

rocks of the same country may have been poured out in the open air.\*

Although the principal component minerals of subaerial lavas are the same as those of intrusive trap, and both the columnar and globular structure are common to both, there are, nevertheless, some volcanic rocks which never occur in currents of lava, such as greenstone, the more crystalline porphyries, and those traps in which quartz and mica appear as constituent parts. In short, the intrusive trap rocks, forming the intermediate step between lava and the plutonic rocks, depart in their characters from lava in proportion as they approximate to granite.

These views respecting the relations of the volcanic and trap rocks will be better understood when the reader has studied, in the 33d chapter, what is said of the plutonic formations.

#### EXTERNAL FORM, STRUCTURE, AND ORIGIN OF VOLCANIC MOUNTAINS.

The origin of volcanic cones with crater-shaped summits has been alluded to in the last chapter (p. 462), and more fully explained in the "Principles of Geology" (chaps. xxiv. to xxvii.), where Vesuvius, Etna, Santorin, and Barren Island are described. The more ancient portions of those mountains or islands, formed long before the times of history, exhibit the same external features and internal structure which belong to most of the extinct volcanoes of still higher antiquity; and these last have evidently been due to a complicated series of operations, varied in kind according to circumstances: as, for example, whether the accumulation took place above or below the level of the sea; whether the lava issued from one or several contiguous vents; and, lastly, whether the rocks reduced to fusion in the subterranean regions happen to have contained more or less silica, potash, soda, lime, iron, and other ingredients.

We are best acquainted with the effects of eruptions above water, or those called subaerial or supramarine; yet the products even of these are arranged in so many ways that their interpretation has given rise to a variety of contradictory opinions, some of which will have to be considered in this chapter.

*Craters and Calderas, Sandwich Islands.*—We learn from Mr. Dana's valuable work on the geology of the United States' Exploring Expedition, published in 1849, that two of the principal volcanoes of the Sandwich Islands, Mounts Loa and Kea in Owyhee, are huge flattened volcanic cones, about 14,000 feet high (see fig. 640), each equalling two and a half Etnas in their dimensions.

From the summits of these lofty though featureless hills, and from vents not far below their summits, successive streams of lava, often 2 miles or more in width, and sometimes 26 miles long, have flowed. They have been poured out one after the other, some of them in recent times, in every direction from the apex to the cone, down slopes varying

\* Syst. of Geol. vol. ii. p. 114.