

Process for optimizing pressure-compensation during borehole deepening

WAIS Divide Ice Core Project

We anticipate that during the 2011/2012 field season we will deepen the WAIS Divide Borehole. It is essential that the hole not make a hydraulic connection to a basal water layer, for biological stewardship reasons. Large pressure differences between the borehole and a basal water system can, in principle, cause fracture of the ice barrier between the two. To minimize the risk of a fracture propagating up from the bed to the borehole, the fluid level in the borehole will be adjusted prior to drilling so that the pressure at the bottom of the borehole is as near neutral as possible (in other words, so that the pressure-compensation is optimal). This document describes the process that will be followed in determining that optimum fluid level.

Two conceptually distinct approaches will be followed. One, the actual *in situ* pressure throughout the borehole will be measured with a highly accurate pressure transducer* during the logging phase of the field program. Two, the *in situ* pressure profile in the borehole will be calculated from measured density of borehole fluid samples taken from a variety of depths, combined with corrections for temperature and compressibility of the fluid. The local acceleration of gravity at WAIS Divide (9.825 m s^{-2}) will then be used to integrate the hydrostatic pressure. Both of these pressure estimates will be compared to the ice pressure, which will be calculated from the known properties of ice (compressibility and thermal expansion coefficient, using the observed temperature profile) and the local acceleration of gravity. We expect that the first approach will yield the more accurate result, but we plan both approaches for redundancy. The first approach was used at EPICA Dome C by Jakob Schwander. He will be on site at WAIS Divide during the anticipated deepening.

Any resulting pressure difference between ice and borehole will then be eliminated by adding or removing fluid, taking into account observations of the actual fluid level in the borehole at the time of the pressure logging.

*<http://www.paroscientific.com/uwapp.htm> The manufacturer states that the precision is 100 ppm, or 0.34 m equivalent in a 3400 m deep borehole. This instrument is on loan from Scripps researchers (Mark Zumberge, PI) who use it in the deep ocean. It has an onboard data logger and batteries so no cable connection is necessary. The outside diameter of the pressure casing (rated to 5000 m of water) is 3" and the unit is 17" long. Weight in air is 7.5 lbs, and 3 lbs in the drill fluid at WAIS-D. The unit will be deployed inside the DISC drill chip chamber or barrel, and will not employ the USGS winch.

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