American Mineralogist, Volume 87, pages 1517–1518, 2002

Preface Remarks to the Reynolds' Commemorative Volume

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This volume of *American Mineralogist* commemorates the scientific work of Robert C. Reynolds Jr. The articles in this commemorative volume show the wide area of clay research impacted by Bob's own contributions. These range from the crystallography of clay minerals; to weathering processes; to the diagenetic and hydrothermal alteration and growth of various clay minerals and their geologic ramifications; to the interpretation of the dating and isotopic geochemistry of clays. Many of the papers were presented orally at the annual Geological Society of America Meeting in Reno in 2000 at a technical session that accompanied his receipt of the Mineralogical Society of America's most prestigious award, the Roebling Medal, which is presented annually to the scientist whose lifetime published research has significantly advanced the mineralogical sciences.

Bob was born October 4, 1927, and was in a high school class of 17 outside Scranton, Pennsylvania, where he was a basketball star. After a stint in the Army Air Force, he met and married RoseAnn, his lifetime companion, supporter, and even lab assistant. Then he graduated from Lafayette College in Pennsylvania, and went to Washington University (St. Louis) to obtain a PhD for a thesis on the metamorphism of olivine gabbros in Norway. He joined the prestigious research team at Pan American Oil Co. in Tulsa, where he commenced his lifelong scholarship on the geologic occurrence and mysterious crystallography of the illite-smectite (I-S) family of clay minerals with his close friend and research colleague, John Hower. In petroleum source-rock shales, this common mineral of the Earth's surface undergoes increases in illite content over the same diagenetic regime of low temperature and pressure in which petroleum is generated in the same shales.

Bob Reynolds, as always, sharing his wide knowledge of clays, here of Devonian shales in Stebbins Gulch , Ohio. Photo by Sylvie Giral.

Bob joined Dartmouth College in 1960 and enjoyed a long fruitful academic career to become active emeritus Professor in 1998. Over his 40 year Dartmouth career he was beloved for his undergraduate teaching of Mineralogy, Historical Geology and of Petroleum Geology and for a limnology and geochemistry field course he co-taught at Lake Powell. Like the proverbial "tree of life" Bob indirectly spawned many directions in clay research through the scores of Dartmouth advanced undergraduate and graduate students he first inspired in his graduate Clay Mineralogy course. The course brought them into Bob's small clay separation and XRD lab across from his office and even required them to write their own elementary computer program for calculating one dimensional X-ray patterns.

Early on, Bob began a task that was to become the forefront of his research effort, to be able to calculate X-ray diffraction patterns of the mixed-layer clays from theoretical first principles. Dartmouth's computing strength and its development of the "Basic" programming language was a nurturing ground to facilitate his unique contributions toward understanding the crystallographic nature of those ubiquitous imperfect clays that are comprised by layers of different mineralogy. His initial paper on the subject (Reynolds 1967) in American Mineralogist presented the methods and the theoretical patterns. This was followed by perhaps the most cited paper in clay science, co-authored with John Hower, on the *Nature of Interlaying in Mixed-Layer Illite Montmorillonites* (1970). In it they compared Bob's theoretical and John's real patterns of I-S values of increasing content of illite layers with depth in the thick shale sequences from Gulf Coast oil wells. At a meeting in New Orleans their realization of the near perfect matches of the patterns laid out on a hotel bed must have been one of those rare magical moments of profound scientific discovery.

In 1984, culminating his pioneering application of computers to X-ray diffraction, Bob completed the user-friendly computer program, "NEWMOD". This revolutionized the practice

0003-004X/02/1112–1517$05.00

of clay science by calculating the basal (00l) X-ray diffraction patterns for most possible mixed-layer minerals depending on the proportions, chemistry and order of stacking of their layers. In 1994, Bob completed his much more complex "WILDFIRE" program for modeling the full 3-dimensional X-ray diffraction patterns (*hkl*) of clay minerals in non-oriented (random) mounts. By its ability to distinguish clay polytypes and quantify the arrangement of cations in the octahedral layer, this too has opened up new fields of clay research for characterizing clays and relating these features to geologic origin.

Some of Bob's papers of the past decade, some published with George Guthrie Jr. and David Veblin, eloquently addressed one of the most exciting quandries in clay science, that is which of the two paradigms best explains the nature of I-S, the mixed-layer one or the fundamental particle one, or some combination. These papers reconcile the different views presented by XRD and high-resolution TEM data (Veblen et al. 1990; Reynolds 1992; Guthrie and Reynolds 1998). In addition to Bob's seminal contributions to the precise crystallography of the clay minerals, there has always been another thread running through his research record. That is the application of clay mineralogy to unraveling geologic history. For example through their extensive study on the Mancos Shale, his student Paul Nadeau and he showed that thick I-S-bearing shale sequences, such as those in the Cretaceous and Ordovician U.S., represent mostly the accumulation and alteration of staggering amounts of volcanic ash distributed as intense pulses through geologic time (Nadeau and Reynolds 1981).

Bob's research with colleagues at Dartmouth extended beyond clays to the geochemistry of watersheds. This work showed how rapidly chemical weathering, promoted by carbonic acid, occurs in the glaciated alpine environment of the Cascades (Reynolds 1971; Reynolds and Johnson, Reynolds, and Likens 1972). This early work can be said to have paved the way for the many studies today of the interplay of orogenesis and weathering in controlling atmospheric CO_2 and climate change. Similar geochemical studies conducted at the Hubbard Brook New Hampshire Field Station first used the term "acidified rain" to invoke the great, and geologically sudden, anthropogenic inputs of atmospheric acids delivered to the New England forests (Johnson et al. 1972).

There is hardly a researcher in clay science whose research has not been impacted by Bob's many and diverse research discoveries. How hampered would our own clay mineralogical research be without his gifts? These include his early insight into mixed –layer clays; his computer programs allowing us to securely characterize natural samples; and the popular text, *X-ray Diffraction and the Identification and Analysis of Clay Minerals* co-authored with his long-time friend, Duane Moore, through two editions. These contributions have added tremendously to our ability to interpret low-temperature diagenetic and weathering processes.

Though these and so many other contributions are readily cited, just as important are those that are not. Many of these came at the annual meetings of our profession's relatively small and coherent Clay Minerals Society, to which Bob has been so dedicated, serving as its president in 1991–1992. Bob has won practically every award offered by the society, each of which comes with the responsibility of delivering a major lecture. He is well known for the great clarity of every one of his presentations. At meetings, he is constantly surrounded by students, young and old, seeking to benefit from his wide knowledge. He always engages us in our research findings and the possible ways to interpret them, and he sees how to relate them to the bigger picture, which consumes him, of how our planet works.

Bob loves the precise practice of science, from asking rocks and the Earth great questions, to formulating research strategies and especially, as his publications so amply show, to taking care to measure reliable data for the answers. He is equally at home in the office, lab and the field, a true whole geologist. His research record has been a work of art. And all the while he has been a generous supporter of a community of searchers and researchers, of students and teachers, one who relishes your discoveries as much as his own. And when the discussions go late into the night, inevitably come his great stories of duck hunting with his dog on the frozen Connecticut, or finding morels in his secret patches of the New Hampshire forest, or his epic motorcycle trips halfway across the continent. What joie de vivre.

It has been a delight to work with the enthusiastic contributors to the volume, and with the many generous reviewers. We are especially grateful to Duane Moore for his general support, and to *American Mineralogist* Managing Editor Rachel Russell ("done is beautiful") and Editor Bob Dymek both of whom encouraged this volume and worked so diligently at all the details to bring it about.

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