

DANSGAARD, W. 2004. *Frozen annals: Greenland ice sheet research*. Copenhagen, University of Copenhagen. Department of Geophysics of the Niels Bohr Institute. 122 pp. ISBN 87-990078-0-0.

Partly autobiographical and partly a scientific documentary, this very readable and informally styled book gives a lively historical account of the contribution to research in Greenland by the Glaciological Group at The Niels Bohr Institute, Copenhagen, Denmark. Starting with an impromptu experiment in 1952, using a beer bottle to collect rainwater during a passing storm to satisfy his curiosity about the sensitivity of its isotopic composition to weather conditions, Willi Dansgaard takes the reader on a fascinating journey through his pioneering work. The reader is given some insight into how a scientist initially working individually and on a limited budget forged opportunities to pursue a burning idea and then created a group that would later become a key player in the much more exacting business of deep ice-core drilling. This journey established stable-isotope (δ) analysis of ice as a powerful indicator of climate change over more than 130 000 years and led to the discovery of the now famous Dansgaard–Oeschger cycles.

Fortified by the success of his early experiments, which showed that he could measure changes in δ which, at least qualitatively, shifted in line with the temperature of formation of the rainfall, Dansgaard describes his ingenious efforts to verify the basic distillation model and demonstrate whether the δ of natural precipitation around the world followed a similar relationship with temperature – at that time without the benefit of a global collecting network. This was to come later during the Cold War, with the establishment of the International Atomic Energy Agency–World Meteorological Office (IAEA–WMO) network, where he finally had the chance to negotiate the systematic collection of samples from more than 100 stations worldwide. His resulting classic paper in *Tellus* (Dansgaard, 1964) laid out a theory for the turnover of heavy isotopes in precipitation that has underpinned the subject ever since.

The story continues to weave in and out of the Cold War, which with the establishment of a large US military station at Camp Century, and later the Dye-line early warning stations across central Greenland, opened up opportunities for logistic support of collaborative deep-drilling activities in the central areas of the ice sheet, in all of which, of course, the group at Copenhagen have been key players. The book follows each Greenland deep drilling in turn and describes the accompanying scientific and technological developments in which members of the group have been prime movers. Although only a few pages are devoted to each of the drilling projects, the principal scientific findings are clearly described in an accessible manner and supported by a wealth of figures. Whilst the highlights are presented as

fairly short nuggets, there is liberal cross-referencing to the principal background papers to guide any reader who wishes to pursue a topic further. In places, the background theory is encapsulated in highlighted boxes which can be absorbed or skipped over without slowing down the main storyline. The subject is brought alive by a clever interplay of narrative, interspersed with extracts from the author's diary and short anecdotes, frequently touched with wry humour, and in places rather colourful terminology. This helps the reader to gain some direct sense of the excitement, and at times the frustrations, of scientific fieldwork, and of the ingenuity needed to overcome inevitable difficulties encountered on the way – some of the solutions would defy present-day systems of risk assessment!

At the same time the book succeeds in giving the reader a glimpse of some of the human and political dimensions of ice-core drilling. Liberally illustrated with photographs, it helps the reader to appreciate the close-knit teamwork needed to bring about the successful deep drillings in Greenland that have done so much to increase public awareness of the potential vulnerability of our present climate. The book gives a sense too of the occasional tensions or misunderstandings between scientists and administrators, sometimes operating under different systems and in different countries, which at times may complicate the course of international collaboration carried out at high cost and a long way from home. Some of this perhaps would be better buried and forgotten, but it is a factor in organizing a multinational deep-drilling operation, and some understanding of the political history may, like understanding past climate, help in planning for future operations. Notwithstanding, the book tells a story of success built on success, closing on a forward-looking note with the recent completion of 7 years of drilling at the North Greenland Icecore Project (NorthGRIP).

This book will certainly be of general interest among the glaciological community, and will also be of value to anyone wishing to gain a rapid overview of the development and achievements of ice-core research in Greenland. It will be a good read even for someone outside the field who is simply curious about this topical subject and the people dedicated to it.

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REFERENCE

- Dansgaard, W. 1964. Stable isotopes in precipitation. *Tellus*, **16**(4), 436–468.