

## JOSEPH R. SMYTH (1944–2026): ARE THE OCEANS JUST THE TIP OF THE ICEBERG?

Legendary mineralogist Professor Joseph (Joe) R. Smyth passed away in January 2026, in Boulder, Colorado, USA. Perhaps best known for predicting that wadsleyite could incorporate oceans worth of “water” into the mantle transition zone (Smyth 1987), Joe was a professor of mineralogy at the University of Colorado (CU) Boulder, which suited his outdoor lifestyle.

Joe studied geology at Virginia Tech, USA (BS 1966), which was becoming an early center of gravity for the field of mineral crystal chemistry at the time. Pursuing that interest, Joe moved to Chicago to work with Joseph V. Smith, one of the great mineralogists of the time. Joe’s work at The University of Chicago (PhD 1970) focused on developing instrumentation for high-temperature crystallography, which he utilized to over 1000 °C to greatly expand knowledge of the high-temperature phase transitions in pyroxenes. At Chicago, Joe also started playing around with Madelung electrostatic potentials (Smyth and Smith 1969), which he would employ 20 years later in his famous prediction of hydrogen-defect sites in wadsleyite (Smyth 1987). The late 1960s in Chicago were a turbulent time, both politically and socially, shaping Joe’s lifetime passion for social justice. His apartment in Hyde Park featured a beat-up old couch, rumored to have once belonged to Enrico Fermi.

Following his PhD and a summer of lifeguarding on Long Beach Island, New Jersey (USA), Joe moved to Harvard, where he held a research fellowship in geology, advised by Charlie W. Burnham. At Harvard, Joe perfected his heating stage for single-crystal X-ray diffraction (Smyth 1972) and met then-graduate student, Robert M. Hazen (Carnegie Institution for Science, Earth and Planets Laboratory). Hazen recalled, “I wanted to learn high-*T* crystallography, and Joe was a kind and patient mentor. I recall vividly that the very first time I mounted a forsterite crystal to do high-*T* work, I cranked up the current too fast and burnt out the furnace. I know that meant Joe had to spend many hours rebuilding the furnace, but he never showed the slightest annoyance at me. I learned a couple important lessons—not the least of which was how to be a supportive and constructive mentor.”

During Joe’s time at Harvard, Burnham and others organized a meeting on Martha’s Vineyard, entitled *Conference on Petrologic Crystal Chemistry* (Boyd et al. 1972). Joe Smyth was among those in attendance to establish a community interested in the “overlap between petrology, mineralogy, and crystallography.” Hazen described the Vineyard conference as an event where the seeds of mineral physics were planted.

From 1972–1976, Joe worked as a staff scientist at the Lunar Science Institute (now the Lunar and Planetary Institute, LPI), where he worked extensively on the crystal chemistry of *Apollo* samples, including armalcolites named after the *Apollo 11* crew members (Smyth 1974a), and discovery of a new bronzite polymorph in lunar rock 76535 (Smyth 1974b), postulated to have cooled slowly at high pressure deep in the lunar crust, which he published in the first volume of *Geophysical Research Letters*.

Prior to joining Los Alamos National Laboratory (LANL) in 1976, Joe was senior lecturer at the University of Cape Town (South Africa), where he met his lifetime friend, Tamsin McCormick, who shared his fascination with eclogitic mantle xenoliths. Not only would Joe and Tamsin go on to publish numerous papers together on the mineralogy and geological

significance of xenoliths from the South African kimberlites (e.g. Smyth et al. 1989), but they also shared a passion for whitewater rafting in the southwestern United States (FIG. 1), which they in turn shared with many people. Steven Jacobsen (CU Boulder, USA) recalls one such trip down the San Juan River in the late 1990s attended by Joe’s former advisor, Charlie Burnham, and Gilberto Artioli (Padua), also a former graduate student of Joseph V. Smith. Stops along that six-day river trip included the Mule Ear diatreme (30 Ma), a kimberlite that fractured its way through the Permian sandstones of southwestern Utah. Tamsin went on to co-lead an environmental and conservation educational organization in Moab, Utah, and Joe visited frequently until his passing.

At LANL (1976–1984), in addition to thinking about potential mineral hosts for free quarks and compiling crystal structures for his book with David Bish (Smyth and Bish 1988), Joe worked on zeolite stability in relation to the proposed nuclear waste repository. In his final paper from the Los Alamos years, Joe wrote in *The Journal of Geology*, “There is substantial evidence to suggest that in environments similar to Yucca Mountain, Nevada, clinoptilolite and mordeinite break down at temperatures above 95 °C”. He recommended that it would be necessary to saturate zeolite-bearing horizons with water to keep temperatures below 85 °C; he felt strongly that zeolite instability would provide a pathway (shrinkage fractures) and driving force (fluid pressure) for the release of radionuclides into the biosphere (Smyth 1982). Joe would later joke that it was that paper that led him to consider a career move into academia. By the fall of 1983, Joe started as assistant professor at CU Boulder, where he became full professor in 1989 and remained through to his retirement in 2018, when he became professor emeritus.

Colorado suited Joe’s outdoors sensibility. In addition to whitewater rafting, Joe was a snowboard instructor at Copper Mountain into his mid-60s. Joe’s cabin in Silverthorne, Colorado, served as an access point for high-country hiking and skiing. Dave Rubie (Bayerisches Geoinstitut, BGI), recalled ski/snowboarding outings from Joe’s Silverthorne cabin following AGU or LPSC as the source of happy memories.

At CU Boulder, Joe would make his prediction of hydrogen in wadsleyite based on the shallow electrostatic potential of the O1 site, an unusual non-silicate oxygen (Smyth 1987; see BOX 1). Hydroxyl was confirmed in laboratory-grown wadsleyite several years later by McMillan et al. (1991), and hydrous wadsleyite has been intensively studied ever since. A search of “H<sub>2</sub>O or hydrogen or hydrous or water” and “mantle transition zone” in one scholarly database yields well over a thousand papers since 1987.

Professor Joseph R. Smyth was a member of the Mineralogical Society of America since 1965, and Life Fellow since 1991. He received a Senior Research Award (Preistrager) in 2004 from the Alexander von Humboldt Foundation and was elected Fellow of the American Geophysical Union in 2007. The German Mineralogical Society (DFG) awarded Joe the prestigious Abraham Gottlob Werner Medal in 2017 (FIG. 2), citing his work on mantle mineralogy and prediction that the mantle transition zone (410–660 km depth) may contain the largest geochemical reservoir of water on the Earth, with “far-reaching implications for plate tectonics, mantle dynamics, and even the origin of water on Earth.”



**FIGURE 1** In addition to his contributions to mineral physics and crystal chemistry, Joe Smyth was a true outdoorsman with a passion for whitewater rafting, skiing, and hiking.

Far more than his awards, Joe is remembered for his kindness and patient mentorship. "One of the best people I've ever met, always kind, polite and fair with everybody," said Prof. Fabrizio Nestola (Padua), who was among the "club of crystallographers," so-called by Prof. Diego Gatta (Milan), at BGI in Bayreuth in the late 1990s and 2000s, including also the authors of this *Heritage* article. Joe Smyth was incredibly supportive of young mineralogists, and he inspired them to think independently and to view crystal chemistry in the context of large-scale geological problems.

Joe's mentorship of young scientists continued well after retirement. Alisha Clark was a new assistant professor in petrology and rock mechanics at CU Boulder during the 2020–2022 lockdowns and describes Joe as her "Covid buddy." They had dinner together weekly. In addition to moral and scientific support, Joe shared some previously untold stories, including one where he helped land a commercial flight from Denver to Santa Fe in the early to mid-1980s. Apparently, the co-pilot was a no-show and passengers were asked if anyone had a pilot's license; Joe had one.

### Box 1 A VISION OF A HYDROUS MANTLE

In 1987, Joe Smyth predicted based on crystal chemistry alone that wadsleyite could host significant water, anticipating by decades the experimental confirmation (Kohlstedt et al. 1996) and eventual discovery of hydrous ringwoodite in diamond (Pearson et al. 2014). Joe's insight helped transform our understanding of the mantle transition zone as a major reservoir of Earth's water, reshaping our view of the deep Earth.

*American Mineralogist, Volume 72, pages 1051-1055, 1987*

$\beta$ -Mg<sub>2</sub>SiO<sub>4</sub>: A potential host for water in the mantle?

JOSEPH R. SMYTH

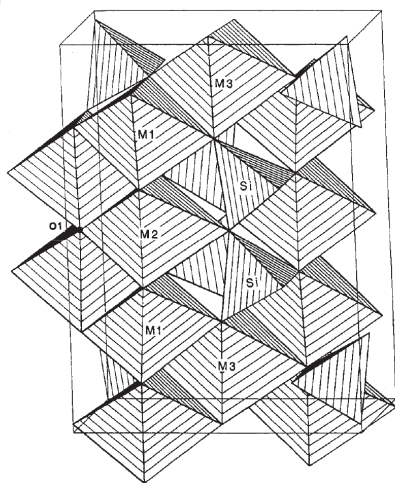


Fig. 1.  $\beta$ -Mg<sub>2</sub>SiO<sub>4</sub> structure, perspective *a*-axis projection, *c* horizontal. The SiO<sub>4</sub> groups are clearly shown. This is a sorosilicate, not an orthosilicate or spinel. The O1 position (labeled) does not bond to Si and thus may be a potential site for water in the lower part of the upper mantle.

FIGURE REPRODUCED WITH PERMISSION OF THE MINERALOGICAL SOCIETY OF AMERICA.



**FIGURE 2** Joe Smyth was awarded the Abraham Gottlob Werner Medal in 2017, the highest award of the German Mineralogical Society, honoring outstanding contributions to research in mineralogy.

Joe's family life included three younger half-sisters, whom he adored. Patricia Smyth said, "When we were little and Joe was traveling the world for research, he would bring us home gifts from different places. Lederhosen from Germany, woolies from Peru, and comic books in French, which he would read to us when he visited." Joe believed traveling the world was a way to not only accomplish more interesting science, but to better understand oneself, humanity, and to promote peace. At CU, Joe instituted a practice of paying the passport application fee for undergraduate students in mineralogy who didn't have one. He knew it was a small barrier (for him), which might inspire his students to travel and meet people from all over the world. There is a plan in Joe's memory to continue that practice of buying passports for students who might otherwise not obtain one.

We will remember Joe Smyth for many things, a founding member of the field of mineral physics, wonderer of the mysteries of the Universe, inspirer of young scientists, sweetly mischievous, and a caring dear friend.

**Steven D. Jacobsen** (University of Colorado Boulder, USA),

**Ross J. Angel** (Istituto di Geoscienze e Georisorse, CNR, Padova, Italy),

**Yu Ye** (China University of Geosciences, Wuhan, China),  
and **Tiziana Boffa-Ballaran** (Bayerisches Geoinstitut, University of Bayreuth, Germany)

### REFERENCES

- Boyd FR Jr, Burnham C, Papike JJ, Prewitt C (1972) Conference on petrologic crystal chemistry. *Eos* 53: 187-189, doi: 10.1029/EO053i002p00187
- Kohlstedt DL, Keppler H, Rubie DC (1996) Solubility of water in the  $\alpha$ ,  $\beta$  and  $\gamma$  phases of (Mg,Fe)<sub>2</sub>SiO<sub>4</sub>. *Contributions to Mineralogy and Petrology* 123: 345-357, doi: 10.1007/s004100050161
- McMillan PF, Akaogi M, Sato RK, Poe B, Foley J (1991) Hydroxyl groups in  $\beta$ -Mg<sub>2</sub>SiO<sub>4</sub>. *American Mineralogist* 76: 354-360
- Pearson G (2014) Hydrous mantle transition zone indicated by ringwoodite included within diamond. *Nature* 507: 221-224, doi: 10.1038/nature13080
- Smyth JR, JV Smith (1969) Electrostatic energy for ion clustering in intermediate plagioclase feldspars. *Mineralogical Magazine* 37: 181-184, doi: 10.1180/minmag.1969.037.286.04
- Smyth JR (1972) A simple heating stage for single-crystal diffraction studies up to 1000 °C. *American Mineralogist* 57: 1253-1256
- Smyth JR (1974a) The crystal chemistry of armalcolites from Apollo 17. *Earth and Planetary Science Letters* 24: 262-270, doi: 10.1016/0012-821X(74)90104-6
- Smyth JR (1974b) Low orthopyroxene from a lunar deep crustal rock: a new pyroxene polymorph of space group *P2<sub>1</sub>ca*. *Geophysical Research Letters* 1: 27-29, doi: 10.1029/GL001h001p00027
- Smyth JR (1982) Zeolite stability constraints on radioactive waste isolation in zeolite-bearing volcanic rocks. *The Journal of Geology* 90: 195-201
- Smyth JR (1987)  $\beta$ -Mg<sub>2</sub>SiO<sub>4</sub>: a potential host for water in the mantle? *American Mineralogist* 72: 1051-1055
- Smyth JR, Bish DL (1988) *Crystal Structures and Cation Sites of the Rock-Forming Minerals*. Allen and Unwin, Boston, 358 pp
- Smyth JR, Caporuscio FA, McCormick TC (1989) Mantle eclogites: evidence of igneous fractionation in the mantle. *Earth and Planetary Science Letters* 93: 133-141, doi: 10.1016/0012-821X(89)90191-X