

ABOUT AGU

Frost, Goldstein, and Korenaga Awarded 2006 James B. Macelwane Medal

Daniel J. Frost, Jerry Goldstein, and Jun Korenaga received the James B. Macelwane Medal at the AGU Fall Meeting honors ceremony, which was held on 13 December 2006 in San Francisco, Calif. The medal is given for significant contributions to the geophysical sciences by an outstanding young scientist.

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Citation for Jerry Goldstein

Jerry Goldstein is one of the most exciting young researchers in space physics today, and his work has significantly advanced understanding of the Earth's magnetosphere. In particular, Jerry is widely recognized as the leading authority on the structure and dynamics of the Earth's plasmasphere, the region of cold plasma of ionospheric origin that is trapped in the inner portion of the magnetosphere.

The foundation for his innovative work on the plasmasphere began at Dartmouth College (Hanover, N.H.), where, under the guidance of Mary Hudson, he performed his thesis research on global oscillations of the geomagnetic field driven by sudden increases in the dynamic pressure of the solar wind. This research provided important observational constraints on the mechanisms by which cold ionospheric plasma fills magnetospheric flux tubes, ultimately forming the plasmasphere.

After Dartmouth, Jerry began a postdoc at Rice University (Houston, Tex.) just as the IMAGE spacecraft was beginning to return the first-ever global images of the inner magnetosphere, including extreme ultraviolet images of the helium component of the plasmasphere. Among the several new discoveries made possible by global imaging was the existence of a distinct plasmaspheric 'shoulder' that forms in the early morning sector during magnetic storms and then corotates with the Earth. Jerry, working with Dick Wolf and others at Rice, used the Rice Magnetospheric Specification Model to demonstrate how such shoulders form in response to northward turnings of the interplanetary magnetic field. Until this result was obtained, the plasmopause was generally thought to lie too far inside the magnetosphere to be affected so directly by solar wind conditions.

In 2002, Jerry moved from Rice to the Southwest Research Institute, in San Antonio, Tex., where he is now a principal scientist in the Space Science and Engineering Division. Since that time he has published 37 definitive papers on various aspects of plasmaspheric structure and dynamics and on the interaction between the plasmasphere and other regions. Especially noteworthy is



Jerry Goldstein

his discovery of the relationship between fast flowing plasma streams in the subauroral ionosphere and the formation and evolution of plasmaspheric drainage plumes during geomagnetic storms. His collaborations with John Foster (Massachusetts Institute of Technology) and Dan Baker (University of Colorado) led to the discoveries of the effect of storm-time plume formation on ionospheric total electron content and of the spatial relationship between the outer radiation belt electrons and the plasmopause, respectively. These latter two accomplishments have important implications for our effort to predict space weather and to mitigate its effects on our communications and navigation systems.

Jerry's talents and contributions are well appreciated by his colleagues, and he is a frequently invited speaker at national and international meetings. He is one of the most active and influential participants in the NSF-Geospace Environment Modeling program, which aims to create linked, physics-based models to describe and predict the dynamic space environment, from the Sun to the atmosphere. He is generous with his time, insightful in his contributions, and unflaggingly curious about how all the pieces of the solar-terrestrial puzzle fit together. Jerry possesses a remarkable facility in data analysis and modeling and has an uncanny ability to absorb and synthesize disparate concepts and observations into compelling insights that result in scientific break-

throughs. These qualities, along with his infectious enthusiasm, make him a scientific leader in our field today, with great promise for tomorrow.

—JAMES L. BURCH, Southwest Research Institute, San Antonio, Tex.

Response

I thank Jim Burch for his very generous citation, and I extend gratitude to my nominating committee (Michelle Thomsen, Dick Wolf, Mary Hudson, Pat Reiff, and Bill Sandel) and to AGU for generously endorsing my nomination.

I am honored, touched, and thrilled to receive the James B. Macelwane Medal. It seems strange to be singled out for recognition, given that any achievements of mine would never have been possible without the many teachers, mentors, and friends who have helped me along every step of the way. As a student, I was very fortunate to work under the guidance of researchers who are both brilliant and kind: first, my undergraduate advisor, Peter Lesser, at Brooklyn College (New York), and then my Ph.D. advisor, Mary Hudson, at Dartmouth College (Hanover, N.H.). As a postdoc it was my privilege to be hired by Pat Reiff and Tom Hill to work with the extraordinary group at Rice University (Houston, Tex.).

My good fortune continues to this day: collaborating with Southwest Research Institute colleagues (including Jim Burch, Dave McComas, Bill Lewis, and Phil Valek) and many, many others in the community (Maria Spasojevic, Pontus Brandt, Michelle Thomsen, Dennis Gallagher, Stephen Mende, John Foster, Dan Baker, Stephen Fuselier, Richard Denton, Mike Liemohn, Bob Spiro, and Joe Perez, to name just a few) has demonstrated to me the essential contribution of peers to an enduring and fulfilling career in science.

I am deeply grateful to the many outstanding members of our community who have been exceptionally generous with their time, their data, and their knowledge. As a younger scientist I am indebted to the real trailblazers of our field, having relied heavily upon decades of research by pioneers such as Don Carpenter and Dick Wolf, and having taken advantage of the new data and new mission opportunities provided by innovators such as Bill Sandel and Jim Burch. I do not feel as though I have discovered anything new as much as benefited from the wisdom and accomplishments of these far more experienced and talented people.

One of the things I enjoy most about our community is that we value more than anything else the quality of ideas. In science, the message supersedes the messenger, and we all have equal voices and equal opportunities. This attitude has fostered in our field a culture of openness and acceptance that is to me quite precious, on both a professional and personal level. After many years of working side by side with so many excellent

scientists, conferences feel not as much like professional occasions as they do family reunions. I have had the rare opportunity to travel all over the world to meet new colleagues and make new friends. I have learned just how much our community values honesty, integrity, humor, and partnership in the search for truth. Indeed I am grateful to be recognized and accepted by such a distinguished group. Thank you very much indeed for this great honor.

—JERRY GOLDSTEIN, Southwest Research Institute, San Antonio, Tex.

Citation for Daniel J. Frost

It is a very great honor to present my good friend and colleague, Dan Frost, one of the three recipients of the James B. Macelwane Medal in 2006. Dan is first and foremost an experimental petrologist who studies problems relating to the mineralogy, petrology, structure, and evolution of the Earth's mantle and core. He got off to an excellent start during his Ph.D. by studying H₂O-CO₂ fluids under mantle conditions at the University of Bristol, U.K., under the supervision of Bernie Wood. He then moved to the Geophysical Laboratory at the Carnegie Institution, Washington, D.C., for 1 year where he greatly expanded his experience by studying the stability and equations of state of hydrous mantle minerals using a broad range of high-pressure experimental techniques. He has been at the Bayerisches Geoinstitut, University of Bayreuth, Germany, since 1997 and is a staff scientist responsible for pursuing research, supervising and developing the high-pressure multianvil laboratories, and collaborating with a large number of external users of this facility.

Over the past few years, Dan has contributed to the understanding of a wide range of geophysical issues, including the width and mineralogical structure of mantle discontinuities, the cycling of water in the Earth's interior, the mineralogy and properties of the lower mantle, early differentiation of the Earth including core formation and magma ocean crystallization, and the composition (light element content) of the outer core. As an example, in one of his most important contributions he showed that a very small amount of metallic iron must coexist with silicate perovskite in the Earth's lower mantle. The explanation for this phenomenon is the dissociation of ferrous iron to a mixture of ferric iron plus metallic iron at high pressure due to the crystal chemistry of silicate perovskite. His contribution provides elegant explanations for the oxidized nature of the Earth's upper mantle and why the mantle became oxidized during or after formation of the Earth's core. There may also be implications for the composition of the atmosphere, although these have yet to be explored.

Dan's scientific productivity has been extraordinary in recent years, with numer-

ous published papers, including four in the journals *Science* and *Nature* in the period 2004–2005. This productivity can be attributed to a number of factors. First, he possesses the ability to identify major problems that are of broad interest to solid-Earth geophysicists. Second, he is not only an extraordinarily careful and innovative experimentalist but he also has the ability to develop sophisticated thermodynamic models in order to interpret and extrapolate experimental data on a sound basis. Third, his outgoing and sociable personality has enabled him to develop numerous productive collaborations with scientific colleagues from all over the world, including in the United States, Japan, United Kingdom, France, Austria, and Italy.

Dan is still at an early stage of his career, and I anticipate that the future will have much to offer in terms of his scientific contributions. In the meantime, I am thoroughly delighted that he is one of the recipients of the 2006 Macelwane Medal in recognition of his scientific leadership, creativity, and enthusiasm.

—DAVID RUBIE, Bayerisches Geoinstitut, University of Bayreuth, Germany.

Response

Thank you, David, for such a kind citation, and thanks to the James B. Macelwane Medal committee and those who wrote supporting letters for their time and consideration. A medal always has two sides, as they say in Germany. On the one hand, it is a really special honor for me to be recognized by such a diverse and eminent organization as AGU. On the other hand, considering the roll call of previous medal winners, one is immediately struck by the great responsibility of in the future not appearing the odd one out on this list.

I am quite sure that I would not be receiving this medal if I had not chosen to do a Ph.D. with Bernie Wood, in Bristol. At the time I was not equipped with the knowledge to make such a good decision, so I consider this to have been pure good luck. I became hooked on doing high-pressure experiments while in Bristol, mainly, I think, because Bernie conveys that sense of excitement and satisfaction from learning something new from an experiment. This is definitely what makes experimental science so much fun for me, and it is such a bonus that I can do it for a living. An experimental habit is quite expensive, however, and I was very fortunate to be able to hone my skills by working subsequently with Yingwei Fei at the Geophysical Laboratory. There is a large amount of what is probably best described as tricks in high-pressure experiments, and Fei is a master of them and passes them on so generously.

It has been a real privilege to spend the past 8 years at the Bayerisches Geoinstitut. In Bayreuth I have learned so much through collaborations with Joe Smith, Steve Jacob-



Daniel J. Frost

son, Reidar Tronnes, and Falko Langenhorst, to name but a few. The word limit here prohibits me from naming all the collaborators and friends who have made my life in Bayreuth so fulfilling and productive over the past 8 years, but I must also mention Christian Liebske, Tiziana Boffa-Ballaran, and Jürgen Konzett. The steady flux of post-docs and other visiting scientists who pass through Bayreuth really ensures that it remains a vibrant and exciting place. The only downside is that over time you see so many friends move on. What has remained constant from the beginning, however, has been the guidance and friendship of David Rubie, who has been always been so generous with his support. I also recognize that the multianvil laboratory would be just a heavy rusting heap without the financial support of the Bavarian State, the DFG, and the European Union Research Infrastructure program.

It is hard sometimes for my wife, Barbara, and our family to understand why my work is so important for me, so it is great to have something tangible to show them as evidence that their support and patience over the past years were at least to some extent worthwhile.

—DANIEL J. FROST, Bayerisches Geoinstitut, University of Bayreuth, Germany.

Citation for Jun Korenaga

In a 1964 *Science* essay, "Strong inference," the biophysicist John Platt elucidated how "certain systematic methods of scientific thinking may produce much more rapid progress than others." Strong scientists entertain multiple hypotheses, as Thomas Chamberlin advised; they produce predictive models that can be tested and rejected, as Karl Popper required; and they filter out false hypotheses using diagnostic data, as Louis Pasteur so brilliantly demonstrated.

Jun Korenaga has shown how a young scientist can deliberately equip himself to make strong inferences about the solid Earth. As a

Ph.D. student in the Woods Hole Oceanographic Institution-Massachusetts Institute of Technology (MIT) Joint Program, he was marvelously ambitious. Not content with a standard thesis project, he conceived an entire research program, for which he recruited not just one or two, but three, advisors—Steve Holbrook, Peter Kelemen, and myself. The problem he chose was the creation of the North Atlantic igneous province during the early Tertiary rifting of Greenland from Europe.

In 1996, he went to sea with Steve on the SIGMA expedition, collecting reflection and refraction data across the southeast Greenland continental margin. He interpreted this rich data set using novel inversion schemes of his own formulation. His results indicated that the thickened basaltic crust was produced by melting at relatively low temperature, at odds with the popular plume-head hypothesis.

With Peter, he considered basalt petrogenesis in more detail. They demonstrated that the trace-element signatures of high-magnesium basalts erupted since the opening of the North Atlantic, when corrected for olivine fractionation and combined with isotopic data, require long-lived major-element heterogeneity in the mantle source. Jun has since shown that this heterogeneity can be explained by subducted oceanic crust buoyantly trapped in the midmantle transition zone and subsequently entrained in the active convection caused by continental breakup.

Numerical modeling of this breakup process constituted the third component of Jun's thesis. He was able to show how thick cratonic lithosphere can modulate small-scale convection in the upper mantle without reducing convective strength, and he used this mechanism to explain the excess magmatism during North Atlantic rifting.

Jun made rapid progress in numerical studies of convection during his postdocs at MIT and the University of California, Berkeley, deriving new scaling relations for the onset and breakdown of small-scale convection that properly account for the strong temperature and depth dependence of upper-mantle viscosity. These investigations elucidated upper-mantle convection beneath large ocean basins and set the stage for important papers on the structure of mantle plumes, the origin of the Ontong Java Plateau, and a radical reexamination of Earth's thermal history.

In two influential papers, he explored how the compositional differentiation of oceanic mantle affected convection in the geologic past. Working backward from the present-day system, he argued that hotter mantle results in more sluggish plate tectonics. This unexpected inverse relationship between mantle temperature and heat flux has allowed him to erect a simple model that simultaneously satisfies geochemical constraints on the (low) abundance of heat-producing elements, petrological constraints on the (low) degree of secular cooling, and seismological constraints on the (low) degree of

mantle stratification. John Platt, as well as William of Occam, would be pleased with this compelling synthesis.

The conclusions Jun has drawn about Earth's thermal history are as controversial as they are profound, and it may take a while to know whether he has cut the Gordian knot. But the span of his research and the keenness of his insights illustrate what strong inference is all about. It is very fitting, therefore, that the AGU has awarded Jun Korenaga its 2006 James B. Macelwane Medal for his contributions to the fundamental understanding of mantle dynamics.

—THOMAS H. JORDAN, University of Southern California, Los Angeles.

Response

Thank you, Tom, for those very kind words. I feel very honored to have been selected for the James B. Macelwane Medal, and I appreciate this opportunity to express my gratitude to my mentors. I first became interested in studying Earth history when I took a course taught by Professor Minoru Ozima, at the University of Tokyo. In retrospect, this starting point is appropriate for my somewhat multidisciplinary style, because his course was called Introduction to Geophysics, but what he actually taught was almost entirely geochemistry.

I have been very fortunate to meet the right people at the right times, and it all seems to happen by accident. When I was a masters student in Japan, I happened to be stuck on a U.S. vessel for about half a year and sailed with Ken Macdonald, Tanya Atwater, Don Forsyth, Dick Hey, and Dave Naar. There I met a few brilliant graduate students like Dan Scheirer, Chaz Weiland, and Yang Shen, and I thought it worth the pain of studying abroad if I could become like them. My advisor, Professor Kensaku Tamaki, generously encouraged me to pursue my enthusiasm.

My life at the Woods Hole Oceanographic Institution and the Massachusetts Institute of Technology (MIT; Cambridge, Mass.) was much more than I expected. As Tom mentioned, I had three supervisors, but my original plan was to work just with Steve. Studying marine seismology was my primary objective, and Woods Hole was a paradise with Bob Detrick, Graham Kent, Ralph Stephen, John Colins, and Dan Lizarralde. But I had to do a second project for my qualifying, and Steve told me his fellow geologist had a nice small project even a geophysics student could easily do. Although it was anything but easy, this project with Peter on the Oman ophiolite turned out to be the most rewarding experience, which forever changed the way I think about science. Working with Peter opened my eyes not only to petrology but also to geodynamics, and Ken Koga, Nobu Shimizu, Henry Dick, Jack Whitehead, and Greg Hirth were always there to help me out.

In the middle of my Ph.D., Steve decided to leave for the University of Wyoming, and I



Jun Korenaga

had to find a new supervisor. Rafi Katzman suggested I ask Tom, and I could not thank him more for this wild idea. Tom was a very busy man, and I could see him only twice a year or so, but every meeting was inspirational, with a lifetime supply of fundamental issues yet to be addressed. From him, I learned how to see through superficial complexities and formulate a problem in the purest form. I was also lucky to get to know Shijie Zhong, who happened to be at MIT when I started to work on computational fluid mechanics.

I went to California for a postdoc and had a great time at the University of California, Berkeley interacting with Mark Bukowski, Michael Manga, Mark Jellinek, and Raymond Jeanloz. Weekly gatherings at the Miller Institute had a unique atmosphere, in which I was compelled to revive my old interest and ponder some nagging issues in the thermal and chemical evolution of Earth.

I am grateful for my mentors, who let me try whatever I wanted to, so I encourage younger generations to be ambitious and expand your horizons, as Earth sciences have so much to offer. Studying such an integrated object like Earth requires more than a collection of specialists.

Now I am at Yale University (New Haven, Conn.), surrounded by interesting characters such as Shun Karato, Dave Bercovici, Jeff Park, Dave Evans, Mark Brandon, John Wetlaufer, Jay Ague, George Veronis, and Karl Turekian. My special thanks go to Shun, who nominated me for this medal. As a geodynamicist, it has been a tremendous privilege to work with the world's best expert on mantle rheology. I would also like to thank Dave Stevenson, Claude Jaupart, and Slava Solomatov for supporting letters. It is an honor to be recognized by those I truly respect.

Last and most important, I thank my wife, Tomoko, who understands all of my dreams and ambitions and knows how to cheer me up in the most difficult times. Thank you.

—JUN KORENAGA, Yale University, New Haven, Conn.