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DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

U.S. GEOLOGICAL SURVEY ROLE IN EARTHQUAKE PREDICTION

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U.S. Geological Survey Role in Earthquake Prediction: Seismology

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Work in the Seismology Branch on the problem of earthquake prediction is based primarily on the recording and analysis of seismic (elastic) waves in the Earth generated either by earthquakes themselves or by artificial sources such as quarry blasts or explosions detonated in drill holes. At the present time this work is still very much a research effort focused largely on earthquake occurrence within the San Andreas fault system and related faults in California. Major aspects of this research include 1) studies of the spatial-temporal patterns of earthquake occurrence as a basis for recognizing distinctive sequences of events that may precede moderate-to-large earthquakes, 2) studies of Earth structure as a basis for the accurate location of earthquake hypocenters and understanding the physical properties and state of active fault zones, and 3) studies of the earthquake source mechanisms as a basis for recognizing possible variations in stress-drop, rupture direction, and so on that may precede moderate-to-large earthquakes.

The telemetered seismograph networks in central California (250 stations) and in southern California (180 stations) represent basic tools for a large part of this research (see Figs. 1 and 2). Stations in the central California network (Fig. 1) are telemetered to U.S. Geological Survey offices in Menlo Park; stations in the southern California network (Fig. 2), which is operated cooperatively by the U.S. Geological Survey and the California Institute of Technology (Caltech), are telemetered to the Seismological Laboratory at Caltech in Pasadena. In both cases signals from each of the stations are recorded on 16 mm film and in a multiplexed FM format on magnetic tape. An example of the seismicity pattern defined by the central California seismic network for the year 1976 is illustrated in Figure 3. The report by Lee and others (1979) is an example of a preliminary study of a recent earthquake (August 6, 1979, M_L=5.7) that occurred within the network.

Timely analysis of the large volume of data generated by these networks requires some form of computer-assisted, interactive processing, and considerable effort has been placed in developing such a system over the past few years. A prototype of one approach to an interactive processing system developed by Johnson (1979) has been successfully used in the routine analysis of data from the southern California network for the past two years. A somewhat different system is currently being operated on an experimental basis for analysis of the central California data. Also operating on an experimental basis in the central California network is a microprocessor programmed as an event detector to serve as an 80-channel interface between the incoming telemetry lines and the minicomputers on which digitizing and interactive analysis is done. This device, which will eventually have a 256-channel capacity, shows great promise as a key element in automatic processing system for earthquakes recorded by the California seismograph networks.

A recently developed system of 100 self-contained portable seismic recorders provides the means for carrying out active seismic experiments using explosive sources to study crustal structure and the properties of fault zones. The portable nature of these recorders (each unit is 0.3 meters on a side and weighs

18 kilograms) allows great flexibility in the design and execution of field experiments. Some noteworthy aspects of this system include an accurate internal crystal clock ($\pm$0.01 s/day), a microprocessor for programming recording time sequences in each unit, and a portable minicomputer for processing data and producing record sections as the field work is in progress. Since development of these instruments was completed in early 1978, they have been used in four major seismic-refraction experiments located in Saudi Arabia; the Yellowstone-Snake River Plain area; Mount Hood in the Oregon Cascades; and the Imperial Valley, California.

Field studies of aftershock sequences, earthquake swarms, or source mechanisms are pursued using a variety of portable seismic recording systems, which include 20 self-contained FM tape units that are capable of unattended operation for 5 days at a time (Eaton and others, 1970) and several new digital event-recording systems.

An area of special study was identified last year for the intensive monitoring of seismicity, tilt, creep, and geodetic lines on as nearly a real-time basis as possible. This area centers on the San Andreas fault in the Parkfield region of central California, which has experienced the recurrence of four very similar magnitude-six earthquakes since 1900 (Bakun & McEvilly, 1979). This section of the fault is also of particular interest because it forms the transition between the "locked" section of the San Andreas fault to the south and a stretch of fault to the north that creeps at a relatively steady rate of 3 cm/y.

Two projects in the Seismology Branch involve cooperative studies of earthquakes in foreign countries. One involves the cooperative operation and analysis of seismic networks in Guatemala and Nicaragua and the other involves joint seismic research in the Garm region of the Soviet Union.

References

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Eaton, J. P., M. E. O'Neill, and J. N. Murdock, 1970, Aftershocks of the 1966 Parkfield-Cholame, California, earthquake: A detailed study: Seismological Society of America Bulletin, v. 60, p. 1151-1197.

Johnson, C. E., 1979, CEDAR--An Approach to the Computer Automation Automation of Short-Period Local Seismic Networks: PhD Thesis, California Institute of Technology, Pasadena, 332 p.

Lee, W. H. K., D. G. Herd, V. Cagnetti, W. H. Bakun, and A. Rapport, 1979, A preliminary study of the Coyote Lake earthquake of August 6, 1979 and its aftershocks: U.S. Geological Survey Open-File Report 79-1621, 43 p.

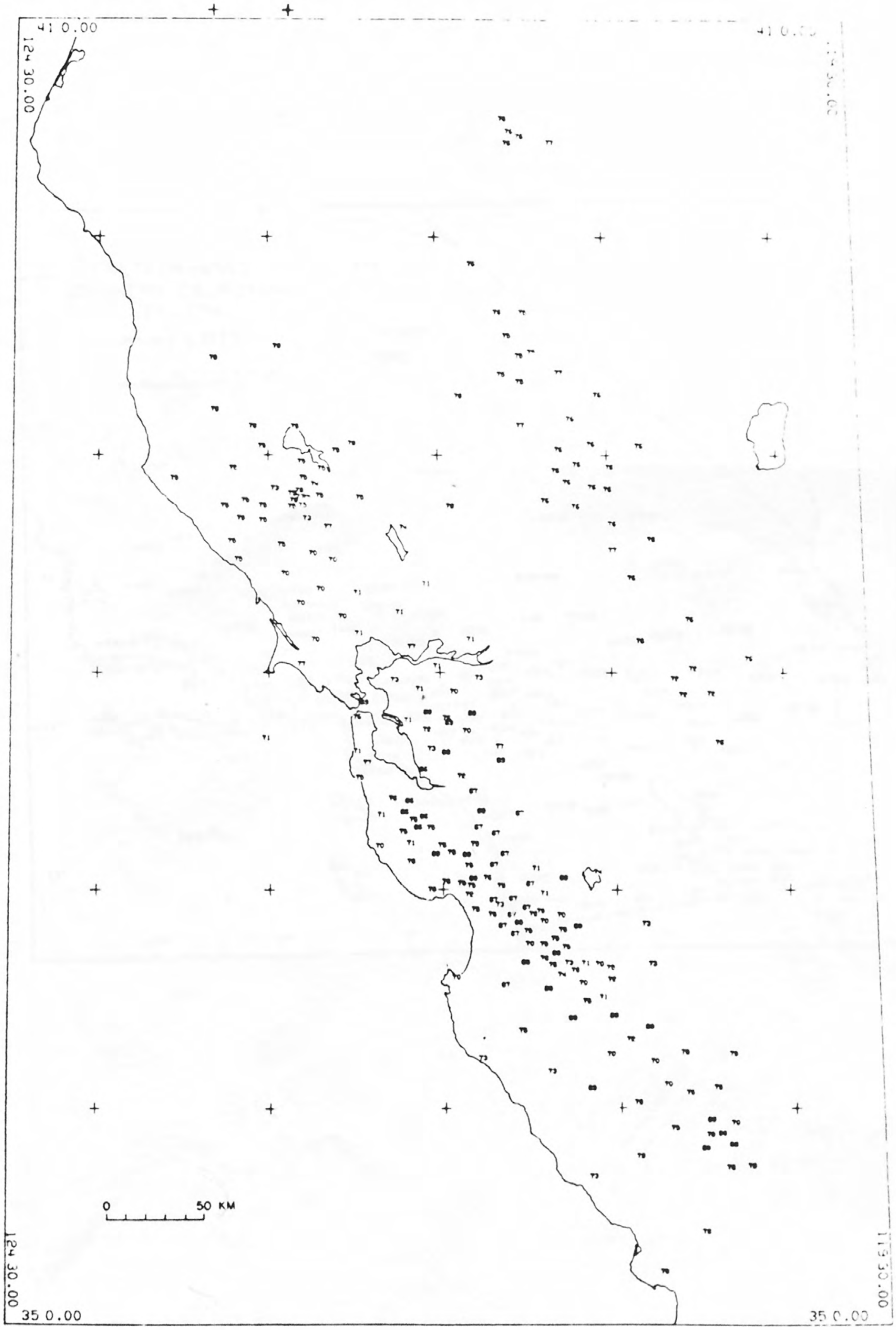
Figure Captions

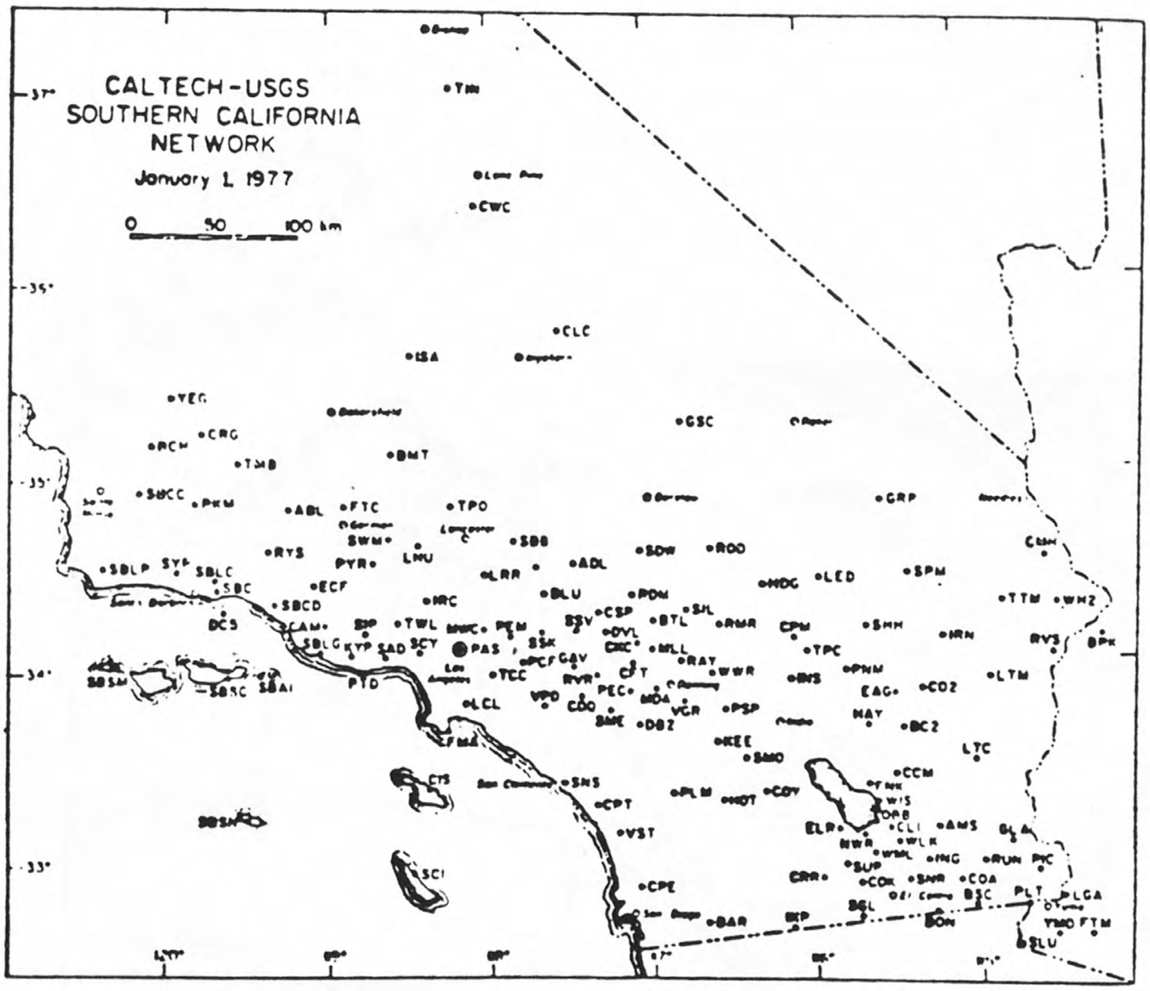
Figure 1. Seismograph stations in the Central California Network.

Figure 2. Seismograph stations in the Cooperative U.S.G.S.-Caltech Southern California Network.

Figure 3. Locations of all earthquakes of magnitude 1.5 or greater recorded by the central California Seismograph Network for 1976.

CALIFORNIA SEISMIC NETWORK — STATION INSTALLATION DATE




CALTECH-USGS
SOUTHERN CALIFORNIA
NETWORK
January 1, 1977
0 50 100 km

1976 EARTHQUAKES - 1:750000 (SCREENED)