Perspectives on my Career in Organic Geochemistry

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Abstract

I have had the pleasure of studying the organic geochemistry of sediments of lakes and oceans for fifty years. I have especially enjoyed the versatility of organic geochemistry; it can be applied to studies of many kinds of geological sequences and parts of geological time. As an important part of my career , I sailed as shipboard organic geochemist on seven ocean-drilling cruises that recovered organic carbon-rich Cretaceous black shales, Mediterranean sapropels, and upwelling zone sediments. Because most marine sediments contain less than one-tenth of percent of organic carbon, learning more about the properties and the paleoceanographic processes important to the formation of these carbon-rich deep-sea sequences has been a long-term theme of my career. At the same time, I have studied organic geochemical records in lakes, where higher sedimentation rates and greater organic carbon concentrations enable higher resolution investigation of depositional processes than in the oceans. In addition, I have studied of peat sequences, which provide relatively detailed records of the paleoclimatic histories of their locations. In summary, my scientific curiosity has permitted me to be a paleoceanographer, a paleolimnologist, a paleoclimatologist, and above all an organic geochemist.

1. Introduction

I have investigated the organic geochemistry of sediments of lakes and oceans for fifty years. I have especially appreciated the versatility of this discipline; it can be applied to studies of virtually all kinds of geological sequences and to many parts of geological time. I have studied settings as diverse as the floor of the deep-sea to modern coral reefs, peatlands, and soils and materials as ancient as the 1.1 Ga Nonesuch Shale of northern Michigan and as recent as the sediments and biota of modern lakes.

Working in these different areas, I have worn many hats, including those of an environmental geochemist, a biogeochemist, a paleolimnologist, a paleoceanographer, and a paleoclimatologist. How I came to be so delightfully diverse is the theme of this perspective on my career.

2. My Early Exploration of the World

I have been curious about the world and how it works for as long as I can remember. Before I had finished grammar school, I had read the two bookshelves full of back issues of the National Geographic that my parents had accumulated, and I had assembled the typical boyhood collections of American coins, foreign stamps, butterflies, match book covers, and rocks and minerals. I was vicariously traveling world, although my actual travels had been limited to northern New Jersey, where I lived, and the Finger Lakes Region of New York, where my relatives lived. Fortunately, these areas were rich in geological, hydrological, and biological features before shopping centers, expressways, and housing developments covered many of them. My father, who had been formally educated in general sciences at Hobart College and paleontology at Cornell University, was more than happy to share his knowledge of these features with me. I learned about glacial moraines and eskers, the basalt intrusions exposed in the Hudson Palisades and the Watchung Mountains, the rise and fall of the tides on the Jersey Shore, erosional features like Watkins Glen and the Delaware Water Gap, and linear mountain chains like the Kittatinny-Blue Ridge of the Appalachians. I also learned how to recognize and identify the local birds and trees. From my readings of the National Geographic magazines, I knew that these living things were different elsewhere. Although I had little idea of why, it didn’t matter – the differences just made the world an even more wonderful and interesting place that I wanted to experience and explore.

3. Important Stages of My Formal Education

3.1 High School Science Program

Fair Lawn High School was a great place to be in the late 1950s for a student like me who was interested in science. Sputnik was launched in 1957, and the Cold War was raging. The school was progressive and had novel programs to enhance the technical and scientific education of its students that were precursors of the STEM programs of the current generation. They included a host of advanced classes for those who showed any interest or ability in math or science. I was one of the lucky students who liked them all, and I was even luckier to be included in the select dozen who were offered a special two-year course that blended physics and chemistry, two disciplines that are fundamentally linked in ways that traditional science courses usually ignore. Being taught to appreciate some of the ways in which natural and physical scientific phenomena are interrelated was a life-changing lesson that has flavored my thinking the rest of my life.

3.2 Chemistry at Carnegie Tech

When it was time to continue my education, I did not find a university that was as progressive as my high school, so I had to choose a traditional science concentration. I elected chemistry, and I decided to attend Carnegie Institute of Technology, largely based on its being in Pittsburgh, which is farther than I had ever traveled from New Jersey. Yes- I was eager to start seeing the world, even if it was only to the "Gateway to the West", as Pittsburgh is known from its heritage of being the start of many wagon trains that settled the West in the 19th century. The school, now known as Carnegie Mellon University, gave me a strong foundation in chemistry. I have always been impressed and pleased by how much I learned about chemistry from the four years I was at Carnegie Tech. Still, I graduated feeling unsatisfied with the seeming narrowness of a college chemistry concentration compared to the comprehensiveness of my high school science education. Before graduating, I had experimented with a year as a bench chemist in a pharmaceutical company, which I enjoyed but soon found monotonous, so upon graduating in 1964 I enlisted in the Navy rather than returning to industry and waiting to be drafted by the Army and likely being sent to Viet Nam.

4 Three Years in the Navy

4.1 Up and Down the East Coast

My three years in the Navy turned out to be very important to me and my future. For one thing, I started to see a lot more of the world, beginning by going to Officer Candidate School in Newport, Rhode Island. Near the end of this four-month program, students were offered some choices as to what roles they might play in the Navy. I chose Explosive Ordnance Disposal (EOD) – military talk for bomb disposal. My reasons were that it sounded more interesting than driving a ship or being given command of a LSD – Navy talk for a Large Steel Desk, plus unlike other interesting choices like being a pilot or on a submarine, it did not require an extension of service. Of course, it could be hazardous, but the Navy had an extensive training program to lessen the dangers, and it included hazardous duty pay to sweeten the deal. So, upon being commissioned as a new Ensign, I was sent first to temporary duty as a deck officer on the USS Elokomin, a fleet oiler stationed in Norfolk, for a couple of months and then to Underwater Swim School in Key West for a couple more months. Although I was starting to travel and to explore new places, something was missing. That "thing" was a special person whom I had left in Pittsburgh. To correct this lapse in judgement, I proposed to Judy Brown from a phone booth in Key West before I left to start EOD School in Indian Head, Maryland, about an hour south of Washington. We had a whirlwind wedding one weekend in Pittsburgh in May 1965 and then began our lives together in Indian Head. Although the proposal and the wedding were hardly romantic, we more than compensated for this spartan start to our marriage after I finished EOD School in September 1965 and was assigned to Naval Air Facility Sigonella near Catania, Sicily, at the foot of Mount Etna, which greeted us newlyweds with an impressive Strombolian eruption.

4.2 NAF Sigonella

The two years Judy and I were in Sicily were life changing for us and especially for me. Unlike subsequent generations, few young people of our era had much experience with travel abroad. We embraced the pleasures and the challenges of living in Sicily, and we took advantage of as many opportunities to see Europe as we could. We twice drove our 1964 Buick Special from Sicily to Denmark and visited almost all the countries in between by road. These trips were always interesting, both from a touristic perspective and from a practical one. Because few of the now-famous European expressways existed at that time, our “compact” Buick took up over half of the narrow and often twisty roads. In addition to our road trips, we were able to hitch rides on the NAF Sigonella DC-3 to Malta, Spain and Greece. We regularly traveled on the now impossible “five dollars a day”, which exposed us to more of the local culture than traveling in a classier style. When we had completed my two-year tour of duty in Sicily and it was time for me to leave the Navy, we were experienced travel aficionados, and we have been ever since.

My EOD responsibilities at NAF Sigonella were interesting and not as risky as might be supposed. My three-man team occasionally had munitions left over from World War II to render harmless, but most of our duties made use of our training as SCUBA divers. One of our annual activities was to help recover plaster-loaded dummy mines deployed by ships and airplanes on a level part of the continental shelf of the Tyrrhenian Sea between Naples and Rome. We spent every day for a month diving to locate the mines so they could be recovered by a mine sweep and returned to Sigonella to verify that their triggering mechanisms had worked as designed. In between my EOD duties, I resumed command of the LSD that had been assigned to me as Sigonella Weapons Department Administrative Officer, but these dull times were mercifully short.

4.3. Finding a Lost Hydrogen Bomb

An important function of my EOD team was to be prepared for special assignments, and a very special one arose in early 1966 when a US Air Force KC-135 tanker and a B-52 bomber carrying four Mark 28 hydrogen bombs collided over Palomares in southern Spain. Both planes crashed, and the unarmed bombs were dropped, one going into the sea. My EOD team was assigned to a small fleet of ships and sailors that had been assembled to recover and disarm it. After two months of searching, the bomb was found in deep water by the manned submersible Alvin. Because I was billeted on the ship that tended the Alvin, I saw it almost every day, and I became fascinated by what it could do and the people who did it. I asked the person in charge of one of the deep-sea recovery contractors involved with the bomb recovery how I could get started in this fascinating way of life, and he recommended several ocean engineering graduate programs. His advice led me to a life in ocean science.

4.4 Coming Home

Judy and I returned to the States in October 1967 onboard the SS Constitution, first-class passage compliments of the Navy. We left Naples and enjoyed port calls in Portofino, Barcelona, Alicante, Tangier, and Lisbon before heading across the Atlantic for New York. It was a great way to leave Europe, much classier than our former travel style, and it strengthened our travel bug. Because I had missed the enrollment deadline for graduate school, I had to wait to apply until 1968. I spent the intervening year as a bench chemist developing resins for a paint company in New Jersey, which cemented my desire to find something more stimulating and comprehensive than routine synthetic chemistry. Because I had somehow conflated ocean engineering and oceanography, I applied to schools of oceanography, not ocean engineering, during this year. This mistake was fortunate.

5. Graduate School of Oceanography

I was accepted at the Graduate School of Oceanography (GSO) at the University of Rhode Island and matriculated there in the fall of 1968. It turned out that it was the right place for me. Like most oceanography programs, GSO required all first-year students to take four core courses, one each in biological, chemical, geological, and physical oceanography. I had found a university program that mandated a broad, comprehensive education like the combined physics-chemistry course that I had enjoyed so much in high school. I was in academic heaven!

Even better, I started at GSO with John Farrington and John Patton under the direction of Jim Quinn, a brand-new assistant professor. Our laboratory-to-be was an empty room waiting for the two Johns and me to paint. A month or so later, we helped unload a truck full of lab furniture. After Jim had ordered glassware and chemicals and had rounded up a used gas chromatograph, we had collectively assembled the first organic geochemistry lab in Rhode Island. The gas chromatograph was one of the first generation of these important analytical instruments that allow identification and quantification of the molecular components of organic matter. It was central to our research, although we had a love-hate relationship with it. We spent about as much time fixing it as we did using it. It was equipped with a low-resolution quarter-inch packed column common to first-generation gas chromatographs. Separating and identifying the constituents of natural samples was challenging and typically involved analyzing the same sample on columns of different polarities that we packed ourselves. Those were indeed the early days of gas chromatography!

John Farrington describes some of the early work done in the Quinn laboratory in his 2019 contribution to *Perspectives of Earth and Space Scientists*. He recounts how Jim admitted that when he arrived at GSO a month before his first students, he did not know much about oceanography, but he was ready to learn along with us. Although not yet an oceanographer , Jim was fine biochemist and a great advisor. Like the sound foundation in chemistry that I received at Carnegie Tech, I have always valued the biochemical background I received from Jim. In addition, he instilled the importance of attending scientific meetings and building scientific networks in his students.

Being at GSO from 1968 to 1972 was wonderful for me. I loved the flow of ideas between faculty and graduate students in all areas of ocean science. Everyone was interested in what everyone else was doing. Even more exciting, this was the time that the theory of plate tectonics was gaining traction. Now I had some inkling of why the Appalachian Mountains were made up of long, linear features like the Kittatinny-Blue Ridge and how the Hudson Palisades and the Watchung Mountains had been formed. In addition, the significance of Milankovitch orbital cycles to changing the distribution of heat on Earth was becoming appreciated. I now was starting to understand why the continental glaciers that created the moraines of northern New Jersey and excavated the Finger Lakes had repeatedly formed and disappeared. On top of this, my dissertation research taught me some valuable life lessons in addition to scientific skills. I was challenged trying to develop a reliable procedure to explore the lipid adsorption-desorption properties of various minerals. This topic may seem esoteric and distant from earth science, but it’s central to the generation and migration of petroleum. Nothing worked for two years, and then I had it. I finished my research, wrote my dissertation, and finished my PhD in only two more years. This story may not be unusual, but I hadn’t met and conquered such a frustrating roadblock before. It was a good life lesson, one that was matched by yet another lesson from Jim Quinn – your research is not finished until it’s been published! This sage advice led to five publications on my dissertation research that launched my career (Meyers & Quinn, 1971a, b; 1973a, b; 1974).

6. The University of Michigan

I decided to forego the usual postdoctoral position after earning my PhD in oceanography because I had spent two years as an industrial chemist and another three in the Navy. I directly entered the job market, and I joined the faculty of The University of Michigan in fall 1972 as an Assistant Professor of Oceanography. When I arrived in Ann arbor, I was pleased to discover a strong and diverse research community in aquatic sciences that included the University’s Great Lakes Research Division and the NOAA Great Lakes Environmental Research Laboratory (GLERL). I had been recruited and hired by the Department of Atmospheric, Oceanic, and Space Sciences (AOSS), in which the ocean science group consisted of two physical oceanographers, a geophysical fluid dynamicist, a lacustrine inorganic geochemist, and now me. I had had no teaching experience prior to arriving, and I had to learn quickly how to teach. I thought that I knew a lot about oceanography from the courses, many seminars, and two research cruises I had experienced at GSO, but I really learned oceanography when I started to teach it.

After a very rocky start in the fall of 1972, the undergraduate oceanography course became one of my favorites that I continued to teach almost every semester for the next thirty-five years.

The constitution of the AOSS oceanic science group started to unravel before long. Within two years, the two physical oceanographers and the inorganic geochemist had departed, and as the sole practicing oceanographer I was tasked with chairing search committees to replace all three of them. This turned out to be a great opportunity for me to convert the oceanic science group into a sea-going oceanography group. Within a year, Dave Rea, a marine geologist, and Bob Owen, a marine inorganic geochemist, had been recruited, and a year later we added Guy Meadows, a geologist who specialized in surf zone processes. We remained together as a collaborative research and teaching team, eventually in 1987 moving to the Department of Earth and Environmental Sciences. I've always considered myself lucky to have been in the right place at the right time to be able to create a small but productive team of like-minded field scientists at Michigan, although having three search committees dumped in the lap of an untenured assistant professor at one time was more than daunting – it was unfair. As the saying goes, "when life gives you lemons, make lemonade". Life had, and I did!

7. Organic Geochemistry of Carbon-Rich Ocean Sediments

When Dave Rea arrived at Michigan in 1975, he brought more than his expertise as an ocean-going geological oceanographer. He brought a strong interest in participating in the Deep Sea Drilling Project (DSDP) that turned out to be contagious to Bob Owen and especially to me. All three of us eventually sailed on multiple drilling expeditions of the DSDP and its successors, the Ocean Drilling Program and the International Ocean Drilling Program. Between 1980 and 2003, I sailed as shipboard organic geochemist on seven cruises. Working twelve hours on and twelve hours off for two months at sea is not for everyone, but I found shipboard life so stimulating, the camaraderie so special, and the drilling discoveries so interesting that I was always eager to participate again. The drilling cruise experiences opened my eyes to earth science puzzles that I had not known, but that I came to appreciate. I was introduced to the curiously organic carbon enriched mid-Cretaceous black shale sequences that we recovered in the South Atlantic, the North Atlantic, the Indian Ocean, and the Equatorial Atlantic. I became intrigued by the similarities between these unusual marine deposits to the organic carbon enriched Plio-Pleistocene sapropel layers in the Mediterranean Sea (Meyers, 2006). I also started to wonder why the organic-carbon rich sediments deposited under the Benguela Current of the South Atlantic are not found in sediment older than the Late Miocene, neither there nor under other ocean margin upwelling systems (Diester-Haass et al., 2002; Giraudeau et al., 2002). Because most marine sediments contain less than one-tenth of percent of organic carbon, these unusually carbon-rich deep-sea sequences have fascinated me ever since my first drilling cruise in 1980, and learning more about their properties and the paleoceanographic processes important to their formation has been a theme of my career for forty years.

8. Organic Geochemistry of Lake Sediments and Peatlands

8.1 Organic Geochemical Paleolimnology

While I was rebuilding the oceanography group at Michigan, I also started to learn about lake sediments, which was something new to me. Living in the Great Lakes State put me in an appropriate location to study the “Inland Seas”, as the Great Lakes are often called. My paleolimnological education began with a suite of surface and cored sediment samples from Lake Huron that had been recently collected by GLERL. My graduate students and I analyzed the sediment fatty acid and hydrocarbon contents, and we published the results that demonstrated place-to-place and depth-related differences in these biomarker molecules (Meyers and Takeuchi, 1979; Meyers et al., 1980a; Meyers et al., 1980b). These compositional differences were my introduction to the immense value of biomarker proxies to reconstruct paleolimnological processes and histories, an approach that has been another long-term theme of my career.

Another important component of my experiences in paleolimnology arose from a chance encounter with a scientist from the Denver USGS Hydrology Division at a Gordon Research Conference. He invited me to participate in a study of Pyramid and Walker lakes, two terminal lakes in the Basin and Range region of Nevada, that he was organizing. These lakes are remnants of the huge postglacial Lake Lahontan, and they function as large paleo-rain gauges in the arid North American West. The USGS was interested in the hydrologic history of this region because the planned Yucca Mountain Nuclear Waste Repository lies within the Basin and Range, and the former existence of Lake Lahontan is evidence that wet conditions that might jeopardize the integrity of the nuclear waste repository are possible. Our study of the organic matter in a sediment core from Walker Lake indicated that regional climate over the past 150 ky had alternated between arid and moist (Meyers & Benson, 1988; Meyers, 1990). This finding was one of the multiple reasons that work on the Yucca Mountain Site that had started in 1987 was terminated in 2010. It also strengthened my interest in learning more about the processes important to delivery of organic matter paleoenvironmental proxies to lakes and their sequestration in lake sediments.

8.2 Organic Matter Delivery and Deposition Processes

Two important features that distinguish lake sediments from ocean sediments are their higher concentrations of organic matter and their higher accumulation rates. These features allow study of lacustrine depositional details and histories at finer resolution than is possible in marine records. During our study of delivery of organic matter to Pyramid and Walker lakes, my students and I determined the C/N ratios and δ^{13}C values of plants growing in and close to the lakes. By comparison to the compositions of cored sediments, we were able to infer century-scale climate-induced changes in proportions of C_3 and C_4 plants in the watersheds and in the proportions of land-derived and lake-derived organic matter delivered to the sediments over the past 1000 years (Meyers, 1990; Meyers et al., 1998). Similarly, I was able to identify mid-Holocene episodes of increased wash-in of land-derived organic matter in sediments of Seneca Lake, one of the Finger Lakes of New York, that indicated short periods of massive flooding, possibly associated with hurricanes (Meyers, 2002). Taiwanese colleagues and I employed the C/N ratios of organic matter in a sediment core that captured the last 21 kyr of climate history in Taiwan. We concluded that four periods of increased delivery of land-derived organic matter to a small lake in southern Taiwan implied times of intensified East Asia summer monsoon (Yang et al., 2011). More recently, I have collaborated with Chinese colleagues to analyze the biomarker compositions of plants that we expected to be important sources of the organic matter in various geologic archives. In one study, we found that plant debris that is washed directly into a montane lake on the Qinghai-Tibetan Plateau dominates the biomarker contents of the sediments, but in contrast to Seneca Lake and Tung-Yan Pond soil organic matter contributions to the sediments are minor in this small lake (Pu et al, 2017).

8.3 Organic Matter Degradation and Redeposition in Lakes

An important part of deconvoluting the origins of organic matter in sediments Is to evaluate how much its elemental, isotopic, and molecular characteristics have been altered, both by diagenesis and by physical sorting, between its origin and its incorporation into the sediment archives. An effective approach to investigate some of these factors is to employ sediment traps that collect sinking particles and thus reveal potential changes in their organic matter contents at different depths between the surface and the sediments of a lake. I was fortunate to participate in sediment trap studies conducted by GLERL in Lake Michigan that provided samples from multiple locations and several sampling seasons. We found that settling sediment particles carried organic matter from in-lake algal production and from land plant debris washed into Lake Michigan to the lake bottom and that the proportions of lake-produced and land-derived contributions changed with distance from shore (Meyers et al., 1980b, 1984). We also found that the amounts and compositions of the particle-bound organic matter changed with depth, indicating that organic matter degradation and microbial replacement accompanied sinking

(Meyers and Eadie, 1993). Finally, we also learned that near-bottom resuspension and lateral transport of the sediment particles was important in this large lake and led to remobilization and redistribution of the supposedly sedimented organic matter.

The dynamic sorting of the sediment particles that entrain organic geochemical source proxies is particularly important to reconstructing paleolimnologic histories. Early in my lake studies, my students and I documented decreases with distance from shore in the contributions of petroleum-derived hydrocarbons to surface sediments from Lake Huron that we could attribute to preferential settling of land-derived suspended particles during their surface transport (Meyers & Takeuchi, 1979). Similar to the Great Lakes studies, the proportion of land-derived contribution of land-derived organic matter diminishes with distance from the mouth of the Truckee River in surface sediments from Pyramid Lake until the particles that carry it are essentially absent in the deep waters of this large lake (Tenzer et al., 1997). This process is important in small lakes, too. Working with colleagues in Brazil, I verified that sorting of the sediment particles that commonly transport organic matter also occurs quickly with distance from shore in Lagoa do Caçó, Brazil. In the case of this small, oligotrophic lake, organic matter produced abundantly by aquatic macrophytes dominates in sediments from shallow water but does not reach sediments under the open waters of this shallow lake (Sifeddine et al., 2011).

Dynamic particle sorting occurs in the deep waters of lakes, too. In a study designed to evaluate the kinds of *in situ* diagenetic changes might occur to sedimentary organic matter, one of my students and I analyzed organic geochemical properties of five sediment cores from Lake Erie. These cores had been obtained at intervals from 1982 to 2003 from presumably identical 65m locations in the deep eastern end of this large lake. The sediment sequences in the cored locations, although as close together in the smooth depocenter of the lake as navigation systems could achieve, were not identical. Instead, their properties indicated that bottom currents had winnowed the sediments (Lu et al., 2014). This phenomenon has been reported in other lakes and in the deep sea, and it can both be a challenge and a source of new information to paleolimnological and paleoceanographic reconstructions. In the case of the deep basin of Lake Erie, our comparisons of the depositional records showed that the types of organic matter in the five cores were the same, although their mass accumulation rates differed significantly. In short, these records provided reliable histories of the changes in aquatic productivity experienced by the Great Lakes over the past two centuries, but unreliable histories of the magnitudes of the productivity changes.

8.4 Peat Paleoclimate Records

I was approaching my 2007 retirement from The University of Michigan when I was introduced to the organic geochemical attractions of peat sequences. One of the attractions is that these deposits contain at least 40% organic matter, so even small samples contain plenty of material to study. Another is that the peat sequences accumulate rapidly in place. They consequently are not subject to remobilization like subaqueous sediments, and their original organic matter sources are easily identified. These features allow peat sequences to yield relatively high-resolution records of the conditions under which they were formed. One of the early interesting things I learned about peat sequences was that they did not start to accumulate most the world over until around 15 ka as global climate gradually became warmer and wetter after the Last Glacial Maximum. This history underscores the sensitivity of peat accumulation to climate changes.

My education into the paleoclimate potential of peat sequences began when I was invited to Xi’an, China, to help a graduate student interpret and publish the results of her biomarker analyses of peat sequences from three locations in China. I spent two weeks working with the student in 2004, and we continued to collaborate after I left Xi’an. Over the next few years, we published a succession of papers on these three sequences (Zhou et al., 2005,2010; Zheng et al., 2007, 2009, 2011) that showed that changes in the peat-forming plant communities and in their degree of preservation recorded the evolution of local climate at the three locations. The Xi’an collaboration was very rewarding. In addition to introducing me to the paleoclimate potential of peat sequences, It led to my being invited to work with two postdoctoral researchers at Hokkaido University in Sapporo, Japan, in 2008 and then in 2010 to work with several graduate students at the China University of Geosciences in Wuhan. In Sapporo, we added compound-specific δ^2H and δ^{13}C determinations to the *n*-alkane analyses done in Xi'an (Seki et al., 2009, 2011; Yamamoto et al., 2010a, 2010b). My association with the Wuhan group has grown to include studies of other Chinese peat sequences and to associations with a host of young scientists. Foremost among these is Xianyu Huang, who was a senior graduate student in 2010 and has become a leader in the organic geochemical group at Wuhan. He and I have collaborated on studies that have identified novel molecular and isotopic biomarkers that record the history of climate-induced changes in the plant communities and depositional conditions that have shaped peat sequences (Huang et al., 2010, 2012, 2013, 2015; Xie et al., 2013; Zhang et al., 2017; Zhao et al., 2018), and we have explored the controls on *n*-alkane δ^2H values in Chinese peatlands (Huang & Meyers, 2019). In addition to my investigations of Chinese peatlands, I have worked on peat sequences in New Mexico (Cisneros-Dozal, et al., 2010) and in the eastern Russian Arctic (Anderson et al., 2011; Anderson & Meyers, 2012). From these various studies and from my readings about other peat sequences, I have been struck by the general strong similarity of postglacial development of peatlands the world over. At the same time, the widespread existence of place-to-place differences indicates different local responses to the evolution of global climate. Peat sequences are indeed very interesting paleoclimate recorders!

9. Meetings, Conferences, and Networking

Jim Quinn encouraged his students to regularly participate in scientific meetings, and I have followed this advice throughout my career. I participated in the first Gordon Research Conference on Organic Geochemistry in 1970, and I have continued to be a regular participant in this biennial gathering for fifty years. I added the biennial International Meeting on Organic Geochemistry (IMOG) to my schedule of regular meetings starting with the 1979 IMOG in Newcastle, England. I have also regularly attended the annual AGU meeting and have encouraged my students to present the results of their research at this important event.

My participation at the biennial IMOG meetings led to establishing the special working relationship with the Japanese earth science community that I enjoy to today. It began with the relationship that I developed with Ryoshi Ishiwatari of Tokyo Metropolitan University in the mid-80s. The two of us were regularly teaching courses in organic geochemistry, and we recognized the need for a current, comprehensive text on this topic. We agreed to collaborate on such a document, and we further agreed to publish it in an easily accessed journal. The result was a review paper published in *Organic Geochemistry* (Meyers and Ishiwatari, 1993) that became a primer for a generation of organic geochemists and has been cited 1775 times as of the end of 2020. Ryoshi and I have collaborated on other similarly comprehensive works, and we have met often at other IMOGs and in Japan. In addition, he was instrumental in establishing a connection between me and limnologists at Kyoto University that led to my working on with the 911m sediment core obtained in 1982 by the Lake Biwa drilling project. Two important outcomes of my collaboration with my Kyoto colleagues were recognition of evidence of glacial-interglacial climate cycles in the long Lake Biwa core and reinterpretation of its age-scale by comparison to marine glacial-interglacial cycles (Meyers et al., 1993; Meyers & Takemura, 1997).

These and other collaborations have been stimulating, enjoyable, and rewarding. Through them, I was able to explore the world and to learn about many of the fascinating organic geochemical connections between natural and physical sciences. It's been a great ride, and I'm still going after five decades!

10. Key Career Points

In summary, I list here a few points that I consider important to the growth and development of my career:

- I have welcomed and cultivated opportunities to explore the different directions that my curiosity took me. However, I believe that I have avoided becoming unfocused by working to understand the underlying organic geochemical processes that unify the various topics and problems that I have explored.
- I have participated in three or four scientific meetings every year throughout my career. I have found these meetings important to developing the friendships and building the networks that I have enjoyed, and they have provided the essential sounding boards to discuss and refine the results of my studies with colleagues and to learn from them.
- I have embraced as many opportunities to visit and collaborate with other scientists as my responsibilities to my family and university would allow. I have lived and worked in Brazil, China, England, France, Germany, Italy, Japan, Sweden, Switzerland, and Taiwan for extended periods. These visits have broadened my appreciation of international contributions to science and strengthened my professional perspectives.
- When I became Professor Emeritus at The University of Michigan in 2007, I retired from teaching and committee service, but not from scientific activities. To the contrary, I am now able to revisit intriguing topics that I had not fully investigated and to explore interesting new directions of scientific inquiry. I simply have more time and freedom to do what I have enjoyed so much during my life – travel and experience the world and do science!
- Finally, I have tried diligently to follow the sage advice that Jim Quinn, my PhD thesis advisor at GSO, gave all his students – “Your research is not finished until it is published”. After fifty years, I have research that I still look forward to finishing!

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