Biography of Edward Irving

The latitude lines plastered across atlases and globes are not the rigid demarcations they appear to be. Over millions of years, continents have moved relative to the Earth's magnetic field, a phenomenon recorded by the magnetization of rocks. Edward Irving, a geologist and emeritus scientist with the Geological Survey of Canada, has been reading the history of latitude variations for more than 50 years. His studies of paleomagnetism provided the first physical evidence of the theory of continental drift (1). In his Inaugural Article (2), published on page 1821 of this issue of PNAS, Irving reviews the areas of research that have informed our knowledge of Earth's history and how the planet's mountain belts, climate, and life have evolved.

Edward Irving (center) with colleagues Judith Baker and Randy Enkin.

From Dinosaurs to Rocks

Irving, elected to the National Academy of Sciences in 1998, was born in 1927 and grew up in the Pennine Hills of northeast Lancashire, England. Like many boys, he was fascinated with dinosaurs at a young age. He remembers studying pictures of the "strange creatures" in his family's books and at the library. Outdoor activities, such as fossil finding and plant exploration, also fueled his interest in science early in life. "The hilly countryside lent itself to an inquisitive child," he says. After finishing grammar school in 1945, Irving was conscripted into the British Army where he had "three years to think about things" and where "[the army] tried to make an officer of me." Instead, Irving volunteered to travel abroad and became an infantryman in the Middle East. Irving enjoyed seeing the world and began to place a priority on finding a job that would pay him to travel. Thus, he blended his interests in the natural world and traveling by entering Cambridge University (Cambridge, U.K.) in 1948 to study natural science, specializing in geology. While there, Irving was under the academic tutelage of the "very learned and very old" Gertie Ellis, who was the first woman reader (an academic staff position) at Cambridge. Her influence marked Irving's learning style. "She advised me to read the original sources—papers rather than books. 'Read what people are actually saying, Irving.'"

After completing his B.A. in 1951, Irving was recruited by Keith Runcorn as a research assistant in the department of geology and geophysics at Cambridge. After a year, Runcorn encouraged him to enter the graduate program in geophysics, which Irving initially had shied away from. "I always had a desire to do research; I just thought I'd never make it," he explains. Irving began studying the history of the Earth's magnetic field, an area of research that remains his academic focus. "What we knew directly of the Earth's magnetic field went only a few hundred years back in observatory records," he says. There had been a "sporadic and somewhat chaotic effort" to use rocks to discern the history farther back, but the research area that Irving entered was still in its infancy at the time. By looking at the magnetic directions imparted to rocks by their iron minerals, Irving, along with fellow students Ken Creer and Jan Hospers, endeavored to read the history of Earth's magnetic field, also known as paleomagnetism. Irving explains paleomagnetism as "the memory that some rocks have of the ancient geomagnetic field." When rocks are born as molten lava and cooled or as sediments accumulating under water, their crystals align with the Earth's magnetic field. As Irving and his colleagues came to realize, this provides a geologic snapshot because the magnetic field appears to shift over time as continents and their deposits move.

During his studies, Irving was able to take advantage of a stable, reliable, and sensitive magnetometer recently designed by Nobel Laureate Lord Patrick Maynard Stuart Blackett. "It was very simple in design, yet sophisticated," says Irving. "It could be built by geologists like me. You didn't need to know electronics." He found that magnetic field directions indicated by the Precambrian rock in the Torridonian Sandstone Series of the highlands of Scotland did not agree with the present magnetic field. This "huge" discrepancy extended over a period of tens of million of years and could be explained only by the shifting of Scotland relative to the pole (3, 4). To recreate the historical latitude, Irving studied sequences of rock 3 km thick, examining the Precambrian magnetic fields preserved in the sandstone's hematite crystals. In another portion of his graduate studies using rock samples supplied by the Indian Geological Survey, Irving made the first physical measurement of the movement of India, finding that it had moved northward by 6,000 km and rotated more than 30 degrees counterclockwise (1). These results fell close to the predictions of Alfred Wegener, who had put forth his theory of continental drift in 1912 (3, 5, 6).

Success from Failure

At the time of Irving's studies of ancient latitudes in 1954, the field was so new

This is a Biography of a recently elected member of the National Academy of Sciences to accompany the member's Inaugural Article on page 1821.

that he believes his doctoral examiners were not familiar enough with the subject matter to recognize his research achievements, resulting in Irving's not receiving a Ph.D. "I'm one of the few people who has ever failed a Ph.D.," he says. He wrote about many new discoveries in his thesis but says he did not "decorate it with unnecessary exhibitions of knowledge." Still, the paper was later published "almost verbatim" (3, 4). The results were not published until after he secured a position as a research fellow at the Australian National University (Canberra). John Jaeger was head of the relatively new geophysics department. "He simply told me about his own disappointments in life and how they'd helped him in the long run," says Irving. "We had a beer and that was that. He let me get on with it."

In Australia, Irving's work tested "the proposition that if continents really had not moved, then the polar path observed from Australia should match that just discovered for Europe" (7). But Australia's path, which Irving and student Ron Green inferred from reconstructing the ancient latitudes, did not match that of Europe (8). "Ten years later, by the time plate tectonics had come along, everything we had done had been vindicated," he says. Studies of paleomagnetism also helped explain climate changes inferred from the presence of temperature-sensitive deposits such as glacial beds. By calculating the latitudes of Australia during the Permian period, Irving showed that Australia was then in high latitudes, further supporting continental drift (7–9). After publishing about 30 papers on his work in Australia, he remembers a few friends saying, "'Why don't you submit them so that Cambridge can make amends?' So I did." He received the degree of doctor of science (Sc.D.), the highest earned degree, from Cambridge in 1965.

A Shift of Continents

While in Australia, Irving met his wife, Sheila, a Canadian citizen, and in 1964 they moved to Ottawa. "The geological exposure in Canada is better than Australia," Irving states. "Canada has been glaciated recently. Much of the surface rock is fresh." The surfaces of Australia have been subjected to 10–15 million years of weathering, whereas "the whole top of Canada has been shined off for you." Irving was initially hired as a research officer for Dominion Observatory (Ottawa) with the Department of Mines and Technical Surveys, with the directive to develop a new facility to study paleomagnetism. Irving returned briefly to England as a professor at the University of Leeds, teaching courses in the geophysics department for one year. In 1967, Irving returned to Ottawa as a research scientist in the Earth Physics Branch of the Department of Energy, Mines, and Resources, where he stayed until 1981. During his time there, Irving focused on the geology unique to Canada. "Canada has the largest Precambrian shield, and it was something of a national duty to study it," he says. "And there are the western mountains, too." As in England and Australia, Irving mapped the polar wander for different segments of Canada (10–12).

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In 1981, Irving moved westward to Sidney, British Columbia, to establish a new "pocket-sized" paleomagnetism laboratory at the Pacific Geoscience Centre with the Earth Physics Branch; this branch was later incorporated into the Geological Survey of Canada. "The post-war period of generous funding was closing, and as a consequence a leanly manned, two-person, automated facility designed for visitors and direct collaborations with other institutions was developed," he says. Some of his work during this time addressed the movements of Vancouver Island and other parts of the Cordillera that have moved sideways and rotated relative to the Precambrian Canadian shield (13–15).

Semi-retired, Irving has recently investigated the "nature of the geomagnetic field in the Precambrian 1,900 million years ago to see how the crust was being deformed and how the latitudes varied."

Despite the initial skepticism of his doctoral examiners, Irving has contributed vast amounts of knowledge about the Earth's past, much of which he puts into perspective with his Inaugural Article. In the intervening years, Irving's scientific contributions have not gone unrecognized. He was made a fellow of the Royal Society of London in 1979 and awarded the Order of Canada in 2003. He remembers one award particularly fondly. The Gondwanaland Gold Medal of the Mining, Geological, and Metallurgical Society of India "meant a great deal to me because some of the first work I did was from India," Irving says. It was the same research for which the doctoral examiners had failed him on early in his career: "You can't expect the world to believe you, but it is sufficient to believe in yourself."

At Home in the Garden

Irving spends his mornings in the laboratory but spends each afternoon at home tending to his large, 1.3-acre garden. "'It's bananas,' our daughter once said. It is big. It's ambitious," says Irving. Except for his time in the British Army and at university, Irving has gardened since age 13. In addition to ornamental plants, he grows "nothing too fancy," such as garlic, beans, peas, and rhubarb, much of which he gives away.

When asked what he is most proud of, Irving states, "Bringing up four sane children with Sheila." Those children have also brought six grandchildren into Irving's life. For this geologist, his bedrock is his marriage. "My mother said not long before she died at [age] 102 that she had had a good life and was satisfied with it because she had a good husband and good children." He feels the same sentiment.

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