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Directional Drilling for Inclination Correction and Potential for Replicate Coring at EGRIP

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During EastGRIP season 2017 we observed a rapidly growing borehole inclination, which culminated at $\approx 5.5^\circ$ in a depth of 550m. In order to correct for this inclination a leaf spring was mounted on the outer glass fiber core barrel, near the drill head of our 2-m core-barrel version of the Hans Tausen Drill to provide a sideways force as close to the cutters as possible. To rectify the inclination, the drill must be rotated such that the spring is facing upwards requiring that the position of the outer core barrel relative to the direction of the inclination be known. The drill electronics houses a 9-axis orientation sensor (BNO055), used for monitoring the relative inclination during drill operation. The inclination is calculated using the data from the tri-axial 14-bit accelerometer. Since acceleration is measured in three directions, it is possible to tell the orientation of the coordinate system of the sensor, relative to the borehole inclination. As the sensor remains stationary inside the pressure tube, and the outer core barrel is locked together with the pressure tube, it is possible to tell which way the spring is oriented relative to the borehole inclination, and thereby to orient it facing “upwards” relative to the gravitational acceleration in order to exert a force downwards on the drill head. This forces the drill into a direction which is more true to the direction of gravity. This method proved to be very effective in terms of changing direction of the borehole inclination. From 570m depth to 730m, the spring was oriented correctly, rectifying the borehole by ≈ 0.1 degree per 5 m. At 730m the drill was assembled incorrectly in a way that the spring force increased the inclination instead of decreasing it. When this was discovered, it was corrected for, and the inclination decreased again, thus demonstrating the ability to change inclination both in the direction of, and opposite to gravity. A similar approach could then be used in attempts exit an existing borehole to retrieve replicate cores for specific depth intervals, or in the case of continuing a drilling around a stuck drill sonde from which the cable has been removed.

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