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Anisotropy of magnetic susceptibility used to detect coring-induced sediment disturbance and filter palaeomagnetic secular variation data: IODP sites M0061 and M0062 (Baltic Sea)

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Inspired by palaeomagnetic data obtained from two sites (M0061 and M0062) cored during IODP Expedition 347 - Baltic Sea Paleoenvironment we studied the Hemsön Alloformation, which is a series of brackish water muds consisting of horizontal planar and parallel laminated (varved) silty clays free from bioturbation. We determined the anisotropy of magnetic susceptibility (AMS) and characteristic remanence (ChRM) directions of a total of 1,102 discrete samples cut from (i) IODP cores recovered by an Advanced Piston corer and (ii) a series of six sediment cores recovered from the same sites by a Kullenberg piston corer. Systematic core splitting, sub-sampling methods and measurements were applied to all sub-samples. We experimentally tested for field-impressed AMS of these muds, in which titanomagnetite carries magnetic remanence and this test was negative. The AMS is likely determined by paramagnetic minerals.

As expected for horizontally bedded sediments, the vast majority of the K1 (maximum) and K2 (intermediate) axes had inclinations close to 0 degrees and the AMS shape parameter (T) indicates an oblate fabric. The declinations of the K1 and K2 directions of the sub-samples taken from Kullenberg cores showed a wide distribution around the bedding plane, with no preferred alignment along any specimen axis. Exceptions are samples from the upper 1.5 m of some of these cores, in which the K1 and K2 directions were vertical, the K3 (minimum) axis shallow and T became prolate. We conclude that the Kullenberg corer, which penetrated the top sediments with a pressure of approximately 15 bar, occasionally under-sampled during penetration and vertically stretched the top sediments. Sub-samples from the upper sections of Kullenberg cores had relatively steep ChRM inclinations and we rejected samples that had a prolate, vertically oriented AMS ellipsoid.

Surprisingly, the declinations of the K1 axis of all sub-samples taken from IODP APC core sections, which were not oriented relative to each other with respect to azimuth, clustered tightly within the 90-270 degree specimen axis (K2 is within the 0-180 degree axis). This axis is the direction across each cores' split surface (i.e. perpendicular to the "push" direction of the sub-sampling boxes). The APC cores were characterized by various degrees of downwards bending of the planar varves towards the inner surface of the core liner. We conclude that the initial hydraulic pressure applied by the APC, which was consistently above 50 bar during Expedition 347, was needlessly high and created a conical sediment structure and the distinct alignment of the magnetic susceptibility axes along specimen axes. APC core sections with marked disturbances were characterized by ChRM inclinations below 65 degrees, which is a lower limit predicted by time varying geomagnetic field models for the duration of the Hemsö Alloformation (the most recent 6000 years). We rejected samples for palaeomagnetic purposes if the K1 inclination was steeper than 10 degrees. Our study highlights the added value of measuring AMS of discrete sub-samples as an independent control of the suitability of sediments as a source of palaeomagnetic data.