4500 to 20,000 feet per second; and Fouqué found the velocity in granite 9200 feet per second.

The position of the epicentrum is ascertained by noting the direction of throw of overturned columns, walls, houses, the converging lines pointing to the region of the surface vertically over the epicentrum. An oblique thrust is most effective in overthrowing objects; and the particular belt-line around the central region along which the waves are most destructive is called the *meizoseismic* curve, and lines of equal disturbance, *isoseismic* curves. Such curves are far from circles.

By means of evidence from fractures in walls and overturned objects, R. Mallet inferred the angle of emergence of the wave, and so calculated the depth of the center of disturbance. From 26 observations of the Neapolitan earthquake of 1857 he deduced a depth of 6½ miles. C. E. Dutton, in his paper on the Charleston earthquake, assumes that the total disturbance is inversely as the square of the distance from the center of disturbance. By noting, in the Charleston earthquake, the circle about the epicentrum at which the total effect diminished most rapidly on going from the epicentrum, he deduced depths of 8 and 12 miles for two distinct centers of disturbance.

The instruments by which the earthquake movements are detected (*seismoscopes*), measured (*seismometers*), and recorded (*seismographs*), are of many kinds. Those which experience in Japan has proved to be most accurate are the so-called Duplex pendulum; the Bracket seismographs of Chaplin, Ewing, Gray, or Milne; and conical pendulums.

The *geological effects* of earthquakes are small, while those of the causes which produce earthquakes are large. Vibrations loosen rocks and may tumble them down precipices, as they tumble down houses and walls. Occasionally they produce some rotation in the objects moved where the object is not equably attached below. They may fracture the rocks and ground in the region of greatest disturbance. They often occasion the drying up of springs.

In Calabria, in 1783, fissures were made that were over a mile long, 100 feet wide, and 200 feet deep. In the Charleston earthquake of 1886, and also in that of 1892 at Quetta, in British Baluchistan, described by C. Davison, railway lines were bent; and in the latter case, on removing the bent rails for repair, the new lines had to be cut 2½ feet shorter than the old ones, owing to a permanent displacement.

But these rending effects and the uplifts, and other results attending them, are effects rather of the deep-seated cause of the vibration and the fracturing. Besides these effects, earthquakes may destroy life in the sea, by impact, as a blow on the ice of a pond will stun or kill the fish. They may also throw the ocean over the land in waves of 30 to 100 feet, carrying in the animals of the sea, and, in these modern times, man's boats and ships, besides lifting and bearing far inland sea-bottom rocks and sand, and great masses of coral rock on the shores of coral islands (page 222). Further: *if a mountain-system* of the length of an America were making, like the post-Cretaceous Laramide System, and a like system cotemporaneously in the other America, sea-borders, continental seas, and land-borders the world over might be mostly stripped of life by earthquake waves. Or, if the mountain systems in progress were of less extent, like the post-Paleozoic, a hemisphere might experience the devastations, and austral land-borders and sea-borders escape.