The technical problems encountered during the 1978-79 season may be due to the long delay from the time the equipment was built until the time it was finally deployed, the delay having been caused by various postponements in the drilling of the RISP access hole.

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Core drilling through Ross Ice Shelf

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During the 1978–79 field season, we performed core drilling through the Ross Ice Shelf at site J–9 as part of the Ross Ice Shelf Project (RISP) and recovered a continuous core with a diameter of eight centimeters through the 416–meter–thick ice shelf.

We used a lightweight drill designed by V. A. Morev of the Arctic and Antarctic Research Institute in Leningrad. As conceived by V. A. Morev and I. A. Zotikov, this drill is based on the principle of adding antifreeze to the melt water generated by the electrothermal drill rather than removing the melt water from the hole. The freezing point of this mixture must be near the temperature of the ice at each depth in order to maintain equilibrium without freezing the fluid in the hole. This method has been used for many years in drilling holes in both temperate and polar glaciers, including holes at Novolazarevskaia Station (to a depth of 800 meters) and at Lazarev and Shackleton ice shelves.

The drill consists of cylindrical, stainless steel pipe, and an electrically heated toroid ring to melt an annulus through the ice column. The drill cylinder contains a piston that can move freely up and down. When the piston is in its lower position, the internal space of the pipe above the piston functions as an alcohol container. When the drill is lowered to the bottom of the hole, the electrically heated toroid melts into the ice, thereby producing a core. The ice core passes into the pipe and pushes the piston up. Through the action of this piston, the alcohol mixture in the upper chamber is delivered to the bottom of the hole. When the piston reaches its upper position, the drill containing the ice core is lifted to the surface, the core is removed, and a new charge of the alcohol-water solution is pumped into the upper chamber, which pushes the piston into its lower position again.

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Drilling began on 1 December 1978 and was completed on 13 December. Prior to 8 December, we halted drilling each night for a rest period. Thereafter, however, to avoid difficulties resulting from the formation of slush during the rest periods, we began continuous drilling, which lasted until we reached the bottom of the shelf.

Figure 2 shows that the freezing point of the fluid in the hole was always kept higher than calculated temperatures. A total of 500 gallons of ethyl alcohol was used to drill through the ice shelf. Figure 3 provides data on speed of drilling, amount of electrical power supplied, and depth of penetration through the ice shelf.

The resultant ice core showed all the characteristic features of glacier ice to a depth of 410 meters. At this depth, an electrical short circuit occurred in the drill and the level of fluid in the hole rose 23 meters; both events indicated hydraulic coupling to the sea below the shelf. Below this depth, the ice was of a completely different structure (Zotikov, Zagorodnov, and Raikovsky, 1979); it tasted salty and possessed structural features typical of old sea ice. The remaining 6 meters of the ice core had a similar appearance. At a depth of 416 meters, the bottom of the ice shelf was penetrated. The bottom has distinct features of sea ice formed by slow freezing of sea water.

Figure 1. Electrothermal drilling rig bringing the bottom piece of ice shelf to the surface. 1 = drilling column; 2 = mast; 3 = winch.

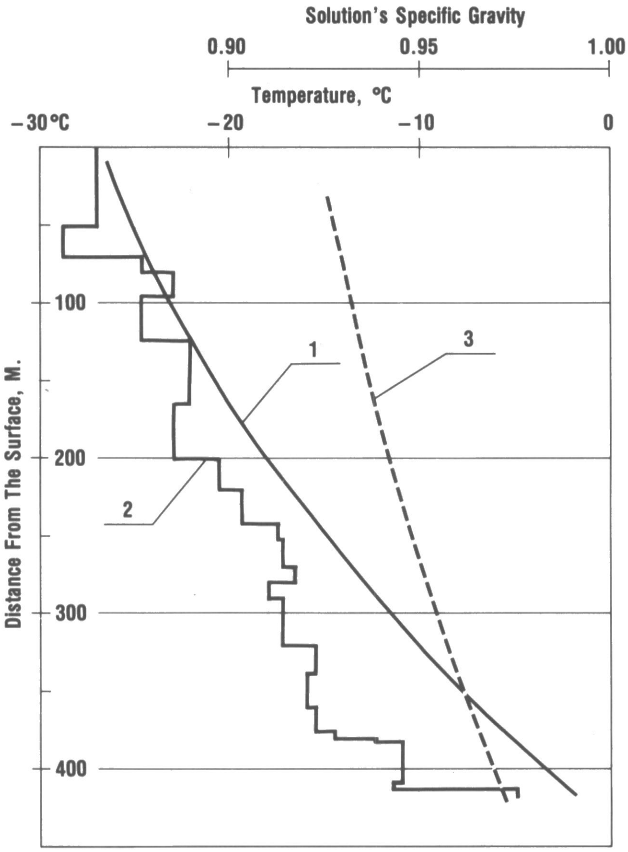

Figure 2. Alcohol-water solution in the hole. 1 = temperature of the ice (Clough and Hansen, 1979); 2 = freezing temperature of melt water–alcohol solution within the hole (calculated from data on alcohol supply to the bottom of drilled ice hole); 3 = specific gravity of the solution within the hole (averaged along the hole).

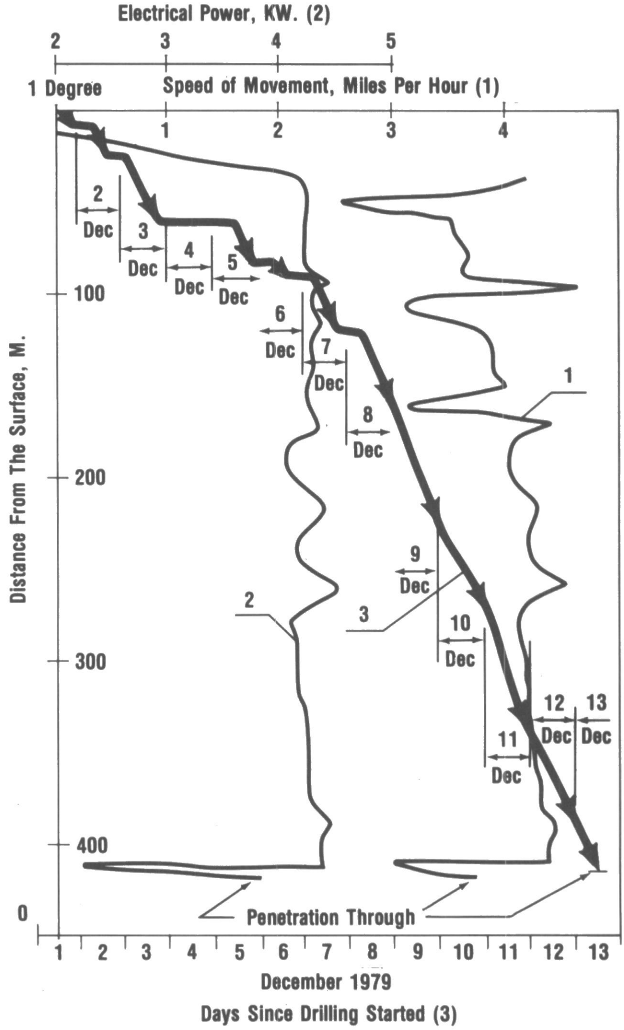

Figure 3. Main characteristics of the drilling process through the Ross Ice Shelf. 1 = speed of thermal drilling; 2= electrical power supplied to the drilling rig; 3 = depth of hole versus time in days from commencement of drilling.

Most of the ice core collected is now stored at the National Science Foundation Ice Core Storage Facility at the State University of New York at Buffalo, where it is available for study.

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