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Acceptance of the 2022 Roebling Medal of the Mineralogical Society of America

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Thank you, Jade Star and William, for your generous words and to all who nominated me for this great honor.

By tradition, I believe an awardee usually takes a few minutes to say something that might be interesting about their career. I would like to share how lucky I have been, in particular, my good fortune in having good mentors, colleagues, and students.

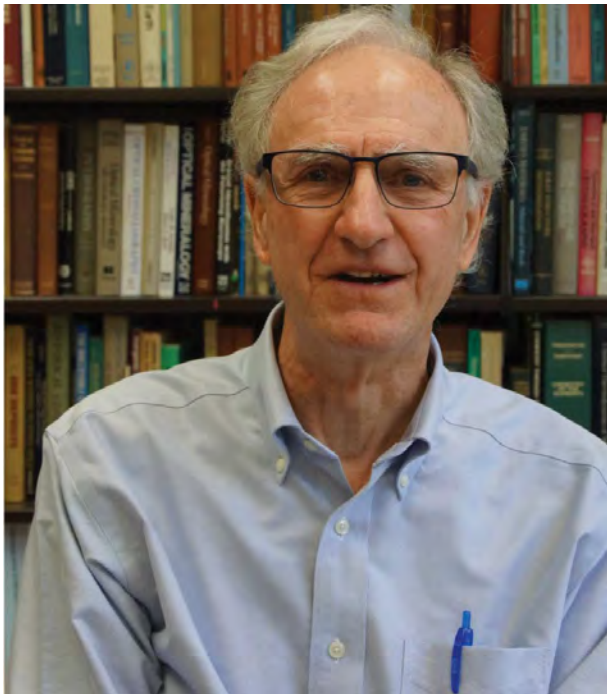
Bob Decker at Dartmouth introduced me to geology, Bob Reynolds taught mineralogy, and Dick Stoiber introduced me to research. This was during the Vietnam War. It was a turbulent period. In the spring of my senior year, 1970, the U.S. bombed Cambodia and National Guard troops killed students on the Kent State campus. To Dick's distress, I withdrew my applications to graduate school and became a carpenter.

It was four years before I was ready to focus on science again. I reapplied to the University of Michigan. I was fortunate. There was a brash new faculty member, who hadn't been there four years earlier, named Eric Essene. Eric introduced me to metamorphic rocks and taught me that if I wanted to understand a rock's history, I needed to understand the constituent minerals. He instilled the rigors of thermodynamics and phase equilibrium. He also encouraged me to join MSA. Eric collaborated widely; his group blended seamlessly with that of Don Peacor and Bill Kelly and included many who remain friends and colleagues, including John Bowman, Steve Bohlen, Phil Brown, Dexter Perkins, John Geissman, and Alan Treiman.

I studied granulite facies marbles from the Adirondacks for my thesis. I tried to map isograds, and that didn't work, but it started my interest in metamorphic fluids. It became clear that water and CO_2 fugacity varied locally, and some rocks were not saturated by a fluid, confounding devolatilization isograds and leading to all sorts of interesting questions that I thought might be answered with stable isotopes.

As it turned out, Eric went on sabbatical my third year and suggested I take the opportunity to learn some geochemistry, but there were no isotope labs at Michigan then (that's hard to imagine now). John Bowman suggested I write Jim O'Neil at the USGS in Menlo Park. Jim generously invited me into his group. This good fortune was transformative. Jim taught me everything about stable isotopes: theory, techniques, applications, and the people. There was a steady stream of guests. Everyone in stable isotope geochemistry visited Jim and wrote something on the wall of his lab.

Another piece of luck relates to a prediction that I got wrong. In the late 1990s, William Peck, Liz King, and I compared the oxygen isotope ratios of magmatic zircons from the Grenville and Superior Provinces and realized that the Archean was less variable and more nearly mantle-like than the Proterozoic. We were



soon joined by Jade Star Lackey and others looking at younger rocks. No one analyzed oxygen in zircons then, so this was new and interesting. It looked like a secular trend. (It turned out later that it is a secular trend.) We decided to analyze the oxygen we could find from Earth. This lead to Simon Wilde and detrital zircons from the Jack Hills of Western Australia that were thought to be Hadean. We needed a testable hypothesis, so I predicted that Hadean zircons would be even less variable than in the Archean and identical to the mantle value. The measurements weren't easy. Zircons are small and complex. I had been working with Colin Graham and John Craven using the Edinburgh Ion probe for 10 years at that point. John Eiler, Lukas Baumgartner, and I had studied diffusion in metamorphic minerals. The precision for $\delta^{18}O$ wasn't great, but I thought it might be sufficient for the zircon project. William and I went to Edinburgh in 1999 and ran the instrument non-stop for 14 days, 24/7, with overlapping 14-hour shifts. I ran graveyard shifts and found the instrument more stable when no one else was in the building. We had five Hadean zircons, including one dated at 4.4 Ga (a not yet reported record that caused considerable discussion), and saved them for last, after every imaginable test. Most of you know how this worked out. My prediction was wrong. The Hadean zircons are not uniformly mantle-like. They record crustal interaction with liquid water. That was a fortunate discovery. It led us to propose

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the Cool Early Earth Hypothesis and testing that became the topic of Aaron Cavosie's thesis. Numerous studies have now confirmed our results, and SIMS analysis of oxygen isotopes in zircons has become common.

We bought a newer generation SIMS in Madison in 2005, and Noriko Kita joined me to direct the WiscSIMS Lab. Again, I was fortunate; she is an artist with the instrument and an excellent scientist. We have focused on improving technique for light-stable isotopes. This complemented my laser-fluorination gas-source mass spectrometer lab; Mike Spicuzza's contributions here were critical. The precision and accuracy of SIMS are now 10 times better than 20 years ago, and many projects are possible. The in situ capability allows us to correlate stable isotope data with other techniques, including imaging, electron microprobe analysis, in situ geochronology and trace element analysis, Raman, and even atom-probe tomography. Again, I have been fortunate to have good collaborators who have taught me and allowed me to branch out to areas in sedimentology, paleoclimatology, and even biology. I regret that I can't name them all in the space allotted.

Before I conclude, I want to thank my wife, Andrée, who is here today. Andrée is a sculptor. She married me 50 years ago when I was a carpenter. This is my greatest good fortune. She has encouraged and assisted me every step of the way.

I'll conclude with a little history of the Roebling medal. I've always admired its elegance. The medal was designed in the 1930s by Avard Fairbanks, then a well-known sculptor, who also designed the "charging ram" hood ornament for Dodge cars and trucks. The automobile/mineralogy connection might seem strange, but it makes sense once you know that Fairbanks taught art at the University of Michigan, hence the relation to Detroit, and would have known Edward Kraus, the first President of MSA who was also at Michigan. By coincidence, Andrée and I received graduate degrees from the same two departments at Michigan 40 years later. The first 65 Roebling medals were struck from solid gold, but now it's a beautiful gold-plated brass. That change was made when I was President of the society. I don't regret that decision. It's "green" and satisfies my New England frugality. The value of the medal goes far beyond how it looks or what it's made of.

We honor Washington Roebling for helping to establish and endow our society, but it's you and the other dedicated members of MSA who make this society vibrant and important. I can't imagine a more meaningful recognition than receiving this award from MSA. I thank you all.