

This Week's Citation Classic

Menzel D W & Vaccaro R F. The measurement of dissolved organic and particulate carbon in seawater. *Limnol. Oceanogr.* **9**:138-42, 1964.
[Woods Hole Oceanographic Institution, Woods Hole, MA]

Organic carbon in aqueous solution may be measured with a precision of ± 0.1 mg C/l using persulfate as an oxidant. Oxidation is accomplished in sealed ampules. The CO₂ evolved is quantified with an infrared detector. [The SCI[®] indicates that this paper has been cited over 150 times since 1964.]

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March 13, 1979

"In the early 1960s, I became interested in the biogeochemical cycling of organic carbon in the oceans because of the then conflicting interpretations of where and how organic materials are recycled in the deep sea. These interpretations influenced thinking not only on carbon cycling *per se* but on the cycling of associated materials such as oxygen, carbon dioxide, and trace elements.

"Ralph Vaccaro and I, then both at the Woods Hole Oceanographic Institution, wanted to test alternate hypotheses. One postulated that the bulk of carbon in the deep sea was refractory and the other that it was recycled rapidly while maintained in 'steady state' concentration. To accomplish this test we first had to design a method to analyze carbon, as existing methods were laborious and lacked the accuracy necessary to establish possible vertical regional differences. For some six months we tried many variations of high temperature combustion proce-

dures, giving up when problems related to contamination and excessive vapor pressures could not be solved. We then opted to develop a wet oxidation technique which overcame both of these difficulties.

"Choosing an oxidant was easy. We borrowed heavily from the previous work of R.F. Wilson¹ and John Kanwisher, the latter our colleague at Woods Hole. As both researchers had used potassium persulfate for the same purpose the efficiency of the oxidant in seawater had been established. Our innovation was to adapt their procedures, which allowed only one sample at a time to be analyzed, by designing a means of sealing and oxidizing samples in glass ampules so that a large number could be processed simultaneously. The two main difficulties we encountered were excluding combustion products from the sealing apparatus when sealing the ampules and, after combustion, recovering the CO₂ evolved quantitatively. There were many frustrations in solving these seemingly simple problems. To this day most inaccuracies in the method are due to the inexperience of operators in the sealing procedure.

"There is obvious satisfaction to the ego in having authored a frequently cited paper. When this is a 'methods' paper, however, the ego is at least partially deflated. While one can assume that described technologies assist others in their work, the authors of similar papers and I have remarked that interest often seems more in the method itself than in results or concepts that derive from application of that method. In our case more than 2,000 requests were received for reprints of the 'methods paper' and less than 50 for others which addressed the hypotheses we started out to test."

1. **Wilson R F.** Measurement of organic carbon in sea water. *Limnol. Oceanogr.* **6**:259-61, 1961.