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Groundwater exchange in the monimolimnion of a meromictic pit lake using conservative tracers (SF_6, ^{18}O, ^{2}H)

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We present tracer profiles (stable isotopes ^{18}O, ^{2}H, and SF_6) and CTD measurements (κ_{25}) from a meromictic mining lake and discuss them in the context of the monimolimnion setting and its coupling to the groundwater.

The lake (Lake Moritzteich, Lusatia, Germany) was filled after lignite mining mainly by inflow of groundwater with variable mineralization. A monimolimnion persists with strong chemical gradients especially within the chemocline. This results in stable stratification and therefore strongly reduced mixing within this layer and a very low exchange with the mixolimnion across the chemocline. Overall, the monimolimnion changes very slowly. Because the measured quantities are virtually unchanging throughout the observation period, the system can be assumed close to steady state and the setting can be described one-dimensional (homogeneous in the horizontal).

The measurements document the meromictic character of the lake. We draw on the shape of the conservative tracer profiles. The shape is the result of the exchange with the lower mixolimnion, lateral flushing with groundwater and the vertical distribution within the monimolimnion. As both processes, effective vertical mixing and groundwater flushing, affect the tracer concentrations, information about these processes can not be deduced separately from measurements of a single tracer.

We show how a combined approach using at least two different conservative tracers can be used to identify an active coupling to the groundwater. The approach is based on a local tracer balance and the comparison of vertical fluxes of the tracers. The existence of a coupling to groundwater with concentrations different from the current layer water in the lake is indicated by deviations from a straight line in the plot of two tracer profiles against each other.

Based on a few parameter assumptions, this information can be used for a rough quantitative estimate of the groundwater flushing as well as a reproduction of the measured tracer profiles using a simple one-dimensional diffusion model.