

wise transported by water or other agents from great distances. Large fragments of rock or boulders frequently occur among the finer particles of such soils, which will generally enable the careful observer to determine the direction from which the drifted materials have come, and the very formations from which they were disintegrated. These considerations throw considerable light on the causes which have produced such great variety in the *inorganic* constituents or mineralogical character of soils.

The *organic* matter which is found in variable quantities in all fertile soils, has been derived from vegetable and animal substances—more particularly the former—which, undergoing decomposition after life has become extinct, are intimately mixed with the soil, and constitute the principal cause of its productiveness. A due proportion, however, of the organic and inorganic constituents is necessary in all soils, to adapt them to different crops, and to raise them to the highest state of fertility. From one to sixty or seventy per cent. of organic matter is to be found in most cultivated soils. The latter is an excess formed on boggy or peaty soils, which require the admixture of marl, clay and other inorganic substances, before they can be profitably cultivated. With less than one per cent. of organic matter, a healthy vegetation could not be sustained. It has been calculated that oats and rye will grow and produce a scanty crop on a soil containing one or one and a half per cent. of organic matter—barley, when two or three per cent. is present; but it may be stated that in general a good yielding soil for most kinds of grain crops, particularly for wheat, must contain from eight to ten per cent. of decayed animal and vegetable matter. It should be remembered, however, that it is not any definite amount of mere organic matter in a soil which *alone* constitutes its fertility.

The *inorganic* constituents of soils deserve particular attention, as they perform an essential part in the economy of vegetation. We shall notice more fully hereafter the nature of these substances. All soils may be readily separated into three principal parts. 1. That which consists of coarse gravel and sand, comprising fragments of flint, limestone, &c., with an occasional and variable amount of undecomposed vegetable matter. 2. Finely comminuted sand, denominated by chemists, *silex*. 3. A portion consisting of very fine powder, hence called “impalpable matter,” and consisting generally of the following substances, in variable proportions: (1). *Aluminous earth*, or clay in a state of admixture with other earthy materials, a substance that gives to soils their tenacity and capability of holding water, and constitutes the chief value of clay for the pur-

poses of pottery. (2). All decomposed *organic* matter, whether of vegetable or animal origin: chemists have given to this substance the name of *humus*, which, combining with oxygen, forms humic acid, which, again uniting with lime and other earths, forms what are designated *humates*;—these latter compounds are supposed to perform an important part in the economy of vegetation, yielding up their carbon to supply the wants of the growing plant, although there is good reason to believe that the principal supply of carbon is derived from the atmosphere. (3). *Silica*, which is a compound earthy substance, formed by the union of an element, *silicon* with oxygen. It occurs in a pure form in quartz rock. The difference between the *silica* of the impalpable matter, and the *silex* or sand, previously mentioned, is simply that the one is crystallised and the other not. *Silica* occurs in nature under different forms, thus adapting itself to the different purposes of the living plant. United with potash, it forms that important and useful compound, the silicate of potash, which gives strength and smoothness to the cuticle of the stem of wheat and other cereals—a fact which every intelligent practical farmer will understand and appreciate. (4). A variety of salts, of which the principal are the following: Carbonates of lime (chalk, common limestones, marl, &c.), magnesia, potash, soda, muriate of soda (common salt), and sulphate of lime or gypsum. All these ingredients are more or less found in the ashes of plants, as well as in soils; and they perform important purposes in the nutrition of animals, whose chief support is derived from the vegetable kingdom. For instance, lime is necessary to form bone in the animal, and to give hardness and strength to the shell of an egg; while soda and potash promote bile, and the muriate of soda, that nourishing substance, milk. There are a few other substances not enumerated above, that sometimes occur in soils in small quantities. Oxide of iron, which is an essential element in the blood of animals, is found in variable proportions; and animal matter, so rich in nitrogen, occurs in all surface soils that are not absolutely sterile.

Most cultivated soils contain from 90 to 96 per cent. of their whole weight, when free from water, of inorganic materials. In peat, and the rich forest soils of this continent, the organic matter of course bears a much higher proportion. Now, this earthy part consists principally of three ingredients. 1. *Silica*, or sand and gravel, of various degrees of fineness. 2. *Alumina*, or clay, occurring generally in shaly or slaty masses, more or less indurated; and intermingled with the soil. 3. *Lime*, occurring as a carbonate, sulphate, or phosphate, in the various rocks and marls that are found near the surface.