58.55	34°42.68′ −116°18.21′	A	4.1	1.51	37	0.16	9108803	
1999/10/16	11:50:39.98	34°40.91′ −116°21.88′	C	3.3	0.84	16	0.21	9108991	
1999/10/16	11:51:44.85	34°27.73′ −116°14.03′	B	3.4	0.28	26	0.20	9108823	

Date	Time	Location	Q	M	Z	PH	RMS	ID	FM
1999/10/16	16:58:08.08	34°29.40′ −116°16.23′	A	3.2	0.00	24	0.21	3321266	
1999/10/16	17:20:20.64	34°40.82′ −116°21.68′	A	3.2	1.02	52	0.20	9109232	
1999/10/16	17:21:01.11	34°28.55′ −116°15.87′	A	3.2	0.00	39	0.17	9112279	
1999/10/16	17:21:55.13	34°36.30′ −116°15.06′	A	3.3	0.01	37	0.22	9109230	
1999/10/16	17:37:04.95	33°12.85′ −115°38.97′	A	3.1	1.68	25	0.27	9109258	
1999/10/16	17:38:48.64	34°25.78′ −116°15.09′	A	4.9	0.01	92	0.21	9109254	
1999/10/16	17:48:31.36	33°16.10′ −115°43.03′	A	3.5	0.71	35	0.26	9109243	
1999/10/16	17:55:16.50	34°31.93′ −116°14.72′	A	3.1	0.95	30	0.13	9109260	
1999/10/16	18:01:57.51	34°42.24′ −116°17.81′	A	4.3	2.86	38	0.19	9109287	
1999/10/16	18:05:22.72	34°34.08′ −116°15.88′	A	3.8	0.00	57	0.19	9109267	
1999/10/16	18:10:20.42	34°47.21′ −116°20.60′	A	3.6	0.00	47	0.18	9109270	
1999/10/16	20:13:37.64	34°41.35′ −116°16.79′	A	4.7	1.30	75	0.22	9109442	
1999/10/16	20:14:10.17	34°41.17′ −116°16.12′	A	4.3	0.01	21	0.28	3321577	
1999/10/16	20:15:54.23	34°31.88′ −116°9.56′	C	3.1	6.00	10	0.22	9109402	
1999/10/16	20:18:58.80	34°34.87′ −116°16.18′	A	3.2	0.01	43	0.26	9109421	
1999/10/16	21:10:50.49	34°40.22′ −116°20.28′	A	4.0	2.52	70	0.19	9109496	
1999/10/16	21:53:56.76	34°29.35′ −116°11.96′	C	3.1	6.00	29	0.24	9109555	
1999/10/16	22:25:28.23	34°27.27′ −116°15.01′	A	3.2	0.51	51	0.16	3320791	
1999/10/16	22:42:55.28	34°21.16′ −116°9.21′	A	3.0	0.07	51	0.22	9109604	
1999/10/16	22:53:41.20	34°42.58′ −116°21.18′	A	4.5	7.53	79	0.21	9109636	
1999/10/16	22:54:08.22	34°39.45′ −116°20.04′	A	3.8	0.89	16	0.23	3321581	
1999/10/16	22:55:38.27	34°42.26′ −116°20.84′	B	3.0	5.02	26	0.15	3321579	
1999/10/17	00:47:24.87	34°36.58′ −116°14.15′	A	3.2	0.00	60	0.21	7150037	
1999/10/17	03:50:04.33	34°41.41′ −116°21.27′	A	3.2	2.24	47	0.17	3321396	
1999/10/17	07:11:16.45	34°51.00′ −116°21.27′	A	3.4	6.29	31	0.21	9110210	
1999/10/17	07:29:22.53	34°42.04′ −116°17.99′	B	3.3	3.72	39	0.19	9110226	
1999/10/17	16:32:40.70	34°21.68′ −116°8.46′	A	3.9	1.87	75	0.21	9110704	
1999/10/17	16:32:53.26	34°21.71′ −116°8.29′	D	4.2	0.00	15	0.22	3320801	
1999/10/17	17:19:11.58	34°31.28′ −116°18.41′	A	3.4	0.00	54	0.16	9110733	
1999/10/17	19:06:44.19	34°31.81′ −116°21.49′	A	3.1	0.00	42	0.13	3321412	
1999/10/17	20:14:05.46	34°30.02′ −116°16.86′	A	3.0	0.01	33	0.26	9110873	
1999/10/17	20:14:20.05	34°28.28′ −116°13.75′	B	3.2	0.00	22	0.20	3320816	
1999/10/17	20:14:57.88	34°19.52′ −116°39.89′	A	3.0	0.01	23	0.19	9110926	
1999/10/17	21:52:37.52	34°40.15′ −116°20.74′	A	3.0	3.40	49	0.21	9110992	
1999/10/17	22:56:19.97	34°32.54′ −116°18.41′	A	3.6	0.01	59	0.19	3321280	
1999/10/18	06:35:47.33	34°21.52′ −116°8.82′	A	4.6	0.06	79	0.20	9111353	
1999/10/18	11:02:19.91	34°51.37′ −116°21.08′	A	4.4	0.09	65	0.21	9111518	
1999/10/19	08:40:35.91	34°26.14′ −116°14.96′	A	3.3	1.38	65	0.15	9112567	
1999/10/19	12:20:44.27	34°42.60′ −116°20.46′	A	4.5	7.56	60	0.18	9112735	
1999/10/19	12:56:17.02	33°2.86′ −115°34.31′	A	3.3	4.69	29	0.21	9112774	
1999/10/19	15:45:12.41	33°2.56′ −115°34.51′	A	3.1	7.21	20	0.20	9112864	
1999/10/19	22:30:31.03	32°20.42′ −115°8.07′	C	3.1	6.00	10	0.17	9113147	
1999/10/21	01:54:06.64	34°52.01′ −116°23.60′	A	4.5	4.03	49	0.17	3320883	
1999/10/21	01:54:34.18	34°52.43′ −116°23.48′	A	5.1	0.97	56	0.24	3321590	
1999/10/21	01:57:38.77	34°51.77′ −116°23.71′	A	4.9	3.51	116	0.23	3320884	17
1999/10/22	12:40:52.53	34°20.14′ −116°12.43′	A	4.2	9.47	77	0.21	9114763	

Date	Time	Location	Q	M	Z	PH	RMS	ID	FM
1999/10/22	13:43:14.73	34°51.33′ −116°23.91′	A	3.8	4.20	65	0.20	9114775	
1999/10/22	16:08:48.06	34°51.90′ −116°24.52′	A	5.0	0.91	140	0.21	9114812	18
1999/10/22	19:57:44.28	34°51.47′ −116°24.37′	A	3.0	0.01	44	0.19	9114962	
1999/10/22	23:11:32.75	34°39.78′ −116°17.06′	A	3.1	0.68	41	0.16	9115061	
1999/10/24	00:08:29.27	34°49.12′ −116°23.17′	A	3.1	2.43	46	0.19	9115561	
1999/10/25	18:26:00.62	34°36.95′ −116°14.54′	A	4.6	0.01	50	0.18	3321011	
1999/11/1	00:29:59.59	36°3.56′ −117°52.48′	A	3.0	2.53	56	0.14	9118830	
1999/11/1	01:53:46.40	34°18.33′ −116°51.08′	A	3.2	0.00	99	0.18	9118857	
1999/11/1	02:0:28.58	34°19.39′ −116°7.10′	A	3.5	0.00	91	0.21	9118869	
1999/11/1	03:40:34.44	34°22.60′ −119°46.50′	A	3.1	2.50	45	0.32	9118885	
1999/11/1	20:19:10.42	33°9.51′ −116°0.75′	A	3.5	3.71	48	0.23	9119111	
1999/11/3	00:32:46.87	34°38.61′ −116°17.38′	A	3.1	3.88	51	0.14	7158805	
1999/11/3	02:52:22.67	34°47.89′ −116°17.05′	A	3.3	4.14	38	0.13	3321425	
1999/11/3	02:55:05.67	34°48.04′ −116°16.90′	A	3.8	4.30	44	0.15	3321426	
1999/11/3	03:27:56.99	34°50.65′ −116°21.44′	A	4.1	7.04	58	0.18	9119414	19
1999/11/3	03:30:00.85	34°51.06′ −116°21.38′	A	3.5	5.82	42	0.20	3321414	
1999/11/3	18:52:23.24	34°42.46′ −116°16.72′	A	3.2	2.78	58	0.21	9119651	
1999/11/4	23:49:59.58	34°50.80′ −116°20.94′	A	3.1	0.99	64	0.23	9120037	
1999/11/6	00:12:16.66	34°30.21′ −116°15.12′	A	3.1	2.13	75	0.22	7159793	
1999/11/6	03:47:34.16	34°49.82′ −116°22.99′	A	3.6	3.92	56	0.17	9120440	
1999/11/6	17:57:23.27	34°50.00′ −116°20.02′	A	3.4	5.66	63	0.18	9120584	
1999/11/7	06:47:49.70	34°47.40′ −116°17.55′	A	4.0	5.06	51	0.14	9120741	20
1999/11/7	07:58:09.71	34°51.87′ −116°24.00′	A	3.1	3.02	27	0.20	9120762	
1999/11/7	09:20:52.41	34°36.32′ −116°18.43′	A	3.4	0.54	80	0.18	9120780	
1999/11/8	07:44:40.18	34°46.66′ −116°21.02′	A	3.4	2.96	51	0.18	9121024	
1999/11/8	16:31:19.90	34°36.06′ −116°16.49′	A	3.5	0.29	78	0.18	9121111	
1999/11/9	12:04:19.91	34°17.66′ −116°4.65′	A	3.0	0.01	52	0.15	9121347	
1999/11/10	04:15:26.45	34°31.45′ −116°17.23′	A	3.4	0.86	60	0.16	9121568	
1999/11/10	14:55:07.11	34°49.65′ −116°23.26′	A	3.2	1.21	22	0.30	9121677	
1999/11/10	22:49:45.52	34°51.04′ −116°24.31′	A	3.0	1.27	31	0.22	9121768	
1999/11/11	00:39:18.39	34°21.09′ −116°27.83′	A	3.5	8.42	75	0.20	9121805	
1999/11/11	06:07:12.35	34°50.94′ −116°20.85′	A	3.1	6.31	42	0.20	9121853	
1999/11/11	15:29:42.43	35°7.46′ −118°39.48′	A	3.0	10.35	60	0.24	9121946	
1999/11/12	03:28:07.86	35°40.50′ −118°6.34′	A	3.1	12.03	43	0.11	9122099	
1999/11/12	05:41:22.93	34°2.90′ −117°15.89′	A	3.4	12.85	110	0.20	9122121	
1999/11/12	15:07:50.71	32°29.22′ −115°24.79′	C	3.1	6.00	24	0.35	9122211	
1999/11/12	17:41:45.17	32°21.82′ −115°18.35′	C	3.2	6.00	25	0.52	9122251	
1999/11/12	18:01:44.76	32°21.76′ −115°18.18′	C	3.6	6.00	26	0.50	9122259	
1999/11/12	18:25:11.80	32°22.12′ −115°18.58′	C	3.3	6.00	28	0.55	9122281	
1999/11/13	06:33:36.93	34°38.28′ −116°17.28′	A	3.0	3.36	60	0.14	9122409	
1999/11/14	14:20:09.41	34°50.14′ −116°24.30′	A	4.5	6.30	70	0.18	9122706	21
1999/11/14	19:05:25.12	34°29.31′ −116°15.91′	A	3.2	1.78	59	0.17	9122756	
1999/11/15	11:02:24.78	34°25.23′ −116°10.96′	C	3.0	5.69	53	0.16	9122927	
1999/11/16	05:52:20.62	34°48.77′ −116°25.80′	A	3.2	4.70	53	0.16	9123112	
1999/11/16	05:52:41.04	34°32.93′ −116°18.39′	A	3.1	2.11	25	0.18	3321450	
1999/11/17	15:02:14.80	34°34.52′ −116°15.02′	A	3.0	4.72	39	0.14	9123447	

Date	Time	Location	Q	M	Z	PH	RMS	ID	FM
1999/11/18	07:09:04.02	34°52.21′ –116°23.90′	A	3.5	0.39	71	0.17	9123647	
1999/11/18	10:29:55.66	33°10.38′ –115°35.94′	A	3.5	3.03	53	0.34	9123711	
1999/11/21	22:15:38.32	34°37.20′ –116°14.98′	A	3.0	0.41	73	0.20	7163776	
1999/11/25	01:54:03.58	33°10.72′ –115°35.67′	A	3.5	2.13	46	0.32	9125084	
1999/11/25	05:18:59.57	34°50.30′ –116°24.55′	A	3.5	6.04	68	0.18	9125125	
1999/11/25	16:01:30.25	35°56.22′ –117°12.96′	A	3.1	5.03	46	0.20	9125191	
1999/12/1	16:44:30.07	34°51.05′ –116°20.73′	A	3.6	5.86	54	0.21	9126544	
1999/12/2	02:19:23.99	34°9.09′ –117°26.98′	A	3.1	13.09	119	0.22	9126657	
1999/12/3	05:54:55.67	34°39.70′ –116°20.40′	A	3.2	2.24	52	0.16	9126882	
1999/12/3	05:54:55.70	34°39.86′ –116°20.16′	A	3.2	2.94	40	0.17	9126870	
1999/12/3	17:50:00.98	34°50.29′ –116°24.18′	A	3.0	5.00	35	0.17	9126951	
1999/12/7	21:58:16.06	33°48.35′ –117°43.12′	A	3.9	11.04	97	0.22	3321584	
1999/12/8	10:53:59.59	34°2.56′ –117°14.79′	A	3.2	14.77	106	0.17	9127885	
1999/12/10	08:36:42.44	34°35.33′ –116°18.01′	A	3.2	0.02	40	0.17	9128326	
1999/12/11	08:56:48.81	34°51.50′ –116°24.34′	A	3.1	1.59	61	0.18	9128463	
1999/12/13	05:47:38.09	34°23.34′ –116°8.76′	A	3.4	5.56	69	0.19	9128729	
1999/12/13	13:20:16.27	34°6.13′ –117°0.47′	A	3.9	3.30	155	0.19	9128775	
1999/12/15	03:46:53.17	34°51.42′ –116°23.42′	A	3.2	6.87	68	0.18	9129090	
1999/12/15	06:29:48.13	34°6.03′ –117°0.42′	A	3.1	3.19	113	0.20	9129102	
1999/12/15	06:52:05.47	34°20.10′ –116°7.02′	A	3.2	2.63	46	0.24	3321650	
1999/12/15	13:45:02.60	34°36.46′ –116°16.95′	A	3.1	3.10	68	0.20	9129139	
1999/12/20	12:05:54.93	34°41.51′ –116°18.69′	A	3.0	1.16	56	0.16	9129969	
1999/12/20	12:07:13.36	34°41.31′ –116°18.82′	A	3.3	0.76	47	0.17	3321716	
1999/12/20	20:44:12.15	34°51.18′ –116°20.43′	A	3.3	6.18	46	0.19	9130027	
1999/12/22	09:11:00.63	34°37.17′ –116°15.06′	A	3.1	0.01	44	0.16	9130273	
1999/12/22	09:16:59.30	34°37.08′ –116°15.00′	A	3.1	0.01	43	0.18	9130277	
1999/12/23	14:30:54.38	34°35.51′ –116°15.87′	B	4.1	7.43	65	0.16	9130422	
1999/12/24	00:43:56.86	34°39.26′ –116°17.52′	A	3.2	3.94	63	0.20	9130550	
1999/12/26	15:14:07.64	34°47.81′ –116°22.29′	A	3.3	1.12	57	0.18	9130917	
1999/12/26	20:21:21.48	34°48.81′ –116°21.29′	A	3.7	4.31	35	0.19	3321763	
1999/12/29	18:12:44.15	34°40.49′ –116°17.64′	A	3.3	2.06	41	0.14	9131501	
1999/12/30	06:24:35.13	34°6.71′ –117°19.68′	A	3.3	17.78	88	0.18	9131620	