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On the origin of fine-grained magnetic mineral (magnetite?) in laminated Baltic Sea sediments and implications for past environmental variability

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We present the result of a geophysical study of a sediment sequence from the Baltic Sea within the BONUS (Baltic Organisations Network for Funding Science) funded project BALTIC GAS that is investigating methane storage and effects of climate change and eutrophication. The over-all aim of this project is to understand large-scale Baltic Sea ecosystem responses to environmental, climate and anthropogenic forcing. Preliminary results are presented from one site (LL19) located in the north central Baltic Proper at 169 m water depth. The sediment record (i.e. the Littorina Sea during the last c. 8000 years) is characterised by alternating periods of homogenised sediments (indicative of oxic conditions) and laminated sediments (indicative of hypoxic/anoxic conditions).
Mineral magnetic properties illustrate clear changes between laminated and non-laminated sections of the core. Standard mineral magnetic measurements i.e. initial magnetic susceptibility ($\chi$) and saturation isothermal remanent magnetization (SIRM), show large differences with greatest magnetization within the laminated sections, indicating a higher concentration of ferrimagnetic minerals. To characterise the magnetic properties in more details a range measurements were made, i.e. rotational remanent magnetization (RRM), magnetic hysteresis measurements, including magnetic extractions. The results show acquisition of RRM in the laminated part indicating a fine grained single domain (SD) source. Hysteresis parameters from individual samples show a large variability, which suggests that the SD grains exist within thin layers within the laminated intervals. With regards to their origin, one possibility is that the SD grains might have been formed post-sedimentary by oxidation of siderite/manganese carbonates to magheamite/magnetite. However, the FORC (First Order Reversal Curve) diagram of a SD dominated sample is practically identical to those of samples with magnetic properties known to be determined by magnetite magnetosomes made by magnetotactic bacteria (MTB).
In summary, the laminated sediment units have a higher concentration of magnetic minerals compared to those that are non-laminated. The minerals in the laminated sections are fine SD grains, which may be biogenic in origin (formed by MTB) or they may originate from post-sedimentary authigenic processes. Further research is needed to conclusively determine the origin of these SD grains. Such information will improve our understanding of long-term element (Fe) cycling and environmental variability within the Baltic Sea and improve the interpretation of palaeomagnetic records.