The Pacific is surrounded by a zone of volcanic activity, and scattered over its surface there are many active and recent volcanoes—in fact, two-thirds of the active volcanoes of the world are situated in, or at no great distance from the shores of, this ocean. The Atlantic, Indian, and Southern Oceans also offer numerous centres of volcanic activity, either in the oceanic islands or on the coasts of the adjoining continents. In short, one may say that all the important volcanic vents of the globe are situated in or near to the great oceans or the enclosed seas which penetrate between continental masses of land.

In addition to terrestrial volcanoes, it must be admitted that the bottom of the ocean is frequently the seat of volcanic eruptions. Although the conditions of observation are much less favourable than in the case of terrestrial volcanoes, still the evidences of submarine eruptions are very numerous. In many instances the volcanic eruptions in the open sea have been accompanied by sulphurous emanations, by steam, columns of water, flames, ashes, scoriæ, and pumice, and the formation and disappearance of islands. Santorin and Graham Island in the Mediterranean, some islands in the neighbourhood of the Azores, and in recent years Falcon Island in the South Pacific,[1] are but a few of the instances that might be cited of submarine eruptions. Earthquake waves have, in a great number of instances, been placed in direct relation with submarine eruptions.[2] The recent extensive soundings throughout the great ocean basins have revealed the presence of conical mountains, rising to various heights above the general level of the sea-bed, but not reaching the surface of the waters. These conical mountains must, from their resemblance in form to volcanic islands, and from the volcanic materials that have been dredged in their neighbourhood, be regarded as the results of submarine eruptions in deep water. We know that masses of lava have flowed for weeks from volcanic islands into the ocean, but at the present time there is little knowledge of the spaces covered by lava-flows on the sea-bed itself. However, the study of ancient geological formations has familiarised us with the idea of such lava-beds or tufas intercalated between marine sedimentary layers, and there can be no doubt that the same order of phenomena occurs in our present seas.

It would appear, then, that the fragmentary volcanic materials which we find carpeting the floor of the ocean have been derived from both subaerial and submarine eruptions, and that, both from actual observations and theoretical considerations, the oceans of the present and recent geological periods are especially well situated for receiving the products of these eruptions. It is difficult, however, to distinguish the products of subaerial from the products of submarine eruptions. In certain cases the dimensions and numbers of vitreous lapilli, dredged from great depths far from land, indicate that these fragments came from centres of submarine eruption not far removed from the points where they were dredged. In the case, however, of large fragments of pumice or of tufa made up

[1] See *Nature*, vol. xli. p. 276, 1890.

[2] E. Rudolph "Über submarine Erdbeben und Eruptionen," *Beiträge zur Geophysik*, 1887, pp. 226 *et seq.*