Believing that in whatever combination the carbonic acid might be present it would be liberated by boiling the water with excess of acid, Mr. Buchanan proposed to determine the total carbonic acid by boiling the acidified water and determining the eliminated carbonic acid. This method was met by the sufficient objection that the carbonic acid so determined would include any that might be present as neutral carbonate, that is, it would include both the molecules of carbonic acid of any bicarbonate which might be present. The sufficiency of this objection lies in the fact that in 1872 the object of determining the carbonic acid in the water was to furnish precise data as to the state of the atmospheric contents of the water or the amount to which the atmosphere available for the creatures living in the water was vitiated, and it was felt that the so-called half-bound carbonic acid of a bicarbonate might be considered as belonging to the atmosphere, but that this was impossible with the other and more closely combined portion.

This being so, Mr. Buchanan lost no time in making such investigations as the short time available would admit of into what might be the cause of the retention of the carbonic acid. It was, of course, well known that if carbonates were present they would account for some portion of the retained carbonic acid, but in view of the negative results which had attended the labours of some chemists who had sought for them, it was evidently important to experiment on other ingredients known to be present in quantity in sea water, and of these the sulphates of lime and magnesia and the chlorides of magnesium and sodium claimed chief attention.

Solutions of these salts were saturated with carbonic acid and distilled either immediately or after an interval of time, and it was found that, as compared with the behaviour of distilled water when similarly treated, solution of sulphate of magnesium exhibited the property of retaining carbonic acid in a marked way like sea water. This being so, Mr. Buchanan drew the practical conclusion that if the carbonic acid is retained whether in whole or in part by the sulphates it will be more easily extracted if these are eliminated. For this purpose, in all the determinations made on board the Challenger, a sufficient quantity (10 c.c.) of a saturated solution of chloride of barium was added to the sample before boiling. The immediately apparent effect of this was that the carbonic acid came away easily and abundantly the moment the water boiled, and passed principally in the first fifth of the distillate; also the liquid boiled down to dryness without any bumping.

As has been mentioned above, one great result of Tornøe's work in connection with the Norwegian expedition was to show that in the waters examined by him the amount of carbonic acid present was insufficient to form bicarbonate with the neutral carbonate which he so easily and accurately estimates by his alkalinity method. It is probable that this holds in the majority of cases, so that the retention of the carbonic acid is accounted for by the dissolved carbonate without the necessity of calling in the assistance of the sulphates. How was it then that the precipitation of the sulphates as baryta sulphate