Partial Support of Joint USGS-CALTECH Southern California Seismographic Network

USGS Award No. 04HQAG0010

Robert W. Clayton
Egill Hauksson

Seismological Laboratory,
California Institute of Technology
Pasadena, CA 91125
hauksson@gps.caltech.edu
Tel: 626 395-6954
FAX: 626 564-0715
http://www-socal.wr.usgs.gov/scsn.html
http://www.trinet.org
http://www.cisn.org

Program Element: Seismic Networks

Key words: Seismicity, strong ground motion, seismotectonics, real-time earthquake information

INVESTIGATIONS

This Cooperative Agreement provides partial support for the joint USGS-Caltech Southern California Seismic Network (SCSN). The purpose is to record and analyze data from more than 12,241 local earthquakes from October 2003 to September 2004 and generate a database of phase data and digital seismograms (Figure 1). The primary product derived from the database is a joint USGS-Caltech catalog of earthquakes in the southern California region and the associated waveforms. We maintain the SCSN infrastructure. We also provide rapid response to emergency services, the media, and public inquiries about earthquakes.

For more detailed information about data access, please contact:
Dr. Kate Hutton at (626) 395-6959
or with E-mail: kate@gps.caltech.edu.

RESULTS

Network Operation

The SCSN operation of network infrastructure consists of: 1) operating computer and communications hardware/software and other instrumentation for data acquisition at the central site; 2) installation and field maintenance of new and existing digital stations; and

3) population and maintenance of earthquake databases. Caltech and USGS personnel share these operations responsibilities. Because the SCSN is a cooperative project of Caltech and USGS, all the facilities listed below are jointly operated and contribute to the overall project mission.

Central Site. The SCSN (formerly TriNet and TERRAscope) differs from most regional networks in both size and data processing approach. Most of the data are transmitted using digital communications, products are generated in near-real-time, and automatically archived in an Oracle database.

We lease frame relay from SBC and Verizon for data communications. This includes more than 120 frame relay drops, over 30 "last mile" radio links, 20 "last mile" optical fiber links, and three T1 lines transmitting the data from the frame relay cloud into the Caltech campus. Through agreements with the local utilities, we operate three T1 microwave links that provide wireless data transmission for about 40 stations using their statewide microwave systems.

The data from approximately half of the analog short period stations are digitized at four different remote earthworm hubs. The remaining stations are transmitted via analog phone lines and the USGS microwave to Caltech and digitized at the central site. In 2003, the USGS plans to decommission the microwave system and deploy a fifth earthworm hub at Edwards Air Force Base, using a leased T1 line to bring the data back to Pasadena.

Two SUN servers, with 4 CPUs each, operating in primary and backup mode, perform the real-time data acquisition and processing. To improve robustness, these two servers and related equipment are located in two different buildings on campus, the Seismo Lab and the USGS building (525 So. Wilson Ave). Two SUN servers are used for software testing and development. ShakeMap is generated using a SUN server and will also be produced in the future using a 2 CPU LINUX server.

Both parametric and waveform data are archived automatically in the oracle database. The data analysts review and modify the already archived data in the Oracle database. A significant part of our effort is also the maintenance of existing data archives and station metadata for the stations recorded by SCSN.

The major software components used by SCSN are TriNet C++, Perl scripts, and Java software, earthworm modules, and commercial software such as Oracle, and SmartSockets. This software requires extensive maintenance because software and hardware need to be upgraded simultaneously, requirements such as station metadata may change and send ripples through the software. Further, improvements in seismological algorithms may need to be incorporated as errors or improvements are discovered.

SCSN. The SCSN operates 155 broadband and strong motion real-time digital stations, 30 real-time strong motion stations, and about 120 short period stations to maintain the detection threshold of M1.8 in southern California (Figure 2). The existing digital stations of TERRAscope are part of SCSN.

Broadband and strong motion sites, provide flat instrument response from 50 Hz-30 seconds or greater. Approximately two thirds of the broad sensors have low frequency response to 120 or 360 seconds. They are sited, away from structures of two

or more stories, and preferentially at sites with low ambient ground noise. At present we operate 155 broadband and strong motion stations and record data from 10 Anza network stations, 3 University of California borehole stations located on the major campuses, and 4 SCEC borehole strong motion stations.

Strong motion reference sites, differ from traditional free field sites. The reference sites must provide flat instrument response in acceleration and on scale recording up to 2 g. In some cases these sites will also have a broadband seismometer. They will be sited away from structures of 2 or more stories but are located near major facilities or near groups of significant structures. Nearly all of the SCSN stations are either reference sites or free field sties. All strong motion sites have local recording. At present we receive signals from 15 Caltech operated K2's.

Short period sites, that have a single vertical component seismometer, are needed to ensure the minimum magnitude threshold of M1.8. These are quiet sites that provide resolution down to ambient ground noise.

State of health, we monitor the state of health of the network using SeisNetwatch. SeisNetwatch can be operated remotely using a regular web browser and field engineers can be notified via paging or email in case problems develop. SeisNetwatch is a good example of how the seismic network community has benefited from TriNet development. Initially, it was developed as TriNetwatch and was made available to the community as SeisNetwatch at the request of the USGS earthworm group in Golden Colorado.

Data transmission. The SCSN data are transmitted to Caltech via frame relay, digital microwave, Internet, and spread spectrum radio. We lease three T1 frame relay lines from Pacific Bell, which terminate at Caltech. At six locations, we collect several stations before the data are put onto frame relay lines, with three stations sharing a single frame relay line. Connecting to remote sites, we lease more than 120 frame relay circuits. For communications we operate, two 3 T1 capacity CISCO routers, a Motorola router, and several terminal servers. We also operate a 2 T1 capacity digital microwave link to Mt. Lukens to connect to the So Cal Edison and City of Los Angeles Department of Water and Power wide area networks. Further, we operate a third last mile microwave link to Verdugo Peak for data transmission from sites located at Southern California Gas Co. sites.

The Southern California Earthquake Data Center. This center has significantly increased the use of the data from SCSN/CISN for scientific research. The web enabled system, which has been in operation for more than ten years, provides on-line storage for more than 5000 Gbytes of data. These data, including, 70 years of catalog, 70 years of phase data, and 20 years of digital seismograms are available through the internet in near-real-time.

Seismicity Summary for Southern California

October 2003 - September 2004

Total number of earthquakes (inside & just outside our area) & quarry blasts located:
12,241 of which
1,543 were 2.0 or larger, of which
261 were 3.0 or larger, of which
34 were 4.0 or larger.

Of the 34 4.0 or larger earthquakes, 26 were outside of our monitoring area (mostly San Simeon & Parkfield sequences. Those inside our area are listed below.

4.3	2003/10/08	04:26:22	32	10.1 N	115	25.5 W	6.0	56 km (35 mi) S of Calexico, CA
4.3	2004/02/14	04:43:11	35	2.3 N	119	7.9 W	12.1	17 km (11 mi) WNW Wheeler, CA
4.4	2004/05/09	01:57:17	34	23.7 N	120	1.3 W	4.4	16 km (10 mi) W of Isla Vista, CA
5.3	2004/06/15	15:28:48	32	19.7 N	117	55.1 W	10.0	68 km (42 mi) SE of San Cl. Is.
4.0	2004/07/13	17:53:52	33	42.7 N	116	3.3 W	12.8	15 km (9 mi) E of Indio, CA
4.3	2004/07/24	05:55:19	34	22.8 N	119	26.2 W	3.6	8 km (5 mi) ESE Carpinteria, CA
4.2	2004/08/21	18:25:12	32	20.5 N	115	13.5 W	6.0	44 km (28 mi) SE of Calexico, CA
5.0	2004/09/29	15:54:54	35	23.4 N	118	37.4 W	3.5	28 km (17 mi) NE of Arvin, CA

The largest ones were:

A Mw5.3 of June 15 southeast of San Clemente Island.
This earthquake generated 10,599 "felt reports", most from the San Diego area, but some from as far away as Imperial Valley, Victorville & Ventura. Because of the great distance to the nearest dry land, the highest intensity was Modified Mercalli Intensity IV.

A Mw5.0 on September 29 in the Arvin area of Kern County.
This generated 2,872 "felt reports" from 385 zip codes, from as far afield as Bishop, Barstow & Temecula. The peak intensity was Modified Mercalli Intenstiy V.

During this time period, only the San Simeon earthquake on December 22 (17,427 reports) and the Parkfield earthquake (14,177 reports), both in the Northern California Seismic Network, generated more public attention.

Processing of Backlog of SCSN Data

We have made more progress in processing earlier backlogs. Events from 1932 through 1976 now have computerized locations and magnitudes consistent with our current calibrations. All data from 1932 onward has been written to the Oracle data base, although some time periods in 1983 and 1981 have not been completely processed. All of the CEDAR system data (1977 through 1980) that are readable from the tapes of that period have been translated from CEDAR format to CUSP & are being converted into the Oracle data base.

Southern California

Seismicity October 2003 -- September 2004

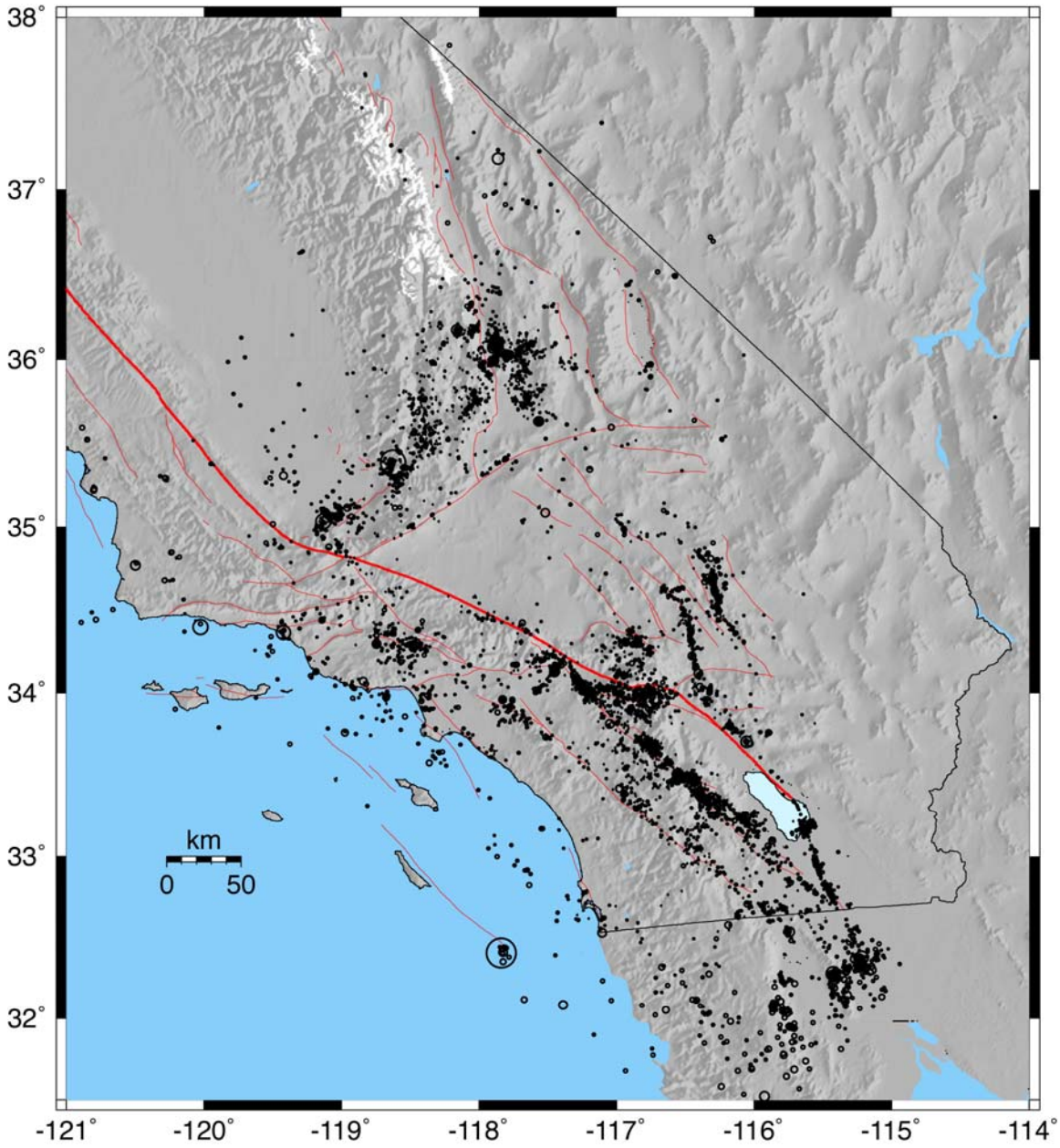

Figure 1. Earthquakes recorded by SCSN/CISN., http://www.trinet.org

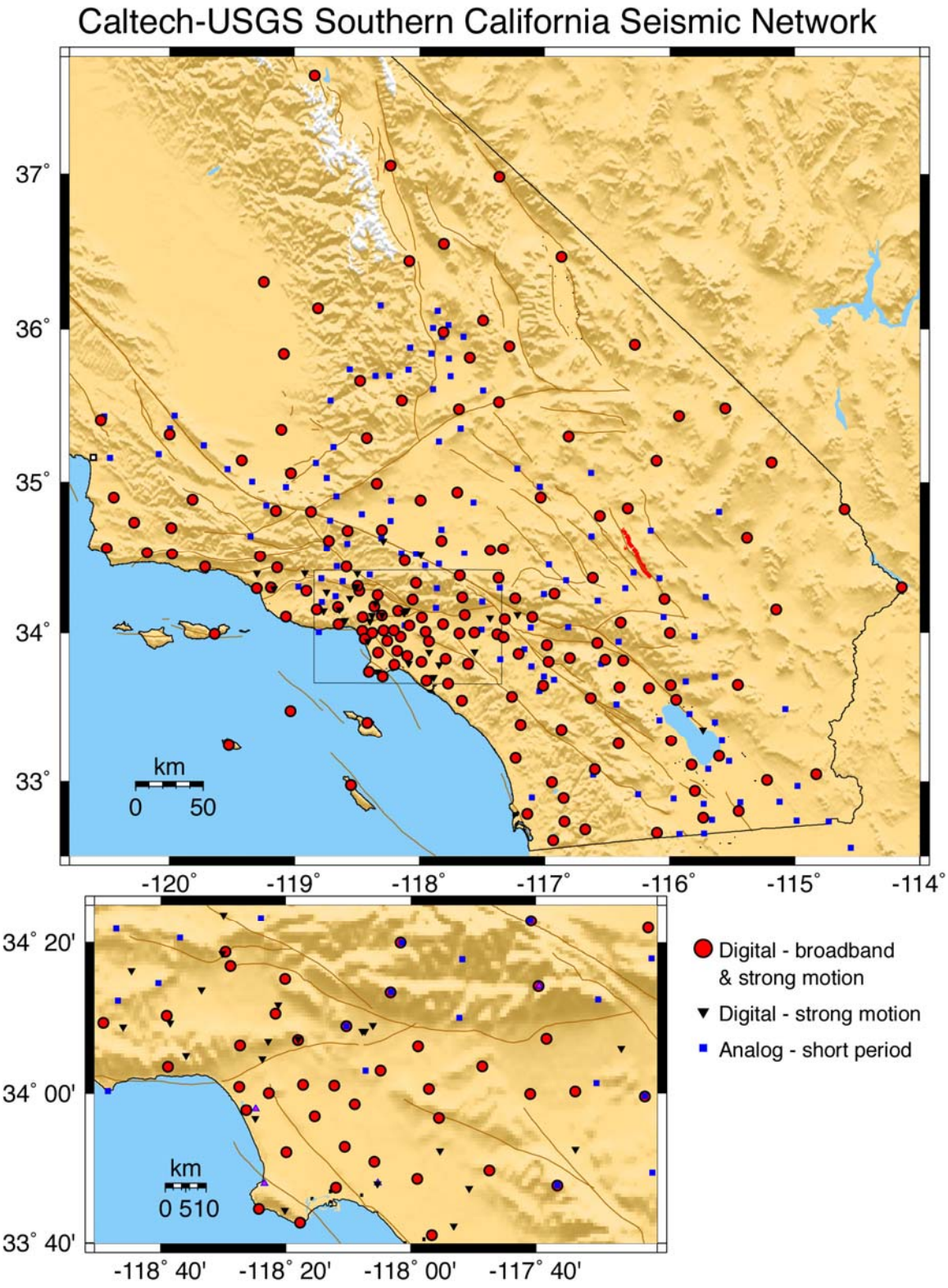

Figure 2. Southern California seismic stations recorded and operated by the SCSN. Not shown are an additional 50 stations recorded by SCSN but operated by other agencies.

Partial Support of Joint USGS-CALTECH Southern California Seismographic Network

USGS Award No. 04HQAG0010

Robert W. Clayton
Egill Hauksson

Seismological Laboratory,
California Institute of Technology

Pasadena, CA 91125
hauksson@gps.caltech.edu
Tel: 626-395 6954
FAX: 626-564 0715
For up-to-date earthquake information, see our home page:
http://pasadena.wr.usgs.gov/scsn.html
http://www.trinet.org
http://www.cisn.org

This Cooperative Agreement provides partial support for the joint USGS-Caltech monitoring of earthquakes in southern California. We recorded and analyzed data from more than 12,241 local earthquakes in FY2004. We also maintain field equipment located at remote sites and equipment and software at the central site in Pasadena. The primary product is a database of earthquake data, which includes a joint USGS-Caltech catalog of earthquakes in the southern California region. We also provide rapid response to emergency services, the media and public inquiries about earthquakes. For information about data access, please contact: Dr. Kate Hutton at (626) 395-6959.

NON-TECHNICAL SUMMARY