

acid, furnished by the decomposition of organic substances, or augmented in certain cases by gaseous emanations from submarine volcanic centres. Here all the conditions are favourable for the formation of manganese nodules. In the plastic materials of the broth-like ooze or clay we may picture the reactions that take place. The fragments of rocks and minerals yield earthy and alkaline carbonates, which go into solution along with carbonates of the protoxides of iron and manganese. The carbonates of the protoxides are in turn decomposed, absorbing and combining with oxygen in solution in sea-water; they are precipitated as sesquioxide of iron and peroxide of manganese in the mud, clay, or ooze, whilst clay and precipitated silica represent the insoluble portion of the original mineral. The oozy surface layers of the deposit and the immediately superincumbent water must, from many indications, be regarded as the seat of these reactions.

At whatever point at the surface of the deposit a particle of peroxide of manganese be formed and deposited, this will gradually attract from solution all the manganese in the neighbourhood. It is well known that the higher oxides of iron and manganese possess in an eminent degree the property of taking a nodular or botryoidal form. Especially do they affect this concretionary and dendritic disposition when formed in a plastic or fluid medium, like the deep-sea deposits. In such a plastic mass precipitation commences generally around some solid substance; this first deposit initiates attractive molecular actions, collecting around itself substances of the same nature disseminated in solution in the water of the adjacent layers of the deposit. In this way have originated the nodules in the clays of geological formations, in particular the concretions of carbonate of iron in shales and septarian nodules in clays.

In the deep sea the points of attraction have been nuclei of various kinds, such as sharks' teeth, carbones of Cetaceans, Sponges, and volcanic fragments, as pointed out in the foregoing descriptions. Concretionary deposits of salts of manganese and iron have taken place around these centres in definite well-marked layers of different degrees of purity. There is no reason to suppose that, like, for example, the sphaerosiderites, the deep-sea nodules were deposited as carbonates and subsequently converted into oxides by pseudomorphism; according to our view the oxides have been formed from solution simultaneously with deposition.

As these concretionary deposits must necessarily in the process of formation embrace the surrounding argillaceous matter containing numerous organic and inorganic particles, it is evident that these substances have been inclosed in the body of the nodules with increase in size. The foreign materials thus mechanically inclosed during the growth of the nodules produce zones of a lighter colour, which alternate with darker ones where the manganese is purer and more compact. From the study of the zonary arrangement in the nodules, it becomes evident that the deposit of manganese is more rapid or more abundant at some periods than at others. The dendritic arrangement traversing the earthy zones, pointed out in the description of the microscopic structure, as well as the