

The Waldemar Lindgren Award for 2005 Citation of Stephen Piercey JAN M. PETER *

Mr. President, friends, and colleagues: It is my great pleasure to present to you Stephen J. Piercey as this year's winner of the Waldemar Lindgren Award. This award is offered annually to a young scientist whose published research represents an outstanding contribution to economic geology.

Steve's nomination was based on a track record of exceptional achievement in the area of igneous geochemistry and economic geology since the completion of his Ph.D. research in 2001. Over the past few years he has authored 15 peer-reviewed papers (seven of these first-authored; plus two more accepted, pending revisions), 18 government publications, and 4 geologic maps. His publications have appeared in leading scientific journals, including *Economic Geology*, *Geology*, *Geological Society of America Bulletin*, and *Canadian Journal of Earth Sciences*. Steve has wisely chosen as his research area the topic of crustal growth and evolution of convergent margins through geologic time. His research theme has been the petrogenesis and tectonics of arc and back-arc volcanic and plutonic rocks in ancient orogenic and greenstone belts, and their metallogenic implications for the formation of volcanogenic massive sulfide (VMS) deposits. In short, he investigates the linkages and drivers between magmatism and ore deposits formation. Although Steve's research achievements are in the broad field of economic geology and metallogeny, the significance of his findings extends into the areas of volcanology, igneous petrology, and tectonics.

Steve received his Honors B.Sc. degree in 1996 at Memorial University of Newfoundland, completing a thesis on "The Geology and Geochemistry of the Southern Pacquet Harbour Group Volcanics, Baie Verte Peninsula, Newfoundland." This work garnered the President's Gold Medal of the Canadian Institute of Mining, Metallurgy and Petroleum for best undergraduate student thesis in Canada in 1997.

He stayed on at Memorial for his M.Sc. thesis, entitled "An Integrated Study of Magmatism, Magmatic Ni-Cu-Co Sulphide Mineralization and Metallogeny in the Umiakoviarusek Lake Region, Labrador, Canada," which he completed in 1998 under the supervision of Derek Wilton. The high caliber of his thesis is evidenced by the fact that it won second place in the Geology Society of the Canadian Institute of Mining, Metallurgy, and Petroleum Student Essay Contest Award in 1999.

For his Ph.D. program, he studied at the Mineral Deposits Research Unit in the Department of Earth and Ocean Sciences at the University of British Columbia under Jim Mortensen. He completed his Ph.D. degree in 2001 with a thesis on the "Petrology and Tectonic Setting of Mafic and Felsic Volcanic and Intrusive Rocks in the Finlayson Lake Volcanic-Hosted Massive Sulphide (VHMS) District, Yukon, Canada: A Record of Mid-Paleozoic Arc and Back-Arc Magmatism and Metallogeny." This area is host to several styles of VMS deposits, some of which are potentially economic, and it is shaping up to be Canada's newest base-metal mining camp.

By North American standards, he completed his thesis in very short order (three years), and its quality was spectacular, as evidenced by his winning the Gold Prize in the Graduate Student Category of the Student Essay (Thesis) Competition of the Canadian Institute of Mining, Metallurgy and Petroleum in 2002.

For his Ph.D., Steve addressed complex geological problems with a balanced approach that involved systematic mapping, specialized laboratory analyses, and rigorous interpretation of all data. His research has clearly benefited from important collaborative partnerships with key individuals in geological surveys, academia, and industry. His research received support from the Geological Society of America, through a Student Research Grant, the Society of Economic Geologists, through a Hickok-Radford Fund-Student Research Grant, and the Natural Sciences and Engineering Research Council of Canada, through postgraduate scholarships (for both his M.Sc. and Ph.D.).

Steve worked closely with Don Murphy of the Yukon Geological Survey, mapping the Finlayson Lake area, Yukon, that forms part of the Yukon-Tanana terrane, at a scale of 1:50,000. This area is host to several styles of VMS deposits (e.g., Besshi-, Cyprus-, and Kuroko-type), some of which are potentially economic, and is shaping up to be Canada's newest base-metal mining camp. This systematic work resulted in the geologic maps we presently have that form the basis for understanding the geologic history of the area and for mineral exploration. The details of the findings were initially published in a series of government publications with Steve and Don as coauthors. The working relationship between Don—who is an expert in bedrock mapping, tectonics, and structure—and Steve—who focused on geochemical and radiogenic isotopic techniques to study igneous petrogenesis and prototectonics, and ore deposits—was a particularly fruitful one. Their work showed that the Finlayson Lake district hosts rocks formed in different tectonic settings that have been tectonically and structurally juxtaposed.

Steve's research carefully combines field mapping and observations, sampling, and the application of standard modern laboratory analytical techniques. However, the results and conclusions are most definitely not ordinary or standard. Through careful mapping, sampling, and analysis, he was able to place the VMS deposits into a tectonic and geologic context, establish a stratigraphic and structural framework for petrogenetic and isotopic research, unravel magma source and differentiation processes, determine the different tectonic settings for the various VMS deposits, and establish criteria for differentiating between fertile and barren volcanic units.

In 2001, in *Economic Geology*, Steve published a seminal paper stemming from his Ph.D. thesis that examined the petrogenesis of the felsic volcanic rocks in the FLA to decipher their petrotectonic setting. He characterized their geochemical attributes (high field strength element-enriched, high Zr/Sc, high Zr/TiO₂) and defined/recognized the prospective felsic

*Presented at the Awards banquet by Mark Hannington.

volcanic units on this basis. He demonstrated that these rocks are the result of high-temperature partial melting of continental crust and formed in an ensialic back-arc rift. He pointed out the differences between these rocks and the Archean felsic volcanic rocks that are prospective for VMS mineralization (they have higher Zr/Y and La/Yb_n than Archean examples), and their geochemical similarity to other Phanerozoic VMS environments, particularly the Bathurst Mining Camp, one of the world's great VMS districts.

Also in 2001, he published a paper in *Geology* in which he recognized boninites in the Finlayson Lake area on the basis of their geochemical and isotopic signatures. He recognized them to be part of a Mid-Paleozoic continental margin-back-arc magmatic system, and that these rocks formed by spreading ridge propagation into an arc constructed of oceanic and continental crust.

In 2002, he published on the geochemistry as well as neodymium isotope signature of mafic igneous rocks of the Finlayson Lake area in *Canadian Journal of Earth Sciences*. He showed that mafic dikes and sills spatially associated with crustal felsic volcanics display an oceanic island basalt signature and were formed by decompression melting of mantle associated with (ensialic) back-arc generation.

In 2003, in *Canadian Journal of Earth Sciences*, he published on the neodymium isotope geochemistry of the felsic volcanic and intrusive rocks in the Finlayson Lake area. He was able to show that those rocks prospective for VMS mineralization have ϵ_{Nd} (350) ranging from -7.8 to -9.5, substantially different from the Late Devonian calc-alkaline and tholeiitic arc felsic rocks in another unit in the area (Fire Lake unit), but similar to intrusive rocks of the Grass Lakes suite. He was able to show that the felsic rocks were variably influenced by evolved Proterozoic continental crust or sedimentary rocks. The high field strength element-enriched, high Zr/Sc, high Zr/TiO₂, high Zr/La and Nb/La, and evolved isotopic signatures of these intrusives allowed Steve to determine they formed from high-temperature melts, and their distinctive geochemical signature allowed for the delineation of potentially fertile versus barren VMS environments in the Yukon-Tanana terrane, and, by analogy, elsewhere.

In August 2004, in *GSA Bulletin*, he examined the geochemical and neodymium isotopic characteristics of mafic and ultramafic rocks in the Finlayson Lake area, Yukon (Fire Lake unit). He showed that these rocks have a wide compositional range, which he indicates records the transition from arc magmatism to initiation of an extensional back-arc basinal environment associated with east-dipping subduction. This was placed into a larger geodynamic context to deduce their roles in Cordilleran crustal growth by demonstrating that initiation of back-arc basin magmatism recorded in the Fire Lake formation was part of a much larger Late Devonian back-arc basinal system forming along the western edge of North America. This work highlights the shift from mafic-dominated back-arc magmatism in the Fire Lake formation to predominantly high temperature, crustally derived felsic magmatism in the Kudzu, Kayah and Wolverine successions (host to the two largest, and potentially economic, VMS deposits in the Finlayson Lake district). His work elegantly demonstrated that underplating basalt associated with rifting

resulted in high-temperature crustal partial melting, felsic magma genesis, and VMS deposit formation.

Upon completion of his doctorate, Steve applied to the Natural Sciences and Engineering Research Council of Canada to pursue postdoctoral studies with Dr. Keiko Hattori at the University of Ottawa; he was successful in his application but chose to decline this in favor of accepting a junior faculty professorial position in the Department of Earth Sciences and the Mineral Exploration Research Centre at Laurentian University, Sudbury, Ontario. It is a rare achievement to secure a faculty position immediately after Ph.D. studies, and this is a testament to Steve's accomplishments and potential. He is now associate professor in the department, having received promotion and tenure a year earlier than is normally the case.

Steve's exemplary productivity is not only evidenced in publications, but in his contributions to geoscience societies, field workshops, outreach activities, teaching, and supervision of graduate and undergraduate student research. He is currently a member of the Society of Economic Geologists, Society for Geology Applied to Mineral Deposits, Geological Society of America, Geological Association of Canada, Geological Association of Canada, American Association for the Advancement of Science, and the American Geophysical Union.

While still at UBC, Steve assumed the role of vice-chairperson for the Mineral Deposits Division (MDD) of the Geological Association of Canada (GAC), and then became chair in the same year he joined Laurentian University. MDD is the largest of the GAC, with a membership of about 600 who are interested in ore deposits. Over the past two years, I was the vice-chair and then chair of MDD (soon to be past-chair), and I can personally attest to the many hours of work that it required; for Steve to do this while working on his Ph.D. is a truly amazing accomplishment. In 2003 he organized a special session at the annual Geological Association of Canada meeting on continental margin VMS deposits, and as an outgrowth of this is serving as a coeditor of an upcoming special issue of *Economic Geology* on the same theme. Since joining Laurentian, he has organized two graduate modular short courses for the department, and has a full teaching load. Steve has also led the development of the new undergraduate teaching curriculum, and serves as the coordinator of the applied M.Sc. program. He has been advisor to 13 graduate and undergraduate students. Currently he is also serving on the SEG Fellowship Admissions Committee, and he finished a stint as Short Course Coordinator for MDD, Geological Association of Canada.

Since his arrival at Laurentian, Steve has set up a vibrant research group that focuses on the application of field, geochemical (major, trace, rare earth element), and stable (C-O-H-S) and radiogenic isotopic (Nd-Sr-Pb) techniques to understanding the tectonic and petrological setting of mineral deposits. This is a testament to his natural and innate leadership and team player skills. He has continued the study of the Yukon-Tanana terrane in the Yukon Territory within the Finlayson Lake area, but also in other areas (e.g., Stewart River, Yukon Territory), and has expanded to examine VMS and gold-deposit environments in Ontario, Manitoba, Newfoundland, and NWT.

I am confident that Steve will develop a vibrant international academic career, following the distinguished track of many earlier Lindgren medalists. In my opinion, Steve is clearly one of the top young scientists in ore deposit research today, and I thank the 2005 SEG Lindgren Awards committee for their decision to award Steve the Waldemar Lindgren Award

for 2005. As a past member of the Lindgren Award committee, I can personally tell you how difficult it is to select the most deserving candidate each year. I congratulate Steve on his past achievements and I know we all look forward to his scientific leadership in the broad field of economic geology in the coming years.

Acceptance of the SEG Waldemar Lindgren Award for 2005

STEPHEN J. PIERCEY

Mr. President, colleagues, and friends: It is with great pleasure that I accept the Waldemar Lindgren Medal of the Society of Economic Geologists this evening. This is truly an honor and quite humbling, and I would like to thank my colleagues, Jan Peter, Mike Lesher, Wayne Goodfellow, and Dave Lentz, for nominating me.

I think I was destined to become a geologist. As a child, I remember searching for fossils and pyrite in shales in rocks of nearby limestone quarries of my home in western Newfoundland. I was always impressed with the beauty of the landscape in this area, particularly the Bay of Islands and how it came to be. It was this early interest in the landscape and rocks that led me to take a geology course in my last year of high school. Geology was not a subject taken by many; typically this course was taken to bump up your marks before going to university and then to be forgotten promptly after the final exam. Fortunately, I had an outstanding teacher, Mr. Roger Chaytor, and it was his lectures on plate tectonics and sea-floor spreading that made me decide to try geology at university.

I was fortunate to attend Memorial University of Newfoundland. Memorial's undergraduate program was truly outstanding—it provided all the basics and was very field oriented. It seemed we were in the field all the time and it made me realize that most problems in earth sciences required field observations to solve them and are in one way or another linked to tectonics. A number of people had significant influence on me while I was a student at Memorial. Bill Iams, my first-year professor, taught with such exuberance and excitement that it made me realize that I made the right decision to enter geology; he also planted the seed for research and pushed me in that career direction. Elliott Burden always reminded me to not become too "overspecialized" and to remember all those organisms in the geologic record that died off because of being too specialized! This advice to remain flexible and a generalist has been very important in my ever-changing career. I owe a lot to George Jenner, who introduced me to igneous petrology, geochemistry, and isotope geochemistry. He supervised my undergraduate thesis and sparked an interest that I still carry today and that guides much of my present (and past) research.

My most significant influence, however, was Derek Wilton. Derek taught economic geology and it was in his third-year economic geology class that made me realize that I could study any aspect of earth sciences by using mineral deposits as the canvas (and I could make money doing it!). I was so

inspired by his course that I undertook an M.Sc. thesis with Derek on magmatic Ni-Cu sulfide mineralization in Labrador. As a graduate supervisor, Derek was a true mentor and friend. He allowed me to try any technique I wanted to solve my thesis problems—most importantly, however, he allowed me to explore and make mistakes and to learn from these mistakes. I'm truly grateful for this—it allowed me to learn a lot about a lot of different things but also how to figure out what techniques work and don't work for various geologic problems.

Following my M.Sc., I undertook a Ph.D. at the Mineral Deposit Research Unit at the University of British Columbia (UBC) under the supervision of Jim Mortensen. I was given a brand-new VMS district, the Finlayson Lake district, to tear apart and to unravel the tectonic evolution and regional scale controls on massive sulfide formation. It was great! How many people are given an entire district to rip apart as part of their Ph.D.? Jim was a truly inspiring thesis supervisor. His door was always open and I cannot count the number of hours we spent discussing and arguing aspects of Cordilleran tectonics and mineral deposits. Jim taught me many things, including Cordilleran geology and geochronology, but his greatest gift to me was teaching me, largely through example, how to collaborate with a wide range of colleagues with diverse interests on a wide range of problems. I am truly grateful for this. I am also indebted to Kelly Russell, who taught me about data modeling and the philosophical aspects of science, something that influences my research every day. I also thank Dick Tosdal of MDRU for his support of my research. I was also lucky to have a great group of fellow graduate students at UBC, in particular, Lawrence Winter, Steve Israel, Geoff Bradshaw, and Scott Heffernan, who were a constant source of stimulating geologic discussion (some serious, some not so serious!).

I was also fortunate to work with two other individuals who also were a great influence during my Ph.D. work. Don Mur-



phy of the Yukon Geological Survey introduced me to the regional geologic setting of the Finlayson Lake district. Don really taught me how to regionally map and use stratigraphy and structure to understand regional tectonic problems. He was also a sounding board for many of my ideas and we have had great pleasure collaborating on our work in the Finlayson Lake district. Suzanne Paradis acted as a sounding board for my ideas and as a collaborator on most of the deposit-scale research I undertook in the Finlayson Lake district. She was always generous with her time for discussion and edited every paper in my thesis in minute detail! It was also at this time that I met Jan Peter of the GSC on field trip to the Finlayson Lake district. This field trip encounter has led to numerous collaborative research projects on massive sulfide deposits that continues to this day.

Near the end of my Ph.D. studies, I was also fortunate to be given an interview for a faculty position at the Mineral Exploration Research Centre (MERC) at Laurentian University. I did not expect to get this position and thought I would do the interview for experience. Much to my surprise, a week after the interview I got a call offering me the position. I was quite enthralled and grateful that the faculty at Laurentian took a chance on such an unknown commodity! My time at MERC and Laurentian has been quite rewarding. Working at a small university often has its challenges, but it also brings opportunities. Laurentian is situated in an outstanding physical environment for mineral-related research and field geology, and fortunately, our faculty and university administrators see the value of and strongly support economic geology-related research. I am also blessed to work in a department of truly outstanding and gifted scientists who are both collegial and work together as a team; it's a great place to work.

I owe special thanks to two of my colleagues, however. Mike Leshner has been a mentor to me and has really helped me progress and become successful as a scientist. He is a true leader and has made MERC and Laurentian a great place to do research. Harold Gibson and I share the same passion for massive sulfide deposits and this has led to significant collaboration, animated discussion, and co-supervision of students. I feel very fortunate to have such a collaborator that stimulates and challenges me every day. I also thank my past and present graduate and undergraduate students and post-docs

from whom I have learned immensely (Kim Bailey, Eric Chaloux, Mike Hocking, Peter MacDonald, Maribeth Moll, Dave Nickerson, Shirley Peloquin, and Tyler Ruks).

In recent years I have also been fortunate to collaborate extensively with Maurice Colpron (Yukon Geological Survey) and JoAnne Nelson (British Columbia Geological Survey). Mo, JoAnne, and I (and others of the ancient Pacific margin NATMAP project) have worked together reconstructing the tectonic and metallogenic history of the ancient Pacific margin of North America. This research has been stimulating, exciting, and truly rewarding—one of the best collaborative endeavors I have ever been involved in. I truly appreciate that Mo and JoAnne keep me honest as a scientist and are so generous with their ideas and time; they are truly outstanding colleagues to work with. I am also grateful for others in the Cordilleran community with whom I've collaborated significantly, including Rob Creaser, Steve Gordey, Charlie Roots, Jim Ryan, and Renee-Luce Simard.

I would also like to thank others in the Canadian VMS community, from industry, government, and academia, who have supported my research in one way or another and have always shared their ideas and provided honest and constructive comments on my research (including Al Galley, Wayne Goodfellow, Mark Hannington, Dave Lentz, Jason Dunning, Jim Franklin, and Lawrence Winter).

Without adequate funding I would not have been able to do the research I do. I extend special thanks to the various companies that have supported my research over the years and I owe a special thanks for the continuous financial and logistical support of the Yukon Geological Survey and of the Natural Sciences and Engineering Council of Canada (NSERC).

Finally, I would like to thank my family. My parents, John and Sandra, taught me the importance of hard work (largely through example!) and allowed me to follow my interests. My wife, Michelle, has been my supporter and biggest fan during my whole career—I owe her immensely for helping me up during the tough times and for keeping me honest when my ego gets bigger than it should! Michelle and my daughter, Elizabeth, constantly remind me of what the most important things in life are.

I thank you for this award, and the Society of Economic Geologists for bestowing such an honor on me.