tunnels, passages, caverns, grottoes, and other cavities of many varied shapes and dimensions are formed.

(1) *Alteration of Rocks.*—The processes of oxidation, deoxidation, solution, hydration, and the formation of carbonates, described (pp. 584, 586) as carried on above ground by rain, are likewise in progress on a great scale underneath. Since the permeability of subterranean rocks permits water to find its way through their pores as well as along their divisional planes, chemical changes, of a kind like those in ordinary weathering, take place in them, and at some depth may be intensified by internal terrestrial heat and pressure. This subterranean alteration of rocks may consist in the mere addition of substances introduced in chemical solution; in the simple solution and removal of some one or more constituents; or in a complex process of removal and replacement, wherein the original substance of a rock is molecule by molecule removed, while new ingredients are simultaneously or afterward substituted. In tracing these alterations of rocks, the study of pseudomorphs becomes important, for we thereby learn what was the original composition of the mineral or rock. The mere existence of a pseudomorph points to the removal and substitution of mineral matter by permeating water.[92]

The extent to which such mineral replacement has been carried among rocks of the most varied structure and composition is probably best shown by the abundant petrified organic forms in formations of all geological ages. The

[92] It is not needful to take account here of such exceptional cases as the artificial conversion of aragonite into calcite by exposure to a high temperature. In such paramorphs the change is a molecular or crystalline rather than a chemical one, though how it takes place is still unknown. Pseudomorphs may be artificially formed. Crystals of atacamite ($Cu_4O_3Cl_2+4H_2O$) placed in a solution of bicarbonate of soda are completely changed into malachite in four years. Tschermak's Min. Mitth. 1877, p. 97.