

Memorial to T. Neil Irvine

1933–2020

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With the death of Neil Irvine on 10 March 2020, at age 87, in Chevy Chase, Maryland, igneous petrology lost one of its most perceptive thinkers. Expertise and skill in fieldwork, in the laboratory and in theory, augmented by a prodigious graphical talent, made Neil Irvine a world authority on layered intrusions.

Thomas Neil Irvine was born in Winnipeg, Manitoba, Canada, on 5 January 1933 and was brought up in rural southern Manitoba. He obtained BSc and MSc degrees in geology at the University of Manitoba in 1953 and 1956, respectively. He moved to the California Institute of Technology in Pasadena for further graduate work and embarked on a study of the Duke Island ultramafic complex in southeastern Alaska, under the supervision of James A. Noble. This work profoundly influenced Neil's career. The spectacular layering of the Duke Island ultramafic rocks mirrored structures in current-bedded sediments so faithfully that Neil became convinced of the efficacy of magmatic currents in the crystallization of igneous rocks. For Neil, it was a faith that remained unshakable. Neil was awarded the PhD in 1959; he published the results of his Duke Island work in a GSA Memoir in 1974.

After returning to Canada, Neil held a teaching position at McMaster University in Hamilton, Ontario, for two years. In 1962, he joined the Geological Survey of Canada (GSC) in Ottawa. At GSC, Neil was a member of a team, led by Charles H. Smith, studying the ultramafic rocks of Canada. Among the latter is the Muskox intrusion, an elongate, gently north-plunging body, about 120 km long, astride the Arctic Circle in the Northwest Territories. The northern part of the body, funnelform in cross section and consisting predominantly of layered ultramafic rocks, narrows southward to a gabbro dike (the "feeder dike") that is exposed over a distance of 45 km. Following surface mapping in the late 1950s, the intrusion was drilled in three places in 1963, to depths of as much as 1220 m. Besides Muskox, Neil also worked in British Columbia, searching for equivalents of the Duke Island ultramafics.

In addition to field study, Neil's interests extended to the theoretical aspects of petrology, including experimental work. In 1972, Neil took up an appointment as a visiting scientist at the Geophysical Laboratory of the Carnegie Institution in Washington. Neil intended to return to the GSC after a year or two, but when Carnegie offered him a permanent position as staff petrologist he decided to accept. Neil remained at the Geophysical Laboratory for the rest of his career.

The move to Carnegie opened new vistas for Neil. With encouragement from the Geophysical Laboratory director, Hatten Yoder, opportunities arose for Neil to visit other layered intrusions, each with its own distinctive characteristics, notably Stillwater in Montana, Duluth in Minnesota, and Bushveld in South Africa. Also, it was at the Geophysical Laboratory that Neil met Alexander R. McBirney, visiting from the University of Oregon. McBirney drew Neil's attention to the potential of double-diffusive convection as an igneous crystallization process. Neil went on to appeal to the process in his studies of Muskox and Stillwater. Even more importantly, McBirney provided the springboard for Neil's work on the Skaergaard intrusion in East Greenland, which



Neil Irvine in his element: standing on a trough layer in the Skaergaard intrusion during the IGCP Project 427 field meeting and excursion, September 2001. Photo by Michael Irvine.

was a keystone of Neil's career at the Geophysical Laboratory.

McBirney had first visited the remote Skaergaard intrusion in 1971, initially to conduct a geophysical survey and oxygen isotope studies. However, realizing that this superbly exposed layered body offered boundless opportunities for wider study, McBirney planned further expeditions. Neil jumped at the chance to set foot on this fabled body of rock and participated in McBirney's next foray to East Greenland in 1974. Neil was to make many more visits to Skaergaard between 1974 and 2000, often collaborating logistically with McBirney's group but always working independently. Neil's main interest lay in deciphering the origin of the igneous structures, particularly the trough layering in the upper part of the intrusion and the relationship between layering and autolithic blocks, which abound in the intrusion. The work involved detailed mapping of outcrops and rock faces,

always with an eye on the third dimension. The longer he worked at Skaergaard the more convinced Neil became that the layering was an expression of sorting and deposition by magmatic currents—a conclusion he had earlier reached in the case of the ultramafic rocks of Duke Island. Neil firmly believed that Lawrence R. Wager—discoverer of the Skaergaard intrusion in 1930 and its early primary investigator—had been fundamentally correct in applying his cumulate theory to Skaergaard layering and that he was building on and extending Wager's work. Neil replicated some of the layering structures in flume tanks built to his design at the Geophysical Laboratory (Irvine, 1980). A culmination of Neil's work at Skaergaard was the publication in 1998 of a paper by Neil and his co-workers Jens Andersen and Kent Brooks which includes a remarkable diagram (Irvine et al., 1998, Fig. 29), drawn by Neil with his trademark artistry, illustrating the dynamic processes they envisioned to have functioned in the western half of the Skaergaard magma chamber. Remaining unpublished are detailed field maps of parts of the intrusion, hand-drawn by Neil.

In the 1980s, Neil's inquisitive, fertile mind led him down another avenue of research. In an attempt to account for the apparently symmetrical disposition of major centers of mafic magmatism (such as the Bushveld Complex) around the Earth, Neil devised a global convection framework, which he propounded in a 55-page paper (Irvine, 1989). He maintained an interest in large-scale processes below and above ground, such as convection in the mantle and movement of air masses, and possible similarities and analogies between them, to the end of his life.

Neil was a stickler for stylistically good writing, in not only scientific papers but also personal correspondence. In this he enjoyed the support of his Canadian wife, Lorna, who was a college professor of English. During Neil's stint as an editor of the *Journal of Petrology*, Oxford University Press in 1992 published his "A writing guide for petrological (and other geological) manuscripts" (co-authored with Douglas Rumble).

In 1982, Neil received the Norman L. Bowen Award from the American Geophysical Union,

primarily for his work on the Muskox intrusion. In 1986, he was nominated a Distinguished Lecturer by the Society of Economic Geologists.

Neil retired in 2003 but continued work in an emeritus capacity at the Geophysical Laboratory for 12 more years.

Not only was Neil an outstanding scientist, he was also blessed with a practical streak. He was an accomplished woodworker. A long flagstone path, with steps, to the front door of his home in Chevy Chase, that he laid single-handed more than 40 years ago, remains intact to this day.

Neil is survived by son Michael, daughter Kerri, and two grandchildren.

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