

student may find an advantage in propounding to himself the following questions, and referring to the pages here cited.

1st, Is the rock entirely crystalline (pp. 174, 258, 268), consisting solely of crystals of different minerals interlaced; and if so, what are these minerals? 2d, Is there any trace of a glassy ground-mass or base (pp. 178, 204)? Should this be detected, the rock is certainly of volcanic origin (pp. 282, 297). 3d, Can any evidence be found of the devitrification of what may have been at one time the glassy basis of the whole rock? This devitrification might be shown by the appearance of numerous microscopic hairs, rods, bundles of feather-like irregular or granular aggregations (p. 204). 4th, In what order did the minerals crystallize? This may often be made out with a microscope, as, for instance, where one mineral is inclosed within another (p. 204).⁵⁷ 5th, What is the nature of any alteration which the rock may have undergone? In a vast number of cases the slices show abundant evidence of such alteration: felspar passing into granular kaolin, augite changing into viridite, olivine into serpentine, while secondary calcite, epidote, quartz, and zeolites run in minute veins or fill up interstices of the rock (p. 587). 6th, Is the rock a fragmental one; and if so, what is the nature of its component grains (pp. 224-225)? Is any trace of organic remains to be detected?

§ iv.—General outward or Megascopic (Macroscopic) Characters of Rocks⁵⁸

1. **Structure.**⁵⁹—The different kinds of rock-structures dis-

⁵⁷ It is possible, however, that a crystal inclosed within another may sometimes have crystallized there out of a portion of the surrounding magma of the rock which has been inclosed within the larger crystal (postea p. 514).

⁵⁸ The following general text-books on rocks may be referred to: Macculloch, "A Geological Classification of Rocks," etc., London, 1821. B. von Cotta, "Rocks Classified and Described," translated by Lawrence, London, 1866. Zirkel, "Lehrbuch der Petrographie," two vols. Bonn, 1866. Senft, "Classification der Felsarten," Breslau, 1857; "Die Krystallinischen Felsgemengtheile," Berlin, 1868. Kenngott, "Elemente der Petrographie," Leipz., 1868. A. von Lasaulx, "Elemente der Petrographie," Bonn, 1875. Bischof, "Chemical Geology," translated for Cavendish Society, 1854-59, and supplement, Bonn, 1871. Roth, "Allgemeine und Chemische Geologie," Berlin, 1879. Other works in which the microscopical characters are more specially treated of, are enumerated on p. 193.

⁵⁹ In the 3d edition of Jukes' "Student's Manual of Geology" (1871), p. 93, it was proposed to reserve the term "Structure" for large features, such as characterize rock-blocks, and to use the term "Texture" for the minuter characters,