

ebullition for the last two thousand years; and we may suppose this fluid mass to communicate with some caldron or reservoir of fused matter below. In the Isle of Bourbon, also, where there has been an emission of lava once in every two years for a long period, the lava below can scarcely fail to have been permanently in a state of liquefaction. If then it be a reasonable conjecture, that about 2000 volcanic eruptions occur in the course of every century, either above the waters of the sea or beneath them,* it will follow that the quantity of plutonic rock generated, or in progress during the Recent epoch, must already have been considerable.

But as the plutonic rocks originate at some depth in the earth's crust, they can only be rendered accessible to human observation by subsequent upheaval and denudation. Between the period when a plutonic rock crystallizes in the subterranean regions, and the era of its protrusion at any single point of the surface, one or two geological periods must usually intervene. Hence, we must not expect to find the Recent or Newer Pliocene granites laid open to view, unless we are prepared to assume that sufficient time has elapsed since the commencement of the Newer Pliocene period for great upheaval and denudation. A plutonic rock, therefore, must, in general, be of considerable antiquity relatively to the fossiliferous and volcanic formations, before it becomes extensively visible. As we know that the upheaval of land has been sometimes accompanied in South America by volcanic eruptions and the emission of lava, we may conceive the more ancient plutonic rocks to be forced upwards to the surface by the newer rocks of the same class formed successively below,—subterposition in the plutonic, like superposition in the sedimentary rocks, being usually characteristic of a newer origin.

In the accompanying diagram (fig. 697), an attempt is made to show the inverted order in which sedimentary and plutonic formations may occur in the earth's crust.

The oldest plutonic rock, No. I., has been upheaved at successive periods until it has become exposed to view in a mountain-chain. This protrusion of No. I. has been caused by the igneous agency which produced the newer plutonic rocks Nos. II., III., and IV. Part of the primary fossiliferous strata, No. 1, have also been raised to the surface by the same gradual process. It will be observed that the Recent strata No. 4, and the Recent *granite* or plutonic rock No. IV., are the most remote from each other in position, although of contemporaneous date. According to this hypothesis, the convulsions of many periods will be required before *Recent granite*, or granite of the human period, will be upraised so as to form the highest ridges and central axes of mountain-chains. During that time the *Recent* strata No. 4 might be covered by a great many newer sedimentary formations.

Eocene granite and plutonic rocks.—In a former part of this volume (p. 230), the great nummulitic formation of the Alps and Pyrenees was

* "Principles," *Index*, "Volcanic Eruptions."