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# A Tribute to Thomas M. Church: Exploring Chemical Oceanography in the Coastal Zone—The History and Future

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One can find different historical perspectives on the development of studying the chemistry of oceans as well as names for this study—marine chemistry, chemistry of the sea, marine aquatic chemistry, marine biogeochemistry, or chemical oceanography. It could be argued that chemical oceanography is the most inclusive for an earth science since oceanography itself is an integrated discipline that links the biology, chemistry, geology, and physics together. Regardless of the name, perhaps the first intensive, modern/post-nineteenth century study of the ocean's chemistry was the GEOSECS Program from ca. 1970–1978. The significance of GEOSECS was that it examined the chemistry of the world's oceans from nutrients to radionuclides, and even a few trace elements, but in a physical context of ocean circulation (e.g., Craig 1972). Thomas M. Church (Figs. 1 and 2) was "born" into the GEOSECS world, receiving his Ph.D. in 1970 from Scripps Institution of Oceanography in the laboratory of Edward Goldberg with the first examination of marine barite in the world's oceans. GEOSECS was a "blue water" program, but Tom Church decided to take the road less travelled at the time to examine chemical processes in the coastal zone. The coastal zone has been described, both then and now and always somewhat facetiously, as the "brown ring around the bathtub," but many would argue that this minimizes its importance since it is here where continental weathering products are primarily introduced to the ocean and where many of these same products are also removed. Primary productivity is at a maximum in coastal waters, and human populations and effects are also concentrated here.

Certainly many had studied chemical processes in the nearshore regions before the 1970s, but the first compilation of most aspects of chemical oceanography in these waters

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**Fig. 1** Tom and Karen Church at their wedding on August 26, 1973. Rumor has it that he would later use the cake knife to cut salt marsh sediment cores. But, Karen has fully supported his science adventures for over 43 years

was the 710 page book entitled *Marine Chemistry in the Coastal Environment* edited by Church (1975) after a well-attended American Chemical Society symposium in 1975. This seminal publication focused scientific attention on the long-neglected coastal zone and featured 41 chapters with topics as diverse as physical chemistry, organic geochemistry, radio-geochemistry, and pollution studies. Subsequent to this book, Tom and his students at the University of Delaware and numerous colleagues have published 21 papers on the cycling of radionuclides, trace elements, nutrients, and organic matter in salt marshes, 25 on estuaries, the Delaware being the major focus, 38 on the atmospheric deposition of trace elements, radionuclides and nutrients to coastal waters, and 12 on continental shelf processes.

In honor of his retirement from the University of Delaware, a special session entitled "Trace element and isotope cycling in the coastal environment: 40 years of innovations"

**Fig. 2** Tom Church perfected many of the clean sampling techniques used for atmospheric sampling of trace metals on board research ships. Here Tom is shown wearing a clean suit he fondly called a "sperm suit" in honor of Woody Allen's 1972 movie, "Everything you wanted to know about sex…but were afraid to ask."

was held at the 2014 American Geophysical Union Fall Meeting. Twenty-five posters and oral talks were given, all covering subjects Tom has studied in the past. This special volume includes six papers based on some of these AGU talks, and reading these papers you can clearly see many connections to topics worked on by Tom over his career. Atmospheric deposition of trace elements by wet and dry routes to coastal waters is discussed in the Gao et al. (2016) paper, while estuarine processing of organic matter in the Danshuei Estuary, Taiwan, is discussed by Wu et al. (2016) and mercury cycling in the Delaware estuary is covered in the Gosnell et al. (2016) paper. It should be noted that the Wu et al. (2016) paper was submitted just prior to its senior author's (K. K. Liu) passing, a friend and colleague whom we will greatly miss.

As a consequence of reclamation activities in several estuaries, Jickells et al. (2016) discuss the related effects of such efforts on nutrient and metal fluxes to the global oceans. Although not strictly a marine environment, Baskaran et al. (2016) examine stable and radioactive isotopes in "sinkhole vents" of Lake Huron to quantify the flux of ground water constituents to this coastal freshwater system. Finally, Dr. Church (2016) discusses the use of the radioisotopes of uranium and thorium to quantify the rates of estuarine and shelf processes, including scavenging of colloidal materials to the sediments (reverse weathering) and groundwater/subterranean estuarine discharges. This paper provides a nice glimpse into the future of chemical oceanography in the coastal environment, not unlike the book over 40 years prior to this special volume.

This volume represents another way we can thank Tom for his many significant contributions to the field of chemical oceanography—the infamous Chemical Oceanography Gordon Research Conference Bermuda shorts not withstanding—and wish him all the best in his retirement years.

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