USGS ROLE IN EARTHQUAKE PREDICTION/TECTONOPHYSICS

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This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards and nomenclature.

The Geological Survey contributes to the U. S. National Earthquake Hazard Reduction Program by monitoring crustal strain, level changes, ground tilt, fault creep, and magnetic field in seismically active regions of California and by carrying out topical research studies on the mechanism of earthquakes.

Crustal strain is determined geodetically by annually repeated laser ranging measurements (Prescott, et al., 1979). The refractive index of the air along the light path is determined by aircraft-borne measurements of temperature and humidity made at the same time as the laser ranging. About 700 lines are measured each year, and networks in 23 different regions of the Western United States (mostly California) have been observed since 1970. Line lengths average 10-15 km and are measured to a precision of 3 parts in 10^7. Typical measured rates of strain accumulation are $0.1\text{-}0.2 \times 10^{-6}$/year. More frequent (weekly) measurements will begin during 1980 on three networks in southern California using a new two-wavelength geodimeter similar to a proto-type instrument that has been operated by the University of Washington in Hollister, California making daily measurements for the past 3 years. A modest program of elevation monitoring is done in southern California, including five separate routes and 400 km of first-order leveling per year.

Continuous monitoring of ground tilt, fault creep, and magnetic field changes are also carried out. Shallow borehole tiltmeters are used to detect possible short-term (hours to weeks) precursors to damaging earthquakes, and 80 such instruments are operating in California.

Aseismic surface fault slippage (creep) is monitored at 40 sites on the San Andreas fault system using invar wire strainmeters. Steady-state rates as high as 30 mm/yr are observed on the central segment of the San Andreas fault. These continuous creep data are supplemented by ∿100 m long alinement arrays, lines of geodetic markers crossing the fault that are resurveyed annually. The magnetic field near active faults is measured continuously at 30 sites with total-field proton magnetometers and in a differential survey mode at 100 additional pairs of sites (Johnston, et al., 1976).

Topical research covers a range of problems. Methods of experimental rock mechanics are used to study the physical properties of rocks and simulated earthquake faults under pressure, temperature, and fluid pressure conditions believed to exist in active crustal fault zones (Byerlee, 1978). Theoretical modeling of deformation processes and precursory behavior are proposed and tested against observations. In-situ stress measurements are made in boreholes up to 1 km deep using the hydrofracture method (Zoback and Roller, 1979).

References

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