

# TERRAscope and CUBE Project at Caltech

The TERRAscope project of the California Institute of Technology began in 1988 and now has six very broadband seismic stations (PAS, GSC, PFO, SBC, ISA, and SVD) in southern California (Figure 1). The goal of TERRAscope is to provide high-quality broadband data needed for significant advances in both regional and global seismology. TERRAscope will replace the old Cal-

tech seismographic network in southern California, which dates back to the 1920s. In many cases, new stations are deployed in cooperation with local institutions. The goal is to encourage involvement of both students and researchers in the operation of the stations and analysis of new data. The station PAS is a joint project between Caltech, the University of Southern California, the U.S. Geological Survey (USGS), and the Incorporated Research Institutions for Seismology (IRIS). The station SBC was deployed in cooperation with the University of California

at Santa Barbara. The station PFO is operated jointly with the University of California at San Diego, and the station SVD was installed and is operated by the USGS. Except for SVD, all of the stations are equipped with a broadband Streckeisen STS-1 seismometer and Quanterra data logger with a 24-bit digitizer and a Kinemetrics FBA-23 strong-motion sensor. The station SVD has a Streckeisen STS-2 seismometer and a Guralp CMG-5 accelerometer. The project is funded mainly by grants from the L. K. Whittier Foundation and the Arco Foundation. In addition to the permanent stations, TERRAscope includes portable seismographs and Global Positioning System (GPS) receivers. We plan to deploy 12 more stations during 1991 and 1992.

TERRAscope complements and extends the capabilities of the existing 220 station (300 components) short-period Southern California Seismographic Network (SCSN). The data from TERRAscope will also be included in the SCSN data base used for generating the CIT/USGS southern California earthquake catalog. Because of their real-time capability and location in a populous earthquake-prone area, both networks enable seismologists to provide the public and State officials with timely information about significant earthquakes. The TERRAscope stations are included as a subnetwork of the global seismographic network operated by IRIS, and the U.S. National Seismic Network (USNSN), operated by the USGS. TERRAscope data recorded on tape cartridge at each station are available from the IRIS-DMC upon request. For further information, please contact: [tim@iris.edu](mailto:tim@iris.edu).

For quick and efficient data access, an automatic dial-up data retrieving system called Caltech Gopher (adapted from the IRIS Gopher system) has been implemented. The Caltech Gopher receives mail from NEIC for teleseisms and the SCSN with origin time, location, and magnitude for regional events. The Gopher retrieves data from all six TERRAscope stations for these events. The TERRAscope data reside in an FTP anonymous account ([seismo.gps.caltech.edu](ftp://seismo.gps.caltech.edu); password: "your e-mail address") at the Caltech Seismological Laboratory, and are available to users through Internet. Usually the data are available within 30 minutes after a regional event and several hours after a teleseism. In the near future a new version of the Gopher software will be installed, which will also make some of the Gopher data available directly from the IRIS-DMC Gopher. When the Data Center of the Southern California Earthquake Center begins full operation in early 1992, it will take over the distribution of earthquake data from southern California, including both TERRAscope Gopher data and continuous data from the tape cartridges. The data will also be available from IRIS-DMC, and future improvements and changes in data access will be posted on the IRIS-DMC bulletin board.

The TERRAscope data have been extensively used for various research projects such as waveform modeling of regional events, development of energy-magnitude scale, inversion of close-in displacement

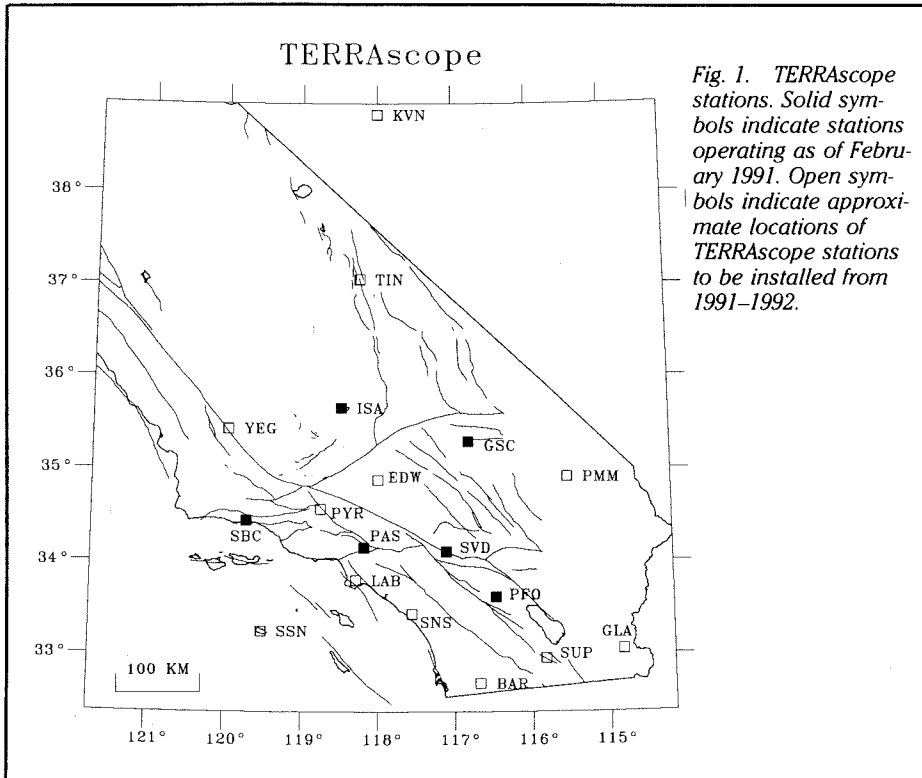


Fig. 1. TERRAscope stations. Solid symbols indicate stations operating as of February 1991. Open symbols indicate approximate locations of TERRAscope stations to be installed from 1991-1992.

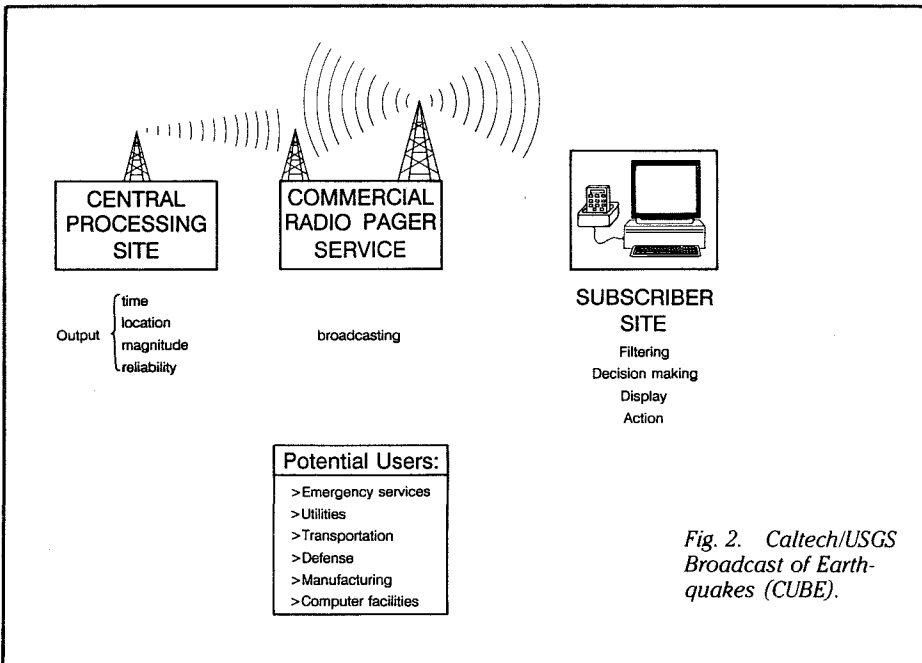


Fig. 2. Caltech/USGS Broadcast of Earthquakes (CUBE).

seismograms, study of non-earthquake events, determination of mantle structure beneath southern California, and determination of the Los Angeles basin structure.

To have the data available for immediate analysis following a major event, we are testing two real-time telemetry systems. One is a satellite telemetry system that is being installed in cooperation with the USNSN. The other is based on data transmission over telephone lines or radio links and a local real-time data collection system developed by Adebahr Systemtechnik.

Rapid determination of seismic source parameters after a large earthquake is very important for mitigating seismic hazards. After a damaging earthquake, the emergency operations undertaken in the first hours can be crucial to save lives and protect property. These operations must be able to take into

account the earthquake's characteristics—the location, depth, size, mechanism, and rupture direction all directly control the extent and distribution of damage. If the seismic source parameters can be quickly and accurately determined after a large earthquake, they can be used effectively, in conjunction with information on the site and macro seismic data, to determine the resulting damage pattern.

With such considerations in mind, Caltech and USGS initiated a pilot project, Caltech/USGS Broadcast of Earthquakes (CUBE) (Figure 2), under CaltechUs Earthquake Research Affiliates program. This is a cooperative research project between Caltech, USGS, and several transportation and utility companies that aims to develop a sophisticated realtime seismic information system using SCSN and TERRAscope. The participants in

this project are actively involved in the research using a radio pager-computer display system. The feedback from these participants helps Caltech seismologists to improve the system, thus contributing to seismic hazard reduction and promoting the advancement of seismology.

For example, on June 28, when the magnitude 5.8 Sierra Madre earthquake rocked Pasadena and much of the Los Angeles area, the participants in this project obtained the real-time information from SCSN in about 7 minutes, updated by more detailed information from TERRAscope, which allowed researchers to make a head start in isolating areas of potential damage.—*Hiroo Kanamori and Egill Hauksson, Seismological Laboratory, California Institute of Technology, and Tom Heaton, USGS, Pasadena, Calif.*