

Not only rain, but also dew and hoar-frost abstract impurities from the atmosphere. The analyses performed by the Rivers Pollution Commission show that dew and hoar-frost, condensing from the lower and more impure layers of the air, are even more contaminated than rain, as they contain on an average in England 4.87 parts of solid impurity in 100,000 parts, with 0.198 of ammonia.<sup>49</sup>

It is manifest that rain reaches the surface by no means chemically pure water, but having absorbed from the air various ingredients which enable it to accomplish a series of chemical changes in rocks and soils. So far as we know at present, the three ingredients which are chiefly effective in these operations are oxygen, carbonic acid, and organic matter. As soon as it touches the earth, however, rain-water begins to absorb additional impurities, notably increasing its proportion of carbonic acid and of organic matter, from decomposing animals and plants. Among the organic products most efficacious in promoting the corrosion of minerals and rocks are the so-called ulmic or humous substances that form with alkalies and alkaline earths soluble compounds, which are eventually converted into carbonates.<sup>50</sup> Hence as rain-water, already armed with gases absorbed from the atmosphere, proceeds to take up these organic acids from the soil, it is endowed with considerable chemical activity even at the very beginning of its geological career.

Chemical and mineralogical changes due to rain-water.—In previous pages, it was pointed out

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<sup>49</sup> Rivers Pollution Commission, 6th Rep. p. 32.

<sup>50</sup> Senft, Z. Deutsch. Geol. Ges. xxiii. p. 665, xxvi. p. 954. This subject has been well treated in a paper by A. A. Julien "On the Geological Action of the Humous Acids" (Proc. Amer. Assoc. xxviii. 1879, p. 311), to which further reference is made in later pages. See also his excellent paper on the decomposition of pyrites, Ann. New York Acad. Sci. vol. iv. (1888).