

CHAPTER XXII.

Density of Sea Water—Composition of Ocean Water Salts—Geographical and Bathymetrical Distribution of Specific Gravity—Carbonic Acid, Nitrogen, and Oxygen in Sea Water—Discussion of Meteorological Observations as bearing on Oceanic Circulation.

DURING the whole of the voyage very particular attention was paid to the determination of the density of the water and the study of its variations. In a freshwater lake the variations of density depend only on the temperature and pressure of the water, in the sea they depend also on the saline matter held in solution. The effects of change of temperature and of salinity on the density of water have formed the subject of many investigations, and have been ably and exhaustively reported on by Professor Dittmar in his Memoir.¹ The effect of pressure on sea water had been studied occasionally by Perkin, Aimé, Regnault, and others. A number of experiments on the subject were made by Mr. Buchanan in the compression apparatus supplied to the ship, and also in instruments directly attached to the sounding line. Professor Tait has been, for some time, engaged in determining the compressibility of fresh and sea water at different temperatures and pressures, and the effect of pressure on the maximum density point of fresh water. Preliminary results have been published by him from time to time in the Proceedings of the Royal Society of Edinburgh. When these experiments are completed, as it is hoped they will soon be, when a new form of apparatus expressly devised for the purpose is delivered by the makers, the application to the Challenger observations will be made. It is impossible, without such preliminary work, to attack with any hope of success the problem of oceanic circulation.

If the effect of change of salinity, of temperature, and of pressure on the density of the water be known, it is possible from a determination of its density at any temperature and pressure to deduce its salinity, and further to deduce the density of the same water at any other temperature and pressure. The method and instruments employed in the determination of the density of the water have been fully described in Mr. Buchanan's Report.² The instrument used was a glass hydrometer weighing about 160 grammes (see p. 109). Its stem was 100 millimetres long and 3 millimetres thick, and was divided into millimetres; the volume of the divided portion of the stem was 0.85 cubic centimetres. The weight of the instrument could be increased by attaching small weights to the top of the stem, and the variations in the volume of the instrument with changes of temperature were very carefully determined. When the hydrometer was

¹ Report on Researches into the Composition of Ocean-Water, Phys. Chem. Chall. Exp., part i., 1884.

² Report on the Specific Gravity of Samples of Ocean-Water, Phys. Chem. Chall. Exp., part ii., 1884.