THE PAST-PRESIDENTS' MEDAL FOR 1996 TO THOMAS E. KROGH

Ladies and Gentlemen,

Tom Krogh is internationally recognized for his innovative work on developing the U–Pb method for dating zircons to new levels of precision. Single grains of zircon now can give dates of several billion years with a precision of one or two million years. His application of this dating technique to key geological problems has had a profound influence on our understanding of Canadian geology. Dozens of researchers and students from around the world have travelled to his laboratory to learn the subtleties of his techniques. They have returned to their institutions or been hired by other institutes and have built Krogh-type laboratories in many parts of the world.

Tom graduated in geological engineering from Queen's University in 1959 and received an M.S. from Queen's in 1961. He went to MIT and joined a team involved in isotopic dating of rocks. After completing his Ph.D., he was invited in 1964 to join the Geophysical Laboratory in Washington, D.C. It was at the Geophysical Laboratory that he and his colleagues were able to develop a mineral-solution technique and build laboratory facilities that reduced the background levels of lead by a factor of one million. It was then possible to analyze single-mineral grains, or parts of grains, instead of the thousands of grains previously required. In 1975, Tom was invited back to Canada to set up the Jack Satterly Geochronology Laboratory at the Royal Ontario Museum. As the founding Director of the Geochronology Laboratory and a cross-appointed Professor to the Department of Geology at the University of Toronto, he has been in a position to interact with many students and scientists.

The list of publications that Tom has authored and coauthored is lengthy. The minerals that he studies, zircon, rutile, baddeleyite and titanite, are minor constituents of the rocks. This means that great quantities of rock have to be crushed and processed. Yet, from these minor minerals, he and his colleagues routinely measure ages on a billionth of a gram of lead with a background at a millionth of a millionth of a gram. Tom loves challenges, and very few geological opportunities that involve age dating get past him. He involves himself both with laboratory procedures and field work in order to better understand the geological environment in which the minerals have formed. Projects of the past 10 years range from mantle xenoliths in Australia, to gold deposits in the Abitibi, to the Chicxulub Crater in Mexico.

Tom has been awarded the Logan Medal of the Geological Association of Canada, the J. Tuzo Wilson award of the Canadian Geophysical Union, and an Honorary Doctor of Science from Queen's University. Thus, with the Past President's Medal of the MAC, Tom has won all Canada's major Earth Science awards. I am honored to present Tom Krogh with the Past-Presidents' Medal of the Mineralogical Association of Canada.

Fred J. Wicks
Past-President

Acceptance Remarks (delivered on behalf of Tom Krogh by Don Davis on May 28th, 1996):

One of the problems with receiving an award is that it would be considered bad form for the recipient to explain in too much detail the reasons for the honor, even though he understands these better than anyone else. However, as a proxy I am under no such constraint.

Tom has written an acceptance speech for me to deliver. Before this, I would like to expand a little on the reasons for this award. To understand the importance of Tom's contributions, you have to realize where geochronology was in the mid-60s, when Tom began his research at Carnegie. About the best errors that one could obtain with the most popular techniques, like Rb–Sr, were ±30 m.y. or more on ages that often had an uncertain significance. U–Pb analyses of zircon promised much lower errors, but zircon usually showed evidence of lead loss, and it was difficult to dissolve. The method in vogue involved fusion with borax, followed by dissolution and a tedious liquid extraction of lead using dithizone. Since borax contains a lot of lead, blanks were very high, requiring that a good fraction of a gram of zircon be analyzed.

While at Carnegie, Tom developed a method for dissolving zircon in clean HF at high temperature in teflon bombs and extracting Pb and U using small columns. This reduced the blank several orders of magnitude, down to tens of picograms, which enabled dating of a fraction of a milligram of zircon, rather than a fraction of a gram.

People also used ^{208}Pb spike to "weigh" the lead by isotope dilution. Since there is already a significant proportion of ^{208}Pb in the radiogenic lead of the zircon (it forms from decay of ^{232}Th), it was necessary to split the sample in two, analyze spiked and unspiked aliquots, and accept an expanded error from this process. Tom figured out an ingenious way of producing ^{205}Pb, which does not exist in nature, by bombarding ^{206}Pb with protons to make radioactive ^{205}Bi. The ^{205}Bi was chemically stripped of the target lead in a hot cell and left to decay to ^{205}Pb. This reduced the work involved in an analysis by half, and is the basis for all high precision U–Pb work done today.

While at Carnegie, Tom also studied the phenomenon of lead loss in zircon and discovered that it was due, not directly to metamictization, but to low-temperature alteration that affects high-U, and therefore damaged, parts of the crystal, owing to interaction with fluid along cracks and surfaces. He also found that even internally unaltered crystals are usually surrounded by a thin rim of alteration. After moving to the ROM, Tom developed a method for abrading off the outer rim of zircon crystals, removing all alteration from internally homogeneous grains and achieving results that consistently record the age of crystallization with errors of about ±1 m.y.; at the same time, he further reduced the level of analytical blank, to picogram, and recently, to sub-picogram levels, enabling precise dating of single crystals of zircon. He also recognized early the importance of other minerals like baddelyite, perovskite and rutile as potential geochronometers. Along with students and coworkers, like Larry Heaman, he applied them to rocks that could not be dated before, like mafic dikes, mantle rocks and mineralization.

The application of Tom's work, and the work of others using his methods, are of pivotal importance to geology. I will mention only two of his broad geological interests. Tom loves to study structurally complicated metamorphic rocks, and his work on the Grenville Orogeny has been life-long. His recent study of deep crustal accretion in the Kapuskasing Structural Zone showed in remarkable detail how continental crust in Archean orogenic zones is built from the top down. It should prove to be a classic in its field. His work on shock-metamorphic features in zircon from impact sites, and particularly his dating of ejecta in the K–T boundary layer with Sandra Kamo, is another series of classic papers that fingerprinted, almost without doubt, the impact site as the Chicxulub crater in Mexico.

The rest of us at the lab, and in similar labs throughout the world, have really only been carrying on Tom's program of research. I can think of no other discipline than geochronology that is having a more powerful impact on geology today. There is no other person who has had a more profound and wide-ranging influence on this discipline than Tom Krogh.

I will now read the speech which Tom gave me to deliver.

Donald W. Davis
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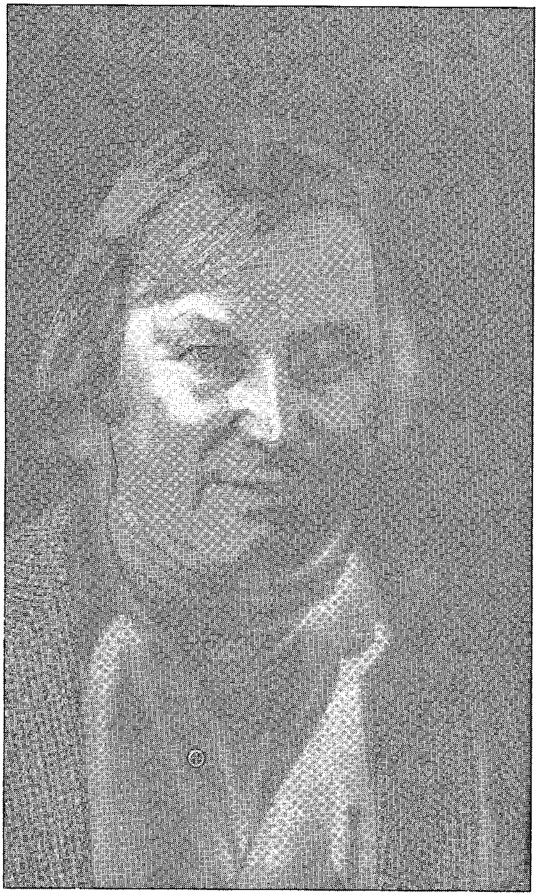
It certainly was a great surprise when I received the call from Pete Roeder explaining this award, and I must thank Pete and the other past presidents on the committee, for adding my name to the list of illustrious past recipients.

Many individuals and institutions have contributed to my career. To begin with, I should thank my parents, who encouraged academic achievement, and even my childhood hobby, collecting rocks, minerals and fossils around Peterborough. My friend's parents threw his out and he became a psychologist – quite a career change!

When I got to Queen's, I decided to turn my hobby toward a career, and was further turned on by A.W. Jolliff. I can still remember him saying a million years is "just a tick on the geological time clock". Counting those ticks became my life work.

I had a great respect for the knowledge and intellect of J.E. Hawley, although I had trouble understanding why he encouraged me to rush off to MIT after only one year on my Masters – after all, I had a new girl friend and had no reason to leave. She, my wife Kathy, survived falling in the mud in my thesis area, suffered through my Ph.D., and managed to raise four well-adjusted children while maintaining an element of sanity in her geologist husband... there should be a medal.

Patrick M. Hurley, a Canadian, was my major influence at MIT. From him, I learned to give full freedom and control to students and to view the big picture as well as details of investigation. The Carnegie Institution of Washington was clearly the main element in my scientific development. Total freedom of direction and minimum base funding were provided, but most important was the exposure to gifted scientists in many fields. In mine, it was Stan Hart of Goldschmidt Medal caliber.



THOMAS E. KROGH

Canada unfortunately lacks endowed institutions like Carnegie, but fortunately, we have been able to create certain critical elements at the Royal Ontario Museum over the past two decades. No base salaries and research funds for most of our staff, but freedom to gain these on our own through research achievements. These led to grants and funded research agreements. The Ontario Geological Survey has been a major supporter throughout the history of the lab. No lab of our caliber is created and operated by one individual, and much of our success is the result of the hard work, dedication and intellect of Fernando Corfu, Yuri Amelin and Donald W. Davis, as well as the painstaking efforts of Sandra Kamo and Yim-Ying Kwok.

The work we do in our special branch of mineralogy usually involves the analysis of a few millionths of a gram of zircon, containing a few billionths of a gram of lead, with a background of a millionth of a millionth of a gram. Most grains have the diameter of a human hair, and from these we abrade away exterior surfaces with a device originally developed by mineralogists. Progress has been rapid, but new avenues especially related to imaging and understanding multi-stages of zircon growth remain; more work for the isotope-mineralogist.

To all of those who have assisted in making this possible, thank you!

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