

Flowstones from SE Spain document a close relationship between North Atlantic temperature and precipitation in the Western Mediterranean between 7 and 112 ka

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Here we present three flowstone records from Cueva Victoria, SE Spain, covering the period between Marine Isotope Stage (MIS) 5 and MIS 3, the Late Glacial and the Holocene. The flowstones were precisely dated by the MC-ICPMS $^{230}\text{Th}/\text{U}$ -method. In addition, stable oxygen and carbon isotope ratios as well as trace element concentrations were determined at high resolution (centennial to decadal scale). Present-day climate of SE Spain is classified as semi-arid with dry summer months (<10 mm/month precipitation) and sparsely developed vegetation.

A large dataset of $^{230}\text{Th}/\text{U}$ ages on several flowstones from Cueva Victoria indicates preferential flowstone growth during warm phases (i.e., interglacials as well as warm interstadials), whereas flowstone growth is interrupted during glacial phases (Budsky et al., 2015). One of the drill cores shows more or less continuous flowstone growth between the Last Interglacial (MIS 5) and MIS 3 (112 – 46 ka). A flowstone from another part of the cave only records the time span from 86 to 50 ka including several growth interruptions. However, both flowstones cover the transition from MIS 4 to 3 including D/O events 17 to 13 at high resolution. Each D/O event is reflected by a remarkable decrease in both $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ values (both up to 3‰) accompanied by decreasing concentrations of Mg and Sr. In particular, longer D/O events, lasting several thousands of years (e.g., D/O 14, 19, 20 and 21), are well represented in the $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ records. The timing is in good agreement with the NGRIP ice core and sea-surface temperatures from the Iberian margin. $\delta^{18}\text{O}$ values are around -3.5‰ and decrease to -5 to -6‰ during D/O events, while $\delta^{13}\text{C}$ values are around -9‰ and decrease to -10 to -11‰ during D/O events. We interpret these changes as more humid conditions during D/O events, with elevated sea-surface temperatures in the North Atlantic and the Mediterranean Sea leading to increased moisture transport and precipitation on the SE Iberian Peninsula. As a consequence, vegetation density increased, which is reflected by the decrease in $\delta^{13}\text{C}$ values and Mg and Sr concentrations and an increase in P content.

In the Holocene, the flowstone grew continuously from the Bølling/Allerød to the mid-Holocene (7 ka). Stable isotopes record a trend of increasing temperatures with decreasing values towards the mid-Holocene ($\delta^{18}\text{O} \approx -6.4$ ‰, $\delta^{13}\text{C} \approx -11$ ‰). However, $\delta^{13}\text{C}$ values record a significant excursion with elevated values (up to -3.8‰) during a period from 9.5 to 7.7 ka related to cold Bond-events in the North Atlantic, which is interpreted as a dry period in SE Spain.

Budsky, A., Scholz, D., Gibert, L., Mertz-Kraus, R., 2015. $^{230}\text{Th}/\text{U}$ -dating of the Cueva Victoria flowstone sequence: Preliminary results and paleoclimate implications, in: Gibert, L., Ferràndez-Canadell, C. (Eds.), *Geology and Paleontology of Cueva Victoria*. Mastia 11-13, Cartagena, pp. 101–109.