Organic carbon mass accumulation rate regulates the flux of reduced substances from the sediments of deep lakes

Thomas Steinsberger[1,2], Martin Schmid[1], Alfred Wüest[1,3], Robert Schwefel[3], Bernhard Wehrli[1,2], Beat Müller[1]

[1]Eawag, Swiss Federal Institute of Aquatic Science and Technology, CH-6047 Kastanienbaum, Switzerland

[2]Institute of Biogeochemistry and Pollutant Dynamics, ETH Zurich, CH-8092 Zurich, Switzerland

[3]Physics of Aquatic Systems Laboratory, Margaretha Kamprad Chair, Ecole Polytechnique Fédérale de Lausanne, Institute of Environmental Engineering, CH-1015 Lausanne, Switzerland.

The flux of reduced substances in lakes from the sediment to the bottom water (F_{red}) is one of the major factors controlling hypolimnetic oxygen consumption and thus crucial for lake oxygen management. We present sediment porewater measurements from five deep lakes with different trophic states at different lake depths. The results suggest that F_{red} is directly proportional to the total organic carbon mass accumulation rate (TOC-MAR) measured in the lake sediments. Because of sediment focusing, both TOC-MAR and F_{red} increase with lake depth. Temporarily anoxic conditions in combination with sediment focusing boosted F_{red} even in an oligotrophic lake. In contrast, F_{red} was surprisingly low in the deep but eutrophic Lake Geneva where persistently high bottom water oxygen concentrations allowed a high fraction of the settled organic matter to be mineralized aerobically. In general, F_{red} decreased systematicaly with mean hypolimnion depth (z_H). As TOC-MAR and z_H are based on more commonly available data sets, these relationships provide an estimate for the O_2 consumption by F_{red}, where no direct flux measurements are available.