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Dansgaard-Oeschger climate oscillation during the early MIS3 in Europe: evidence from a multi proxy (bulk & clumped stable isotopes and trace elements) speleothem record in Han-sur-Lesse, Belgium

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The Marine Isotope Stage 3 (MIS 3) – a period between 60 and 27 ka ago during the last glacial cycle – experienced several abrupt climatic warming phases known as Dansgaard-Oeschger (DO) events. The DO events are abrupt transitions from cold (stadial) to mild (interstadial) climate conditions.

Speleothems are precious continental records and provide important climatic information at high resolution. However, during this time period, the north central Europe is less studied because the MIS 3 is generally not recorded, due to the climatic conditions. Here, we present the first Belgium continuous speleothem (flowstone) record covering the early MIS 3 (from 60 to 40 ka) from the Verviétois Gallery that is part of the Han sur Lesse cave system (southern Belgium). High resolution bulk stable isotope and elemental combined with U-Th dating are used to define the Belgium climatic variability. Additionally, clumped isotope measurements have been performed to reconstruct temperature to better constrain climatic response during the DO 16-12.

The multiproxy approach used to investigate the speleothem record shows a regional response to the global climate conditions during MIS3. The $d^{13}C$ and $d^{18}O$ values as well as the elemental analyses (Mg, Ba and Sr as water availability proxies and P and Zn as soil development) mirror the DO 16 and 12 events indicating dry-wet and cold-warm changes. During interstadials events low values of $d^{18}O$ and $d^{13}C$ and Mg, Ba and Sr content suggest wet/warm conditions, while the increase of isotopic and elemental values during the stadials support a climate deterioration with cooling and drier conditions. The clumped-isotope temperatures, performed on the DO 16 and 12, suggest warm interstadials ($12^{O}C$ +/- $2^{O}C$) and cold stadials ($7^{O}C$ +/- $2^{O}C$) climate.

During the DO12, a delay in the climatic amelioration and the vegetation is observed. This delay, also noted in south-west France cave (Villars cave), seems to be linked to a delay between increase

of temperature and water availability allowing the soil above the cave to growth. Also, a climatic deterioration occurred after the DO11, with an increase time lag from the north to the south of Europe, showing a progressive cooling to the south Europe. It is interesting to note that this gradual cooling in Europe coincides, withing dating error bars, with the potential progressive north-south decline of the Neanderthals in Europe.