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New online method for water isotope analysis of fluid inclusions in speleothems

Stéphane Affolter (1,3), Markus Leuenberger (1,3), Dominik Fleitmann (2,3,4)

(1) Climate and Environmental Physics, Physics Institute, University of Berne, CH-3012 Berne, Switzerland, (2) Institute of Geological Sciences, University of Berne, CH-3012 Berne, Switzerland, (3) Oeschger Center for Climate Research, University of Berne, CH-3012 Berne, Switzerland, (4) now at Department of Archaeology, School of Human and Environmental Sciences, University of Reading, Whiteknights, PO Box 227, Reading RG6 6AB, UK

Speleothems are increasingly becoming key archives for paleoclimate reconstruction. The fluid inclusions contained in these speleothems represent natural repositories of cave drip waters. The hydrogen (δD) and oxygen (δ^{18}O) isotopic composition of fluid inclusions can yield direct information on the isotopic composition of paleo-precipitation, which can then be combined with isotopic analyses of speleothem calcite to either directly calculate paleotemperatures or to reveal changes in the source of moisture. To liberate speleothem fluid inclusion water and to measure its isotopic composition, a new method was developed. It consists of a simple hydraulic crushing device similar to the one used to extract noble gases from fluid inclusions. Prior to crushing, the sample tube is conditioned by heating and flushing with nitrogen in order to release adsorbed water. Thereafter, the speleothem sample (approximately 1g of calcite) is crushed and the released water from fluid inclusions is transferred by a nitrogen gas stream to a laser spectrometer using a wavelength-scanned cavity ring-down spectroscopy (WS-CRDS) technology that allows us to simultaneously monitor hydrogen and oxygen isotopes. The main task we would like to address with this method is a comparison between the isotope signals of the fluid inclusion and calcite to reduce uncertainties associated with the interpretation of calcite δ^{18}O values in speleothems in Switzerland and Turkey.

Currently, we are mainly focussing on a stalagmite (M6) from Milandre cave, Jura, Switzerland. We installed a high precision drip logger, which continuously counts the number of water drops per time unit using an acoustic technique. This way we can monitor the drip water rate at the sampling site and collect drip water, which was originally dripping and precipitating on the M6 stalagmite. In parallel, we collected rainfall water at the MeteoSwiss station “Le Mormont” located close to the cave. Thus we are able to compare δD and δ^{18}O isotopic composition of drip and rainfall water. This will help us to characterize the water transfer through the soil zone and bedrock into the cave and to understand the fractionation process that can precede the calcite production and the formation of fluid inclusions.