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# Presentation of the Roebling Medal of the Mineralogical Society of America for 2002 to Werner Schreyer

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Mr. President, distinguished mineralogists, and guests, I was delighted when Werner Schreyer asked me to be his citationist, because I admire him for his scholarship, for his dogged pursuit of the perfect experiment seeking exquisite minerals, and for his application of experimental mineralogy to petrological problems. Werner and I have had parallel lives in experimental petrology, following paths that have converged from time to time, and with each convergence has come growing respect and friendship. But as a schoolboy in the 1940s, I hated Werner Schreyer, and I'm sure that he hated me. We were receiving bombs from our respective air forces in Germany and England, and wartime propaganda is a powerful opinion-shaper. One of the exercises in my school's Air Training Corps was aircraft recognition, identifying the silhouettes of German aircraft, and Werner probably was expert in the same exercise as a member of the "Hitlerjugend".

About 15 years later, when our parallel paths met for the first time, we were both studying the silhouettes of microscopic cordierites, with their beautiful cruciform twins reminiscent of the aircraft recognition that occupied us in school. I was at Penn State studying my thesis buchites from Skye, and Werner was doing the first definitive experiments of cordierite synthesis and stability using Tuttle bombs at the Geophysical Laboratory in Washington, D.C. Despite the fact that encounters with German visitors at Penn State had already softened my inculcated anti-German reactions, our first contact, when we both presented cordierite papers at one of those early, cosy, AGU Spring Meetings, evoked within me a guarded reaction—"Warning, warning, this is a German!". I was really happy to learn that continued contact with Werner and other German scientists demonstrated conclusively that hatreds bred during war dissolve in the fellowship of science.

Whereas I abandoned cordierite after one paper, Werner never lost his first love. I counted 41 papers in his CV with the word cordierite in the title, between 1958 and 1993. These include experimental studies and natural occurrences. They involve cordierite with manganese, iron, sodium, potassium, beryllium, lithium, argon, $CO_2$ and $H_2O$. Werner's affair did falter for a while, when he destroyed cordierite and generated other parageneses by extending his experimental studies in the MASH system to pressures above10 kilobars. The flux of cordierite publications was temporarily reduced through a few years as he pursued the intensive development of high-pressure metamorphic grids. With Fritz Seifert, in 1969, he noted that the experimentally discovered assemblage talc-kyanite would be evidence for rocks metamorphosed at subcrustal pressures. His 1973 discovery of this assemblage in Afghanistan rocks was celebrated with the definition of whiteschists, pelitic rocks metamorphosed at very high pressures; talc-phengite is another significant assemblage. Whiteschists were soon discovered in many other parts of the world, including the European Alps, Africa and China.

Christian Chopin joined Werner in experimental MASH studies, published in 1983, and then searched for corresponding Mg-rich metamorphic rocks. Chopin's 1984 discovery in the Dora Maira Massif of those incredible coesite-pyrope rocks requiring burial of continental rocks to at least 100km defined Ultra-High-Pressure-Metamorphism. This was followed by many subsequent discoveries of UHPM and UHTM environments. Werner became intimately involved in the comparison of the natural parageneses with the calibrated assemblages of high-pressure experiments, and more recently with the effects of partial melting and critical points and fluids in such rocks. As his experimental capability pushed to higher and higher pressures, he kept revealing additional minerals and complexities. In 1986, he and his colleagues synthesized a calcium-free pumpellyite called MgMgAl-pumpellyite. Now, there's a strange mineral, with composition near a hydrated pyrope. Werner related it to high-pressure hydrous minerals under subduction zone conditions. Its potential significance in this important but poorly understood process was illustrated recently in an experimental paper by Bromiley and Pawley on the role of the mineral (now called Mg-sursassite) in "a possible mechanism for the deep subduction of significant volumes of $H_2O$". This involves the complete transfer of water from hydrated peridotites at moderate pressures into higher-pressure phase A-bearing assemblages.

Our second convergence was in 1970, when I was asked to join the IUGS Commission on Experimental Petrology, with Werner as the first Chairman (1970-1976). Werner had moved in 1966 from Kiel to the new Ruhr University at Bochum, which was still under construction. I remember about six huge, stark concrete buildings that reminded me of wartime, German bunkers and German efficiency. There are now about 13 buildings, with a much-matured landscape. Other Commission members summoned by Werner were Dave Green, William Scott Mackenzie, Tony Naldrett, Ken Yagi, and later Vilen Zharikov. Werner was building a department from scratch, and any self-respecting department needs a mature teaching and research array of minerals and rocks. In order to obtain a suitable collection, Werner had been taking students in a van to classic localities throughout Europe. Great boulders lying around the laboratory attested to the efficiency of this collecting process. We visitors wondered if there were any decent specimens left

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in Europe after these expeditions. Enhancement has been a continuing process, as I learned from Barb Dutrow, a visiting Humboldt Fellow working with Werner on staurolite stability during 1985–1987. At the end of a department-sponsored, stimulating field trip, everyone spread their samples out on the road, and Professor Schreyer picked out the best ones for the Department Collection. He compensated amply for this administrative seizure, however, by providing dinner at his home, where his charming and supportive wife Marianne (sitting over there today) served a magnificent meal, superbly complemented by Werner's selection of special wines for each of the multicourses. Werner and Marianne would never have met in Germany, but they came to Washington independently, met in1960 at a party given by the Austrian Embassy, and decided in 1961 to marry in1962 after their return to Germany. I am reminded that Werner has often guided me to special restaurants: mussels in Dusseldorf, huge grilled shrimps in Pretoria, monster lobsters in Cape Town, tender steaks in Kyoto, and Chinese delicacies in Edinburgh.

Now, back to the1970 IUGS Commission meeting. Under Werner's leadership, we decided that our most effective contribution would be to organize symposia in the Conferences organized by various disciplines with a view to illustrating how experimental and theoretical mineralogy and petrology had applications everywhere. Two of our early symposia were at International Geological Congresses of 1972 (Montreal), and 1976 (Sydney). Another was with the IUGG (1975, Grenoble). In addition to illustrating applications, we had the mission to show that "Phase Diagrams are Easy". Werner's continuing skill in the "Easy" part was demonstrated at the Lyell-Hutton Bicentennial Symposium on Edinburgh in1997, when he presented a lecture explaining phase diagrams and their metamorphic applications to an audience dominated by science historians. By jove, I think they got it! This gift and passion for explaining phase diagrams extends into Werner's everyday life, as many students have discovered at sociable meals when Werner covered their paper napkins with sketches of complex diagrams.

One potential convergence of our paths failed about 15 years ago. Werner was coming to USA on sabbatical, and I had hoped that he could come to Caltech. Instead, he went to Santa Barbara for "geochronology research". Werner—geochronology? In fact, he was checking out the isotopes of those Dora Maira specimens, but I think that his decision may have been reinforced so that he could resume singing with George Tilton. Thirty years earlier they had spent time together in Washington with the National Cathedral Choir.

Our most recent convergence was last September at the IMA General Meeting in Edinburgh. After 22 years on the IUGS Commission, Werner took on more international administrative responsibilities as a Councillor of IMA. This kept him very busy at committee meetings alongside our past-President, Kase Klein, who is IMA Treasurer. But he also found time to present a paper related to his extensive experimental investigations of boron-bearing systems, an expansion of work in his favorite MASH system. Werner is an expert in obscure boron-bearing minerals. I had often heard him talking with agitated excitement about exotic boron minerals whose names I can't remember. Ed Grew, a boron collaborator, nominated Werner for the Roebling Medal. Everybody knows for whom the mineral Rossmanite was named—last year's Dana Medallist—but Werner may be one of the few who knows that its formula includes boron.

The Edinburgh paper was entitled: "Two potentially new borate minerals in a kotoite-bearing marble from Eastern Siberia". His two discoveries were identified from birefringent specks in a single thin section. Mineral A is considered "to represent a new Al-dominant end-member of the hulsite group." As Werner remarked during his presentation, "not everyone knows the hulsite group," so let's move on to the second Mineral B with recipe something like this:

Take forsterite, replace the Si with B, and some O with F, making BF-forsterite; next, mix 2 parts of BF-forsterite with about 1 part forsterite. If the right spices are added, one then obtains an orthorhombic mineral with typical formula revealed by electron microprobe to be:

$(Mg_{1.90}Fe^{2+}_{0.05}Mn_{0.01})(B_{0.80}Si_{0.19})O_{3.20}(F_{0.45}OH_{0.35})$.

The mineral is to be named Pertsevite after the Russian coauthor who provided the thin section.

This citation offers the barest sampling of Werner's prodigious productivity. He has also investigated experimentally many major mineral groups: micas, chlorites, serpentines, amphiboles, pyroxenes, as well as less familiar minerals such as osumilite, carpholite, humite, tourmaline, sapphirine, kornerupine, yoderite and deerite-howieite-zussmanite. In 1978 he was honored with a new mineral, schreyerite, a vanadium titanium oxide. All these minerals remind me of a term that I encountered only recently. Fritz Seifert described Werner as a "truffle pig: somebody with an incredible nose for hidden delicacies, as if mineral assemblages could also emit pheromones", and Werner praised Christian Chopin as a truffle pig, with "the nose or keen eyes to see in the field and under the microscope the unusual, the new, and we tried to link that to the chemical systems". This is not a very elegant title, but it is clearly a term of appreciation, a title that must be earned.

Mr. President, I am proud to present for the Roebling Medal the Mineralogical Truffle Pig Professor Doctor Werner Schreyer. He has earned not only this Medal, but also the titles "Boron Buff" and "Cordierite King."