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PRESENTATION OF THE ROEBLING MEDAL OF THE MINERALOGICAL SOCIETY OF AMERICA FOR 1970 TO GEORGE W. BRINDLEY

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In preparing a citation of a man like George Brindley—a scientist who has spent 42 years hard at the job, produced some 218 papers (an average of over 5 per year), collaborated with some 40 colleagues, shepherded over 30 graduate students to their advanced degrees, and received numerous honors—the problem is one of picking the high spots, detecting the theme, and revealing the underlying characteristics: the nature of the man who makes such a massive contribution to his science. As I ruminated over this matter with the 15 mimeographed pages of his bibliography spread over the table top before me, patterns of words and word combinations in the titles became evident. Further the changing word patterns over the years reveal, in a gross manner, the progress and changing interests of the man. Let's look at a few of the key words that characterize some of the entries of this crystallographic encyclopedia.

Starting in 1928 when the first paper bearing the Brindley name appeared as co-author with his Professor, R. W. James, of Manchester University, in the *Proceedings of the Royal Society*, our budding scientist of a mere 23 years of age got off to a flying start. For in the four years it subsequently took him to move from the M.Sc. to the Ph.D. he had 27 solid publications to his credit—one for each year of his young life. Key words such as *carbon atom*, *chlorine ion*, *aluminium*, *MgO*, *perfect crystals* coupled with *charge distribution*, *X-ray refraction* and *reflection*, *optical dispersion*, *scattering factors*, and *diamagnetic susceptibility* reveal the young physicist producing a wide diversity of contributions culminating in the calculation of atomic scattering factors that stood unchallenged and unrefined for over twenty years.

With the Ph.D. under his belt and his ability to deal with simple substances and perfect crystals well documented, the true character of the Brindley we now know began to come forth. The key words of the thirties and early forties, such as *powder*, *alloys*, *salts* for the subjects; *lattice distortion*, *ionic deformation*. *atomic vibration*. *asymmetry* for the crystallographic characteristics suggest that he had said to himself, implicitly or perhaps even explicitly: "I say, old boy, enough of this perfect crystal stuff, let's get after the sanguinary anomalies!" And from that day forth, George Brindley, in the best tradition of his fictitious countryman, Sherlock Holmes, has spent his life snooping through the kingdom of recip-

rocal space, tracking down atomic, molecular, and layer lattice deviates, and exposing them to the harsh glare of the academic sun in the scientific tabloids of his day.

I believe that a mineralogist, observing in this young physicist of the thirties the unusual ability to simplify the apparently complex, might well have predicted that he would inevitably end up in the interlayered labyrinths of the clay minerals. And in the mid-forties the key words announce that he had arrived: *kaolinite*, *kaolinitic fireclays*, *halloysite*, *serpentine*, *chlorites*, and on through the list of all the common and many uncommon layer silicates; together with the descriptions *randomness*, *disorder*, *chemical and thermal transformations*, *mixed layer*, *long range order*, *high temperature reactions*—the more complicated, the greater the challenge as he moved through the decades of the forties and fifties.

In the sixties, as if the natural varieties offered insufficient complexity, our crystallographer—by now turned metallurgist-ceramist-solid state scientist-mineralogist as occasion demanded and opportunity arose—added organic chemistry to his list of disciplines as is revealed in seventeen papers with titles laden with words like *alcohols*, *ketones*, *amines*, *fatty acids*, *purines*, and *pyrimidines*.

And finally, lest there be any lingering suspicion of narrowness or over specialization, let's take note of words, salted throughout the record of the last 25 years, such as: *basal Permian sands*, *origin*, *composition*, *genesis*, *synthesis*, *alteration products*, *nomenclature*, to say nothing of "On fears and freedoms" and again "Examinations, credits, grades, and all that."

But key words are simply indicators of the research record. What of the other facets of this internationally eminent crystallographer?

Born in 1905 in Stoke-on-Trent, the environment and a number of events in his young life indicate it might have been hard for him to avoid being a teacher even if he had not had the inclination to teach. His father was a school-teacher and the only way George could financially manage a college education at Manchester University was to take advantage of grants provided to students committed to education. Since in England all education students are required to take the full three year science course, the aspiring physicist not only moved in his chosen direction but profited from a full year of required practice teaching after his B.Sc. Being somewhat obliged to go into high school teaching George might have had difficulties with his own education beyond the Masters Degree had not a temporary position as Demonstrator in Physics opened up when an astrophysicist at Leeds University took leave to pursue research at Mt. Wilson observatory. Unfortunately for astrophysics, conveniently for George, the man died in a mountaineering accident in this country

and Demonstrator Brindley successfully competed for the open Assistant Lecturer position.

In the absence of time to describe fully Brindley's teaching exploits let me simply illustrate by recounting two events—one about 40 years ago, another last year to indicate the affection of his students. It seems that directly over the demonstrator's bench in his lecture hall at Leeds there was a trapdoor in the ceiling. Immediately following the occasion of his marriage in 1931 to Catherine Fenton—a Scottish lass whom he met on one of his hiking trips in the Highlands, and, I should add here, a wonderfully fine and self-sacrificing wife who unfortunately cannot be here today because of illness—two students, having gained access to the passage above, removed the trap-door and at an appropriate moment in the demonstration, dumped buckets of confetti upon the head of the honeymooner. Unfortunately, my informant was not fully versed in the sequel to the story but knowing George I would guess that what followed was not consternation but more likely a short lecture on the effect of arm-waving turbulence on the gravitational settling of flaky particles.

In another vein, but reflecting again appreciation and love of a good teacher, George received the Matthew J. and Anne C. Wilson outstanding Graduate Teaching Award from his College of Earth and Mineral Sciences at Penn State last year. His Dean advised me that George's name was entered into the competition because more alumni of the College had spoken to him over the years of the unequaled excellence and long-lasting effectiveness of this man's teaching than was the case for any other professor in the College. When I asked one of his current students to what he attributed Brindley's strength as a teacher and preceptor the reply was: "It's simple, he works like a dog!"

Finally, although I could recount lists of other honors, fellowships and memberships, society offices, these are all in the record and I prefer to close on the theme that this man has served his sciences not only as an exceptional researcher, teacher, and society member and officer but also —like the donor of the medal he will shortly receive, though in a different sense—as a "bridge builder" *par excellence.*

In the research area I have already intimated how he is constantly building bridges of knowledge between and among the disciplines.

In his teaching the so-called generation gap is bridged so effectively it's just not visible between him and his students; and his lucid lectures daily and over the term period constantly are bridging the communication gaps that provide the *raison d'être* of educational institutions.

But the other, more unusual bridges that G. W. Brindley constructs with precision, persistence and, I must add, the enthusiasm of a true artist immersed in the love of his craft, are the bridges between labora-

tories and between countries. Each is a bridge that has involved careful design and patient toil by this man and his colleagues at the other end. Each is shaped differently in terms of the human relations involved but each provides an effective means for graduate students and colleagues to serve their science more effectively. The first such bridge was between Leeds and the laboratory of Jacques Mering in Paris with later development of access routes to various other French crystallographic centers. The bridge to Mering—one of the most accomplished of European crystallographers in the study of the characteristics of layer lattice silicates—has led to lifetime friendship of the two men and meritorious joint contributions to their science.

Brindley's move from Leeds to Penn State in 1953 (which I am proud to have helped "engineer") simply lengthened the spans to various European Laboratories with which he was, by then, collaborating. In the late fifties, working with M. Nakahira, then a Research Associate at Penn State, bridge building to the Orient began. Completed with his six months stay as a Visiting Professor at the Tokyo Institute of Technology in 1961 this bridge—as that to Europe—is in constant use. In the past few years, in fact, George has made two lecture tours to Japan, Korea, and Taiwan to the considerable benefit of clay mineralogists in the universities there and also to the ceramic industries of these countries. Brazil came into the picture in the mid-sixties. And throughout this past decade a small parade of co-workers and students have used the Brindley-Fripiat bridge between Penn State and the University of Louvain in Belgium. That these bridges are true two-way avenues which speed the progress of science and international understanding was perhaps best evidenced when the University of Louvain awarded him the degree of Doctor of Science, *honoris causa*, just about a year ago. An outstanding reason for the success of these bridges was given by our Belgium colleague, J. Fripiat, when he said on this occasion: "Cette présentation serait incomplète si l'on passait sous silence les qualités humaines du Professeur Brindley. Les nombreuses personnes rassemblées dans cette salle qui ont eu le privelège de travailler avec lui ainsi que tous ceux qui l'ont approché connaissent sa profonde courtoisie, son intégrité intellectuelle et sa grande simplicité et son sens profond de l'humour."

And lest these human qualities of George Brindley receive insufficient attention in the present citation, let me end by describing one more Brindley bridge. The incident took place in Brazil last year while our friend, in the company of several of his hosts, was strolling along the docks of a seaport town. Noting an interesting looking freighter tied up to the wharf, George decided to go aboard and have a look around; but unfortunately failed to notice, as he stepped from the dock edge, some

eight feet of water between him and the freighter. Only the most vivid imagination can properly picture the consternation of his Brazilian colleagues as their charge—the world famous crystallographer (who by the way does not include swimming among his accomplishments)—disappeared from sight with a resounding splash. But they need not have feared, for by the time they had the courage to peer over the edge, bridge-builder-Brindley, lacking other construction materials at hand, had bridged another gap—this time by pushing hands against the pilings of the dock and feet against the side of the ship. In response to the expected query from above he is reported to have stated that yes he seemed to be all right but he was afraid his glasses were missing.

Mr. President, it is with very great pleasure that I present to you our Roebling Medalist of 1970, Dr. George W. Brindley.

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ACCEPTANCE OF THE ROEBLING MEDAL OF THE MINERALOGICAL SOCIETY OF AMERICA FOR 1970

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Mr. President, Dr. Bates, Honored Guests, Fellows and Members of the Society, Ladies and Gentlemen:

I am deeply conscious of the great honor you bestow on me by this award of the Roebling Medal. When I have looked at the names of previous recipients, I have never thought of myself as measuring up to their achievements. To be enrolled in this company is indeed the ultimate honor for a mineralogist and especially for one who qualified as a physicist. As a student in the laboratory of Sir Lawrence Bragg and R. W. James in Manchester at the time when Jackson and West were working on the structure of mica, I was probably nucleated with interests which only developed 20 years later.

Quite a few times I have been asked how I came to be interested in the study of clay minerals, for up to 1945 my interests had been mainly in X-ray scattering factors, in the deformation of metals, and in lattice vibrations. During World War II, when normal university research in England was largely suspended, I occupied myself with some amateur geological field work. Stimulated by reading Bagnold's book, *The Physics of Blown Sand and Desert Dunes*, I turned to a study of some windblown