Carbonic acid is given out in respiration, and is a product of animal and vegetable decay; and by this means it becomes distributed through the air and waters. The humus acids, among the results of vegetable and animal decay by oxidation, occur in all damp soils in which such decay is going on. The action of these acids has been studied by A. A. Julien.[1] They are effective especially through their affinity for iron protoxide, magnesia, lime, soda, potash, and some other protoxide bases.

a. In water, carbonic acid takes up calcium carbonates from any calcareous material, whether in the state of limestone, or in other conditions, to make calcium bicarbonate for transportation. On evaporation, the bicarbonate again becomes calcium carbonate. The amount taken up is increased by the presence of magnesium or sodium sulphate in the waters (Hunt). The Mammoth Hot Springs contain 0·6254 parts of calcium carbonate in 1000 of water, which is over 4 times as much as pure water saturated with carbonic acid will take up (Russell).

b. It takes the bases — potash, soda, lime — out of a feldspar, thus destroying the mineral to as great a depth in a rock as the carbonated water and air can penetrate, and reduces it to clay. This is true especially of the potash-feldspars, orthoclase, and microcline. The same work is done by the humus acids. The clay results thus: Orthoclase consists of silica, alumina, and potash. In the change it loses the potash and part of the silica, and becomes silica, alumina, and water. Thus the compound, $K_2O.Al_2O_3.Si_6O_{12}$, becomes $H_2O.Al_2O_3.Si_2O_4$, and 1 of water. Half of the water (H_2O) received replaces the potash (K_2O) lost.

c. Carbonic acid decomposes other minerals in a similar way, taking out the protoxide bases. It may thus form a soluble iron bicarbonate in waters, which streamlets may convey to marshes. But only a trace of this iron salt can be held in waters under the existing atmospheric pressure. The humus acids also make, with iron, soluble salts, and do, at present, the chief part of such transportation for the making of bog ores. On the evaporation of the solvent waters, the iron in each case is usually deposited as hydrous sesquioxide or limonite.

d. Further: it is supposed that carbonic and humus acids may aid in the oxidation of the protoxide-iron of a mineral by bringing it to the surface of a mass of porous rocks, so as to make the oxidation possible.

2. *Destructive effects.* — For the reasons stated carbonated water containing humus acids has done a vast amount of eroding work.

(*a*) *Draining out by infiltrating waters.* — The lightest work is the draining of any soluble ingredient out of a rock. Calcareous grains are thus drained from a porous calcareous sandstone, or quartzyte, increasing its porosity. So also calcareous fossils are removed from rocks that admit infiltrating waters, leaving the rock cellular. When a crystalline limestone or marble, a porous rock, consists of dolomite, but contains mixed calcite, all the calcite grains are drained out because they are the most soluble, and the rest are left to fall to loose sand, an effect exemplified in many places over Canaan, Conn., and Berkshire County, Mass. If the fossils of a limestone are made of calcite and aragonite (the latter the prismatic calcium carbonate), the aragonite portion is taken away — a fact first reported by Sorby. Shells of the kind referred to are those of the genera *Pinna, Mytilus,*

[1] On the reaction of the humus acids see A. A. Julien, *Rep. Amer. Assoc.*, 1879.