

Thermal and Pressure Bore Hole Logging in Wells Drilled for Ice Coring

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Received 25 March 1993; accepted 11 June 1993

Some deep wells drilled for ice coring during the last 2430 years in the Polar sheets have emphasized the importance of obtaining a detailed, continuous thermal log of the bore holes, as part of a multi-parameter recording strategy aimed at interpreting the recent history of the Earth from the layers of ice cores, at detecting temperature variations over long periods, at monitoring the thermodynamic characteristics, and calibrating the flux models of the ice sheet.

Measurements carried out after drilling or between one drilling phase and another are exclusively of scientific interest. These measurements should be repeated periodically in the years after drilling has ended, until the well is usable.

A continuous ΔP log of the in-fill liquid should also be recorded to prevent misleading interpretations of anomalous temperature gradients arising from fluid dynamic perturbations.

A new sophisticated logging tool has been developed to meet the particular conditions of the deep wells filled with DFA type fluid containing densifier compounds.

PROBE FOR THERMAL LOG AND LIQUID PRESSURE LOG IN THE ICE DRILL HOLE

The programmed logging device will be equipped with two thermometers, type Pt 100, and two pressure transducers (quartz type).

The thermometers and pressure transducers in the probe will be fitted with auxiliary electronic equipment for converting the analogic signals into digital data for transmission to the surface PC. This solution should reduce the calibration problems and simplify transmission through the 4 km long cable.

Almost continuous temperature records could be attained over the range $+10^{\circ}$ to 60°C , with a precision of $\pm 1.10^{-2}\text{ }^{\circ}\text{C}$ and accuracy of $\pm 1.10^{-3}\text{ }^{\circ}\text{C}$. The reaction time of the thermometers will be as short as possible (few seconds). Measurements should be performed very close to the bore hole wall and below the probe. A high accuracy is required to measure the very low temperature gradients and to detect the probable convective cells in the fluid.

The pressure transducers would permit in-hole fluid pressure logs with an accuracy of $\pm 1.10^{-4}$ M Pa (about 1 cm) over the range zero to 30-40 M Pa. The various devices will be inserted in a thermally insulating Dewar container to prevent thermal losses in the bore hole and to guarantee a suitable thermal regime for the electronic devices.

Very little electric power is needed. Roughly fifteen to twenty hours will be required to lower and raise the logging probe in the well, to give the thermometers time to cope with the small thermal variations and to minimize fluid-dynamic perturbances. The lowering speed could be about 10 or 15 cm/s. Some stops (5-10 minutes) could be programmed at critical points, or at the check points every 500 m, in order to reach stabilization temperature.

Editorial handling: G. Orombelli

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