Reply to review #2

Brief Communication: The Danish Replicate Drilling System – Results from the First Field Test

Authors: Westhoff and others

General Comments

The concept and method presented in this paper for creating a notch in the wall of an ice borehole are novel and unique and worth publication. Overall, the content was well written and supported by the figures.

Thank you very much for the positive statement and the review.

Was there a reason the inclination plots were not included as evidence of success in this paper? It is an important and critical feedback that can be used to determine the depth of both the broached groove and milled notch. Cable tension alone only doesn't give a good indication of how successful the milling operation was or if a large enough notch has been created to move on to the next step. Was a borehole camera deployed to get video or pictures of the groove or milled notch/step? If so, the images would be very interesting to include in this paper.

To verify the rotation of the drill, we used the live-rotation in a few-degree increments. This does not change the orientation of the drill's azimuth and inclination and is not recorded in our software.

We attempted to use a borehole camera, but the fiber-optic cable camera did not manage to acquire images. The high-pressure sealed GoPro captured images, but due to the very cloudy liquid these were not usable.

I recommend adding a section before the conclusion describing the next steps, modifications, and plans for further testing to demonstrate a full deviation can be completed and replicate cores recovered using this method.

Thanks for the recommendation. We will add this section before the conclusion.

Specific Comments

Lines 11-14: The sentence beginning with "By determining the borehole orientation…" does not make much sense as written and could use rewording for better clarity. I feel the following sentence misguides the reader into thinking that the purpose of the ledge is just for setting the weight of the drill on where I think the significance of the milling is to create a new guiding path for the core drill to exit the parent borehole. The two sentences could be replaced with something like "A groove is first cut on the uphill side of the borehole wall using a broaching process. This groove is then used to guide a milling tool to produce a circular notch and ledge in the downhill side of the borehole. Gravity would now guide the ice core drill into this newly formed notch diverging from the parent borehole, gradually producing full diameter replicate ice cores."

Thank you very much for the suggestion. We will rephrase the sentences as suggested.

Section 1: I suggest adding a few sentences at the beginning of this section describing the benefits and importance of replicate coring and why it is important to continue to develop this technology. Thanks for the suggestion, we will add this.

Figure 2: Panels C & D show the new/duplicate hole inclined beyond vertical. This may give some readers the wrong impression and I suggest editing the schematic, so the new/duplicate borehole isn't shown inclined beyond vertical. I think it should be mentioned somewhere in the paper that the parent borehole must have a certain amount of inclination and the new/duplicate borehole must have an inclination between 0 and less than that of the parent borehole for this technique to work as presented. I also recommend labeling the key parts (broaching cutter, groove, spring, and milling head) in the pictures.

Thanks for the suggestion. We will adapt the figure with the vertical orientation and the labeling of the key parts. We will also elaborate on the new borehole's inclination

Line 80: Doesn't the parent borehole need to have inclination greater than 0 for this to work?

We would like to have an inclination of 2° (or more) for the replicate operations. While we can start the deviation process in a plumb hole, later steps require that the drill "falls" into the new hole - requiring some inclination.

Figure 4: Labeling or highlighting in a bright color the key parts (broaching cutter, milling head, spring, and linear slide and bolt for limiting the travel) in the pictures that are described in the figure text would be helpful.

Thanks for the suggestion, we will add the labels.

Lines 133 to 135: I suggest the rewording for better readability. "The drill is then pulled up 20 m to complete the first 2 mm deep cut. After lowering the drill back to the starting depth, the motor is rotated another 90 degrees, extending the broaching tool the full 5 mm into the side of the borehole. The drill is once again raised 20 m to complete the second cut, leaving a 5 mm deep and 30 mm wide groove." Thank you for the suggestion, we will implement it and combine it with the suggestion from reviewer #1, who also suggested changing this section.

Line 141: Change this first instance of "AT" to "Anti-Torque (AT)". Will be done.