

W. BARCLAY KAMB

1931–2011



Kamb, an accomplished photographer, took this shot of Keith Echelmeyer exploring a hundred-foot-deep Antarctic crevasse.

W. Barclay Kamb, the Rawn Professor of Geology and Geophysics, Emeritus, died at his home in Pasadena on April 21, 2011. He was 79.

Kamb, one of the world's leading glaciologists, determined the crystal structure of all the known phases of ice and studied the dynamics of glacier movement. A rugged outdoorsman, he developed and maintained an intellectually and physically challenging field program on glaciers around the world, devising new techniques for making technically difficult measurements under extreme conditions in places like Alaska and Antarctica.

Born in San Jose, California, in 1931, Kamb began his Caltech career in 1948 as a 16-year-old freshman. He earned a BS in physics in 1952 and a PhD in geology in 1956. Hired upon graduation as an assistant professor of geology, Kamb rose through the ranks to become a full professor in 1962 and Rawn Professor in 1990. He served as chair of the Division of Geological and Planetary Sciences from 1972 to 1983, and as vice president and provost from 1987 to 1989.

"I can say with absolute certainty that were it not for Barclay Kamb, I would not be at Caltech," says provost Ed Stolper, the Leonhard Professor of Geology and one of 10 faculty members in the division hired during Kamb's time as chair. "He was more than a mentor—he epitomized the Institute. His willingness to serve was an inspiration: He was asked on a few days' notice to become provost, after having already completed more than a decade as division chair, and he did not blink. His truly extraordinary intellect and focus; his under-

standing of the importance of field work interpreted in a rigorous physical, chemical, and mathematical framework; and his commitment to the division and to the Institute all taught the cohort that he hired what was so special about Caltech and about our responsibility to preserve it."

Kamb's interest in the physical sciences was broad. Although he began his graduate studies as a physics student, a strong love of the outdoors and the influence of geology professor Bob Sharp (BS '34, MS '35)—who had been named by *Life* magazine as one of the 10 great U.S. college teachers of 1950—changed his course. Kamb also became interested in mineralogy and X-ray crystallography, doing his PhD thesis on the structure of the complex mineral zunyite under the direction of Nobel laureate and professor of chemistry Linus Pauling (PhD '25). Pauling not only regarded Kamb as his best student, he introduced him to his only daughter, Linda. In 1957, a year after earning his PhD, Barclay and Linda were married. By 1965, they were the proud parents of four sons.

"My brothers and I were fortunate to grow up as part of the Caltech family," says son Alexander (Sasha) Kamb (PhD '88). "We used to walk over after school and kick around my father's back office among the rocks, minerals, and maps. And we were passive participants on Caltech-sponsored outdoor trips, like geology field camp in the Sierra Nevada Mountains, and expeditions to the Blue Glacier up in Washington. These experiences helped to mold us and rank among my fondest memories of him."

Sasha says that beyond his father's gifts for math and science, he wrote beautifully, sketched like a professional artist, fixed cars, built houses, spoke multiple languages, and played three instruments. "But most

impressive to me, in the face of all the evidence to the contrary, he thought he was just like everybody else," he says.

Kamb first made his name in glaciology at the Blue Glacier on Mount Olympus in Olympic National Park, Washington, where he directed Caltech's research program for over 10 years. From Washington, Kamb moved on to the glaciers of Alaska, where he pioneered the use of high-pressure hot-water jets to drill through the ice all the way to the hitherto inaccessible bottom. He also developed methods for taking samples and images of the contact between the glacier and the underlying bedrock.

Many of the borehole instruments were one-of-a-kind devices, designed by Kamb and built from scratch in the machine shop at Caltech. "Barclay did not like black boxes," says glaciologist Hermann Engelhardt, a senior research associate, emeritus, who collaborated with Kamb for over 45 years. "He needed to understand every detail of his instruments down to the tiniest screw."

The hot-water drill Kamb and Engelhardt developed debuted in 1982 on Alaska's Variegated Glacier in "the first detailed study of a surging glacier during its active period," according to Engelhardt. This galloping glacier was moving as much as 65 meters per day, over 300 times its normal pace, "with high-pitched ice quakes and new crevasses opening overnight under the sleeping tents and the drilling platform. The ice accumulation of 20 years was swept through the valley in just three months." In those days before GPS, the flow was monitored by hand with a theodolite and a network of surveyors'

PICTURE CREDITS:

40, 41, 43 — Kamb family



Kamb surveys Alaska's Variegated Glacier in 1993. Crevasses can open anywhere during a surge; this one just missed the survey stake, and was still slowly growing.

stakes equipped with radio-controlled lights for nighttime measurements. “Barclay called it his Christmas tree,” Engelhardt recalls.

In 1988, Kamb began the Antarctic Project, which ran for 12 summers and yielded “a seminal series of papers in *Science* and *Nature*” while training over 100 field assistants, including grad students and postdocs from around the world. “Antarctica is the coldest and windiest and remotest place on Earth, and the base of the ice is certainly the remotest destination in Antarctica. Only Barclay had the vision, the stature, and the courage to launch such an ambitious project—to go where nobody had gone before and study the basal conditions of the biggest glaciers on Earth,” says Engelhardt.

Kamb focused on the ice streams in the West Antarctic Ice Sheet that empty into the Ross Ice Shelf, a floating expanse roughly the size of France that projects out into the Ross Sea. “An ice stream is like a current in the ocean,” explains Engelhardt. “It’s a fast-moving current of ice in an ice sheet.” Over the years, the team drilled hundreds of boreholes as much as 1,600 meters deep to reach the base of the ice streams.

Since the boreholes were water-filled, each one was a race against

refreezing. “Instruments had to be inserted quickly, or when taking videos from the base of the ice, the downhole working time was limited to guarantee the safe return of the camera,” Engelhardt recalls.

The drilling confirmed what Kamb had discovered in Alaska—the ice streams’ rapid movement was made possible by a lubricating layer of high-pressure water between the ice and the bedrock below. Kamb’s work also implies that in a warmer climate, fast-moving ice will speed up due to increased lubrication. “A glacier is a very good instrument to monitor climate change,” says Engelhardt. “In Alaska we see the surge cycle getting shorter and shorter, and tide-water glaciers disintegrating.”

Kamb also found that the till—the deposits of clay, sand, and gravel beneath the ice that have been carried downstream by the glacier—“contained an abundance of diatoms, showing that West Antarctica was an open ocean in the recent Pleistocene [about 12,000 years ago],” Engelhardt says. “This happened under CO₂ concentrations in the atmosphere much lower than today. Barclay’s results could not speak louder

and clearer that the catastrophic decay of the West Antarctic Ice Sheet is a real possibility, with a consequent sea-level rise of some six meters, if climate change is not taken seriously and reversed responsibly.”

Kamb was a fellow of the Geological Society of America and the American Geophysical Union, and was a member of the American Academy of Arts and Sciences and the National Academy of Sciences. His many honors included a Sloan Research Fellowship, a Guggenheim Fellowship, and the Mineralogical Society of America Award. In 1977, he won the Seligman Crystal, the highest award in glaciology presented by the International Glaciology Society. And in 2003, the American Advisory Committee on Antarctic Names formally designated Ice Stream C, the central stream flowing into the Ross Ice Shelf, the Kamb Ice Stream.

Kamb is survived by his wife, Linda Pauling Kamb; his brother, Peter Ray, and his sister, Barbara Marinacci; his sons, Barclay, Alexander (Sasha), Anthony, and Linus; and nine grandchildren.

—KN/DS 

The Kamb family poolside in the backyard, circa 1978. From left: son Anthony; Kamb; wife Linda; twins Alexander (Sasha) and Barclay; and, in front of them, son Linus.

