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Presentation of the Roebling Medal of the Mineralogical Society of America for 1977 to Raimond Castaing

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Mr. President, Fellows and Members of the Mineralogical Society of America, and Guests:

Once in a rare while science is blessed with the work of a man whose vision and genius, in the course of a few years, advances the field by a quantum jump. We are honoring today such a man with the Roebling Medal of the Mineralogical Society of America.

In 1949, Raimond Castaing, then a graduate student working under the direction of Professor A. Guinier, developed the idea to use a focussed electron beam to excite X-rays in microscopically small, solid targets. The wavelengths or energies of the recorded X-rays allow qualitative identification of the elements present in the target, and measurement of the intensity of an individual X-ray line, in comparison to the intensity of the same line emitted under the same conditions by a standard of known composition, makes possible quantitative elemental analysis. As part of his Doctor of Science dissertation Castaing, applying these principles, built an instrument that became known as the electron microprobe X-ray analyzer. However, Castaing's contributions go much beyond the invention of a new analytical tool. In fact, he also established the theoretical and analytical principles of the electron microprobe technique, including procedures and theories for the correction of raw X-ray intensity data obtained with the instrument for instrumental and differential-matrix effects, such as drift, background, mass absorption, secondary fluorescence, and atomic number. It was his deep understanding and theoretical treatment of the processes involved in the interaction of electrons and X-rays with matter that made possible quantitative analysis of micron-sized minerals. Although not a mineralogist by training, Castaing immediately recognized the immense potential of this new analytical technique to mineralogy and petrology and collaborated with colleagues in these fields (for example, as early as 1958 with Kurt Fredriksson in the analysis of individual, micron-sized meteoritic dust spherules recovered from deep sea sediments).

Professor Castaing's invention of the electron microprobe X-ray analyzer as well as his pioneering work on the theoretical principles of quantitative electron microprobe analysis have had a revolutionary, profound impact on mineralogy, petrology, and all other scientific disciplines requiring the knowledge of the quantitative elemental composition of micron-sized volumes of solids. His contributions to mineralogy and petrology can only be compared with those that resulted from the introduction of microscopy of thin sections in polarized light and of X-ray diffraction into our science. Although in the beginning a tool used by only a few mineralogists, most major University geology departments, industrial and government research laboratories now have research groups actively applying this technique to a multitude of mineralogical, petrological, and related research problems, and every mineralogist's research is now affected by the availability of this method of *in situ*, essentially non-destructive, elemental analysis of micron-sized minerals in polished thin sections. To illustrate the incredible impact that Castaing's work has had on the earth sciences, let me quote some numbers. As of this writing, I have in my files reprints of about 2,000 papers dealing with earth science topics where the electron microprobe was employed as one of the major research tools. Presently, the rate of publication of such papers is about 250 per year. Up to May, 1971, one hundred sixteen new minerals were described, most of which, because of their small sizes, would not have been established as new species if it had not been for the electron microprobe which made possible their quantitative elemental analysis.

In recent years, Professor Castaing's creative genius has provided us with yet another revolutionary new analytical tool, namely the ion beam microprobe. Working with a talented graduate student, G. Slodzian, they used a focused ion beam to sputter secondary ions from a solid target and analyzed the secondary ions in a mass spectrometer. With this method, trace element and isotope analyses of mi-

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cron-sized minerals in polished thin sections are possible. Although quantitative analysis with this technique is still difficult and many problems in its application have yet to be overcome, the potential of the instrument has already been demonstrated in a number of excellent recent studies in mineralogy and petrology. There is no doubt that in the next few years, this new tool will open new frontiers of research in mineralogy and petrology that heretofore have essentially been beyond experimental approach. I am thinking, for example, of the measurement of the distribution coefficients of trace elements in synthetic and natural systems. Undoubtedly, Castaing's work will once again have a profound impact on our science.

Raimond Castaing is a Professor in the "Laboratoire de Physique des Solides" at the University of Paris at Orsay, one of the most outstanding laboratories in the world in this field. I should also mention that he is an accomplished mountain climber and excellent rugby player. He has published over 100 papers and has lectured extensively not only in Europe, but also in the United States. In fact, Castaing's frequent visits since 1951 to the U.S.A., particularly in the early years of electron microprobe development, have much contributed to the considerable progress that was made in this country in this field. Professor Castaing has been honored over the years by many scientific institutions and organizations, both in Europe as well as in the United States. However, it is especially gratifying that recognition now comes from the mineralogical scientific community which has benefitted more from his work than any other group of scientists.

Mr. President, it is a special honor for me to present the founding father of electron microprobe analysis, Professor Raimond Castaing, as the 1977 recipient of the Roebling Medal of the Mineralogical Society of America.

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Acceptance of the Roebling Medal of the Mineralogical Society of America for 1977

RAIMOND CASTAING

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Mr. President, Dr. Keil, Members of the Mineralogical Society of America, and Guests:

I was extremely proud indeed when I knew that the Mineralogical Society of America had awarded me the Roebling Medal; but my essential feeling was a deep gratitude for the community of mineralogists, who have taken so large a part in the success of that technique of microprobe analysis that I had developed initially for metallurgical applications.

It was nearly thirty years ago, in the late forties, when I tried to apply X-ray emission spectroscopy to point analysis of metallic samples. I was just fresh from the Ecole Normale Supérieure and I had joined the Materials Department of the ONERA, the French office for aeronautical research. I had been given there in 1947 a magnificent Christmas gift: two electron microscopes, together with the suggestion of using them for studying the fine structure of the light alloys used in aircraft industry. I still remember my enthusiasm when I observed for the first time on the

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