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A Holocene multi-proxy speleothem palaeoclimate record from Iraqi-Kurdistan

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A number of factors make the eastern Fertile Crescent (present day north-east Iraq) inherently suitable and attractive for paleoclimatic investigations. Firstly, it is located at the transition zone between two major climate regimes, North Atlantic Westerlies and the Indian Summer Monsoon system, making it especially susceptible to shifts in climate. Secondly, it has a long and rich history of human occupation throughout the Holocene, making it ideal for the investigation of human-environmental relationships. Thirdly, the Fertile Crescent has been identified as a climate change 'hotspot' and palaeoclimate reconstructions can help to place modern climate into a meaningful perspective. The production of high resolution palaeoclimate records can therefore be used to test model simulations to help predict future shifts in climate, particularly changes in water availability. However, no well dated, highly resolved and long Holocene records currently exist covering the eastern Fertile Crescent.

Here we present the first high resolution multi-proxy speleothem palaeoclimate record covering the entire Holocene from northeast Iraq in an attempt to identify and investigate the presence and magnitude of Holocene climate variability. The stalagmite (SHC-03) is 3.17m long and was collected from Shalaii Cave, Iraqi Kurdistan. It is sampled at a ~5-10 yr resolution and covers the last ~10,300 years. We use a multi-proxy approach through the use of oxygen (δ18O and carbon (δ13C) isotopes and trace element (Mg/Ca and Sr/Ca) analysis.

Firstly, our findings suggest that there is a strong link between the long-term changes in the SHC-03 δ18O profile and changes in the oxygen isotope composition of the Eastern Mediterranean Sea, implying a strong 'source effect'. Changes in the oxygen isotopic composition of the Eastern Mediterranean Sea during the Holocene are controlled by the amount of freshwater outflow from the River Nile related to monsoon intensity. As a result, we propose some caution should be taken when interpreting oxygen isotopes ratios from the Eastern Mediterranean paleoclimate records as a proxy for rainfall amount.

Carbon isotope ratios, trace element concentrations and oxygen isotopes ratios (on shorter timescales) provide an important understanding of variations in effective moisture throughout the Holocene. Our current results support previous pollen and palaeoclimate modelling studies, indicating that maximum effective moisture peaked at ~6000 Yrs BP. The new Shalaii Cave record provides an important climatic and environmental background to significant archaeological developments that occur during the early Holocene in this region.