The telemetered seismograph network is supplemented by a network of 20 portable seismograph stations that can be moved into the field for special studies within hours after an earthquake occurs. Earthquake signals are recorded on special slow-speed, low-power, magnetic-tape recorders that can operate unattended for up to 10 days on a single reel of tape. Magnetic tapes from the portable stations are then "played back" and recorded in visual form for analysis at NCER.

These portable stations already have been used successfully to study earthquakes in many areas: in Colorado, in the Yellowstone National Park region of Montana and Wyoming, and in Chile, Nevada, Alaska, and California. Earthquakes can be located with unprecedented accuracy with the new telemetered and portable seismograph networks. An example is the study of the aftershocks of the 1966 earthquake sequence in the Parkfield-Cholame area. In this study, using accurately recorded earthquake waves and supplementary information (extrapolated from explosions) on the speed at which these waves travel in the earth's crust, aftershocks were found to lie vertically below the surface fracture zone of the San Andreas fault at depths ranging from near the surface to 15 kilometers. We believe this is the first time that earthquakes have been shown to occur directly in a mapped fault zone.

Some segments of the San Andreas fault zone are "active" with many small earthquakes and a few moderate ones. Other segments are strangely quiet. An example of a quiet zone is the area of our telemetered Peninsula cluster of seismographs southwest of Menlo Park, through which we are keeping the earthquake pulse of a segment of the San Andreas fault that broke violently during the San Francisco earthquake of 1906. Another quiet zone is the segment of the San Andreas fault zone south of Cholame that broke in the great Fort Tejon earthquake of 1857.

The areas of frequent small or moderate earthquakes are also areas where "fault creep" or slippage is commonly observed, whereas creep is generally not observed in quiet zones.

We are investigating the significance of these observation.

In addition to our seismological studies of earthquakes, we are recording seismic waves generated by explosions to study the deep structure of the earth's crust and upper mantle. Early studies of earth structure emphasized a broad reconnaissance of the structure of the continent. We are now making much more detailed studies of the deep structure of the San Andreas fault to obtain information on the broad geologic environment in which earthquakes occur, and on the speed with which earthquake waves travel, permitting their accurate location.

Preparations are under way to begin a study of the relations between the intensity of ground motion associated with earthquakes and the nature of geological materials on which buildings are constructed.

Other geophysical studies

To study the relations among earthquakes, fault creep, and regional crustal deformation in earthquake-fault zones, scientists at NCER are conducting comprehensive studies of crustal strain. Such studies are made by repeatedly reobserving the slowly changing locations of survey markers and analyzing their movements in relation to the geologic conditions and earthquake activity in fault zones. Experimental observations of earth tilt and space and time fluctuations in the earth's gravity and magnetism in fault zones are also under way.

A modern, well-equipped rock-deformation laboratory is nearing completion at NCER. In this laboratory, rock samples will be subjected to pressures and temperatures that we expect deep in the earth's crust and upper mantle to study how rocks may actually deform and fail when an eathrquake occurs. These studies will be coordinated with actual measurements of rock stress in specially drilled holes in active fault zones.

Geologic studies

Geophysical research on earthquakes is closely coordinated with a variety of geologic studies. These include research on the regional geologic and tectonic framework of earthquake-fault zones in the California-Nevada region and Alaska, research on the relations of basement and volcanic rocks to movements along the San Andreas fault, study of the relations of the evolution of sedimentary basins to the geologic history of the San Andreas fault system, detailed mapping of recent fault breaks, and studies of the relations between land forms and fault-displacement rates. These studies are particularly valuable in determining from the historic and geologic record where earthquakes may occur. They have shown, for example, that total displacements along the San Andreas fault zone have