A profile was flown from Vostok Station towards dome B along the flowline to assist interpretation of the Soviet Vostok core (Robin *et al.*, 1977; Robin 1977).

(c) Sub-ice terrain was investigated in the Wilkes subglacial basin (Drewry, 1976), to the grid east of South Pole Station and beneath dome B.

*West Antarctica.* (a) A 100-kilometer reconnaissance grid was established between the network accomplished in 1974-1975 in Marie Byrd Land (Rose, in press, a) and the Ellsworth Mountains to investigate bedrock geology and in particular the boundary between East and West Antarctica. Analysis and interpretation of radar data will be supplemented with magnetic measurements.

(b) Data are allowing a better understanding of ice flow towards the Ronne and Filchner Ice Shelves. Two lines were flown along the axis of and across the Foundation-Patuxent Ice Stream. In addition the grounding line of the Filchner Ice Shelf was determined with increased precision between the south-western end of the Heritage Range and the Pensacola Mountains. The ice shelf edge is found to be located up to 100 kilometers farther inland than suggested by previous mapping.

(c) Sounding was conducted along the flowline downstream from Byrd Station and into the Ross Ice Shelf via ice stream 'D' to assist interpretation and modelling of ice sheet regime (Rose, in press).

(d) The first large sub-ice lake in West Antarctica was detected along the western flank of the Ellsworth Mountains. The water body is at least 13 kilometers in extent occupying a bedrock hollow beneath 3,500 meters of ice. Several smaller lakes were also identified.

*Ross Ice Shelf.* One mission collected data over the Ross Ice Shelf at the request of the Ross Ice Shelf Project. In addition, two lines were flown for further investigation of bottom roughness characteristics of the shelf, begun in 1974-1975. Application of radio scattering theory developed by C.S. Neal on the basis of this latter work has enabled a detailed interpretation of the physical nature of the ice/water interface to be made. Zones of very smooth bottom have been located in areas of known and potential bottom melting. Moreover, assessment of the radio frequency dielectric absorption within the shelf has, in conjunction with the scattering theory, revealed areas in which sea water appears to be freezing to the ice shelf base. The distribution of bottom melting and freezing is of oceanographic interest (Neal, in press).

*Other continuing investigations* include studies of layering in East Antarctica (Robin *et al.*, 1977); studies of birefringence and thus anisotropy of the dielectric constant of radar wave propagation in ice sheets (Hargreaves, 1977); detailed soundings behind the McMurdo dry valley area indicating the presence of sub-ice water, moraine, and a local ice surface dome rather than general overspilling of the main ice sheet (Drewry, in press); estimation of the heat flux through the base of an ice sheet (Drewry, in press); and study of the relative chronology between formation of ice sheets in East and West Antarctica (Rose, in press; Drewry, 1978).

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# Glaciology near Byrd Station

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We are investigating the dynamics of ice flow along the Byrd Station strain network and the interpretation of the Byrd Station core results. The radio-sounding by National Science Foundation, Scott Polar Research Institute, and Technical University of Denmark detected internal layers in the ice sheet. Analysis shows that this layering probably is associated with the sedimentary stratigraphy and that the ice sheet near Byrd Station has been flowing in a simple, nearly steady-state fashion for some tens of thousands of years (Whillans, 1976). A comparison of ice export rates with replenishment by new snow accumulation supports this result of simple ice flow and finds that, although the ice sheet is close to steady-state, it is thinning slowly, at a rate of a little more than 0.03 meter per year (Whillans, 1977).

The cause of this thinning first was attributed to inadequate present-day snow accumulation, but recently a much more satisfactory explanation has been found (Whillans, in press). About 14,000 years ago the surface climate of the ice sheet warmed, and this warmth has been penetrating the ice sheet. The rate of penetration depends on the downward movement of ice and on conduction. Warmer ice can deform more readily, so the shearing and velocity of the ice is now faster than it was. A warming of about 8°C about 14,000 years ago explains why present-day velocities are too fast to maintain the ice sheet in its present configuration. This thinning in the central west antarctic ice sheet will continue and eventually will affect ice flow downglacier toward the Ross Sea.

Because the tilting of the Byrd Station core hole has been measured (Garfield and Ueda, 1976) it now is possible to model the ice flow and to calculate the depth-age relationship for the Byrd Station core with some reliability (Whillans, in preparation). At a depth of about 1,200 meters, the oxygen isotopic ratio of the ice changes by a large amount. This is attributed to the climatic change at the end of the last, Wisconsinan, glaciation. The time scale shows that the change began about 17,000 years ago, 3,000 years earlier than in north Greenland. Values similar to today's values were attained 10,000 years ago at both sites. The model also finds that the central ice sheet has thinned by about 200 meters because of the warming effect.

On a different topic, the variations in snow accumulation on the ice sheet near Byrd Station have been analyzed statistically (Whillans, in press, b) to assess how much of the variation in annual layer thickness along an ice core, say, must be caused by regional accumulation changes and how much by local variability. Sedimentary layers are expected to vary horizontally, over short distances, because of the presence or absence of drifts and sastrugi. Near Byrd Station the local effect has an approximately Gaussian distribution with a standard deviation of 0.02 meter of ice equivalent, which is enough to cause layers of separate seasons occasionally to be absent at a single site.

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# Ross Ice Shelf Project 1977-78

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The 1977-78 Ross Ice Shelf Project (RISP) field season was marked by two major achievements: penetration of the ice shelf at the RISP drill camp J-9 (82°22.5'S. 168°37.5'W.), and completion of the Ross Ice Shelf Geophysical and Glaciological Survey (RIGGS).

RIGGS activity began 9 November with the opening of the field camp at Q-13. Ground-based measurements were conducted while awaiting the arrival of the chartered Twin Otter aircraft. Although the airplane did not arrive on site until 9 December and navigation instrument problems plagued the project, nearly all work planned was completed. Operating from camps located at Q-13 (78°57'S. 179°55'W.) and C-16 (81°05'S. 172°45'E.), 81 strain networks were revisited and 13 new sites were established, including 8 for geophysical measurements. Tidal gravity measurement was again conducted at J-9 and at a new site, O-19 (79°33'S. 163°18'E.).

At the J-9 drill site, the ice shelf was penetrated with the Browning flame-jet drill on 2 December. This first access hole was frozen and lost before any scientific measurements could be made beneath the shelf. Redrilling was completed on 14 December, and the access hole was used from then until 2 January. The hole was reamed every 3 to 4 days to keep it open during this period.

The wireline coring drill was moved after attempts to melt out the drill stem that became stuck last season. Wireline coring was completed to a depth of 170 meters when the season ended.

Reports in this issue describe the activities and preliminary results of the 16 projects involved in RISP.

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