ARTHUR L. DAY MEDAL

Presented to Richard G. Gordon

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Citation by Kenneth P. Kodama

The defining paradigm of how Earth works is plate tectonics. Clearly, the development of the plate tectonic model is a fundamental achievement of the earth sciences. Richard Gordon, the 2002 Arthur L. Day Medalist, has been and is a major contributor to our understanding of the plate tectonics that is occurring now and has occurred in the distant past. Richard's achievements have been in two main areas. His earlier work involved using paleomagnetism to study plate tectonics while his more recent work has evolved to give new, important understanding of the plate tectonic paradigm using a variety of geophysical data.

One of Richard's first contributions, as a graduate student, was to develop a method by which paleomagnetic data can be used to determine the minimum velocity of a plate or continent at times in the past. This method gave the new insight that continents had moved rapidly in the past; hence, the slow motion of continents today is only an accident of present-day plate geometry. This work lead to one of Richard's most important contributions as a young professor, paleomagnetic Euler poles (PEP). With his co-authors, Allan Cox and Scott O'Hare, he developed a method for analyzing paleomagnetic apparent polar wander paths to determine all three components of past plate motion. This approach can give the past positions of a plate in both latitude and longitude, rather than just paleolatitude that results from standard analysis of paleomagnetic data.

Richard has also contributed to a better understanding of true polar wander. He and his colleagues have shown that the hotspot and no-net-rotation-of-the lithosphere reference frames are very similar. His work supported work by others that hotspots have moved in latitude, but went on to show that the Hawaiian hotspot has moved relative to the paleomagnetic and spin axes, an indication of true polar wander. Unraveling the history of true polar wander has important implications for understanding the dynamic behavior of plates and Earth's mantle, as well as interpreting apparent polar wander for paleogeographic reconstructions.

Richard has intensively studied the kinematics of the Pacific plate and furthered understanding of Pacific basin plate tectonics. He has developed mathematical techniques for combining and analyzing heterogeneous paleomagnetic datasets to determine pole positions for Pacific plate apparent polar wander. He has also developed rigorous techniques for analyzing inclination-only data from marine sediment cores and the shapes and amplitudes of marine magnetic anomalies to further constrain past Pacific plate motion. In this work, and in all of his work, one of Richard's hallmarks is his attention to rigorous propagation of errors through his analyses. This attention to error analysis has allowed him to test different hypotheses much more quantitatively than previous workers. Richard worked with co-authors David Engebretson and Allan Cox on a widely cited, award-winning paper that carefully reconstructed the Euler poles describing the motion of Pacific basin plates with respect to the bordering continental plates during the Mesozoic and Cenozoic. This paper has been extremely important to those studying the consequences of plate interactions at the edges of the Pacific basin and is still used today to explain the motion of far-traveled tectonostratigraphic terranes.

Richard's research focus has evolved from ancient plate dynamics to present day plate tectonics. Working with Seth Stein and graduate students, he has developed NUVEL-1 that describes "instantaneous" plate motions of the 12 major plates. This model of instantaneous plate motion is based on a massive dataset comprising spreading rates from marine magnetic anomalies, directions of relative plate motion from transform fault trends, and seismic slip vectors. It is a threefold increase over earlier datasets. NUVEL-1 has given new insights about current plate motion.

NUVEL-1 has had other implications for Richard's research. In defining plate motions over the past 3 m.y., Richard and his colleagues recognized that India and Australia could no longer be assigned to the same large plate. A diffuse plate boundary needs to be located between the two continents in the Indian Ocean. This realization has lead to important and extensive work that has recently redefined our understanding of the plate tectonic paradigm. Richard has suggested a modification of the plate tectonic model in which he defines composite and component plates. The simple lithospheric plates of plate tectonics are now envisioned to be composites that are made up of component plates separated by diffuse plate boundaries. This modification provides new insights about basic assumptions of plate tectonics; it is showing exactly how rigid the lithosphere is.

I've known Richard since he and I were graduate students together at Stanford. He's always shown an intensity and strong dedication to his work, but beyond that to Earth sciences and to science, in general. He actively promotes the recognition of other scientists for their contributions. It's an honor to be his citationist today.

Using geophysical observations, Richard Gordon has made many important, significant contributions to our understanding of how the Earth works. He has been at the forefront of collecting new data sets that illuminate our understanding of plate tectonic processes, but more importantly he has framed scientific questions about plate tectonics in new ways. He is well-deserving of the Arthur L. Day Medal.

Response by Richard G. Gordon

If I was allowed to be so presumptuous as to pick any one honor I might receive in my professional life, the Arthur Day Medal would be it. It pleases me enormously to be recognized for the application of physics to the solution of geologic problems (I make no pretense about the chemistry part), and it's humbling to see the list of past medalists, which includes a great many of my personal heroes in geoscience. I am thrilled to be receiving this award.

My interest in active tectonics and geoscience may have its roots in having grown up in the foothills of the Diablo Range in California, between the Calaveras and Hayward faults, and as a 12-year-old having gone on several eye-opening and memorable natural history field trips along the California coast, in the Mojave Desert, in the Sierras, and in the Basin and Range. My interests in Earth remained dormant, however, until I made a short move to the west of the San Andreas Fault to attend the University of California at Santa Cruz, where as a junior I took an introductory geology class from Casey Moore and introductory geophysics classes from Rob Coe and Eli Silver. I was hooked, and still am. I next crossed back over the San Andreas fault to do graduate work at Stanford, where I learned much both from the faculty and from my fellow graduate students.

As scientists, to separate what we know from what we think we know can be a delicate endeavor, and has been a task with which I have often been confronted in my research. I was fortunate at Stanford to be able to see how Allan Cox, my thesis advisor, thought both rigorously and creatively about data, especially paleomagnetic data . Allan, who himself received the Day Medal while I was his student, also set a high standard, through his example, of how to write clearly about complex subjects. I learned much from him, but probably not as much as I should have. One lesson, which I had to wait a few more years to learn is that it is not enough to have convinced oneself that one is right—to be effective you also have to convince nearly everyone else. This has caused me to try to further raise the level of rigor, documentation, and clarity in my papers. Seeking these higher standards has also caused me on occasion to realize that I wasn't as right as I initially thought that I was. I hope that receipt of this award indicates that I've at least had some partial success, however.

The Day Medal recognizes a body of work and thus recognizes the contributions of the many scientists with whom I have collaborated and without whom I wouldn't be receiving this honor. My own former students with whom I have published papers being recognized today include Laurel Henderson, Phil Bryan, Gary Acton, Katerina Petronotis, Alice Gripp, Dezhi Chu, and Jim Lemaux. I want particularly to acknowledge two outstanding former students with whom I have had long-running and enormously productive collaborations—Donald Argus and Chuck DeMets. For the determination of the NUVEL-1 set of relative angular velocities of the plates, Don was the lead worker for the Atlantic Ocean and Chuck for the Pacific and Indian Oceans. The two of them literally divided and conquered the globe.

I have had the good fortune to collaborate with David Engebretson, who is a very creative scientist and was a fellow graduate student at Stanford. I first learned about the deformation in the equatorial Indian Ocean from Seth Stein, a colleague of boundless energy with whom I collaborated for many years. I have enjoyed synergistic collaborations on Cenozoic and Cretaceous global plate motion with Donna Jurdy and Roy Livermore. During the past decade my main collaborator, aside from my students, has been Jean-Yves Royer, who is a master of the art of quantitative plate reconstructions. It is with sadness that I acknowledge another wonderful colleague, Stephen Zatman, who died three months ago at the age of 30 in an automobile accident. Stephen and I, in part with Mark Richards and Mark Jellinek, made some real progress in understanding various aspects of the dynamics and rheology of diffuse oceanic plate boundaries during Stephen's last two and one-half years.

Before I conclude, I want to give special thanks to my citationist Ken Kodama. As he mentioned, he and I were in graduate school together. What he diplomatically did not tell you was that, to complete his thesis work, Ken had built an oven for the thermal demagnetization of paleomagnetic rock samples. Ken graciously loaned me his oven to demagnetize some of my own rock samples. One evening I left it overnight to run at a temperature higher than it had been used before. In the morning I discovered that it had caught fire. Fortunately the fire died out without triggering the sprinklers that would have ruined the entire laboratory. Unfortunately, however, Ken's thesis work was delayed several months until I was able to rebuild the oven. That Ken nominated me for this award probably means that he has forgiven me, at least I hope so.

The past 25 years have been an exciting time to be a geoscientist, and I am looking forward to the next 25. I thank my family and loved ones, my students and colleagues, the scientists who took time from their busy schedules to write supporting letters, the committees responsible for selecting the Day Medalist, the GSA, and all of you.