

undoubtedly facilitated the liberation of the carbonic acid, and at the same time the amount of carbonic acid eliminated from sea water by this method was never more than about one half of what Jacobsen found in water of the North Sea under similar conditions? These effects were due to the fact that when chloride of barium is added to a solution containing sulphates and carbonates in suitable proportion, a double salt of carbonate and sulphate of baryta is precipitated, and this salt, as was observed by Rose, is only very slowly attacked even by strong acids. The effect then of the addition of the chloride of barium was, besides removing the sulphates, to remove the carbonate from the carbonic acid with which it was combined, and in this way facilitate its escape, and to preserve the carbonate from attack by the saline solution by transforming it into the more refractory double baryta salt. This result was not foreseen by Mr. Buchanan at the time, but it justifies the presumption that the amounts of carbonic acid found by him in the numerous samples of water examined really do give with considerable accuracy the factor which was sought, namely, the carbonic acid which is present in the water, otherwise than as carbonate. As Professor Dittmar has found that this can be in a great measure eliminated by simple shaking with air at ordinary temperatures, this carbonic acid is rightly looked on as atmospheric.

When the carbonate has been precipitated as double salt by means of chloride of barium, the half-bound carbonic acid thus set free would, if sea water from which the carbonates have been removed, behaved like pure water, be completely eliminated on distilling over about one-eighth of the liquid. Now, although the bulk of it does come over with the first portions of the distillate, a number of experiments made for the purpose of testing the matter showed that, even after 70 per cent. of the liquid had passed, traces of carbonic acid were evolved. This may be due either to the retaining action of chlorides, as was supposed by Jacobsen, or to a slight decomposition of the precipitated carbonate by the boiling saline solution. If the former be the case, then the results require no correction, for they give what was sought, namely, all the carbonic acid not united to base in the form of normal carbonate ( $R_2CO_3$ ); if the latter supposition be true, then all the results are in excess of the truth. Considering the absolute uniformity with which the determinations were made, this error in excess would probably be a constant very small amount which would fall to be deducted from all the results. The results then, as copied from Mr. Buchanan's journal in Professor Dittmar's Report (p. 119), give a maximum value for the loose and half-bound carbonic acid. Any correction which may have to be applied will be subtractive, and probably insignificant.

On looking at the results as tabulated, one is struck at once by their want of uniformity. The great variations in values under similar conditions are certainly real, and not to be explained by defects in the method. Confining the attention for a moment to the quantity found in surface water, and assuming, with Professor Dittmar, the amount of carbonic acid present as neutral carbonate to be 55 mgrm. per litre, it