

materials, whether liquid or solid, build up volcanic cones by successive layers—a fact which has been established by modern observers in opposition to the notion come down from antiquity, that volcanic hills are produced by an uprising or tumefaction of previously horizontal layers of rock by the action of a force from beneath. First among the gaseous products of volcanoes is watery vapor; water appears not only to be involved in all volcanic eruptions, but to be intimately combined with the lavas, to which, as Scrope has shown, it helps to give liquidity. The water at this high temperature is retained in combination under great pressure but as this pressure is removed passes into the state of vapor, a process which explains the swelling up of lavas and their rise in the craters of the volcanoes. Besides watery vapor, carbonic and hydrochloric acid gases, and hydrogen, both free and combined with sulphur and with carbon, are products of volcanoes. The combustion of the inflammable gases in contact with air sometimes gives rise to true burning mountains—a name which does not properly belong to such as give out only acid gases, steam, and incandescent rocky matters, which are incombustible. The escape of elastic fluids from lavas gives to them a cellular structure, but when slowly cooled under pressure, as seen in the dykes traversing the flanks of volcanoes, the stony materials assume a more solid and crystalline condition, and resemble the older eruptive rocks found in regions not now volcanic. These include granites, trachytes, dolerites, basalts, etc., and are masses of rock which, though extravasated after the manner of lavas, became consolidated in the midst of surrounding rocks, and consequently under considerable pressure. Their presence marks either the lower portions of volcanoes whose cones have been removed by denudation, or outbursts of liquefied rock which never reached the surface. The escape of such matters, and the formation of volcanic vents, are but accidents in the history of the igneous action going on beneath the earth's surface. We shall, therefore, regard the extravasation of igneous matter, whether as lava or ashes at the surface, or as plutonic rock in the midst of strata, as, in its wider sense, a manifestation of vulcanicity, and for the elucidation of our subject consider both those regions characterized by great outbursts of plutonic rock in former geologic periods, and those now the seats of volcanic activity, which, in these cases, can generally be traced back some distance into the tertiary epoch. To begin with the latter, the first and most important is the great continental region which