French glaciological activities at the South Pole

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Deep drilling tests. During recent years, most of the French glaciological activities in Antarctica have been made at Dome C. The work accomplished included particular shallow sampling and coring down to a depth of 905 meters. Studies of the samples made it possible to reconstruct recent and long-term (up to 30,000 years old) changes of the Earth's atmospheric environment (climate, aerosols, and atmospheric composition) and to evaluate the importance of global volcanic activity and pollution.

Because the ultimate aim is to drill deep enought to study climate changes over the last climatic (125,000-year) cycle, we found that it was necessary for us to develop a new piece of deep-drilling equipment. Previously, we had not been able to drill deeper than 905 meters without using a drilling fluid because below 905 meters the hole closed as we drilled.

Deep-core drilling equipment is heavy, expensive, and needs a lot of logistical support (the main part being the drilling fluid: about 50,000 liters for 3,000 meters). So, in a first stage, we developed a small diameter melting probe which recovers water instead of ice. The analysis of the stable isotope content of this water gives valuable information about climate in the past and the temperature profile of the ice sheet can be obtained when the drilling operation is completed. The probe, called "climatopic" (Gillet et al. 1982) was tested during the 1981–1982 field season to Dome C. Because of some defects, it was not possible to go deeper than 235 meters. We made some modifications to the probe, and we used it this field season at the South Pole.

The 8-person team arrived at the South Pole around 15 November 1983 with 15,000 kilograms of equipment. We drilled through the firn to a depth of 127 meters with an electromechanical drill and recovered good cores. We then put a polyethylene casing in the hole. A first series of tests was made with the thermal drill to a depth of 201 meters. When we measured the diameter of the hole, we found bottlenecks appeared in some places, so we decided to ream the hole with a small electromechanical drill. (This drill also allowed us to recover 50-centimeter length cores from time to time.) During this reaming, the drill became unscrewed, fell down, and was impossible to retrieve.

The platform was moved on a few meters and we drilled a new hole, recovering solid cores to a depth of 143 meters. A new casing was put down and on 30 December, we started to drill with "climatopic" again. With the experience gained in the first hole, we had good results to a depth of 213 meters. Deeper, we had some problems when we started the circulation of water at the beginning of each run; we decided that this was probably because with the increasing depth, the height of fluid in the hole was more important (50–70 meters instead of 30 meters). The time spent in the very cold fluid increased, cooling the drill in a more significant way and probably making it more difficult to start water circulation. We lost some time making some modifications to the drill to get better results.

On 16 January at 330 meters we had some difficulties with the measuring circuits. The repair lasted 3 days. When we drilled again, during the second run, we suddenly got stuck at 336 meters. The information given by the measuring devices seemed at the time to be correct but they were probably wrong (and this could explain why the drill got stuck).

For a few days, we tried without success to recover the drill using alcohol. The cable has been left in the hole with the tower erected, and we will have to come back later to recover the cable and the main part of the equipment.

Because we could not drill deeper than 336 meters, this drilling operation was not a success. Nevertheless, the work performed during this field season shows that with minor improvements, this "climatopic" thermal probe, it is hoped, would be an efficient piece of deep-drilling equipment. We determined that runs of about 5 meters can be obtained and at 300-meter depth; the overall time needed for each run is 2 hours. These figures lead us to believe that a deep drilling could eventually be possible during a summer season with this equipment.

Ice-core studies. Stratigraphy (visual), density measurement, and continuous sampling for isotope studies (4,200 samples) have been made along the 127-meter ice core. One hundred thin sections of snow and ice collected between 40 and 123 meters deep are used for crystal-size studies.

Continuous electrical conductivity measurements performed along the core indicate four high levels (100 percent over the background level) spanning 20 to 40 centimeters of ice over the 1,000 years covered by this core. The more recent peak, found at 29-meter depth should correspond to the Tambora eruption of 1815.

Although the volcano identification needs further chemical and microscopy studies, this peak may be used as a chronological horizon as it was found on seven other cores drilled (30 meters deep) in a 10-kilometer radius around the Station at depths ranging between 22 and 29 meters; this scattering reflects the geographical variability of the accumulation rate in the area.

Shallow pits and cores were also sampled for complementary studies (beta radioactivity profiles, heavy metals content, electron microscopy, and glaciochemistry studies for the last 1,000 years).

Acknowledgments. This work was supported by Terres Australes et Antarctiques Françaises Centre National de la Recherche Scientifique and the Division of Polar Programs of the National Science Foundation. We also acknowledge useful help from the Polar Ice Coring Office of the University of Nebraska.

Reference

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