## THE LOCATION OF EARTHQUAKE EPICENTERS

ACCURATE determination of earthquake epicenters is important, for they are of much assistance in locating active faults. In a recent article on the fall of columns during the Long Beach earthquake, March 10, 1933, Professor Thomas Clements reaches the conclusion that the major shock had its origin in or near Compton instead of on the sea floor a short distance off Newport Beach, as had been indicated by seismograph records. In addition to evidence from overturned monuments in cemeteries, Professor Clements mentions the absence "of a so-called tidal wave, which might have been expected with violent earthquake waves emerging on the sea floor, and this regardless of whether the movement along the fault was vertical or horizontal."[1]

This erroneous conception of the cause of seismic sea waves is common, and has even found its way into a recent text-book of geology. A seismic sea wave is caused by a sudden vertical displacement of the sea floor. The time interval between the arrival of the earthquake vibrations and the arrival of the wave gives an accurate determination of the distance of the displacement from the point of observation, and is, therefore, useful in fixing the position of the origin. Many severe earthquakes have originated under the ocean without being accompanied by sea waves.

In spite of the fact that the San Andreas fault extends under the ocean for several miles, there was no sea wave at the time of the San Francisco earthquake of 1906, because the displacement was horizontal. Earthquakes due to vertical displacements along submarine faults may not always be accompanied by sea waves, for many of the smaller displacements do not extend to the surface. Vertical vibrations, indicative of a vertical displacement, seem to have been dominant near the epicenter of the Santiago-de-Cuba earthquake of February 3, 1932, which originated under the ocean, but there was no sea wave. Absence of a sea wave, therefore, can not be used as evidence that an earthquake did not originate under the ocean.

The evidence from overthrown columns must be used with great caution. If the base of a column is rectangular the direction of fall is usually limited to one of four directions. Some columns topple over, and some fall because they are displaced on their pedestals. If the earthquake is due to a horizontal displacement, columns close to the fault are usually overturned in directions parallel to it. During the San Francisco earthquake of 1906 objects close to the fault were commonly overturned or displaced parallel to it, while at a distance they were mostly displaced at right angles to it.

[1] SCIENCE, n. s., 78: 100–101, 1933.

In densely settled regions the epicenter can usually be located most accurately through a study of the distribution of intensity, but in comparing the relative intensity at different localities it is necessary to consider the character of the foundation material, for the apparent intensity is always much greater on made ground and unconsolidated alluvium, especially when saturated with water, than it is on rock or residual soil. At Long Beach and Compton, where damage as a result of the recent earthquake was great, the foundation conditions are poor.

From seismograph records it is possible to determine the distance to the point where the disturbance started. A displacement must begin in a rather limited area, and then extend rapidly over the fault surface and, sometimes, to adjacent faults. It is therefore possible for the area of maximum intensity to be a short distance away from the point of initial displacement.

When the position of an epicenter is determined from the records made on distant seismographs the error may be 50 km. or more; but in the southern California area, where the Carnegie Institution of Washington has established several stations equipped to study local earthquakes, it should be possible to determine the origin of the initial disturbance with an error of less than 5 km.

If the epicenter of the Long Beach earthquake was near the coast, as is now indicated, it was probably due to a displacement on the Inglewood fault, which was mapped and described as an active fault by me when I investigated the Inglewood earthquake in 1920.[2]

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## WHY DO WE PERSIST IN TALKING ABOUT THE "EXPANSION" AND "CONTRACTION" OF CHROMATOPHORES?

ONE may well question the wisdom of adopting a mode of expression which the author himself commonly feels under obligation to repudiate. To those who are familiar with the voluminous literature relating to vertebrate chromatophores, and with the great importance of some of the biological problems which center in them, the following attempt to adjust our terminology to our accepted view-point will perhaps not appear futile. Such persons are well aware of the two chief divergent views which are held respecting the changes of form that these cells appear to undergo in response to stimuli. The first of these is the more obvious interpretation of the phenomena observed,

[2] "The Inglewood Earthquake in Southern California, June 21, 1920," Stephen Taber, *Bull. Seis. Soc. Amer.*, X, 1920, pp. 129–145.