

Presentation of the 2020 Roebling Medal of the Mineralogical Society of America to Andrew Putnis

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The Roebling Medal is the highest award of the Mineralogical Society of America, and it is based on a substantial and long history of research that has significantly impacted our science, broadly defined. I, and a remarkable and internationally diverse set of five preeminent mineralogical scholars (in alphabetical order, Prof. Jay Ague, Yale University; Bjørn Jamtveit, University of Oslo; Prof. J.G. (Louie) Liou, Stanford University; Prof. Hugh O'Neill, Australian National University; and Prof. Ian Parsons, University of Edinburgh), all agree that Professor Andrew Putnis is a fully appropriate and ideal recipient for this historic award. Andrew is currently John Curtin Distinguished Professor, Curtin University, Perth, Australia, and also Senior Professor, Institut für Mineralogie, University of Münster, Germany. Previously, Andrew was Lecturer in Earth Sciences, University of Cambridge, from 1981 to 1995. He obtained his Ph.D. at the University of Cambridge in 1976.

Andrew Putnis and I met more than 30 years ago, and we became very close colleagues well over 20 years ago even though our specific areas of interest are different (petrological for him, environmental for me). Over the years, I have been fascinated with his work, and I have learned a great deal from him in both fundamental and applied domains. He did a short sabbatical with me in Blacksburg in 1994, and I did longer sabbaticals with him in Münster in 1998, 2002, and 2008 resulting in four joint publications that collectively have been cited quite a lot. I am still very close to Andrew, and marvel at his work, continually learning from it and citing it, but for very different applications. I know that this speaks to the sheer brilliance and applicability of his work, which spans thermodynamics, mineralogy, petrology, crystallography, experimental and instrumental science, and even field geology. Perhaps my fascination with Andrew comes because it is nearly impossible to pin him down to an area of specific expertise. In fact, his broad scientific thinking and intuition are second to none, in my experience, and as such, he is simply a scientist's scientist. This also explains why his additional references for this Roebling Medal are from such a diverse, international set of exceptional scholars and pioneers who span generations.

If one tries to classify a truly gifted mind into ordinary categories, which in a way does Andrew a disservice, one comes up with the following.

(1) The solid-state chemistry and physics of minerals, including especially mineral microstructures and nanostructures, as well as phase transformations, order-disorder, magnetism, solid solution, solid state exsolution, TEM for imaging, analytical, and

crystallographic (diffraction) purposes, all used with both modeling (including computational) and experimental approaches.

(2) Surface science of minerals, primarily applied to mineralization and dissolution at interfaces, crystallization inhibitors and promoters, dissolution inhibitors and promoters, much of this brilliantly facilitated with some of the best use ever of atomic force microscopy in the mineralogical and materials sciences along with his wife, Dr. Christine Putnis, a renowned mineral-water interface expert; and

(3) Andrew's crowning achievements, mineral-fluid interactions, including mineral replacement reactions, how porosity is generated, fluid-induced mechanisms of deformation, minor and trace element distribution, much of this related to metasomatism and metamorphism, and mostly applied to natural Earth processes for the purposes of difficult-to-understand and interpret phenomena, but also Earth-related industrial applications, like prohibiting industrial scaling and subsurface contaminant remediation.

The above topics have resulted in a remarkable array of publications numbering into the many hundreds. Andrew is first author on his two most cited papers, and of his 23 most cited papers, he is first author of a quarter of them, which in today's academic publishing climate is quite unusual.

Andrew's most-cited journal article was published in 2002 as a single-authored publication in *Mineralogical Magazine*, entitled "Mineral replacement reactions: from macroscopic observations to microscopic mechanisms." It is certainly a classic. Interestingly, in its first six years, it was cited a reasonable number of times. However, after 2009, the paper was either discovered or adopted (or perhaps both), because since then, it continues to be cited (to this day) at double the average rate after those first years. Clearly, this is not common, and it supports my thesis that Andrew is an original thinker who is most often well ahead of his time. The paper is very special because it is highly conceptual, using deep common sense related to a clever mixture of general chemical/thermodynamic principles, yet visionary at the same time. Andrew, all those years ago, understood *coupled* dissolution-precipitation, thinking about porosity generation, fluids, and relative solubilities of mineral components, fully challenging the accepted belief in solid state reaction dominance in mineral replacement reactions. The phrase "paradigm shift" is overused (and misused), but this is clearly one of those cases where that is the proper descriptor. Andrew's ideas seemed to bear fruit, now backed by experiments and new computations, as well as what is now seen in real rocks when one knows what one is looking for.

Andrew's most cited publication is his 457-page mineralogy "textbook," entitled *An Introduction to Mineral Sciences*, pub-

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lished in 1992 by Cambridge University Press, still in its original edition, but also still reprinted each year because it remains fully relevant. Again, this book is well ahead of its time. It was a two-year project for Andrew, written in Cambridge. Mineral description and identification are missing, but many of the highly quantitative subjects are there, including crystallography, mineral properties from the standpoint of tensors, diffraction and imaging (X-ray and electron based), spectroscopy (NMR, vibrational, electron spin resonance, optical, Mössbauer, and so on), ideal atomic structure as well as defects, thermodynamics and kinetics, and transformation (exsolution and structural). Each subject is covered with great sophistication. But to understand this book, you better be well versed in calculus, have a good grounding in thermodynamics, and an appreciation for solid-state physics would be useful. The fact that this book is *still* cited in the peer-reviewed research literature is stunning. It's a textbook going on 30 years old!

The Roebling is not given for service tasks relevant to the science of mineralogy, and that is perfectly understandable, but it should be noted that, despite Andrew's many seminal contributions to our science, and his remarkable volume of output, he has also found the time to serve our science like very few others ever have. Again, this shows his commitment to his field, being all in for research, for mentorship, and for helping in publishing and funding agency's work, and work well. Just very briefly, he has been Coordinator and/or Partner in eight EU-funded Marie Curie Initial Training Network projects, each involving up to ten European Universities and Industrial Partners, with very large research funding over the last 20 years or so, which is extraordinary. This

has made an enormous difference in the lives of many young Ph.D. students and postdocs, and has helped give them a vital boost in their careers. I have witnessed Andrew working tirelessly in and around these programs, and many new professors, in addition to top-level industrial scientists, have resulted. In addition, Andrew formerly served as Chief Editor of the journal *Physics and Chemistry of Minerals*, and he was the Founding Editor of *Cambridge Topics in Mineral Physics and Chemistry*, not to mention being Associate Editor for other journals. He has organized countless sessions and led many conferences for decades, way too many to list. He has been the host of a stunning seven Humboldt Fellows (me included!). Finally, among many other high-level service roles, he has been on innumerable and various European Research councils, advising on program funding, again for decades. The traveling that he has done just for this is remarkable.

I close with a quote (excerpt) from Andrew's *An Introduction to Mineral Sciences* textbook, just inside the front cover, where he described his new book 29 years ago. This quote is prophetic, as if he was writing it more than a quarter of a century later (i.e., today). Here it describes the essence of his book, which foretold the placement and use of this masterpiece so many years later. It is literally the essence of Andrew's career, or what Andrew taught all of us: "The subject of mineralogy is moving away from the traditional systematic treatment of mineral groups toward the study of the behavior of minerals in relation to geological processes. A knowledge of how minerals respond to a changing geological environment is fundamental to our understanding of many dynamic earth processes."