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Sedimentary and pore water geochemistry linked to deglaciation and postglacial development of Lake Vättern, Sweden

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Lake Vättern, in south central Sweden, underwent profound environmental changes during the Late Weichselian deglaciation of Fennoscandia. It evolved from (i) a sub/proglacial lake situated at the westernmost rim of the Baltic Ice Lake (BIL) into (ii) a brackish to marine phase where the Vättern basin was a part of the Yoldia Sea connecting the North and Baltic Seas, and finally to (iii) a freshwater basin as isostatic rebound following deglaciation led to its isolation. The sedimentary and pore water geochemical signatures associated with these dramatic environmental changes were investigated in a 74 m composite sediment core from southern Lake Vättern. This was accomplished using high-resolution X-ray fluorescence measurements of elemental data along with discrete measurements of total organic carbon (TOC), δ13C, mineralogical composition (XRD) and pore water chemistry.

Proglacial sediments in Lake Vättern are devoid of organic matter, and show cyclic trends in elemental data, grain size and mineralogy. These are interpreted as varved sediments whose thickness decreases upcore from decimeters to millimeters. The coarse grained varves are enriched in Ca, Si, Zr and Sr and contain calcite while the fine grained varves are enriched in K, Rb, Ti and Fe and lack calcite. Overall, the presence of calcite is limited to the proglacial sediments and reflected in the elemental data by an abrupt decrease of Ca at the (i)/(ii) transition. This suggests a glacial/glaciofluvial origin for the calcite, likely eroded from local limestones that borders the lake basin in the northeast.

The saline incursion at the beginning of phase (ii) is evident in pore water chemistry by a significant increase of the major sea water species (Cl, Na, Mg, K and Ca) but is not clearly seen in the sedimentary geochemistry.

Increased biological production in and around the lake during stage (iii) is strongly reflected in sedimentary geochemistry showing decreasing detrital inputs, increasing TOC and δ13C signals and a mineralogical composition that resembles the fine grained varves of the proglacial sediments, but with a more intense quartz signal. Furthermore, pore water profiles show substantial increase in the concentration of redox sensitive species (Fe, Mn and P) indicating anoxic biodegradation in the sediments.