Transantarctic Mountains ice core study

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Several sites within the Transantarctic Mountains fit the requirements necessary for the retrieval of ice cores that can provide valuable information concerning climate change and atmospheric chemistry. During the 1984–1985 austral summer, our group recovered, with the aid of the Polar Ice Coring Office, a 201-meter long core from a 2,800-meter high snow massif atop the Dominion Range (85°15′S 166°10′E) close to the confluence of the Mill and Beardmore glaciers. Chemical properties (sulfate, nitrate, fluoride, chloride, phosphate, sodium, reactive silicate, and total beta-activity) and physical properties (stratigraphy, density, and solid conductivity) combined with oxygen-isotope analysis (provided by P. Grootes and M. Stuiver, University of Washington) are currently being completed on one 6-meter snowpit, several 2-meter snowpits, fresh and aged surface snow, and the 201-meter core. Final results from the study await analysis of several more sections of core, but it is apparent that the study will provide valuable information for the period 0–2,000 years ago in some cases with seasonal detail, concerning: volcanic activity, source and input timing for chemical species transported to the drill site, changes in atmospheric chemistry and mass balance, and ice mass stability for the area. The Dominion Range core will be supplemented by a coring program in southern Victoria Land to begin in austral summer 1987–1988 in an attempt to provide a regional view of climate change and atmospheric chemistry for the Transantarctic Mountains.

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Ice-core drilling for paleoclimatic information at plateau remote

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An ice-core drilling program was conducted during December 1986 and January 1987 at a remote site (84°S 43°E, 3,330 meters above sea level) near the Pole of Relative Inaccessibility on the east antarctic plateau. The central research objective of this program is to acquire information about atmospheric concentrations of insoluble and soluble particulates, atmospheric temperature, and net mass accumulation during the last two or three millennia. The plateau remote program complements programs previously conducted at South Pole Station (Mosley-Thompson et al. 1985), Siple Station (Mosley-Thompson, Mountain, and Paskievitch 1986; Mosley-Thompson in preparation), and on the Quelccaya ice cap in the Peruvian Andes (Thompson, Mosley-Thompson, and Arnao 1984; Thompson et al. 1985, 1986).

The drilling was performed by the Polar Ice Coring Office (Kuivinen and Koci, *Antarctic Journal*, this issue). Two deep cores (205 meters and 202 meters) and 13 shallow cores of depths varying between 8 and 22 meters were recovered. Weather conditions were generally clear with a persistent wind of 5 meters per second from the quadrant between 320° and 10° (with reference to true north). Temperatures ranged from a high of −26°C toward the end of the season and near the warmest part of the day to a low near −40°C. Sastrugi as high as 0.4 to 0.5 meters were observed to be oriented in two prominent directions. The long axis of the first set of sastrugi was nearly parallel to the observed surface wind (approximately 0° or true north). This is also approximately parallel to the surface contours (extracted from Drewry 1983). The second set of sastrugi was oriented 30°–40° from true north suggesting formation by wind obliquely crossing the elevation contours. This may reflect the prevailing winter surface wind regime which exhibits high constancy due to the thermal wind effect. The latter effect results when an extensive atmospheric inversion layer lies over a gently sloped surface (Schwerdtfeger and Mahrt 1968).

Multiple vertical sequences of samples were collected from the walls of two pits and will be analyzed for insoluble microparticle concentrations and size distributions, liquid conductivity, anion concentrations, oxygen-isotope ratios, and total Beta radioactivity. Density profiles were measured in each pit. A preliminary estimate of net annual accumulation based solely upon visible stratigraphy suggests 40 to 70 millimeters of ice equivalent per year and a high degree of variability from year to year. The visible stratigraphy was mapped and a video camera was used to produce a permanent record for more detailed study. Shallow cores (8 to 20 meters in depth) were collected behind the sampled pit walls for comparison with pit samples. Ten of the shallow cores were collected prior to pit excavation and the pit sampling was conducted immediately upon excavation to minimize contamination. The stratigraphic mapping and photography were performed last.

The analyses of the 13 shallow cores, in conjunction with samples collected from two pits, will allow assessment of the spatial variability present in the particulate concentrations, liquid conductivities, oxygen-isotope ratios, and net mass accumulation records. This assessment is necessary to determine the limit to which annual information can be extracted from the two deeper cores. The characteristics of the annual signal (if present) in each of the preserved ice core parameters must be determined and any interrelationships understood. The modification of the annual signal by depositional and post-deposi-

tional processes must be quantified and taken into consideration when interpreting the results from the 205-meter and 202-meter cores.

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Isotopic alteration of firn cores

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Firn cores are collected as part of many antarctic research projects. Such cores are usually packaged in 1-meter sections in plastic bags for shipment to the United States because of limited field time and the amount of work involved in detailed sampling. Sampling for oxygen-isotope analysis occurs at some later time. Results obtained in our laboratory on two South Pole firn cores and on snow-pit samples show that such firn cores readily undergo isotopic smoothing throughout the core sections and isotopic enrichment at the ends. This type of storage makes the cores unsuitable for studies of the seasonal isotope cycle.

A firn core was drilled near Amundsen-Scott South Pole Station during the 1980–1981 field season (Kuivinen 1981). The 103-meter core was stored initially in plastic in Rutford core boxes in a van at the South Pole. In December 1982 an Ohio State University field party hand-augered a firn core from the bottom of their pit 1 (Mosley-Thompson, Kruss, and Bain 1983) from 3.24 meters down to 19 meters for M. Giovinetto, University of Calgary, Alberta, Canada. After splitting the cores, the ¼-core oxygen-isotope samples were packed in plastic and stored three to a core tube. The samples were stored in core tubes at the Quaternary Isotope Laboratory below −18°C. They were sampled immediately before measurement.

The history of the cores is shown in figure 1. As detailed in figure 2, the oxygen-isotope results of these cores show the effect of prolonged storage (between 1-1/2 and 4-1/2 years) under various conditions. The smoothing, which occurred during storage, in the top 10 meters of the firn from both cores is obvious when we compare the stored-core profiles (figure 2, b and d) with profile a (figure 2) obtained by Jouzel et al. (1983) from a pit wall and core sampled in the field in 1978 and with the oxygen-isotope profile of wall C of the 1982 pit 1 (figure 2, c) (Mosley-Thompson et al. 1985). This confirms the observation by Jouzel et al. (1983) of relatively rapid smoothing of the stable isotope signal during core storage in the Grenoble cold rooms.

The isotopic alteration is different for the two cores. The 1980 core shows an oxygen-isotope maximum at the ends of each of the 1-meter core sections. In the 1982 core, there is no correlation between the 1-meter core breaks and the oxygen isotopes. It is tempting to attribute this difference in alteration to the 2-year storage of the 1980 core in a van at South Pole. During summer the temperature in the van may have been considerably above ambient, leading to low relative humidity and significant water-vapor loss by the core sections. Mass loss by evaporation is also indicated by high microparticle concentrations at the ends of core sections (Mosley-Thompson, personal communication).

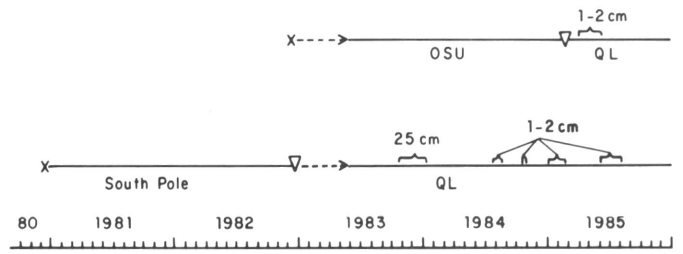

Figure 1. History of two South Pole firn cores. x denotes core drilled; ▽denotes core split; ---> denotes core shipped from South Pole to the United States; ⊥denotes oxygen isotope measurements of samples covering 25 centimeters or 1 to 2 centimeters per sample. ("QL"—"Quaternary Isotope Laboratory." "OSU"—"Ohio State University.")