

## Polar Ice Core Research

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Research Theme Implemented in FY 2014:

“Warming events and evaluation of their impacts in the past 150,000 years viewed from Greenland ice” (Grants-in-Aid for Scientific Research [S])



After wrapping up my graduate studies, I worked for a time at New York State University and Japan’s National Research Institute for Earth Science and Disaster Prevention, then in March 1998 assumed a position with the National Institute of Polar Research (NIPR). My research at NIPR has been focused on identifying past climatic and environmental change through the analysis of ice-core samples from ice sheets and glaciers in the polar regions. Since transferring to NIPR, I have benefited immensely from Grants-in-Aid for Scientific Research (Kakenhi). Kakenhi is one of the few sources of funding that enable investigators to apply their creativity in research on fundamental themes. Moreover, in my view, it is also one of the best sources of funding if measured in terms of cost-performance. Although sweeping improvements have been made to the framework for research grants in recent years, cuts in Management Expenses Grants have made Grants-in-Aid for Scientific Research even more important. I thus look forward to continuing improvements.

Ice-core studies can be divided into roughly three basic stages: ice-core drilling operations, the analysis of ice-core samples, and the pursuit of research that harnesses the analytical data. The first two stages, namely, ice-core drilling and analysis, demand an enormous investment in time and labor. Drilling and extracting ice cores from a depth of over 2,000 meters is a process that takes over three years on its own. If you add all of the preparatory tasks from project planning and the design of drilling equipment to the transportation of supplies and the construction of a base camp, the time involved will frequently stretch beyond 10 years. Polar ice sheets and glaciers are in uninhabited regions of the world that are difficult to access. Significant amounts of time are spent planning and preparing for projects of this nature due to the various difficulties that typically encumber implementation.

To date, we have been able to pursue ice-core drilling projects in Antarctica chiefly with funding provided to NIPR for undertakings in Antarctic exploration and monitoring. Following many years of preparation, in 2006 we finally succeeded in drilling to a depth of 3,035 meters at the Dome

Fuji station located in inland Antarctica. This achievement enabled us to study climatic and environmental changes that have taken place over a time span of more than 700,000 years. Fortunately, several applications for Kakenhi by my research colleagues were approved, providing access to funding that covered most of our expenses for the analysis and study of the valuable ice-core samples obtained at Dome Fuji.

In a parallel undertaking from 2008 to 2012, an international team of researchers from 14 nations conducted ice-core drilling operations to a depth of more than 2,500 meters in northwestern Greenland under the North Greenland Eemian Ice Drilling (NEEM) project. I participated in this project as a team member representing Japan. However, undertakings in Arctic research did not have access to the kind of funding frameworks available to exploratory projects in Antarctica. Consequently, we were unable to confirm until the last minute whether Japan would be able to participate in this international project or not. Thanks to the invaluable efforts expended by executives and administrative staff at the Research Organization of Information and Systems (ROIS) and the NIPR, we secured spending which the ROIS president could decide to disburse at his discretion as well as NIPR's Management Expenses Grants, and somehow were able to remit the 30 million yen sum required for project participation. This came a year after the NEEM project had been put into motion. Afterward, I was also extremely fortunate to have an application for a Grant-in-Aid for Scientific Research (S) approved in 2010, and was allowed to utilize that funding to offset expenses for business travel by Japanese researchers to Greenland, the transportation of observational instrumentation and supplies and ice-core samples, the purchase of equipment for ice-core analysis, and analysis-related expenses. I was genuinely delighted when I learned that my application had been approved.

Without Kakenhi, it obviously would have been impossible for me to pursue my ice-core research at Dome Fuji in Antarctica or in arctic Greenland. I am thus extremely grateful for that grant assistance. That said, in this age of fiscal strain at the national level, I am still extremely apprehensive about the prospects for securing funds for future ice-core drilling projects. Many nations are already racing to select drilling sites and launch projects in inland Antarctica to drill the "world's oldest ice core" of over one million years in age and decipher why the cycle between the ice ages widened from 40,000 to 100,000 years. Japan has identified a candidate site for this undertaking near its Dome Fuji station. Even so, determining how to acquire the necessary funding will be a huge challenge. In Greenland, Denmark has led in drafting plans for a new ice-core drilling project aimed at facilitating studies of the stability of Greenland's ice sheet, and Japan as well as the US, Germany, France, and Switzerland have been called on to participate. However, the share of costs to be borne by each participant will easily surpass 100 million yen, a sum that

would be virtually impossible to offset with Management Expenses Grants. I would like to rely on Kakenhi for this but the truth is that very few Kakenhi categories offer anything near the funding required for the pursuit of large-scale ice-core drilling projects. Ice-core samples from Dome Fuji and arctic Greenland have yielded unexpected findings that traditional forecasting methods were unable to foresee. Although those findings have garnered the spotlight through publication in *Nature*, *Science*, and other leading international journals with strong impact, it takes many long years from the initial project planning stages to achieve research accomplishments of this kind. At the project formulation stage, it would thus be difficult to file an application for Kakenhi because under that framework in its current form, one has to demonstrate a certain measure of research accomplishment within a short timeframe of only around five years. This is essentially the same problem faced by investigators in many fields of endeavor, not just ice-core research. I yearn for the creation of a grant framework capable of accommodating research that requires longer periods of time to demonstrate accomplishment or that incurs expenditures for participation in international projects.

International projects involve research on themes that Japan is unprepared to pursue on its own, and demand teamwork with other nations. Even if a Japanese researcher is fortunate to win approval of a grant application involving participation in an international project, it would be convenient if the grant framework allowed the disbursement of that grant funding to be postponed for several years in the event the project launch is put off due to circumstances in other nations. Additionally, now that researchers face the increasingly tough expectation that they deliver results in the short term, I would prefer to see the adoption of a research evaluation system that enables young researchers to pursue their dreams with research projects that, like ice-core studies, demand more time from the planning stage to the demonstration of their accomplishments.