## Progress on Thermo-Mechanical Drills at the Polar Ice Coring Office

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The Polar Ice Coring Office (PICO), located at the University of Alaska Fairbanks (UAF), presently employs two kinds of drills, a thermal-type drill and a mechanical-type drill. The thermal drill, which uses hot water with a spraying nozzle in the front, is primarily used for drilling access holes. The mechanical drill is used for obtaining ice cores.

The objectives of PICO are to reach the bottom of the 3170 m (10,400 ft) thick Greenland ice sheet and to probe great depths in Antarctic ice fields. It is believed that ice cores retrieved from this entire depth will contain 200,000 years of Earth's climatic history, and the analyses of these cores will provide an excellent opportunity for the scientists to verify the validity of the greenhouse global warming theory. To reach such great depths, PICO has been experimenting on innovative drilling techniques and developing state-of-the-art drills. One such development is a drill that combines the features of both thermal and mechanical drills.

A 15 cm (6 in) nominal size thermo-mechanical drill has been fabricated at UAF. At the time of this writing, this drill is ready to be tested at the PICO ice test well. It is expected that this type of drill (or a refined version of it) will enable researchers to retrieve ice cores from great depths and obtain debris-laden ice and subglacial samples from the bottom portion of ice sheets. The collection of bedrock samples beneath the Greenland ice pack is another goal for this type of drill. A complete description of this thermo-mechanical drill can be found in Das et al (1992).

In this presentation, we will illustrate the system with a number of diagrams and slides of hardware. The system consists of a submersible pump to circulate drilling water from within the ice, a triplex pump to provide hydraulic power, heaters, specially designed instrumented hose and a down-hole mud motor to drive the drill. The core barrel has been designed with tubes around it that carry hot water. These tubes deliver the water near the mechanical drill head at the cutters, thus washing and melting away the ice chips that are produced during the coring operation. From environmental considerations, use of water as a drilling fluid, replacing commonly used antifreeze solutions, is a strong positive attribute of this drill.

An attractive feature of this drill is that, to access sub-glacial till and bedrock, we can rapidly drill to the basal ice level using the standard hot water drill, which is an existing technology. Once this level is reached, we can replace the drilling nozzle with a down-hole mud motor plus the newly designed core barrel and continue coring the sub-glacial materials. For bedrock coring, the core diameter may be smaller due to increased power requirements and pullback forces to break the core. Furthermore, the core barrel may require modification, and the cutters must be equipped with carbide or diamond faces. However, the basic design that we have presented here for the thermo-mechanical drilling system will remain unchanged.