



## **Extending the dated continental climate record: U-Pb ages on speleothems from high-Alpine caves**

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The unique oxygen isotope records of past continental climate preserved in speleothems in caves provide important links to the global climate record from oceanic sediments. In general the ages of these records can be determined by U-Th isotope disequilibrium dating but in a number of cases these records extend to ages where this technique becomes imprecise or even unuseable.

Earlier work has shown that the relative U and Pb concentrations result in sufficient change in  $^{206}\text{Pb}$  abundance for U-Pb ages to be determined with useful precision down ages as low as 0.1 Ma.

Here we report on U-Pb investigations of samples from high-Alpine caves with ages ranging from 0.18 Ma to approaching 2 Ma. Analyses were performed on cm-scale sub-samples from apparently continuous growth episodes in individual hand specimens. This generated isotopic data with sufficient range in U/Pb ratio to determine  $^{238}\text{U}$ - $^{206}\text{Pb}$  isochrons; this range results from independent variations in both U and Pb concentrations. The pattern of variations in the former were determined in advance by phosphor-imaging and used to guide sub-sample selection.

The apparent U-Pb ages from conventional calculation were corrected for the effects of initial isotope disequilibrium in the  $^{238}\text{U}$  decay series, including estimates of initial excess  $^{234}\text{U}$ . The latter were initially based on previous analyses of nearby samples but are currently being supplemented by mass-spectrometric analysis of  $^{234}\text{U}/^{238}\text{U}$  on the same sample solutions used in the U-Pb measurements.

Three samples from the Spannagel Cave have U concentrations from 5 to over 300

ppm and Pb concentrations down to less than 10 ppb; they yield disequilibrium-corrected ages of  $281 \pm 26$ ,  $309 \pm 4$  and  $542 \pm 36$  ka. Preliminary data on two samples from the Wilde Mann cave and an adjacent site indicate substantially older ages of  $1.79 \pm 0.04$  and  $2.02 \pm 0.04$  Ma.

These samples have unusually high U concentrations but for ages above 1 Ma even U levels in the ppm range can yield quite precise ages if the initial Pb levels are low.