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A 300 ky-long high resolution stalagmite record from Northern Turkey: Millennial-scale events and Black Sea flooding

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There is a distinct lack of long and continuous paleoclimate records in Turkey and the entire Eastern Mediterranean region. In order to fill this gap of knowledge, we analyzed five stalagmites from Sofular Cave (41˚25'N, 31˚56'E; 442m asl) near Zonguldak approximately 10km apart from the Black Sea coast.

A total of 7300 carbon and oxygen isotope measurements and 174 Uranium-series ages were performed on five stalagmites. Based on ^{230}Th-dating results (dating errors vary between 0.2 and 3.7%), we extracted paleoclimate information for the last 300ky. The analyzed stalagmites cover the time intervals 0 – 21.7ky, 24.1 – 80ky, 93 – 106ky, 116 – 118ky, 127 – 131ky, 155 – 240ky and 280 – 295ky BP. To liquidate existing temporal gaps is part of the ongoing work.

The Turkish Black Sea coast is considered as one of the wettest parts in the country and exhibits high winter as well as summer precipitation. The main moisture source in this region is the Black Sea due to the predominance of northerly winds throughout the year. Therefore, long-term changes in δ^{18}O-signal reflect the isotopic composition of the Black Sea surface water. On shorter timescales (decadal to centennial), seasonality of rainfall and rapid temperature fluctuations are thought to be the primary controls on δ^{18}O. δ^{13}C-values are influenced by humidity, type of vegetation (proportion C3 and C4 plants, vegetation density) and soil activity. Warmer periods are characterized by more negative δ^{13}C-values, indicating a higher abundance of C3-plants and a more prolific biological activity in the soil zone.

The record starts in recent times with δ^{18}O-values around -8‰ VPDB and shows a gradual decrease to values around 14‰ VPDB at 15.5ky BP. The δ^{18}O-profile is in good agreement with the δ^{18}O-record of the Black Sea marine drill core [Bahr et al., Earth and Planetary Science Letters 2006]. This supports our assumption that the Black Sea was the main moisture source even during glacial periods. Modern δ^{13}C-values vary around 10.5‰ VPDB reflecting the modern C3 dominated vegetation, whereas glacial δ^{13}C-values average 8‰ VPDB. The Younger Dryas (YD), Bølling-Allerød (BA) and Dansgaard-Oeschger (DO) events are clearly discernable in the δ^{13}C- as well as in the δ^{18}O-record from Sofular Cave. Warmer and more humid climatic conditions prevail during the BA and DO-events are indicated by lower δ^{13}C- and higher δ^{18}O-values. Although the Eemian Interglacial is currently not fully resolved, the covered time interval shows δ^{13}C- and δ^{18}O-values comparable to modern values. The onset of the Eemian is indicated by a sharp increase in δ^{18}O at 130ky BP, from 15‰ VPDB to 11‰ VPDB. The δ^{18}O-profile shows two extraordinary low and sharp minima at 170ky and 215ky BP. Their values of 18‰ VPDB are ∼6‰ lower than during the last glacial period and possibly related to a larger contribution of isotopically depleted freshwater from a more northerly catchment area. Positive δ^{18}O-values around 8.5‰ VPDB between theses two excursions (190 – 210ky BP) are comparable with present day data and correlate with sea levels higher than ∼-35m asl (Bosphorus sill depth) [Siddall et al., Nature 2003]. Based on the composite Sofular δ^{18}O record, we find evidence for at least 7 periods (centered at today, 80ky, 100ky, 120ky, 200ky, 230ky, 285ky BP) when the Black Sea was connected with the Mediterranean Sea.

δ^{13}C-values are more negative during warm and humid interglacial periods, whereas covered glacial periods are characterized by more positive δ^{13}C-values and a distinct millennial- to centennial-scale variability. DO-events

are well expressed between 11 and 80ky BP and 12 DO-like events are also apparent between 156 and 180ky BP (MIS 6), similar to Sanbao and Hulu Cave [Cheng et al., Geology 2006; Wang et al., Nature 2008].

In summary, this study shows global as well as local signals in the longest known paleoclimate record from the Eastern Mediterranean region and bears high evidence for a reconstructable absolutely dated Black Sea – Black Lake history.