Unexpectedly low organic carbon burial efficiency in anoxic sediments is linked to the absence of physical protection: Lessons from the Western Gotland Basin (Baltic Sea)

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The burial of organic carbon (OC) in marine sediments controls atmospheric CO_2 and O_2 concentrations and is a key process in the global carbon cycle. Approximately 160 Tg of carbon are buried in marine sediments every year, of which 90% occurring in continental shelves, making these a crucial hotspot for carbon burial. Sediments beneath anoxic bottom waters are believed to bury OC more effectively, as oxygenated waters host a greater variety of fauna, and some OC compounds can only be broken down by enzymes such as oxygenases. Mass accumulation rate (MAR) also seems to play an important role, in fact, high MAR limits the sediment time exposure to aerobic bacteria, thus annulling any effect due to the presence of O_2 in the water column. Recently, however, sediments of the Gotland Basin (Baltic Sea) have been shown to have unusually low OC burial efficiencies (~10%) considering their MAR and despite being overlaid by anoxic bottom waters. To investigate this unexpectedly low OC burial efficiency, five stations were sampled across the Western Gotland Basin (among these, two were assessed for Fe-OM associations). Measurements of the sulphate reduction rate showed that the OC was much more reactive than expected for its age. Additional analyses of iron-organic carbon associations revealed that the potential for physical protection, occurring either via coprecipitation with iron minerals or mineral adsorption, was very low (below detection limit in one core, and a maximum of 7% of the organic carbon was linked to iron in the other, considerably low compared to global average of 20%). Our results, suggest that the absence of physical protection in the Western Gotland Basin seems to lead to an unusually high mineralisation rate (low OC burial efficiency) despite the anoxic conditions of the water column above. Therefore, the link between oxygen exposure and OC mineralisation rate may not be universal as current believed.

Keywords
Carbon; Burial; Iron; Physical protection, Baltic