PENROSE MEDAL

Presented to
Susan Werner Kieffer

Susan Werner Kieffer
University of Illinois at Urbana-Champaign

Citation by Stephen Marshak

When Sue Kieffer was growing up in a small town in northwesternmost Pennsylvania, she would take forever to walk home from school, for she couldn't help wondering about all that she saw on her path home. That wonder about the world around her—and later, about other worlds—has stayed with her during an amazing professional career that has so far spanned 45 years, and is still going strong.

After receiving her undergraduate degree in physics from Alleghany College, Sue jumped across the continent to study geology and planetary sciences at Caltech, where she received her Ph.D. in 1971. Like many scientists coming of age during the 1960s, she had wanted to voyage into space. Though that didn't happen, Sue's interest in objects in and from space has been a continuing theme in her career. Her graduate work addressed the dynamics of impact at Meteor Crater. Initially, she approached the challenge from a modeling perspective, but when one of her mentors, Gene Shoemaker, showed her a thin section of shocked sandstone, Sue had a light-bulb moment, realizing the importance of seeing geologic features and phenomena first-hand, as part of any geologic study. This principal that has guided her work ever since. Her work on shock metamorphism led Sue into the physics of shock waves. She determined, that in order to understand them, she needed to know the heat capacity for stishovite, but found that such information didn't exist. This challenge might have stopped most geologists, but not Sue. She taught herself relevant aspects of physical chemistry, and generated a classic and widely used series of papers on the thermodynamics and lattice vibrations of minerals.

From Caltech, Sue moved to a faculty position at UCLA, and from there she went to the U.S. Geological Survey in Flagstaff, Arizona. A year later, Mount Saint Helen's began to erupt, and Sue was soon camping on a ridge overlooking the volcano. Subsequent to the explosion, she mapped tree blow-down patterns, and saw in the patterns, a clue to how the lateral blast of the explosion worked. Once again, Sue realized to that, to understand geology, she needed to learn yet another new discipline—rocket-nozzle dynamics. In effect, to understand a geologic map, Sue literally became a "rocket scientist." Over the years, she's applied this understanding to address several topics pertaining to volcanic eruptions and geysers, on Earth and on the moons of Jupiter and Saturn.

While at the USGS, Sue also turned her attention to two of America's greatest wonders. Her interest in eruptions, and on supersonic flow in bubbly water, led her to Old Faithful Geyser. Once again, wanting observation to guide theory, Sue and her colleagues took a field trip down the throat of Old Faithful, via a video camera. The unique footage is likely the only imagery that will ever be obtained of what the inside of this celebrity geyser looks like. From the steam of Old Faithful, Sue plunged into the icy froth of the giant rapids in the Grand Canyon. The first time Sue saw the rapids, she asked the question, "What caused the waves?" Up until then, the standard answer was simply that they were due to flow over debris. But Sue, being Sue, sought a more rigorous explanation. In order to let observation guide theory, she mapped the rapids, taught herself geological fluid dynamics, and developed a theory showing how constrictions cause hydraulic jumps that produce the waves.

From the USGS, Sue moved back into academia, by taking a position as a Regents Professor of Geology at Arizona State University. From ASU, she headed to British Columbia, and then Toronto, where she tried her hand in the private sector, as a consultant specializing in the analysis non-linear phenomena. The University of Illinois at Urbana-Champaign was able to lure Sue to the Midwest, where she held the position of Walgreen Chair of Geology, along with a joint appointment in the Department of Physics, until her retirement last year. At Illinois, Sue expanded her work on extraterrestrial eruptions, tackling the mysterious plumes of Enceladus, and most recently, has added the study of landslides to her immense palette of interests. She was an inspiring colleague and a wonderful friend, and Shadow, Sue's beloved border collie, immediately became the department mascot.

The Penrose Medal focuses on accomplishments from "eminent research in pure geology." Sue has clearly made a great many profound contributions that qualify. She takes foundational concepts—such as how atoms vibrate in a mineral lattice, how supersonic gases blast from a rocket nozzle, or how water flows in a flume—and makes them geological. But the research side of Sue is only part of her story. She is an accomplished author who delights in making science accessible to non-scientists, as exemplified by her recent book on The Dynamics of Disaster. She is also a superb musician, and a former champion marathon runner. And, she is also citizen of the world who, especially in recent years, has invested considerable time and energy on broader issues of societal significance, such as sustainability and geoethics.

Sue has led an amazing journey through the breadth of geology, a journey that has yielded insight into a diversity of subjects. Her multiple contributions have been recognized by numerous honors. She is a member of the National Academy of Sciences and of the American Philosophical Society, and she received both a MacArthur "genius award," and GSA's Day Medal. It is most fitting that Sue's unique role in advancing our understanding of geology—from the microscopic to the megascopic scales—has led to her receipt today of 2014 Penrose Medal. Please join me in congratulating Susan Kieffer on this wonderful award.

Response by Susan Werner Kieffer

Thank you very much, Steve,

I was truly thrilled to receive notice of the Penrose award, perhaps even more than thrilled: the Icelandic word 'berserker' might have briefly applied! Many Penrose Medalists before me have expressed my feelings of both pleasure and unease at having their work recognized in this way in light of many worthy peers. But, as George Thompson said in 2008 "After brief consideration, I decided to accept!"

I would like to acknowledge the "usual suspects"—people in my career who have been in the right place at the right times. As an undergrad in physics and

math at Allegheny College in northwestern Pennsylvania, I had two fantastic women physics professors who inspired me greatly, Georgie Scovil and Barbara Lotze. At Caltech, I had the good fortune of doing my thesis with Gene Shoemaker—in fact, only after graduated did I rediscover in my scrapbooks that in 9th grade, I'd cut out a newspaper article about Gene and his dream of going to the moon, a dream that became mine. Fortunately, along the way in the geology-based Caltech planetary program, I learned that I really wanted to be stuck on earth so I could become a geologist!

From Caltech, I went to UCLA where I had the pleasure of being immersed in an extraordinary group of researchers—John Christie with his then state-of-the-art early transmission electron microscope, Gerhard Oertel, John Rosenfeld, Ron Shreve, and Gary Ernst. I will never forget a GSA meeting where I was giving a paper on mineral thermodynamics at the beginning of my tenure year. The room was packed when all five of those senior professors walked in to evaluate my talk, perhaps trying not to be noticed, but it was hard to miss them standing in a row in the back of the room! Thanks again to that UCLA group for nurturing me through the transition from grad student to academic.

From UCLA, it was on to the USGS where I had incredible Branch Chiefs—Dave Stewart, Phil Bethke, and Patrick Muffler. They not only supported my work, but, like the UCLA faculty, listened to what I said. It was also there that I began my career-long association with E-an Zen, who challenged and inspired me at every step along the way in things both scientific and moral. E-an, the social conscience of GSA, is now gone, but hopefully his memory will linger on in a GSA memorial effort that you will all be hearing about.

Very early in my professional life, I had a resolve to work in government, academia and private sector. After a long decade of demonstrating that I have absolutely no survival skills in the private sector, I was saved by Steve Marshak, Jim Kirkpatrick, the Charles R. Walgreen, Jr., foundation, and the geology department at the University of Illinois. Many thanks to you, Steve, my research colleagues Xinli Lu and Pinaki Chakraborty, my mathematician colleague, Gustavo Gioia, my aeronautics colleague, Joanna Austin, and my friends in the geology department, for a wonderful decade of collegiality, and an equally wonderful time as a continuing emeritus professor.

And finally, many, many thanks to GSA, to the Penrose Selection Committee, and to my colleagues and the members of the Society for the interactions over these decades. Our collective work in the geosciences has made, and must continue to make, a difference in how humans interact with our planet.

View images along with the full text from
Susan Werner Kieffer's Gold Medal Lecture at
http://www.geosociety.org/awards/14speeches/GML-Penrose.pdf