

The onset of the Mediterranean climate in western Europe inferred from dating and CT scanning of unsectioned stalagmite

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Speleothems are widely used as a proxy for decadal and multicentennial climate variability. Interpretations of seasonal climate patterns from terrestrial climate archives are rare, and stalagmites are able to provide this information through analysis of variability in seasonal growth fabrics that record seasonal distribution of rainfall [1]. Non-destructive CT scanning is used here to reconstruct calcite density [2] from an unsectioned stalagmite, and we use this as a palaeoclimate novel proxy.

Here, we present a high-resolution, accurately-dated early- to mid-Holocene palaeoclimate record from Refugio Cave in southern Spain, constructed using stalagmite density variations. The reconstruction and the chronology benefit from tracking the growth axis in three dimensions, allowing increased confidence in the interpretations.

Early Holocene is characterised by relatively denser calcite and slower growth rates that suggests warming trend and evenly distributed rainfall throughout the year. The onset of Mediterranean climate was preceded by aridification event observed as stalagmite growth hiatus between 8.2 and 7 ka BP that coevals with the maximum northward location of Intertropical Convergence Zone during the Holocene [3], that moved strengthened North Atlantic Subtropical High further to the north resulting in the weakening of the westerlies. High stalagmite growth rates and relatively low calcite density from 6.2 ka BP until 4.3 ka BP, when stalagmites growth ceases, suggest that winter precipitation dominated annual totals, and that the transition to a Mediterranean climate occurred at this time.

[1] Boch *et al* (2011) *Sedimentology* **58**, 508-531, [2] Mickler *et al* (2004) *Journal of Cave and Karst Studies* **66**, 3-8, [3] Haug *et al* (2001) *Science* **293**, 1304-1308.