THE PAST-PRESIDENTS' MEDAL FOR 1999 TO FRANK C. HAWTHORNE

Frank Hawthorne began his career working on the crystal chemistry of amphiboles at McMaster University. At that time, there were many significant structural and crystal-chemical problems to be solved in this group of minerals. These problems were regarded as some of the most intractable in the mineralogical sciences. To solve these problems, he utilized a wide variety of experimental techniques (X-ray and neutron diffraction, infrared spectroscopy, Mössbauer spectroscopy), and rapidly became recognized as the leader in this field. The results of these studies were eventually summarized in his outstanding 300-page paper on amphiboles, for which he was awarded the Hawley Medal of the Mineralogical Association of Canada in 1983.

The work on amphiboles led to a general interest in complex problems, and in particular those involving rock-forming minerals. Consequently, he has worked on many minerals of geological importance, *e.g.*, staurolite, vesuvianite, pyroxenes, beryl, tourmaline. In all instances, he has solved many outstanding structural and crystal-chemical problems. This work has been characterized by the intention of fully understanding the crystal-chemical details of these minerals such that they can be used in a petrological context as constituents of geothermometers and geobarometers or as indicators of conditions prevailing during progressive crystallization of magmas.

This focus on complex problems has typically required the use of non-standard experimental approaches. Throughout his career, Frank has been involved in the application of novel analytical and spectroscopic methods to mineralogical problems. In particular, he has been a strong proponent of the multi-technique approach to complex crystal-chemistry problems. He is an acknowledged expert in Mössbauer spectroscopy, and was a keynote speaker at a recent Royal Society of Chemistry (U.K.) symposium on the spectroscopy of natural materials. He is involved in infrared and Magic Angle Spinning Nuclear Magnetic Resonance spectroscopies and organized the recent Mineralogical Society of America short course (and edited the accompanying 700-page volume) on Spectroscopic Methods in the Earth Sciences. In this regard, he is well-known for his views that geoscientists must be the leaders in these new methods of analysis, as the developments should be driven by geological imperatives rather than the whims of physicists or chemists.

His principal area of interest for the last 10 years has been in the energetics of minerals. This has involved the development of a new conceptual framework for the interpretation of the crystal structures and behavior of complex minerals based on the energetic content of the chemical bonds in a structure treated as a topological network. This work has been recognized as an important advance in solid-state chemistry and crystallography. In recognition of his stature in this field, he presented a Plenary Lecture at the International Union of Crystallography meeting in Perth (Australia) in 1987. However, Frank is a geologist at heart, not a chemist or a physicist, and the principal objective of his work is to interpret the nature and occurrence of minerals. The end result of the scheme is an approach that is fairly transparent and simple, and that shows great promise in rationalizing the mineral assemblages seen in such complex environments as highly fractionated granitic pegmatites, gossans and saline lake sediments.

The work on the synthesis of amphiboles in the early 1980s led him to realize that we were not adequately characterizing fine-grained products of mineral syntheses, and he began work on Rietveld structure refinements as a suitable method to resolve this problem. This technique has worked very well, and it is now possible to characterize both the degree of order and composition in multiphase synthetic assemblages involving amphiboles, pyroxenes and associated minor phases. The method has been widely adopted by experimental mineralogists and petrologists.

Recently, Hawthorne and his students have worked on Cu^{2+}-oxysalt minerals in an attempt to understand the Jahn–Teller effect and electron–photon coupling in these structures. This work has involved the development of an extensive structural hierarchy for these minerals, *ab initio* molecular orbital calculations on Cu-anion clusters and development of Cu-anion potentials for molecular mechanics calculations, plus the experimental characterization of electron–phonon-driven phase transformations in simple systems.

The common thread that runs through all of Frank's work is the desire to develop a simple and intuitive understanding of complex minerals and their roles in geological processes. Although the more complex minerals are difficult to characterize and understand, they intrinsically contain more information than simple minerals

on the history of the environment in which they occur. This has been the motivation for most of Frank's work. It has had a broad influence on a variety of geological disciplines, and has contributed significantly to our understanding of a variety of geological environments.

Frank Hawthorne is a scientific leader, he is the driving force behind many of the new and exciting ideas in mineralogy today. In parallel with this scientific progress, he is compelled to do as much as possible to bring this work to the attention of others. He is consistently and continually involved with the organization of conferences and symposia, activities that have been complemented by long periods of service to scientific associations, including the Mineralogical Association of Canada, the Canadian Geological Congress, and the Mineralogical Society of America. He has also served NSERC as the chairman of the Solid Earth Science grant-selection committee.

Frank has never lost sight of the need to bring the advances he has made to student education. Frank has worked with, "created", and influenced some of the country's best graduate students in the mineralogical sciences. Many of Frank's former students are currently employed as faculty at universities across the country. In academic circles, this is probably one of the most fundamental and convincing ways that one can be recognized. Moreover, this ensures that the influence of his work will be carried into the future, as Frank's desire to understand complex minerals is being passed on to a new generation of mineralogists. His work has revolutionized mineralogy, and the part that it plays in understanding Earth processes. Thus, in recognition of these achievements, I am especially pleased to present Frank Hawthorne with the Past Presidents' Medal of the Mineralogical Association of Canada.

Roger H. Mitchell
Past-President, MAC

Members and Guests:

I thank MAC for this award, and I thank my nominators for the extravagant things that they must have written about me.

I would like to take this opportunity to acknowledge some of my scientific debts to my collaborators and friends over the last 25 years. I went to Manitoba as a post-doctoral fellow with Bob Ferguson, and spent a happy two years doing nothing but Crystallography and working with Bob on a series of topics that greatly expanded my knowledge of Mineralogy. At the same time, I encountered Petr Černý and began what seems to be a lifelong learning process about granitic pegmatites and their constituent minerals. More importantly, Petr taught me that there are more minerals than just the rock-forming silicates that had dominated my scientific thoughts until then. Since then, Petr and I have had a satisfying and enjoyable collaboration on a truly wide variety of topics. More recently, I have had considerable interactions with Norman Halden, specifically involving microbeam techniques and non-linear dynamics, and more generally ranging the gamut of the scientific enterprise; in addition, I have been trying to make him more mineralogical, and he has been trying to make me more responsible. I also wish to recognize the importance of my departmental environment, as this is crucial to anyone who wishes to develop significant experimental facilities. In this regard, I have received exceptional encouragement and help from the more recent chairs of my department, George Clark and Norman Halden, who have provided an environment not only in which it is possible to do research, but also in which it is fun to do research.

When I listened to Roger Mitchell listing all the things that I had done, I was somewhat taken aback, as it seemed to me that my students had done most of those things. I have been exceptionally lucky in having some very clever and talented students, and they have taught me a lot, some of it scientific. Lee Groat, Peter Burns, Ray Eby and Mark Cooper were all outstanding, but unfortunately they eventually graduated, and all but Mark went on to work elsewhere. However, Julie Selway and Chris McCracken are keeping on the good work while I sit in my office listening to Pink Floyd. I have also been lucky enough to be involved with (or jointly supervised) some of Petr Černý's and Al Turnock's students, particularly Scott Ercit, Mike Wise, Dave Teerstra, Harvey Buck and Mati Raudsepp. My post-docs Mati Raudsepp and Michael Schindler have been extremely stimulating colleagues, and I hope that our collaborations will continue for many years.

My strongest collaboration has been with Roberta Oberti. Since 1983, when I first visited Pavia, we have been involved in a succession of difficult problems involving amphibole crystal chemistry. Without the superb experimental expertise and insight of Roberta, Luciano Ungaretti, Elio Cannillo, I would not have got very far with the amphiboles. Roger mentioned "my" work on light lithophile elements in rock-forming minerals; without the experimental expertise of Luisa Ottollini, it would all have been guesswork. The Centro at Pavia has been a haven for me to visit and collaborate with, and I want to acknowledge my debt to its founder, the late Pep Rossi, a scientist of great vision who I was proud to call my friend.

I have continuing collaborations with many scientists around the world. In particular, the synthetic-am-

phibole consortium. Giancarlo Della Ventura, Jean-Louis Robert, Mark Welch, Mati Raudsepp and myself have had a lot of fun struggling with long-range and short-range order in amphiboles. Joel Grice and I continue to struggle with crystal structures now and then when I get stuck. Mark Cooper, unfortunate enough to now work permanently in my laboratory, is the most expert experimental crystallographer I have ever met, and our collaborative work brings me great pleasure and amazement.

I have extensive interactions with the mineral collecting world in the search to find "good crystals", and I am continually amazed at their unstinting help. In particular, Bill Pinch is unparalleled in finding crystals where everyone else is sure that none exist, the result of a depth of mineralogical knowledge that astounds me (and everyone else), and Charles Key has an eye for the new that is uncanny. Without their help, we would not have found half the novel structures that we have done.

I came to Manitoba as an academic innocent and stayed that way for several years. Fortunately, I encountered several people who aided in my scientific and political education: Fred Wicks, Kurt Kyser, Brian Fryer, Roger Mitchell, Fred Longstaffe and Rod Ewing. If I am now somewhat capable of looking after myself, it is due in large part to the instruction of these friends.

I have published most of my work in *The Canadian Mineralogist*. In this regard, I have been lucky enough to be "edited" initially by Louis Cabri and more lately by Bob Martin; as editors, they were/are (you can't edit this "/" out, Bob) absolutely outstanding.

All these people I have mentioned have contributed immeasurably to my career and have greatly enriched my life by their friendship; I thank them all.

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