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Presentation of the Roebling Medal of the Mineralogical Society of America for 2000 to Robert Coltart Reynolds Jr.

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Mr. President, members of the society, and guests:

The basis of this award, outstanding original research, is readily accessible in the published literature and clearly establishes this man as a superb scientist. Less accessible is the kind of information that makes it possible to characterize this man as a really fine human being as well. He's a humble, unassuming person. Let me give you an example that illustrates Reynolds as a scientist and a human being. When he called to tell me about the announcement of the reward, one of his first remarks was that he was embarrassed to be receiving it before Victor Drits. Then again, just last week, he called to make sure that when I mentioned his development of the program that models 3-dimensional structures, that I should make sure everyone knows that he started from the work of Drits, Cyril Tchoubar, and others. Now, here's a quote from Victor Drits:

> I know Professor Reynolds as a brilliant scientist and without any exaggeration one may state that he is the best known expert in the world of X-ray diffraction analysis of finely-dispersed layer compounds, and first of all, of clay minerals.
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> Actually, Professor Reynolds is a pioneer in the study of mixed-layer minerals by simulating diffraction effects from defective structural models. It is remarkable that his pioneer paper devoted to this problem was rejected at first because it contained so unusual results. At that time it was really difficult to imagine that layers having different structures, different compositions, and different dimensions could coexist within the same crystallites. Even more astonishing was the discovery that such disordered structures were characterized by XRD patterns containing rather sharp and intense reflections. Furthermore, the positions of these reflections did not obey Bragg's law and their apparent *d*-spacing did not correspond to the actual interplanar distances in the sample. Finally, the article was published in *American Mineralogist* (1967) and its publication opened a complete new field in clay mineralogy.

In the same vein, Reynolds says that John Hower taught him clay mineralogy; that Herman Roberson brought him the idea about how to calculate a diffraction profile; that he used Douglas MacEwan's approach; that someone showed him how to program; that Chuck Drake involved him in the Lake Powell project; that Noye Johnson introduced him to the Hubbard Brook project; that it has been the great support of the Dartmouth geology faculty and the great students he's had that have made his career; etc., etc.

There are no pretensions in this man. He will engage fully in conversation with the stranger next to him in a small-town diner as readily as with the president of any organization. And, I know this sounds like the Boy Scout oath, but he really is always civil and fair and reserved in his judgment of others. If you enjoy good conversation, next time you talk with him, bring up the subject of European history, or a dozen other topics, and be prepared to engaged in detailed accounts and comparisons.

The first time I met Rapid Robert Reynolds was in 1980. I was at the University of Illinois on sabbatical to work with John Hower. John fixed me up with an office and said that I would soon have an office mate, but he would not be there for a few days because he was riding his motorcycle . . . from New Hampshire . . . in March. Well, I've seldom spent a more stimulating three months than those with Reynolds and Hower. Reynolds and I became more deeply entangled when, after an editor sent a draft of a book I was trying to write, to Reynolds for an evaluation. At our next meeting, we discussed the book, and he accepted my invitation to join in the effort that produced two editions of *X-Ray Diffraction and the Identification and Analysis of Clay Minerals*.

Let me briefly sketch for you some of his background. Robert Reynolds comes to this award by an uncommon path. Bob was born in Scranton, Pennsylvania, and grew up in tiny Dalton, just 12 miles away. How tiny you ask? There were 16 in his 1945 high school graduating class, 14 of whom had been in the first grade with him. During his high school years his most obvious interest was basketball. Bob perfected his game, and with his teammates, developed a reputation as giant killers. Known to his teammates as Rip, he was the leading scorer on this team that was the district champion his junior and senior years. He approached basketball the same way he would approach the mastering of other skills latter in life, deliberate, careful concentration on the basic elements of the problem. The clearest indicator of what he would become, however, was his interest in chemistry. With the support of a sympathetic principal who allowed him to order chemicals and glassware through the school, he built a chemistry lab that filled one bedroom of his home and certainly rivaled in sophistication the chemistry lab at the high school.

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Except for an A in chemistry, his first pass at academia was a bust. He left Penn State before finishing his freshman year, and joined the army where, he says with just a faint smile, “I served my country by playing basketball and playing the trumpet in the Army Air Force band.” Completing his stint in the army, he enrolled at Keystone Jr. College only a few miles from where he had graduated from high school. Here, having matured a bit, besides playing basketball as captain and leading scorer for the 1948–1949 team, his studies were good enough to gain admittance to Lafayette College in the fall of 1949. It’s there that he first encountered geology and mineralogy under the guidance of James Dyson and Yngvar Isachsen. He was married in 1950 while at Lafayette, which equates to another step toward getting serious about studies. He married Roseann Fabio from Scranton. They had met and become sweethearts while in high school.

Isachsen had earned a Master’s degree at Washington University (St. Louis) and recommended that Bob apply there for graduate school. It was here that fate brought Bob and John Hower together. They met standing in line to register for classes. They became life-long friends in the fullest sense of the word. They both did their theses under A.F. Frederickson, and then both went in 1955 with Frederickson to Pan-Am Petroleum. In 1960, Reynolds joined the faculty at Dartmouth College, and when he retired from there just two years ago, he was the Frederick Hall Professor of Geology and Mineralogy.

Reynolds’s thesis (1955) was titled *Corona development in Norwegian hyperites and its bearing on the metamorphic facies concept.* Both Frederickson and Hower were interested in clay mineralogy and Bob’s early publications suggest that he was shifting from igneous and metamorphic petrology toward low-temperature geochemistry. One of his early interests was the use of boron as a paleosalinity indicator and illite as the most likely recorder of its presence. Then, intrigued with the unusual behavior of a mineral that could swell in one crystallographic direction while maintaining crystallographic integrity in the other two, he studied the ethylene glycol-smectite complex. This marks the beginning of his concentration on modeling the structures of layered minerals. This concentration came into full flower in the paper to which Victor Drits refers, *Interstratified clay systems: calculation of the total one-dimensional diffraction function.* Bob describes the time during which he wrote the prototype for what is now called NEWMOD as lost time. He had never written a program, but of course in the atmosphere at the time at Dartmouth, everyone talked about writing programs. So, as he struggled with this, he relates that he could think of nothing else, see nothing else; Roseann took him to church where he stared into space thinking about the problems of making this program work. He was present, but not present. For two years.

A story that has almost the stature of an urban legend, except that it’s true, is that of Reynolds and Hower meeting in a New Orleans hotel room at the 1967 GSA meeting. Hower had a satchel full of XRD tracings of samples from a well drilled in the Texas Gulf Coast, but with different peak positions that seemed to be a function of depth. Hower pulled one out, spread it on the bed and said to Bob, “Have you ever seen anything like this?” Bob’s eyes lit up and he pulled out a calculated trace and said, “It looks just like that.” And so this epiphany went to the weest hours of the morning, Bob matching each pattern that John could offer. The resulting paper, perhaps the most cited in all of clay mineralogy, *The nature of interlayering in mixed-layer illite-montmorillonites*, they wrote in one week.

This program and its polished successor, NEWMOD, copyrighted in 1985, broke the dam for the analysis of mixed-layered clay minerals. This extremely user-friendly program allowed undergraduates to match experimental patterns with calculated tracings by changing variables such as proportions of the components, by changing the chemistry of the components, and the order and arrangement of stacked layers. Perhaps not too surprisingly, NEWMOD has been found useful for modeling minerals other than clay minerals. A case in point is the 1995 paper by Guthrie, Bish, and Reynolds on modeling of opal-CT, a system of much interest to the petroleum industry. If Reynolds were known for nothing else, his chapter in Brindley and Brown (eds.) *Crystal Structures of Clay Minerals and their X-Ray Identification* would have spread his reputation for clear exposition far and wide based on the numbers of people who have turned to this chapter for instruction. Brindley had come in contact with Reynolds during Reynolds’ struggle to get his 1967 paper published, the one Drits refers to. Brindley was impressed enough to invite Reynolds to write this chapter.

The logical extension of the NEWMOD modeling program, which models the basal or 00L series of peaks of a layered structure, is one that models the HKL series of peaks. And Reynolds has provided this in the form of his WILDFIRE program, copyrighted in 1994, which can calculate the patterns of the polytypes of illites, illite/smectites, and chlorites. It also can model cis- and trans-type occupancies in the octahedral sheet of dioctahedral types of layer silicates. Now mineralogists are finding these newly revealed variations as they look at data with new eyes, eyes provided by WILDFIRE modeling. In addition to seeing manifestations of structural features that had not been noticed before, this provides a tool for dealing quantitatively with degrees of disorder of several kinds, and to begin the task of figuring out what these are trying to tell us about the environments in which they formed.

Bob’s list of publications in clay mineralogy is extensive. His papers are characterized by exquisitely careful lab work, perhaps best characterized by his 1992 paper that quelled the controversy about whether or not we were seeing artifacts of preparation when we looked at XRD tracings, and he clearly demonstrated that we do not. However, his interests are a good deal broader. He has been involved with a consortium of other scientists from 12 disciplines (Potter and Drake, p.18) on the Lake Powell Research Project, from its inception until it disbanded (1971–1976). He continues to be interested in weathering and rates of weathering. His versatility encompasses, in addition to subjects mentioned above, published papers in limnology of Lake Powell and in alpine weathering in the Cascades and temperate weathering at Hubbard Brook in New Hampshire. With Noye Johnson and Gene Likens, in a paper published in 1972, they may be the first to have labeled rain as acid and given us the term acid rain. It’s my very great honor and pleasure to present Robert Coltart Reynolds Jr. to you as the next recipient of the Roebling Medal. He deservedly joins this most distinguished international group of 59 mineralogists.

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