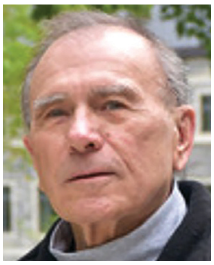
## PRESIDENT'S LETTER

### *Quartz—What Goes Around Comes Around*



Robert J. Bodnar

The theme of this month's issue of *Elements* is related to what is arguably the most over-looked mineral on Earth—quartz in its many varieties, and other $SiO_2$ polymorphs. While quartz is the second most abundant mineral (after feldspar) in the continental crust — making up roughly 4%–5% of the continental crust by mass, it is relatively insignificant in the Earth as a whole, representing perhaps only 0.1%– 0.2% by mass of the Earth.

The mineral quartz has played an important role in my career, although in an indirect way. Much of the work by myself, my students, and post-docs has been on fluid (and melt) inclusions. The most common host for fluid inclusion studies is quartz, owing to its ubiquity in a wide range of geologic environments, its hardness and lack of well-defined cleavage, which serve to preserve fluid inclusions well, and its transparency that allows inclusions to be observed in thick sections during microthermometric analysis under the microscope.

NMNH 177451 National Mineral Collection, Smithsonian Institution, Gift of Tricia and Michael Berns.

Quartz has played a major and evolving role in human history. The earliest known stone tools were often fashioned from quartz, chert, or flint, and striking flint against iron pyrite or iron-rich rock was employed to produce sparks hot enough to ignite tinder. This was one of the primary fire-making methods of prehistoric and early historic peoples worldwide. Quartz has also had spiritual and ritual significance in many cultures. Aboriginal Australians considered quartz crystals to have powerful spiritual properties and used them in healing ceremonies and initiation rites, and Native American peoples across North America used quartz crystals in medicine bundles and shamanic practice. Early millstones used to process grain were often made from quartzite or sandstone, and many cultures produced extraordinary jewelry and ornamental vessels carved from various colored varieties of quartz. In a very real sense, the Stone Age—which encompasses the vast majority of human existence—was largely a Silica Age.

In more recent times, quartz has contributed to major advances in technology during the past 100+ years. Owing to the discovery that thin slices of quartz crystal could oscillate at extremely precise frequencies when subjected to an electric current—the piezoelectric effect (discovered by Pierre Curie in 1880, but only industrially exploited from the 1920s onward)—made quartz crystals essential for radio transmitters and receivers in which quartz oscillators stabilized broadcast frequencies far more reliably than any electronic circuit could. By WWII, every radio-equipped soldier, ship, and aircraft needed quartz crystals to operate on assigned frequencies without drifting into other channels—and the demand for high-quality quartz was staggering: the U.S. alone needed tens of millions of crystals, creating a near-desperate scramble for supply. Crystal oscillators required optically clear, inclusion-free quartz because impurities, fractures, or twinning defects cause irregular or unstable oscillation. Moreover, the crystal had to be cut at very precise angles relative to its internal structure, and even tiny flaws could make a crystal useless for frequency control.

The United States and Europe had almost no domestic sources of high-grade quartz. The world's best deposits were in Brazil, making Brazilian quartz a strategically critical war material. During WWII, the U.S. government negotiated directly with Brazil for supply, and the crystal-cutting industry rapidly industrialized. The scarcity and strategic importance of natural, high-purity quartz drove one of the major materials science achievements of the post-war era: the development of hydrothermal synthesis of cultured quartz in the late 1940s–50s, which eventually made the natural crystal trade far less critical. Interestingly, the search for high-purity quartz in the Soviet Union led to major advances in fluid inclusion research, because the Soviets were using fluid inclusions as one of many tools to predict the quality of a quartz deposit.

In the past, quartz crystal was considered so vital for military uses that a U.S. national defense stockpile of more than 600,000 kilograms was amassed. This was natural piezoelectric-grade quartz crystal, built up primarily as a legacy of the WWII-era need for radio frequency control crystals. In the 1990s the U.S. aggressively drew down that stockpile. Beginning in the early 1990s, the Department of Defense determined that over 99% of the National Defense Stockpile inventory was excess to the Department's needs and Congress authorized its disposal. During the 1993 fiscal year, the NDS sold 176.8 metric tons of quartz valued at $1.64 million. During the 1994 fiscal year, sales totaled 313.1 metric tons valued at about $6.3 million—*of which 96.8 metric tons valued at $3.21 million were sold within just six days at the Tucson Gem and Mineral Show (Arizona, USA)*! Much of the stockpile was sold to gem dealers and collectors rather than industry, because the large natural crystals were prized for carvings and spheres. By the time the sell-off was largely complete, almost nothing remained. As of September 30, 2019, the National Defense Stockpile contained just 7,148 kilograms of natural quartz crystal—down from over 600,000 kg at the peak—a reduction of roughly 99%.

High-purity quartz (HPQ) is, if anything, even more critical today than it was in the 20th century. The applications have shifted dramatically toward the technology sector. Semiconductors represent by far the largest and most demanding application. Manufacturing silicon chips requires HPQ at almost unimaginable purity levels (often 99.998% $SiO_2$ or higher). The entire modern chip industry—every smartphone, computer, server, and AI accelerator—depends on a steady supply of HPQ. HPQ is also needed by the photovoltaic industry for solar cells, and the explosive global growth in solar energy has made this a major and expanding market. Optical fiber is essentially ultra-pure fused silica (quartz glass). The extraordinary clarity required to transmit light signals over kilometers without significant loss demands very high purity quartz starting material. High-intensity discharge lamps all use fused quartz envelopes because of quartz's ability to withstand high temperatures and transmit UV light that ordinary glass would block.

Today, HPQ has become one of the most strategically significant industrial minerals of the 21st century. There are few substitutes, with AI chip demand increasing rapidly, and semiconductor manufacturing that favors natural HPQ processed to extreme purity over less-pure synthetic quartz. The world's premier deposits of semiconductor-grade quartz are remarkably few. As such, HPQ is now included among the list of critical minerals by many countries, including the U.S. (where it is listed as silicon rather than HPQ), China, the EU, and others. The Spruce Pine deposit in North Carolina (USA) is widely considered the single most important source of HPQ on Earth, supplying a large share of the global semiconductor industry's needs. However, this single source of HPQ represents a significant supply risk to the U.S. For example, when Hurricane Helene hit North Carolina in late 2024, HPQ production was shut down temporarily as roads were blocked, electricity was cut, and flood damage was widespread—briefly rattling the global semiconductor supply chain.

While quartz is extraordinarily common as a mineral, *high-purity* quartz of semiconductor grade is vanishingly rare. The challenge isn't finding quartz; it's finding quartz with the right internal crystal structure and sufficiently low trace element contamination to meet modern industrial standards. Abundance at the macro scale tells you almost nothing about availability at the quality level that matters. The mineral sciences have an important role to play in meeting demands for HPQ through careful and detailed analysis of the crystallography and composition of quartz and its contained micro- to nanoscale solid (and fluid) inclusions to identify quartz that meets the rigorous quality standards needed by modern industries.

**Robert J. Bodnar**, 2026 MSA President

## NOTES FROM CHANTILLY

- **Renewal Season!** It is not too late to renew your memberships for 2026, as well as subscriptions to MSA's publications. Member dues are: Regular Members and Fellows ($90); Early Career Members ($50); Student Members ($20); Senior Members ($0); Sustaining Members ($240 – membership plus a $150 contribution to support MSA's many activities). You can renew via the home page of MSA's website: www.msaweb.org. At that time, we hope that you will also make a contribution to one or more of MSA's funds. These funds support our student research grants, lecture series, websites, education and outreach activities, awards, and much more. **PLEASE NOTE: When you join or renew, you will be asked by our new membership system to create a password. This password is only for accessing your membership information. You will still use your email (username) and five-digit member ID (password) to access MSA's online publications.**

## MSA 2027 ANNUAL MEETING

MSA will be holding its second Annual Meeting in Tucson, Arizona, USA from February 14–17, 2027. The afternoon of Sunday, February 14, will be devoted to oral sessions of interest to both mineralogists and mineral enthusiasts. There will be poster sessions at the GEM Ballroom of the Doubletree Hotel Convention Center from Sunday through Tuesday of the meeting. Oral presentations will be at the Tucson Convention Center, which is adjacent to the Doubletree Hotel. On the Thursday after the meeting (February 18) there will be field trips to areas of geoscientific interest around Tucson. Please put the 2027 MSA Annual Meeting on your calendar now. For more information, visit the MSA Annual Meeting website at https://msaweb.org/annualmeeting/.

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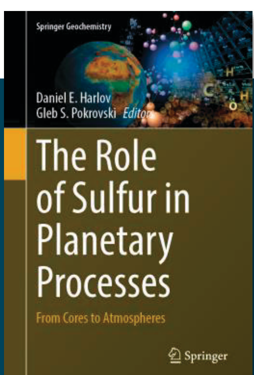


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OneGeochemistry

*Announcing Goldschmidt 2026 Town Hall*

OneGeochemistry representatives and members will be hosting an open Town Hall on **resources for geochemical data publication and documentation of analytical protocols** at Goldschmidt this July in Montréal. Panelists and attendees will discuss how geochemists can integrate FAIR data publication into their research workflows, and present potential solutions for **automatically connecting labs and instruments with repositories** for geochemical data and analytical setups.

The Town Hall will be held on **Thursday July 16th at 13:00 - 14:00** during the lunchtime program.

Existing projects will be showcased and attendees are encouraged to suggest new areas of interest. Join us if you produce or work with geochemical data, or are interested in shaping the data lifecycle and improving the transparency and reusability of science.

Find more information and data best practices at www.onegeochemistry.org