

the nummulitic or Eocene period. These strata had, in fact, acquired the *transition* texture from the influence of causes which, since their deposition, had modified their internal arrangement.

*Texture and origin of Plutonic and metamorphic rocks.*—Among the most singular of the changes superinduced on rocks, we have occasionally to include the slaty texture, the divisional planes of which sometimes intersect the true planes of stratification, and even pass directly through imbedded fossils. If, then, the crystalline, the slaty, and other modes of arrangement, once deemed characteristic of certain periods in the history of the earth, have in reality been assumed by fossiliferous rocks of different ages and at different times, we are prepared to inquire whether the same may not be true of the most highly crystalline state, such as that of gneiss, mica-schist, and statuary marble. That the peculiar characteristics of such rocks are really due to a variety of modifying causes has long been suspected by many geologists, and the doctrine has gained ground of late, although a considerable difference of opinion still prevails. According to the original Neptunian theory, all the crystalline formations were precipitated from a universal menstruum or chaotic fluid antecedently to the creation of animals and plants, the unstratified granite having been first thrown down so as to serve as a floor or foundation on which gneiss and other stratified rocks might repose. Afterwards, when the igneous origin of granite was no longer disputed, many conceived that a thermal ocean enveloped the globe, at a time when the first-formed crust of granite was cooling, but when it still retained much of its heat. The hot waters of this ocean held in solution the ingredients of gneiss, mica-schist, hornblende-schist, clay-slate, and marble, rocks which were precipitated, one after the other, in a crystalline form. No fossils could be inclosed in them, the high temperature of the fluid and the quantity of mineral matter which it held in solution, rendering it unfit for the support of organic beings.

It would be inconsistent with the plan of this work to enter here into a detailed account of what I have elsewhere termed the *metamorphic theory*\*; but I may state that it is now demonstrable in some countries that fossiliferous formations, some of them of the age of the Silurian strata, as near Christiania in Norway, others belonging to the Oolitic period, as around Carrara in Italy, have been converted partially into gneiss, mica-schist, and statuary marble. The transmutation has been effected apparently by the influence of subterranean heat, acting under great pressure, or by chemical and electrical causes operating in a manner not yet understood, and which have been termed *Plutonic* action, as expressing, in one word, all the modifying causes which may be brought into play at great depths, and under conditions never exemplified at the surface. To this Plutonic action the fusion of granite itself in the bowels of the earth, as well as the super-inducement of the metamorphic texture into

\* See Lyell's Manual of Elementary Geology.