transition zone will be less complex, too. At a firn temperature of −50°C, the portion of gases adsorbed at the firn grain surface is expected to be minimal. Therefore, it is believed that gases enclosed in ice samples from South Pole Station represent the composition of the atmosphere at the time of enclosure better than ice samples previously available.

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Reference

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Ice core drilling, 1980–1981

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The Polar Ice Coring Office (PICO) conducted field tests of an intermediate-depth ice core drill at Amundsen-Scott South Pole Station during December 1980. Ice cores collected from two test holes of 49 meters and 108 meters were logged, packaged, and stored at the station for future sampling by other investigators.

The drill, designed and built by the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), had been tested in Greenland during 1976 and had undergone several modifications at both CRREL and PICO prior to deployment to Antarctica in 1980. The objective during this season was to test the unit to a depth of 500 meters, collecting continuous ice core from the South Pole Station for later analysis. A drill shelter and core-processing laboratory van were set up in the center of the taxiway oval at the station. Drilling commenced using the original components of the CRREL drill: a 3,000-kilogram winch unit with armored cable, a horizontal tower, and various combinations of lightweight fiberglass drill barrels driven by a submersible pump motor. Drilling proceeded to a depth of 49 meters; beyond that depth the drill could not penetrate vertically. Runs made with an inclinometer indicated that the hole was being drilled in an ever-increasing spiral; this resulted in the drill's being wedged in the curved hole, thus preventing further penetration. It appeared that the drill was too light to deploy the cable properly and control penetration speed.

A new hole was then started using a heavier (120 kilograms) drill built by PICO. This unit collects core 4 inches (10.16 centimeters) in diameter, in contrast to the CRREL drill, which collects 3-inch (7.62-centimeter) core. Four days of drilling produced promising results: core of excellent quality averaging 1.40 meters per run during the first 90 meters, average core retrieval of 5.5 meters per hour, and winch line speeds of up to 400 feet per minute (122 meters/minute) during raising of the drill. At a depth of 92 meters, a line tension of 4,000 pounds (1,818 kilograms) was registered by the load cell during core break. When the drill was brought up, two breaks in the cable's armored jacket were apparent, and in other places the cable's neoprene sheath showed evidence of the cable's being slightly birdcaged. The damaged 100-meter portion of the cable was removed, and drilling continued to a depth of 105 meters, where the cable broke again during a core break that registered over 4,500 pounds (2,045 kilograms); the cable was again shortened and reterminated. On the next run it again broke, and the drillers decided to terminate the season's drilling because of the increasing danger to both personnel and equipment in the event of catastrophic cable failure. The change to the larger diameter PICO drill produced an expected increase in line tension needed to break the core, but the tension as recorded on the load cell should not have been sufficient to break the cable if it had been manufactured and spooled to the designer's specifications. The complete drill has been returned to the PICO workshop for further engineering research concerning corebreak, cable, and winch design.

The PICO core-drilling program at South Pole Station was augmented by studies conducted by the Physics Institute, University of Bern, of the process of gas enclosures in ice and the composition of air enclosed in bubbles in cold ice. Data from their study should provide information about the composition of the atmosphere at the time the ice formed. Experiments were conducted in which air filling the pore space in the firn was collected and analyzed, and determinations were made of the variations in crystal size and shape of pores with increasing depth (see Stauffer, *Antarctic Journal*, this issue).

In addition to the drill test at the South Pole Station, PICO prepared and loaned a National Science Foundation Swiss shallow drill (100-meter capability) to the British Antarctic Survey for use in their drilling program on the Antarctic Peninsula. The British successfully collected cores from two holes of 30 meters and 83 meters. Unfortunately, this drill suffered severe damage and was not recovered after being dropped off the drilling tower and falling free from the surface to the bottom of the 83-meter hole.

Two members of the PICO team visited the Ross Ice Shelf Project drill camp J-9 and recovered a recorder and magnetic-data tape from the Norsk Polarinstitutt oceanographic freeze-in experiment.

The PICO drill team included Jay Arneson, Leendert Kersten, Karl Kuivinen, John Litwak, Philip Marshall, and Richard Tillson. Bernhard Stauffer of the Physics Institute, University of Bern, Switzerland, conducted the core analysis and gas sampling program upon completion of the drilling.

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Reference

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