It has been observed indeed that the fragmentary materials not infrequently contain finer crystals than the accompanying lava.[18]

(3) Volcanic Blocks (p. 239) are larger pieces of stone, often angular in shape. In some cases they appear to be fragments loosened from already solidified rocks in the chimney of the volcano. Hence we find among them pieces of non-volcanic rocks, as well as of older tuffs and lavas recognizably belonging to early eruptions. In many cases, they are ejected in enormous quantities during the earlier phases of violent eruption. The great explosion from the side of Ararat in 1840 was accompanied by the discharge of a vast quantity of fragments over a space of many square miles around the mountain. Whitney has described the occurrence in California of beds of such fragmentary volcanic breccia, hundreds of feet thick and covering many square miles of surface. Junghuhn, in his account of the eruption in Java in 1772, mentions that a valley ten miles long was filled to an average depth of fifty feet with angular volcanic débris.[19]

Among the earlier eruptions of a volcano, fragments of the rocks through which the vent has been drilled may frequently be observed. These are in many cases not volcanic. Blocks of schist and granitoid rocks occur in the cinder-beds at the base of the volcanic series of Santorin. In the older tuffs of Somma, pieces of altered limestone (sometimes measuring 200 cubic feet or more and weighing upward of 15 tons) are abundant and often contain cavities lined with the characteristic "Vesuvian minerals."[20] Blocks of a coarsely crystalline granitoid (but really trachytic) lava have been particularly observed both on Etna[21] and Vesuvius. In the year 1870 a mass of that kind, weighing several tons, was to be seen lying at the foot of the upper cone of Vesuvius, within the entrance to the Atrio del Cavallo. Similar blocks occur among the Carboniferous volcanic pipes of central Scotland, together sometimes with fragments of sandstone, shale, or limestone, not infrequently full of Carboniferous fossils.[22] Enormous masses of various

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[18] Sartorius von Waltershausen, "Sicilien und Island," 1853, p. 328.

[19] But see the remarks already made on volcanic conglomerate, ante, p. 283.

[20] See H. J. Johnston-Lavis, Q. J. Geol. Soc. xl. p. 75.

[21] For the erupted blocks (Auswürflinge) of Etna see "Der Aetna," ii. pp. 216, 330, 461.

[22] Trans. Roy. Soc. Edin. xxix. p. 459. See postea, Book IV. Sect. vii. § 1, 4.