



A warming-cooling cycle between 3.8 and 3.2 ky BP: correlations of speleothem and bivalve compositions with ice core records

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Climate conditions during the Holocene were relatively stable compared to the entire Quaternary, so that only minor fluctuations are detectable in stable isotope records of ice cores. On the other hand, continental records in Europe show climate change events (e.g., glacier movement periods, or lake level changes) that had even significant societal effects. One of these minor climate fluctuation events took place during the Bronze Age, about 3 to 4 ky BP (e.g., Haas et al., 1998, Vollweiler et al. 2006, Mangini et al. 2007, Siklósy et al., 2009). During this time both cold/humid and warm periods are assumed in the Alpine area with very close ages. In a speleothem record from Southern Hungary, Siklósy et al (2009) have also detected a significant climate change event that they correlated with similar stalagmite data from the wider region. On the base of coupled H and O isotope compositions in inclusion-hosted water and the host carbonate, Siklósy et al. (2009) interpreted the O isotope peak as a sign of strong cooling, although other studies (Vollweiler et al., 2006 and Mangini et al., 2007) would rather suggest warming for the same isotope excursion. In order to investigate this contradiction, freshwater bivalve shells (*Unio* sp.) were collected from Bronze age archeological excavations around Lake Balaton (Central-Western Hungary) and the C and O isotope compositions measured. The data indicate warmer/dryer conditions around 3. ky BP, very close to the isotope peak in the speleothem records.

These observations lead us to compare our geochemical data from speleothems and bivalve shells with other stalagmite records as well as with the GISP2 oxygen isotope data. H, C and O isotope compositions as well as trace element data (e.g., Mg/Sr ratios, P concentrations) in stalagmite carbonate can be well correlated, indicating a warming-cooling cycle and humidity change in the northern hemisphere between 3.8 and 3.2 ky BP. Warming commenced around 3.8 ky BP and lasted for ~200 years, followed by an ~300 ky long cool phase. This cycle can also be detected in the GISP2 isotope record.