wave previous to the retreat. Nor could the motion of the waters at Madeira have been caused by a different local earthquake; for the shock travelled from Lisbon to Madeira in two hours which agrees with the time which it required to reach other places equally distant.*

The following is another solution of the problem, which has been offered: — Suppose a portion of the bed of the sea to be suddenly upheaved, the first effect will be to raise over the elevated part a body of water, the momentum of which will carry it much above the level it will afterwards assume, causing a draught or receding of the water from the neighbouring coasts, followed immediately by the return of the displaced water, which will also be impelled by its momentum much farther and higher on the coast than its former level.†

Mr. Darwin, when alluding to similar waves on the coast of Chili, states his opinion, that "the whole phenomenon is due to a common undulation in the water, proceeding from a line or point of disturbance some little way distant. If the waves," he says, "sent off from the paddles of a steam-vessel be watched breaking on the sloping shore of a still river, the water will be seen first to retire two or three feet, and then to return in little breakers, precisely analogous to those consequent on an earthquake." He also adds, that "the earthquake-wave occurs some time after the shock, the water at first retiring both from the shores of the mainland and of outlying islands, and then returning in mountainous breakers. Their size is modified by the form of the neighbouring coast; for it is ascertained in South America, that places situated at the head of shoaling bays have suffered most, whereas towns like Valparaiso, seated close on the border of a profound ocean, have never been inundated, though severely shaken by earthquakes." ‡

More recently (February, 1846), Mr. Mallet, in his memoir above cited (p. 456), has endeavoured to bring to bear on this difficult subject the more advanced knowledge obtained of late years respecting the true theory of waves. He conceives that when the origin of the shock is beneath the deep ocean, one wave is propagated through the land, and another moving with inferior velocity is formed on the surface of the ocean. This last rolls in upon the land long after the earth-wave has arrived and spent itself. However irreconcileable it may be to our common notions of solid bodies, to imagine them capable of transmitting, with such extreme velocity, motions analogous to tidal waves, it seems nevertheless certain that such undulations are produced, and it is supposed that when the shock passes a given point, each particle of the solid earth describes an ellipse in space. The facility with which all the particles of a solid mass can be made to vibrate, may be illustrated, says Gay Lussac, by many familiar examples. If we apply the ear to one end of a long wooden

* Michell, Phil. Trans. vol. li. p. 614.
† Quarterly Review, No. lxxxvi. p. 459.
‡ Darwin's Travels in South America, &c. 1832 to 1836. Voyage of H. M. S. Beagle, vol. iii. p. 377.