American Mineralogist, Volume 109, pages 1839–1840, 2024

Memorial of Larry Wayne Finger (1940–2024)

Robert M. Hazen[1,*]

[1]Earth and Planets Laboratory, Carnegie Science, 5241 Broad Branch Road NW, Washington, D.C. 20015, U.S.A.

On June 21, 2024, the noted mineralogist, crystallographer, and computer scientist Larry Wayne Finger died peacefully at his home in Smithville, Missouri, surrounded by his family. He was 84 years old. As a pioneer in the invention and implementation of computer-driven automation of scientific instrumentation, Larry had a profound influence on a generation of mineralogists and petrologists.

Larry Finger, the oldest of 3 children, was born on May 22, 1940, in Terril, Iowa. In 1952, his family moved to a 240-acre farm in southern Minnesota, where they grew feed corn and soybeans. At the age of 13, following a severe accident to his father, Larry was given the responsibility to run the farm for several months—a time he recalled that gave him the knowledge and, equally important, the confidence to solve difficult problems. He seldom boasted, but he was proud of his ability as a pre-teen to drive a tractor and plow rig straight backward through a narrow fence opening. He derived pleasure from the mechanical world: well into the 1980s, at a time when most suburbanites drove automatic cars, Larry insisted on stick shifts and tuning his own vehicles. His history of embracing tough challenges (along with his propensity for wearing short-sleeved shirts on the coldest of Winter days) were Minnesota legacies that persisted throughout his life.

Despite the demands of the farm, Larry graduated as valedictorian of Tracy High School in 1958 and enrolled at the University of Minnesota, where he earned both a Bachelor's degree in Physics (1964) and a Ph.D. in Mineralogy (1967). While at the University, Larry met and then married Denise Lanning—they had two daughters, Cynthia and Pamela—and celebrated their 62nd anniversary shortly before his death.

Studying with noted mineralogist and crystallographer Tibor Zoltai, Larry came under the spell of X-ray crystallography at a pivotal time in the field. A half-century earlier, Max von Laue and the Braggs had won their Nobel Prizes for X-ray diffraction and crystal structure determination. Their work demonstrated that crystals scatter X-rays in specific directions and that the analysis of positions and intensities of those scattered X-rays could be used to deduce the periodic atomic structures of crystals. By the 1960s, laborious methods of measuring X-ray photographs—spot-by-spot visual analysis of those positions and intensities—were being replaced by equally laborious but more quantitative methods employing 3- and 4-circle X-ray diffractometers.

A diffractometer (see photo) centers a tiny crystal mounted at the end of a needle on a rotating holder. That crystal is bathed in an X-ray beam, which diffracts off the crystal at precise angles. The various circles and arcs of the diffractometer allow the operator to align these diffracted X-ray beams with a precisely positioned X-ray detector. Crystallographers prior to the mid-1960s had to hand calculate angles for each diffraction spot, then hand crank the circles to the calculated positions and collect the spot and background intensities. The determination of one crystal structure, often involving measurements of hundreds to thousands of individual spots—could take a year or more in an effort worthy of a Ph.D. thesis. In the 1960s, few university geology departments had the instrumentation and expertise to teach these skills. One of the most famous and prolific X-ray laboratories was established by MIT Prof. Martin Buerger, who trained a generation of influential mineralogist crystallographers, including Charles Burnham, Donald Peacor, Charles Prewitt, and Tibor Zoltai.

Larry Wayne Finger (1940—2024). Photo ca. 1972, courtesy of the Carnegie Institution for Science.

Larry Finger, an academic "son" of Zoltai and thereby "grandson" of Buerger, was instrumental in bringing X-ray diffraction into the computer age—contributions that led to an explosion of crystallographic research. Following his Ph.D., Larry came to the Geophysical Laboratory of the Carnegie

* E-mail: rhazen@carnegiescience.edu

0003-004X/24/0010–1839$05.00/DOI: https://doi.org/10.2138/am-2024-M102024

Institution in Washington, D.C.—a position he held for 32 years until his retirement in 1999. At Carnegie, he joined recent MIT graduate Charles Burnham. Together they enjoyed a state-of-the-art Picker 4-circle diffractometer—one that Finger helped to modify in a new and powerful way. In a theme that reverberated throughout his career, Finger combined his expertise in hardware and software to attach computer-controlled stepping motors to the several circles of the diffractometer. Working closely with the Geophysical Laboratory's Electronics Engineer, Christos Hadidiacos, they automated the diffractometer, linking the motors to a computer that calculated angles and drove the circles to correct positions (Finger et al. 1973). Thanks to this invention, what might have previously been a year's project could be completed in a few days. The demand for this improvement was so great that Finger and Hadidiacos started a small company to retrofit an older generation of manual diffractometers, as well as electron microprobes, with their "Krisel Control" automation (Finger and Hadidiacos 1971, 1972).

In 1976, Finger was joined by Carnegie Postdoctoral Fellow Robert Hazen, and they began a quarter-century collaboration in the emerging field of high-pressure and high-temperature crystallography—a pursuit they dubbed "comparative crystal chemistry." Together, Finger and Hazen published more than 100 papers and a book (Hazen and Finger 1982), including 27 articles in *American Mineralogist*. His favorite publications involved extreme crystallographic challenges, including devising new methods of high-pressure crystallography (King and Finger 1979; Skelton et al. 1991), high-pressure single-crystal studies of condensed hydrogen (Mao et al. 1988), determination of the complex structure of fingerite (the mineral named after him; Finger 1985), and measuring X-ray diffraction from what was at the time the smallest crystal ever attempted (Skelton et al. 1992).

While at Carnegie's Geophysical Laboratory, Larry influenced the next generation of mineralogical crystallographers by mentoring more than a dozen predoctoral and postdoctoral fellows, including Ross Angel, Andrew Au, Robert Downs, Hubert King, Joseph Mariathasan, Yoshikazu Ohashi, David Palmer, Linda Pinckney, Russell Ralph, Nancy Ross, Takehiko Yagi, Hexiong Yang, and Jinmin Zhang.

Influenced by the untimely deaths of two Lab colleagues and wanting time to pursue other interests, Larry retired at age 59. His fondness for symmetry elements manifested in a passion for square dancing with Denise. They performed at the highest competitive levels, tracing out rotation axes and mirror planes on the dance floor. For the better part of 6 years, they traveled the country, driving a Ford F450 pickup, pulling a big camper trailer, and visiting 47 of the lower 48 states (they only missed Florida).

Six years of wanderlust was followed by two decades living near their daughter Pam's family, including two grandchildren, Riggins and Cael, outside Kansas City. Larry's expertise as a hardware and software engineer found new outlets as a consultant, mentor, and member of an organization that rejuvenated old computers and provided them to students in need. Even in his final weeks and months, Larry's eyes sparkled as he recalled writing the Linux code to make old machines work with new operating systems.

It is rare in science for one individual to open pathways to discovery for so many others, as recognized by the award of a Humboldt Preis to Larry in 1996. By pioneering the automation of X-ray diffractometers and electron microprobes and by applying those methods to a host of crystal-chemical problems, Larry Finger led the geoscience community in producing a flood of crystallographic and analytical data—contributions that continue to usher in a new age of geoinformatics.

References cited

Finger, L.W. (1985) Fingerite, $Cu_{11}O_2(VO_4)_6$, a new vanadium sublimate from Izalco volcano, El Salvador: crystal structure. American Mineralogist, 70, 197–199

Finger, L.W. and Hadidiacos, C.G. (1971) Automation of an electron microprobe. Carnegie Institution of Washington Year Book 70, 269–275.

——— (1972) Electron microprobe automation. Carnegie Institution of Washington Year Book 71, 598–600.

Finger, L.W., Hadidiacos, C.G., and Ohashi, Y. (1973) Automated X-ray diffractometer. Carnegie Institution of Washington Year Book 72, 694–699.

Hazen, R.M. and Finger, L.W. (1982) Comparative Crystal Chemistry: Temperature, Pressure, Composition and the Variation of Crystal Structure, 231 p. Wiley

King, H.E. Jr. and Finger, L.W. (1979) Diffracted beam crystal centering and its application to high-pressure crystallography. Journal of Applied Crystallography, 12, 374–378.

Mao, H.K., Jephcoat, A.P., Hemley, R.J., Finger, L.W., Zha, C.S., Hazen, R.M., and Cox, D.E. (1988) Synchrotron X-ray diffraction measurements of single-crystal hydrogen to 26.5 gigapascals. Science, 239, 1131–1134.

Skelton, E.F., Ayers, J.D., Qadri, W.B., Moulton, N.E., Cooper, K.P., Finger, L.W., Mao, H.K., and Hu, Z. (1991) Synchrotron X-ray diffraction from a microscopic crystal under pressure. Science, 253, 1123–1125.

Skelton, E.F., Ayers, J.D., Qadri, W.B., Hu, J.Z., Finger, L.W., and Mao, H.K. (1992) X-ray diffraction from a 28 attoliter crystal volume. Advances in X-ray Analysis, 35, 617–621.