

Acceptance of the Dana Medal of the Mineralogical Society of America for 2016

SUMIT CHAKRABORTY

¹Ruhr-Universität Bochum, Universitätsstrasse 150, Bochum, NRW 44780, Germany

Once you have digested the news, two lists fleet through your mind—those who have received the recognition before you and those who have not. The first list is daunting and inspirational; the second is humbling. Both remind you of the responsibility the award bestows upon you.

This award recognizes work done on diffusion. Diffusion is about taking a random walk, exploring neighborhoods, and improbable jumps. It is inefficient, unfocused but omnipresent and about the journey rather than reaching a goal. Along the way, it allows one to reach seemingly impossible spaces with extraneous encounters that are enriching. I have been privileged to experiment with that all my life, including throughout my career, and am now even being recognized for it.

With parents in Kolkata, India, who never went to college but supported education despite financial difficulties, it was doubtful at one point whether I would even go to college. From there, to be standing here, defines improbable. I am sorry that they are not here to see this day. My aunt, who saw us through those difficult financial times and much else, has been able to share the surprise.

How did it happen? I have learned that “...it is twice blest; It blesseth him that gives and him that takes,” said originally in a different context, applies to teaching as well. I have been multiply blessed all my life to have outstanding teachers and students, who have taught me with patience and compassion in spite of my failings. I am very glad that many of them are right here today.

It is well and good to hang out and explore, as long as someone pays you to do that. I had the great fortune to find employers in my early career (Jibamitra Ganguly, Fritz Seifert, Herbert Palme) who did not count the numbers of funding dollars I brought in or the number of papers I put out, but described me as “productive” in spite of that. The only way to express gratitude for that generosity is to try to provide the same luxury to the next generation of young scientists; I try to follow those role models the best I can.

“Only you and your advisor believe in timescales obtained from diffusion” was a comment made early in my graduate student career. This was not an isolated opinion, and it meant that finding funds (or jobs!) was and is not easy. Nobody would have funded a proposal to re-measure diffusion coefficients in olivine that had already found their place in textbooks; and it would not have been done, were it not for the generosity of my early employers. Allow me to retrace some steps of the random walk that has brought me here today.

As a high school student, my go-to person for problems in physics and math was Deepanwita, the elder sister of my friend Aniruddha. Once I got to college and had something to tell her that she did not know about, I sat down once and told her at length about plate tectonics. About 30 seconds after I finished

she asked “So why do the plates subduct and go down, and do so along a well-defined plane?” I did not have an answer then and hardly have one now, but it was a very early lesson on how to ask THE critical question.

At college in India, I had an excellent group of caring teachers, but two in particular—Dhrubajyoti Mukhopadhyay and Aniruddha De—taught me that the

complexity of nature was not an excuse for sacrificing clarity of logic in the description of features and processes. De taught me in addition that one looked at thin sections to read processes, and perhaps most importantly, advised me exquisitely in my search for a graduate program.

That search took me to Arizona and Jibamitra Ganguly, who epitomizes the patience of my teachers. The tone was set in my very first exchange with him in India, after I had been accepted in the graduate program at Arizona.

After various topics:

JG: Have you studied any thermodynamics so far?

SC: Yes, of course.

JG: So you know what activity is?

SC: Yes... (will remain unstated)

JG: [Expressionless change of topic].

...discussion continues...near the end of the meeting

SC: So do you want me to do or prepare something before I come to Arizona?

JG: Yes, just try to forget whatever you have learned of thermodynamics—it is easier to start from zero than from negative [Expressionless]

SC: That will be no problem, Sir.

I do not know that many people would have had a graduate student career after that exchange, and that last line haunts me to this day. I have somehow managed to get away with incidents like that through my career. Many more of them were with Jibada, as I call him today.

Totally unplanned on my part, I landed into what in hindsight was an extraordinary program for quantitative petrology with Ganguly teaching mantle petrology, thermodynamics, and diffu-



sion, Tim Loomis teaching diffusion and metamorphic kinetics, and Denis Norton teaching heat and mass transport and fluid-rock interaction. This was squarely rounded off by global geochemistry from Jon Patchett, analytical methods from Joaquin Ruiz, physics of the Earth from Clem Chase and Randy Richardson, Tectonics from Pete Coney, and reflection seismology from Roy Johnson. Outside the department, Mike Drake, John Lewis, and John Jones introduced me to planetary sciences. The late Krishna Vemulapalli at the chemistry department taught thermodynamics in a way that I follow in my own courses today. The steep learning curve was manageable because of a large group of friends in and out of the department—the group included people like Kunal and Sari, Ross, Sheila, Cadi, Karin, Scott, and Larry.

Arizona was followed by Bayreuth, where I landed accidentally again. This was a fourfold explosion of intellectual and technical impetus: the colleagues, the technical and administrative support (not inconsequential, when one has to navigate bureaucracy in a foreign language), the visiting teachers, and the scientists I could travel from Bayreuth to meet. The group photos from the period between 1990 and 1994 that are available on the web document what an illustrious group it was. I co-authored papers with Dave Rubie, Don Dingwell, Ruth Knoche, and Hubert Schulze, but learned from the entire crew. Above all, they provided a wonderful home away from home.

The “visiting teaching staff” I encountered in Bayreuth was formidable and included Dick Yund, George Rossman, Tony Lasaga, David Kohlstedt, and Shun Karato, with each of whom I had extensive interactions. I travelled to several long “time is not money” meetings, where Hermann Schmalzried and Alan Lidiard spent a lot of one-on-one time explaining the intricacies of point defect thermodynamics to me. Several other physicists and material scientists introduced me to details of numerical simulations, statistical mechanical methods, and other facets of diffusion.

Cologne followed, yet again without a formal job application (formal job applications, all through this period, were dead ends). Herbert Palme taught me cosmochemistry and much else for four years, and provided the setting to work with Christof Petry, Stephan Stahl, Astrid Holzheid, Christian Holzappel, Günther Suhr, and most notably, Ralf Dohmen—a connection that has lasted to this day.

I finally got a job as the result of a formal application in Bochum, and there began the chain of research initiatives that maximized output from limited funding—I would like to mention five of these in particular. First, based on the suggestion from a chemist friend, Rajesh Vatsa, I tried to get funding to develop the use of pulsed laser ablation for diffusion experiments. It was not easy, but through the combination of some fortunate coincidence (finding Markus Siegert, someone both Ralf and I knew, was actually using one of those machines meant we could do the proof-of-concept experiments on his machine) and wise advice from Susanne Faulhaber at DFG (who provided the opportunity to respond to criticism), we got the machine that has served us and many other groups across the world to this day.

Second and third, Fidel Costa and Laurence Coogan showed up with an interest in learning diffusion stuff (modeling, experiments, the whole package) without funds and persisted with it.

With each of them I eventually managed to get a project funded to hire a doctoral student—Maren Kahl and Kathi Faak, respectively. I learned about volcanology in the triangle of Fidel Costa, Maren Kahl, and Massimo Pompilio, and about ocean floor petrology with Laurence and Kathi.

Fourth, Somnath Dasgupta had a fellowship and I had a model for disequilibrium melting that I wanted to test in a field area. It eventually led us to Sikkim in the Himalaya, and we realized that we needed help with structure, geochronology, and much else. The team of Dilip Mukhopadhyay, Daniela Rubatto, Robert Anczkiewicz, Fred Gaidies, Claudia Trepmann, and Sudipta Neogi was assembled, with funding only for Sudipta. Nilanjana Sorcar participated as a doctoral student funded from India, and Taras Gerya and Manuele Faccenda pitched in with thermomechanical modeling. Several of these people had their own small research grants and other means to bear the expenses, but we never had collective funding to produce all the publications that did eventually come out.

A final example came with Pranesh Sengupta (a Humboldt Fellow) and Sara Fanara (departmental post-doc). I learned about nuclear waste disposal, and we worked on problems of diffusion and reaction in glasses, melts, and the glass-transition without any funding for those specific things.

During all of this time, a long-term exploration of diffusion in silicates and its implications for reaction kinetics involving minerals continued with Ralf Dohmen. Other than a project I had once with Tom Sharp, with Elke Meissner as a doctoral student, the entire body of work on Fe-Mg diffusion in olivine came out of such unfunded exploration. Ralf has been a solid sounding board through the years for all kinds of ideas ranging from experiments, model, and theory to everyday administrative issues. Hans-Werner Becker, Detlef Rogalla, Ulrich Hoppe, Thomas Müller (Thommy), and Jan ter Heege have been additional supporting forces; and students such as Sascha Borinski, Katharina Vogt, Sabrina Schwinger, Hannah Bobrowski, Joana Polednia, Tim Küsters, Alex Potrafke, Kai Düffels, Jan Sessing, Patrick Remmert, Gerrit Schäfer, Lars Zilch, and Frauke Petersen have taught me much while I advised their theses.

More recently, my interests in the tectonic evolution in the early Earth has been funded, and I find myself learning from Santanu Bhowmik and my current doctoral students—Priyadarshi Chowdhury and Sampriya Basak. Thomas Fockenberger, Hans-Peter Schertl, Heinz-Jürgen Bernhard, Niels Jöns, and Christopher Beyer, the technical and administrative staff at Bochum, and small but regular support from the central administration of the University ensure that we remain productive. Further afield, Bruce Watson, Jamie Connolly, Ben Harte, Ed Bolton, and Barb Dutrow have provided many words of wisdom over the years, and John Craven has been a sheet anchor for our research.

This is an opportunity to express my gratitude to all of the people named above—as should be clear, it was for the love of science that these people participated and persisted. In these times of anxiety about funding for different aspects of our science in the future, my hope is that the narrative provides some confidence that while research grants are important and essential, they need not be rate limiting for scientific inquiry.

Beyond the academic world, I have been fortunate to run a household—if one can call a unit spread over multiple countries

that—with Kathleen where “I have to do a review” counts as part of operations.

And finally, all the education and opportunities are of little use, unless there is someone to call the king naked, and nobody does that better than children. Shomik, at one point in his kindergarten days, would ask me “What did you do today, Baba?” and I gave him a ball-by-ball commentary, not even thinking that he registered much. After about three days of that, which happened to be during one of those difficult stretches in the life of the department, he just burst out laughing and said “You only teach and do meetings, why do you call yourself a scientist?”

I was ashamed. I made it a point to do something every day to earn that designation.

I thank the Mineralogical Society of America and the supportive members of the Dana Medal committee for giving me the opportunity today to renew the pledge in public. That diffusion and timescales would be academically acceptable partners was not a given when the journey began; that it has gained acceptance today is because of many, many individuals who have contributed and only some of whom have been named above. I accept this honor on behalf of all of them as a journeyman award for me. Thank you.