

aspect of the demanganised nodules, show, however, that the deposition of iron and manganese during the formation of the nodules has been continuous.

This variation in the abundance of manganese deposited at different times may be explained by the variable quantity of carbonic acid in the sea-water, or the new additions of volcanic materials. Everything seems to indicate that these concretions increase in size with extreme slowness, and during their formation the chemical conditions of the solvent may have undergone many changes. The emanations of carbonic acid from submarine volcanic regions may have varied in intensity, for it is known that such variations take place with terrestrial volcanoes, according to the phase of the phenomena and the distance from the centre of eruption, and in a few deep-sea waters the Challenger found a great excess of carbonic acid.

It has been shown that large numbers of the nodules have two surfaces, separated externally by a median line; the superior surface is relatively smooth, and evidently projected above the clay or ooze, while the inferior one being much rougher and covered with asperities was without doubt plunged in the deposit. The layers of water resting on the deposit must be regarded as almost stationary, while we know that oozy deposits have but little consistence for the depth of at least 6 or 12 inches below the surface. There is a large body of evidence to show that it is in these conditions that the reactions resulting in the formation of manganese nodules have taken place.

In certain geological formations phenomena in every way similar to those taking place in the deep sea are observed; the concretionary substances are observed to have been eliminated from the mass of the rock, and to have accumulated in certain points in the form of nodules. The concentration of silica in the flints in limestones and chalk might be cited as an example. At Station 252 there is a parallel example in the deep sea; here there was a remarkable haul of manganese nodules containing between 20 and 30 per cent. of manganese peroxide, while the light coloured Red Clay in which they were imbedded contained only a trace of this substance, the oxide being entirely concentrated in the nodules. Where manganese nodules occur in greatest abundance, however, the clays are generally of a chocolate colour due to the presence of immense numbers of minute brown grains of manganese, which serve as a pigment to the deposit.

When we turn to a consideration of the remarkable localisation of the manganese in certain regions of the ocean, and of the altered volcanic materials which there accompany the nodules, facts are met with which throw a stronger light on their mode of formation as well as on the source of the manganese. Should it be admitted, for instance, that the manganese comes from the surface where the dissolved carbonates would be, by elimination of the carbonic acid, transformed into oxides and precipitated to the bottom of the sea there to accumulate, this gives no explanation of the geographical distribution, nor of the mineralogical associations of the nodules at the points where they are most abundant. We have repeatedly stated that the decomposition of volcanic products gives rise to clay,