PROFILE

Profile of Lonnie G. Thompson

Within the bustling campus of Ohio State University (Columbus, OH) rests one of the most extensive archives of the Earth's history chronicling the past 700,000 years. Visually, this repository may not appear impressive: no fossils or pottery fragments, just ice—lots and lots of ice. Over 7,000 m (≈4.2 miles) of glacial ice, to be exact, have been collected from some of the most imposing mountaintops of the world: the Andes, the Himalayas, even the snows of Mount Kilimanjaro. Trapped and preserved within these frozen cylindrical cores, however, lies the true beauty of these specimens: small flecks of dust and oxygen isotopes that provide a historical record of trends and shifts in the earth's climate.

At first glance, the geologist who led the way in stockpiling this vast frozen library, Lonnie Thompson, University Distinguished Professor at Ohio State University's School of Earth Sciences, also appears unassuming. But, starting with a 1974 reconnaissance mission to the Quelccaya ice cap in Peru, Thompson has led 50 expeditions to remote highlands in 15 countries, braving howling winds, frostbite, rockslides, and altitude sickness in his quest to collect and analyze these valuable ice cores. Considered the founder of tropical alpine paleoclimatology, Thompson had the foresight to understand the importance of ice in tropical latitudes when most eyes were focused exclusively on polar latitudes. But even he did not realize just how valuable his ice-core collection would become.

In 1978, as Thompson was preparing for his first ice-core drilling on Peru's Quelccaya, he decided to take some baseline measurements of the glacier so he could monitor how tropical glaciers behave over time. "I didn't know quite what to expect, since no one had ever taken such measurements on Quelccaya, the world's largest tropical ice cap," he says. Every 2 to 3 years, he returned for updated photographs and measurements, which revealed a surprising flow: the Quelccaya glacier was retreating, and, not only that, the retreat was accelerating (1). "If you go back to that time, global warming wasn't even an issue. People were worrying about the next ice age." But measurements of other glaciers revealed the same stark results; the ice caps were getting smaller, whereas the air around them was getting warmer.

As highlighted in Thompson's Inaugural Article in a recent issue of PNAS (2), the results of which also appeared

Lonnie G. Thompson

in a recent National Research Council report that Thompson helped review (3), the ratios of oxygen isotopes in various ice cores show that the current temperatures in many tropical regions are the warmest they have been in millennia and are now threatening many of these glaciers with extinction. This alarming trend has turned Thompson into both a scientist and an advocate for the cause to protect these precious commodities, and his effort on both fronts earned him an election to the National Academy of Sciences in 2005. Although Thompson wants his repository to be a place where scientists can analyze ice samples from all over the world, he does not want it to become a museum that holds the last vestiges of these glaciers.

Coal to Cores

Thompson was raised on a small farm on the outskirts of Gassaway, WV. He grew up in a working-class family, and, unfortunately, rural West Virginia was not an easy place to find work. Thompson had numerous part-time jobs while in high school, and he managed to raise some extra revenue at school by betting on one of his favorite pastimes: predicting the weather. Thompson had set up an amateur weather station in a family barn, where he took temperature, pressure, and humidity readings twice a day. "And at that time, you could actually get from the NOAA [National Oceanic and Atmospheric Administration] a daily weather map for the U.S., and then you could look at those charts and learn to predict what's going to happen the next day and the following day by what's upstream from where we were living," he says. "If you could have gotten a degree in meteorology in West Virginia or Ohio, I may have ended up there because I did really enjoy it."

Thompson entered Marshall University (Huntington, WV) in 1966, undecided as to which scientific field to pursue. He started studying physics and met his future wife, Ellen Mosley, who was the only woman majoring in physics at that time. After doing well in an introductory geology class during his junior year, however, Thompson was invited by the instructor to help out in a project making mineral sets for West Virginia's state parks. Working on the sets and discussing geology with the other students convinced Thompson that earth science was the path to follow, and he graduated with a bachelor's degree in geology in 1970.

At the time, Thompson's career ambitions swayed toward the practical side. "I think that, like many people, when I started out, I was looking for what I could train myself in so I could get a job and receive a paycheck," he says. "Then, I think, if you're lucky, as you go down that route, somewhere along the line, you find your purpose." For his financial goals, Thompson applied to Ohio State University with the aim of studying with J. William Schopf, a well known coal expert who worked for the U.S. Geological Survey. If there was one thing that was plentiful in West Virginia, it was coal. Once Thompson arrived in Columbus, however, he was exposed to the then-new field of polar paleoclimatology, which examines the physical and chemical properties preserved in layers of ice and snow to understand ancient climate patterns. Thompson obtained a part-time job analyzing some of the first deep-ice samples from Greenland and Antarctica and was thrilled by the experience.

He switched to the Institute for Polar Studies at Ohio State University but felt that the polar ice cores were not telling the complete story. "Polar glaciers only cover 10% of the earth, and they're in regions where nobody lives," he explains. Thompson then crossed paths with John Mercer, a glacial geologist who, before coming to Ohio State, had worked for the American Geographical Society, compiling an atlas of the planet's glaciers. "[Mercer] brought with him all the aerial photographs he had used in making the atlas, and it was in those boxes that we found the photos of the Quelccaya ice cap," says Thompson.

This is a Profile of a recently elected member of the National Academy of Sciences to accompany the member's Inaugural Article on page 10536 in issue 28 of volume 103.

Thompson began thinking that studying this tropical ice would be an effective way to connect the data from the Arctic and Antarctic. Says Thompson, "50% of the surface of the planet is in the tropics, that's where 70% of the people live. That's also the place where you have the big climate events that impact the world today. El Niño, monsoons—those are all tropical phenomena."

Thompson and Mercer took the photographs to Washington, DC, to meet with the manager of the Office of Polar Programs, which at the time was the only agency that funded ice studies. Thompson recalls that the manager seemed interested in his proposal but in the end told him, "Lonnie, we can't fund that because it's not north of the Arctic Circle and it's not south of the Antarctic Circle." Disappointed, Thompson headed to Byrd Station in Antarctica later that year to do fieldwork for the 1973–1974 summer season. "Toward the end of that field season, I got a telex from the program manager, Jay Zwally," says Thompson, "and it said, 'I've funded all of my real science projects, and I have $7,000 left. What could you do on that tropical glacier for $7,000?' And I telexed back and said, 'I think we could get there!'"

Thompson, hiking on Mount Kilimanjaro glacier, 2000.

Reaching the Summit

In June 1974, Thompson stood before the awe-inspiring sight of Peru's massive Quelccaya ice cap stretching across the horizon. He seemed an unlikely sort to be standing at the summit of this imposing ice cap; although he had a fair bit of wilderness experience stemming from his youth in the Boy Scouts in rural West Virginia, he had only one previous mountain climbing experience, a harrowing one that was still fresh in his mind. As his 1974 field season at Byrd Station was concluding, one of Thompson's colleagues, David Rugh, convinced him to stop in New Zealand on the way back to the U.S. to scale Mount Malte-Brun. The climb started well, but at one stage Thompson slipped and swung off the side of the mountain. "I was looking down the 2,000 feet below me," he recalls, "and I'm saying, 'God, if I get off of here, I will never climb another mountain again for the fun of it!'"

Yet, just a short time later, Thompson and colleagues Mercer, Chilean glaciologist Cedomir Marangunic, and Canadian mountaineer John Ricker stood at the summit of the Quelccaya ice cap. After a grueling 2-day journey from the end of the nearest road, these four expeditioners became the first recorded people to set foot on the Quelccaya ice cap. They stayed at the top for a few more days, recording the first glaciological and geologic data from this icy environment (4).

Shortly after Thompson returned from the exploratory trek, he wrote an ambitious proposal to go back and drill the ice field. The Atmospheric Science Division of the National Science Foundation (NSF) funded his venture, based on their interest in obtaining El Niño and monsoon data. "And they didn't care where the records came from, whether it was ice or lakes or instruments," says Thompson. He admits that he was a bit naïve in his approach. "We thought, OK, we bring up a drill from Antarctica and a generator, and we'll contract with the Peruvian Air Force for a helicopter, and we fly up there, we drill the core, put [the ice] in the helicopter, and we leave," he says. However, after two failed attempts, it became apparent that they could not get the gear up to the 19,000-foot-high ice cap. The helicopter could not ascend that high, and the drill and generator were too large for pack animals. Undaunted, Thompson and his colleagues climbed up, leaving the drill and generator behind, and obtained a 24-year record of the isotopes and dust accumulation from one crevasse, from which they published a paper on the El Niño record (5). "Still, we really either had to give up at that stage or come up with a new way to drill," he says.

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Thompson and Bruce Koci, an engineer at the University of Nebraska (Lincoln, NE), came up with the idea of a solar-powered drill, which should operate fairly well in the thin mountain atmosphere. With Koci, who designed and tested the solar panels, Thompson wrote another NSF proposal. "Willi Dansgaard over in Denmark, a pioneer in glaciology and someone I really admired, was one of the reviewers, and he actually sent me a copy of his review, which essentially said the ice cap was too high for human beings, and the technology did not exist to drill," says Thompson. "So I figured we were pretty much finished." Fortunately, the new program manager, Hassan Virji, a meteorologist from the University of Wisconsin (Madison, WI), went out on a limb and gave Thompson a second chance. "[Virji] told me that maybe Dansgaard was right, but we would never know until we tried," says Thompson. This time, Thompson hedged his bets, knowing full well how many things could go wrong. "Before I left, I actually started preparing to enter the M.B.A. program at Ohio State, just in case Willi was right," he says. "Life is about having options!"

Fortunately, the fates smiled on Thompson's 1983 drilling excursion party: they managed to get all their gear up by pack animal without incident and even drilled two cores to the bedrock instead of one. Also, "[1983] turned out to be a big El Niño year," says Thompson, "which maximized the radiation coming in because of the lack of precipitation." The only snag was that they did not have the ability to bring the cores back frozen, so they bottled and sealed 6,000 water samples. "And one set of bottles we sent to Dansgaard's lab, and he analyzed the isotopes on them, and from that day on he was our biggest supporter," says Thompson.

With those first samples, Thompson managed to build a 1,500-year record of tropical precipitation, revealing past El Niños as well as dry periods (6), including evidence that that the Southern Hemisphere was cooled by the "Little Ice Age" that occurred between A.D. 1500 and 1800 (7). Over the next 20 years, Thompson and his team, many from the original expedition, followed up with dozens of other expeditions, traversing the globe to collect ice samples to build an older, more thorough record. Return trips to the Peruvian and Bolivian Andes yielded samples that went back over 20,000 years to the last Ice Age (8, 9), revealing that the Amazon basin was much cooler and drier in the ancient past and highlighting that the tropics were just as susceptible to climate shifts as temperate regions are. Ice from the top of Mount Kilimanjaro indicated that a heavy drought affected that region ≈4,000 years ago (10), coinciding with the Biblical account of a great Egyptian famine. Cores taken from the remote Himalayas go back even farther, some over 500,000 years (11), rivaling the ancient ice unearthed from the polar regions.

The Heat Is On

In 1992, Thompson gave his first presentation on global warming at a public lecture at Ohio State. "Interestingly, when it was originally scheduled, it was canceled because it was too cold, −25, so I got a lot of ribbing over that the next week when we did present it," he recalls. "But you know, we don't see things like that in Columbus anymore," he adds. Indeed, as the years went on, fewer and fewer people were laughing as the evidence of climate change from Thompson and others began to mount, perhaps most dramatically in 2001. After his expedition to the top of Mount Kilimanjaro, Thompson proclaimed that the ice surface had dwindled by 80% in the 20th century and could be completely gone by 2015. Although Thompson had been following glacier retreat in the Andes for years, attaching this effect to a mountain that attracts over 25,000 tourists a year helped capture the public's attention and turned Thompson into a celebrity.

In his PNAS Inaugural Article (2), Thompson returned to his ice-core library to place this recent warming trend in a historical context. Looking at historical composites of oxygen isotope ratios within several core samples, Thompson found that the current warming at low latitudes is unprecedented for at least 2,000 years. In fact, radiocarbon-dating the recently exposed plants at the edges of Quelccaya showed that the glacier has not been this small for over 5,000 years, before a widespread cooling event that blanketed much of the tropics and is evidenced in many tropical records. "And the fact that the plants were so well preserved, of course, means that the system is capable of abrupt change, whether naturally driven or human-driven," Thompson says.

With another abrupt climate change potentially looming, Thompson's collection efforts have taken on a sense of urgency. He has targeted 13 sites around the world as high-priority areas for recovery, although he is pessimistic that he will be able to extract cores from all these mountain glaciers before they dwindle as they have on Mount Kilimanjaro. Thompson notes that there are many hindrances, not the least of which has become, ironically, the cost of fuel. "Right now we have a drilling project in the southwest Himalayas, and fuel prices in Tibet have doubled," he says. "It's absolutely amazing how much we are at the mercy of fossil fuels."

Still, Thompson will do what he can to preserve these shrinking pieces of history. When he is not in the field, he tries to make people aware of the situation of climate change as much as possible, whether at university lectures, local churches, or in front of the U.S. Senate. "I think credibility is an important point, whether people listen or not," he says. His most recent venture was serving on the advisory board for the climate-change documentary *An Inconvenient Truth*, a film he thinks will help bring about positive action on this topic (12). With chronic asthma and aging bones, Thompson knows he only has a few years of glacier trekking left, and he hopes that when he puts his pick axe down for the last time, future generations will be able to study glaciers someplace more exotic than the cold room at Ohio State's Polar Research Center.

Nick Zagorski, *Science Writer*

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