

Section ii. Earthquakes¹⁶⁹

By the more delicate methods of observation which have been invented in recent years, it has been ascertained that the ground beneath our feet is apparently everywhere subject to continual slight tremors and to minute pulsations of longer duration. The old expression "terra firma" is not only not strictly true, but in the light of modern research seems singularly inappropriate. Rapid changes of temperature and atmospheric pressure, the fall of a shower of rain, the patter of birds' feet, and still more the tread of larger animals, produce tremors of the ground which, though exceedingly minute, are capable of being made clearly audible by means of the microphone and visible by means of the galvanometer. Some tremors of varying intensity and apparently of irregular occurrence, may be due to minute movements or displacements in the crust of the earth. Less

¹⁶⁹ On the phenomena of earthquakes consult Mallet, *Brit. Assoc.* 1847, part ii. p. 30; 1850, p. 1; 1851, p. 272; 1852, p. 1; 1858, p. 1; 1861, p. 201; "The Great Neapolitan Earthquake of 1857," 2 vols., 1862; D. Milne, *Edin. New Phil. Journ.* xxxi.-xxxvi.; A. Perrey, *Mem. Couronn. Bruxelles*, xviii. (1844), *Comptes rendus*, lii. p. 146; Otto Volger, "Untersuchungen über die Phänomene der Erdbeben in der Schweiz," Gotha, 1857-58; *Z. Deutsch. Geol. Ges.* xiii. p. 667; R. Falb, "Grundzüge einer Theorie der Erdbeben und Vulkanensausbrüche," Graz, 1871; "Gedanken und Studien über den Vulkanismus, etc.," 1874; Pfaff, "Allgemeine Geologie als exacte Wissenschaft," Leipzig, 1873, p. 224. Records of observed earthquakes will be found in the memoirs of Mallet and Perrey; also in papers by Fuchs in *Neues Jahrb.* 1865-1871, and in Tschermak's *Mineralog. Mittheilungen*, 1873 and subsequent years. See also Schmidt, "Studien über Erdbeben," 2d edit. 1879; "Studien über Vulkane und Erdbeben," 1881; Dieffenbach, *Neues Jahrb.* 1872, p. 155; M. S. di Rossi, "La Meteorologia Endogena," 2 vols. 1879 and 1882; M. Gatta, "L'Italia, su vulcani e terremoti," 1882; J. Milne, "Earthquakes and other Earth-movements," 1886, and his beautifully illustrated volume on the Japan Earthquake of October, 1891. G. Mercalli, in his "Vulcani e Fenomeni Vulcanici in Italia" (1883), gives an account of the Italian earthquakes from 1450 B.C. to A.D. 1881; he separately describes the great Ischian earthquake of 1883; "L'Isola d'Ischia," Milan, 1884. Much interesting information will be found in the *Bulletino del Vulcanismo Italiano*, which began to be published in 1874; also in the *Transactions of the Seismological Society of Japan*—a society instituted in the year 1880 for the investigation of earthquake phenomena, especially in Japan, where they are of frequent occurrence. Other papers are quoted in the following pages.