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Tracking fluids in aquatic systems by monitoring naturally accumulating or artificially injected gas tracers with a portable mass spectrometer (miniRUEDI)

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The miniRUEDI is a portable mass spectrometer for analysis of gases in environmental and geological systems. The instrument allows simple and accurate quantification of dissolved gases in aquatic systems using the gas-equilibrium membrane-inlet mass-spectrometry (GE-MIMS) technique. Numerous studies successfully used this technique to investigate the origin, transport and exchange of fluids and gas species in the environment. Recent work has focused on tracking gas-labelled fluids, using either naturally accumulating or artificially injected gases.

We applied the miniRUEDI technology to study the exchange of between rivers and groundwater. In a first study, we investigated the effects of river-bed erosion in the Rhine river (Switzerland) by injecting He, Kr and Xe repeatedly in the adjacent aquifer system, and by monitoring the evolution of these tracers at a pumping well. The observed tracer breakthrough curves showed how the groundwater flow system evolved in response to changes in river bed permeability. In a second study, we analysed dissolved-gas concentration profiles along the Colorado river (USA) using a floating miniRUEDI. The the He and CO_2 profiles help locating and quantifying the discharge of deep groundwater into the river. In a third study, we labeled river Emme (Switzerland) with He to track the river infiltration into the nearby aquifer, which is used for drinking water production. In a fourth study, we used gas time series data to calibrate a physical model of river/groundwater water exchange and atmosphere/water gas exchange in the Bulang river (China), and to quantify the mass balance of CO_2 and CH_4.

In addition to these river/groundwater studies, high-resolution gas time series were explore in novel applications. We used (i) a long time series of dissolved gases to characterize the dynamics of deep fluids in the context of seismic activity, (ii) artificially injected Kr to quantify internal circulation of water masses in Rotsee (Switzerland), and (iii) He spiked water to investigate the water uptake and sap transport in trees.

In this presentation, we will showcase a miniRUEDI instrument to demonstrate the use of high-resolution time series of gas tracers in aquatic environments.