

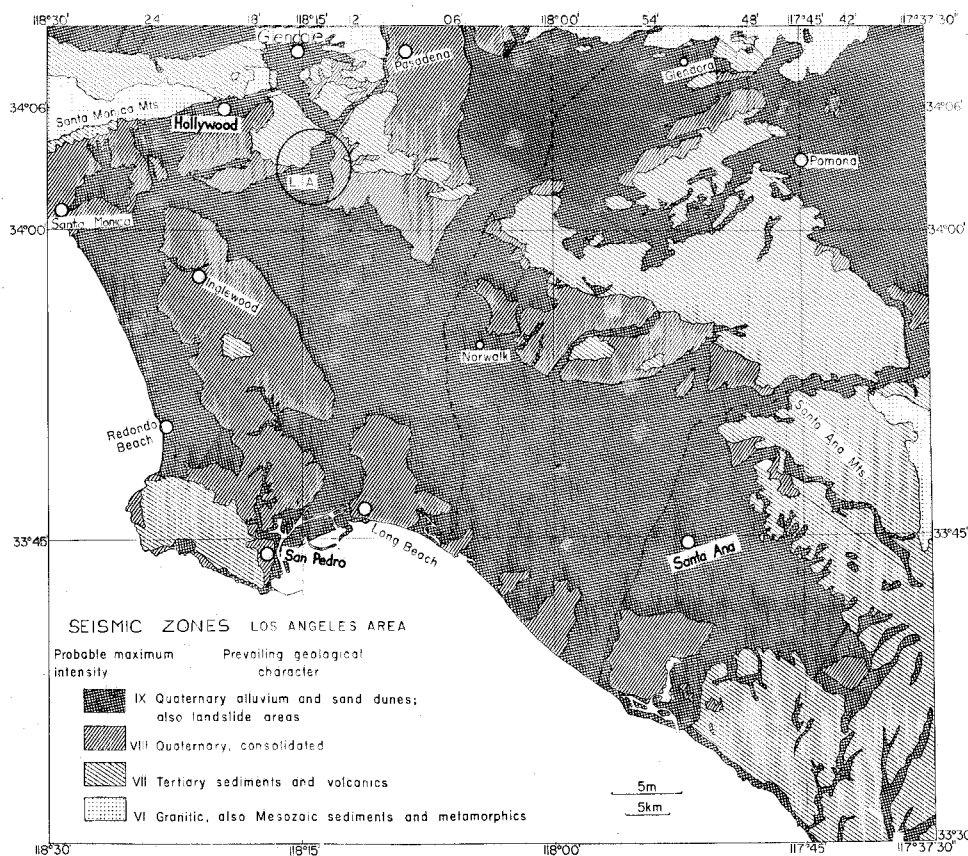
Regionalization map of the United States showing the maximum intensity of earthquake shock that can be expected in any one area. Areas assigned higher intensities do not necessarily represent the location of earthquake epicenters, but merely the probability of strong shaking from sources possibly at considerable distance.

## Mapping Earthquake Risk Areas

*A Caltech seismologist outlines the areas where damaging earthquakes are likely to occur*

Seismologists have always known that about 80 percent of all small earthquakes in the United States occur in California. Now, after making a comprehensive national survey, Charles Richter, professor of seismology at Caltech, has found that the risk of *damaging* earthquakes is just as great in many other states. Among the high risk areas, in fact, are northwestern New England and New York near the St. Lawrence rift; a belt extending east from the central Mississippi Valley through South Carolina and part of Georgia, the Rio Grande Valley in New Mexico and southwest Texas; and a narrow belt extending through Montana, Idaho, Utah and Arizona.

Dr. Richter has mapped the United States into regions showing the probable maximum intensity of earth shocks that can be expected in any region. He uses the Mercalli intensity scale, which differs from



A map of the Los Angeles area showing the maximum intensity of earthquake shock that can be expected in any one section. The Mercalli scale is used, giving the intensity of a shock as felt in any particular locality. Intensities below VI are usually too weak to cause structural damage; those over IX rarely occur.

the Richter magnitude scale in that it measures the amount of shaking at any one point, while the Richter scale is related to the amount of energy released by an earthquake at its origin.

In this mapping project Dr. Richter has laid out the United States in earthquake risk areas ranging in intensity from VI through IX on the Mercalli scale. (Intensities below VI are too weak to be considered, and those above IX are too rare). Intensity VI can cause slight damage to weak buildings; VII, considerable damage to weak buildings and negligible damage to strong ones; VIII, heavy damage to poor construction and slight damage to well-built structures; IX, considerable damage to good construction.

In these earthquake risk maps, Dr. Richter has not attempted to predict when and where earthquakes will occur, but where *damaging* ones are *likely* to occur—based on local geology, proximity to active faults, and the history of temblors in the area. The estimates do not represent the probability of average-sized quakes, but the maximum shock that could be anticipated over the years.

The maps are part of a paper on seismic regionalization soon to be published by Dr. Richter in the *Bulletin of the Seismological Society of America*. The paper, which presents and discusses maps for the Los Angeles basin and vicinity, for California, and for the United States, parallels work done in Russia on seismic regionalization. According to Dr. Richter, the Russians have already mapped risk zones in southern and eastern perimeters of their country, and have

incorporated the findings in their building codes.

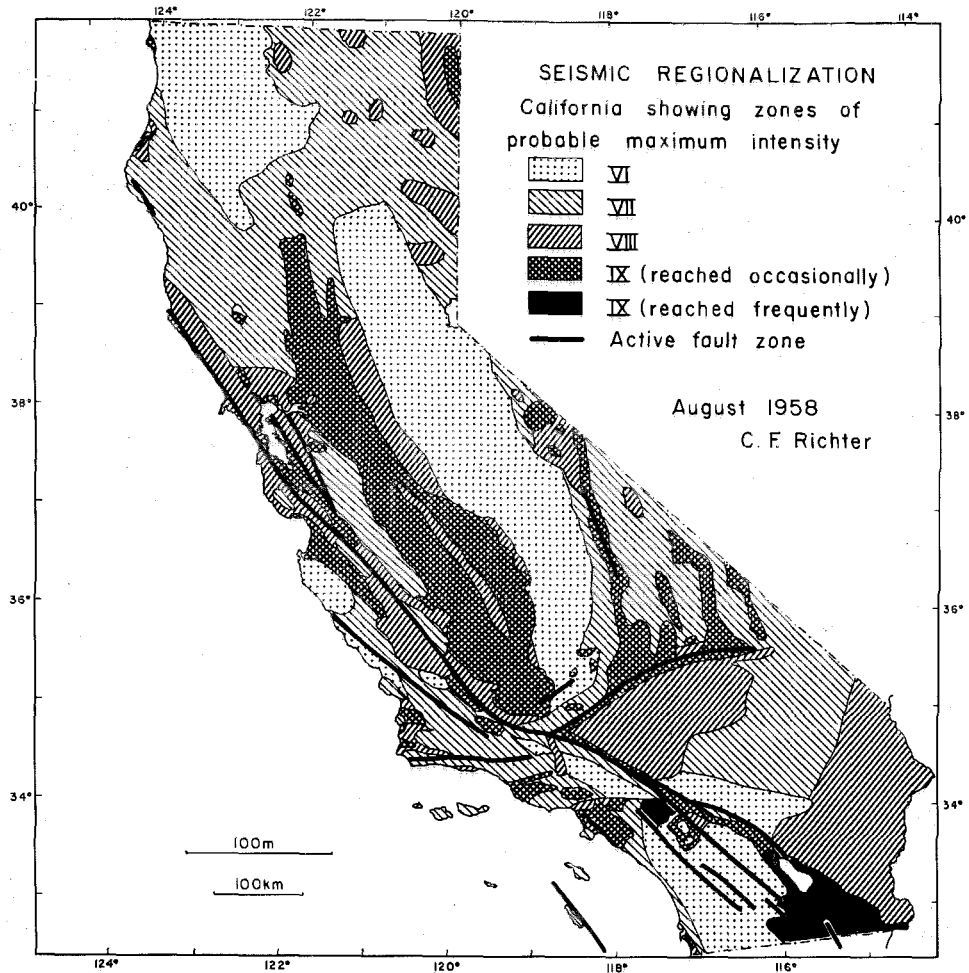
On maps such as these, the effect of variations of ground from point to point can be shown only on a large scale. This is known as microregionalization, which takes into account sharp and marked changes in the earth's formation, such as a sudden shift from sandy alluvium (where an earth shock is apt to be of higher intensity) to solid granite (where the risk is low). Dr. Richter's map of the Los Angeles Basin, above, is an example of microregionalization. Small-scale maps like those of California (page 17) and the United States (page 15) require considerable generalization. Dr. Richter describes his mapping for the Los Angeles Basin area as "reasonably definite." That for California is "fairly reliable, but less so in desert and mountain areas." And that for the United States is "in part highly speculative and subject to substantial change."

Regionalization, and especially microregionalization, can be used in construction and planning (as they are now being used in Russia) as indicating the maximum effects to be considered in designing permanent structures. Insurance companies and structural engineers are showing considerable interest in the Richter project.

Envisioning the possibility of zoning a city for earthquake protection, Dr. Richter notes that, generally speaking, buildings constructed on mountains or solid rock are likely to suffer the least damage from earthquakes. Those on foothills are a little more susceptible. Structures on lower hilly and terrace areas

Map of California showing the maximum intensity of earthquake shock that can be expected in any one area.

Unlike the detailed Los Angeles map on the opposite page, this map covers areas in broad blocks. The active fault zones mapped as narrow belts are where damage and risk are of exceptional character.



are higher quake risks. And buildings on valley alluvium and sandy areas near the coast are the highest risk areas.

Usually residential areas are on higher ground, where the earthquake risk is generally less. Industrial areas — and of course harbor developments — are likely to be on low ground, which may be sandy, alluvial or even marshy, and subject to higher risk.

In California, the principal high risk areas are lowland parts of the Los Angeles basin, the San Joaquin Valley, the southern Sacramento Valley, the San Francisco Bay area, and two other areas (the San Bernardino-Riverside district, and the Imperial Valley) where there is also a frequency risk for damaging shocks. These two areas are associated with fault complexes — fractures in the earth's crust along which the earth on one side is moving with respect to that on the other — which are areas of special risk.

Although California is high in earthquake risks, it has some of the lowest risk areas in the nation. It is a state of great contrasts, geologically, and in many areas the lowest and highest risk districts adjoin each other.

Areas of lowest risk in the United States include parts of southern California, the Sierra Nevada mountains, the Klamath and Siskiyou mountains in northern California and southern Oregon, mountains in the

north of Washington State and Idaho, and southern Florida.

Dr. Richter has a rough rule for estimating the likelihood of a damaging shock: Where an average of 500 small quakes occur each year, one great temblor may be expected once every 40 years; but in areas where 50 small quakes occur yearly, one great one may be expected about once every 400 years.

Southern California has an average of 200 small earthquakes a year, so that best evidence indicates that great earthquakes may be expected here on an average of about once per century.

"In large measure, the effects of four principal past earthquakes govern the estimates of damage possibilities in California," Dr. Richter explains. "The four are the great temblors of southern California in 1857, in Owens Valley in 1872, San Francisco in 1906 and Kern County in 1952. Earthquake risk in this state depends primarily on the character of local ground and only secondarily on geographic position. Most of the points are near enough to one of the principal faults to justify an estimate of Intensity IX on the Mercalli scale on poorly consolidated ground."

Dr. Richter hopes that his study will introduce a relatively new principle of investigation to American seismologists and will lead to more and better work of the same kind.