

For about two decades the main support of this research was industrial, especially the steel industry. Remembering the benefits that the Geophysical Laboratory research had been to the iron and steel industry, I enjoyed turning this around and using our research results to apply to geological problems, as well as to steelplant problems.

While I was a graduate student and reading the papers from the Geophysical Laboratory, the masterpiece, I thought, was the paper by Bowen and Schairer on the system  $\text{MgO-FeO-SiO}_2$ , published in 1935. In our research at Penn State we were able to carry this work a step farther by working at higher oxygen partial pressures, and therefore the system,

$\text{MgO-FeO-Fe}_2\text{O}_3\text{-SiO}_2$ . This work in my opinion gives us further substantiation of Bowen's arguments for the origin of the calc-alkaline rocks by fractional crystallization of olivine basaltic magma.

I realize fully that this award is in recognition of the work of a group. I have had some fine students, and three of them, Arnulf Muan, Della Martin Roy, and Rustum Roy, are now senior members of the faculty at Penn State. As a member of this group, I gladly accept this award in recognition of the work of several dozen people at The Pennsylvania State University over a quarter of a century, and of my former colleagues at the Geophysical Laboratory.

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### **Presentation of the Mineralogical Society of America Award for 1972 to Arthur L. Boettcher**

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*Mr. President, Fellow Members, and Guests of the Society:*

It is a real privilege for me to introduce a friend and colleague for the Mineralogical Society of America Award. Dr. Arthur L. Boettcher earned this award at least in part because he has developed the art of hard work and long hours to a high degree. This is well known to his students. Because he moves so rapidly between office and laboratory, they have christened him "Art the Dart." I shall try to give you some idea of how he acquired such a distinguished title without being born into the ruling class.

"Art the Dart" does not look like Peter O'Toole of the ruling class because he grew up in Montana, and after graduating from high school he spent four years on active duty with the U. S. Air Force. Another four years at the Montana School of Mines gave him a bachelors degree with honors in Geological Engineering, and a charming wife, Mary. Mary was one of those lovely airline hostesses who make the monotony of air travel tolerable by wearing themselves out with constant cheerfulness for the pas-

sengers. After one weary flight she checked into a hotel in Great Falls, Montana, and when the elevator opened there was a good-looking bell-boy, who turned out to be Art Boettcher working his way through the School of Mines. That was in the days when Art sported a crew-cut; these days, the bell-boy's cap would not fit over his generous locks. Mary reports that she took one look at him and said "That's for me." Now, Art is a steady and persistent worker, but it seems that in Mary he found his match. In a short time they were married, and on their way to Pennsylvania State University for graduate work.

As a graduate student, our Award winner tackled a wide range of problems as a teaching assistant and in positions of research. These included various mapping projects, the kinetics of cement hydration, the identification of concrete aggregates exhibiting frost susceptibility, and teaching in a tough, three-term course in mineralogy and crystal chemistry. For his Ph.D. thesis, he completed a fine mineralogical and petrological study on the vermiculite deposit and associated rocks near Libby, Montana.

Although his research was field-based, he was well aware of phase equilibrium studies and their utility, so he decided to learn more about experimental petrology. He came to work with me in Chicago in 1966. Dr. Newton had just arranged the purchase of 3 piston-cylinder units for the department, and the one assigned to us was soon humming constantly as Art explored a series of systems involving water at mantle pressures. This was the most productive period that my laboratory has ever seen. Art has been darting from one pressure vessel to another ever since.

After considering several academic prospects, the Boettchers returned to Penn State in 1967, this time as members of the faculty. This is a period when most people ease off a little on their research activities, as they try to keep their lecture notes ahead of the new courses that they have to teach. But not Art Boettcher. Within a year, he had worked out the phase relationships in the system  $\text{CaO-Al}_2\text{O}_3\text{-SiO}_2\text{-H}_2\text{O}$  between 10 and 35 kbar.

Many man-hours of work have been expended on this system without the return of satisfying results. The person who nominated Art for this Award had worked in the system, and he knew that it was a real bear—as I glance around the room I see a few bearish faces of others who have suffered similarly. Despite the problems, Art produced such a magnificent

phase diagram, that I have seen experienced petrologists burst into tears when they look at it. A phase diagram as successful as this is a sign of real achievement. His subsequent research on the influence of water and carbon dioxide on the melting relationships of basalt and peridotite, with buffered oxygen fugacity, deals with far more complex systems, but somehow the phase diagrams do not have quite the same impact.

Art is now a dedicated experimentalist, and an administrator in charge of the geochemistry division at Penn State, but he continues to find his inspiration in the field. He has been very active in taking students to field camps, and on special trips to places as far away as Iceland and the European Alps. Recently, in search of the Moho, he led a group of students through Boulder Pass, somewhere in the Alps. One student, tired of clambering over boulders and scrambling across scree, exclaimed: "Oh, how I hate the frigging Quaternary!" Art overheard the expletive remark, and with a teacher's hope that maybe he could help a student with problems, he asked immediately, "What quaternary system do you hate?"

Mr. President, it gives me great pleasure to introduce Dr. Arthur L. Boettcher, the 1972 recipient of the MSA Award for his research in the quaternary system  $\text{CaO-Al}_2\text{O}_3\text{-SiO}_2\text{-H}_2\text{O}$  at high pressures and temperatures.