Coupled Sulfur and Carbon Cycling in Limnic Sediments of Lake Willersinnweiher (SW-Germany)

J. F. HARTMANN[1,2], Y. M. WELLACH[1], M. ISENBECK-SCHRÖTER[1*] AND F. KEPPLER[1]

[1] Institute of Earth Sciences, Heidelberg University, Im Neuenheimer Feld 236, 69120 Heidelberg, Germany (*corresp.: margot.isenbeck@geow.uni-heidelberg.de)

[2] Alfred-Wegener-Institut, Helmholtz-Zentrum für Polar- und Meeresforschung, Am Handelshafen 12, 27570 Bremerhaven, Germany

Lake Willersinnweiher is a small mostly monomictic gravel pit lake with a maximum depth of 20 m and a surface area of about 0.17 km^2 located in the Upper Rhine Valley (SW Germany). It is connected to the shallow aquifer of the Rhine sediments, supplying a Ca-HCO_3-SO_4-type groundwater. Coupling between groundwater and surface water as well as the discharge of anoxic products from the turnover of organic substances result in high concentrations of sulfide species, ammonia and methane in the anoxic hypolimnion of Lake Willersinnweiher.

Our data show seasonal and spatial variations of the depth of the pelagic redoxcline and the fluxes of the redox sensitive elements manganese, iron and sulphur and methane in the sediments as well as the water column.

Lake water and pore water analyses further indicate the presence of intense anaerobic oxidation of methane (AOM) in the upper sediment layers. Here, upward migrating methane is most likely consumed via sulphate. Sulphate-methane transition zones (SMTZ) are generally described for marine sediments, whereas pronounced SMTZ have been observed for very few specific freshwater environments only. AOM efficiency in the SMTZ is thereby decreasing with increasing lake depth. Consequently, the release of methane into the bottom water is higher in profundal areas of Lake Willersinnweiher. Furthermore, methanogenesis and intense sulphur cycling trigger non-steady state conditions in AOM settings within the sediments. Seasonal effects on nutrient availability and discharge of anoxic products across the sediment-water interface result in divers reoxidation processes in the water column coupled to oxic and suboxic conditions.

Our data indicate that Lake Willersinnweiher is a sink for sulphur, whereas methane and inorganic carbon are produced and significantly discharged into the groundwater. Hence, the groundwater wells surrounding the lake show relatively high methane concentrations compared to a groundwater background.