

determinations to which I had occasion to refer above. Following the example of the Norwegian chemists, I measured the surplus base (*i.e.* the base left unsaturated by the sulphuric and hydrochloric acid) by the weight of carbonic acid (CO_2) which it would need to convert it into normal carbonate, and referred it to 1 litre of water analysed. But it struck me that in discussing any series of such determinations, they must be referred to a constant salinity, and I accordingly reduced all my numbers to 100 parts of total salts or 55.42 of halogen counted as chlorine; so that with me 'alkalinity,' as designating a quantity, means 'the weight of carbonic acid (CO_2) present as normal carbonate (*i.e.*, in forms similar to carbonate of lime) in every 100 parts of total salts,' which, on an average of 130 cases, and if the number of parts by weight of carbonic acid be taken in grammes, corresponds to 2.78 litres. Omitting a number of abnormally high or low values, and a few suspected analyses, which left 130 cases for discussion, I found the alkalinity in the whole set to range substantially from 0.140 to 0.164, and then, confining myself to 'surface' waters (meaning waters from depths not exceeding 100 fathoms) and bottom waters, and referring on both sides to 100 samples, I found that alkalinities from 0.140 to 0.148 occur preferably in surface waters, while from 0.148 to 0.160 the bottom waters were in the majority. From a graphic representation¹ showing the frequency of occurrence of certain narrow ranges of alkalinity, I concluded that the most frequently occurring value is

For surface waters,	.	.	.	.	.	.	.	0.146 ± 0.002
For bottom waters,	.	.	.	.	.	.	.	0.152 ± 0.003

which values may be adopted *provisionally*, for the two kinds of ocean water. In fifteen cases I was in a position to compare with one another the alkalinity of a surface water and the bottom water at the same Station. In two cases the balance was in favour of the surface water, the numbers being 0.015 and 0.010 respectively; in one case the difference was *nil*; in the remaining twelve cases it was in favour of the bottom water, the differences ranging from 0.002 to 0.019. According to the above two averages the alkalinity of bottom water exceeds that of surface water by 0.006, meaning of course 0.006 grammes of carbonic acid per 100 grammes of total salts, or 0.014 grammes of lime CaO per 100 of chlorine, if we assume the increase in alkalinity to be owing to additional lime. My determinations of the lime, as stated, had shown the presence of 0.013 grammes of extra lime in deep-sea as compared with shallow waters. The *closeness* of the agreement is of course accidental. That the surplus base in a sea water is not owing entirely to carbonate of lime is too obvious to be specially pointed out. In sea water (as in any mixed salt solution) each base is combined with each acid, and as there are four acids and four bases there must be sixteen salts, the individual percentages of which we have no means of determining. But there are reasons for assuming that the carbonic acid

¹ See Diagram, Phys. Chem. Chall. Exp., part i. p. 136, 1884.