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# New on-line method for water isotope analysis of fluid inclusions in speleothems using laser absorption spectroscopy: Application to stalagmites from Borneo and Switzerland

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Speleothems are recognised as key continental archives for paleoclimate reconstructions. They contain fluid inclusions representing past drip water trapped in the calcite structure. Speleothem can be precisely dated and therefore the oxygen ($\delta^{18}$O) and hydrogen ($\delta$D) isotopes of fluid inclusions constitute powerful proxies for paleotemperature or to investigate changes in the moisture source over several interglacial-glacial cycles. To liberate fluid inclusion water and to analyse its isotopic composition, a new online extraction method developed at Bern is used. The principle can be summarised as follows: Prior to crushing, the sample is placed into a copper tube, fixed to the line previously heated to 140˚C and flushed with a nitrogen and standard water mixture. Thereafter, the speleothem sample is crushed using a simple hydraulic crushing device and the released water from fluid inclusions is transferred by the nitrogen-standard water mixture flow to a Picarro L1102-i isotopic liquid water and water vapor analyser. The measuring principle is based on wavelength-scanned cavity ring-down spectroscopy (WS-CRDS) technology that allows us to simultaneously monitor hydrogen and oxygen isotopes. Reproducibility of standard water measurements is typically better than 1.5 ‰ for $\delta$D and 0.4 ‰ for $\delta^{18}$O. With this method, we successfully analysed $\delta$D and $\delta^{18}$O isotopic composition of a stalagmite from Northern Borneo (tropical West Pacific) covering almost two glacial-interglacial cycles from MIS 12 to early MIS 9 (460-330 ka) as well as recent samples from Switzerland and Borneo. These results are used in combination with calcite $\delta^{18}$O to reconstruct paleotemperature. Currently, we are measuring a stalagmite from Milandre cave (Jura, Switzerland) covering the Bølling-Allerød, Younger Dryas cold phase and the Holocene.