

Process for deciding how deep to drill the WAIS Divide borehole

During the 2011/2012 field season we will have the opportunity to 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. If we are confident that the bed is frozen and there is not a basal water layer, we can safely drill as deep as possible including recovering some soft sediments (which would have a large science return as marine diatoms of last interglacial age may be present). If there is even a remote possibility that there is a liquid water layer at the bed, we must stop drilling above the bed to insure that a hydraulic connection is not formed. To maximize the science return we intend to drill as deep as possible with the available equipment, while always being confident that a hydraulic connection will not be created.

Highly accurate ($\pm 0.01^{\circ}\text{C}$) and precise ($\pm 0.001^{\circ}\text{C}$) borehole temperature measurements will be made at the initiation of the season to determine the existing temperature gradient at the bottom of the hole. These measurements will be made before other operations have disturbed the thermal state of the borehole. Seismic measurements will be made to determine the amount of ice remaining below the borehole. Both the temperature and seismic measurements will include an estimate of the uncertainty of the measured values.

The maximum expected basal temperature will be estimated using the information from the borehole temperature and seismic measurements. Ice melts at $-2.7 \pm 0.1^{\circ}\text{C}$ at the pressure present at the bottom of the ice sheet. Additional logging may be performed at any time during the deepening process to refine the estimate of the maximum expected basal temperature.

The Lead Driller's primary responsibility is for the safety of the drilling crew and equipment. A secondary responsibility is to collect core as deep as requested by the Chief Scientist for Borehole Deepening and Replicate Coring (Severinghaus). The Chief Scientist for Borehole Deepening and Replicate Coring is responsible for making the decision of how deep to drill following the procedures presented below. The SCO Representative (Voigt) is responsible for the safety of the science crew, and also has the authority stop the drilling or any science activity at any time if safety is jeopardized. The Chief Scientist for the WAIS Divide ice core project (Taylor, who will not be in the field) will review the decisions made in the field to the extent that is practical.

If the maximum expected basal temperature (taking into account all uncertainties) is colder than -5°C , the bed will be considered to be safely frozen. [The 2.3°C difference between this threshold and the melting temperature is a conservative buffer to allow for possible unknown factors.] In this case drilling may continue as deep as possible, perhaps even into the bed. Drilling will be halted when the drill is unable to penetrate deeper, or drilling is halted by either 1) the Lead Driller, 2) the Chief Scientist for Borehole Deepening and Replicate Coring, or 3) the SCO Representative.

If the maximum expected basal temperature is warmer than -5°C , it will be considered possible that a liquid water layer is present at the bed. In this case drilling will continue until there is 50 m of ice below the borehole. This 50 m of ice is called the "stewardship buffer" and is intended to conservatively insure that at least 20 m of fluid-impermeable barrier remains, taking into account measurement uncertainties and the possibility of englacial plumbing or bed irregularities. During drilling the fluid level in the borehole will be adjusted to a near-neutral state of pressure compensation to reduce the risk of a fracture propagating up from the bed into the borehole.

Final version – Approved by WAIS Divide Executive Committee, 9/8/2011