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Reconstructing climate using the geochemistry and computed tomography of stalagmites

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Geochemical analyses and CT scanning of a well-laminated stalagmite (TC-EMP-12) from Conch Bar Cave in the Turks and Caicos Islands reveal climate variability over the late Holocene. The CT scans show complicated internal structure, and were used to assess the porosity, locate changes in growth axis directions, and to identify the ideal plane for sectioning the sample. The top 20 cm of the stalagmite sample, which we also present a stable isotope record for, consists of regular alternating bands of dense and more porous calcite. Hounsfield Units (HU) quantify the attenuation of the X-rays through the sample, and therefore reflect material density and composition. The upper part of stalagmite TC-EMP-12 typically is characterised by HU of between 2000-3000. The lower 25 cm are significantly more porous with irregular shaped bands, which may contain organic contamination, represented by low HU (below 2000). Critically, CT scanning reveals few changes in growth axis direction, which could have affected the climate reconstruction if the sample were sectioned along an inappropriate axis. These variations in calcite density, porosity, and band regularity record changes in vegetation and rainfall intensity above Conch Bar Cave, and may also reflect an early Holocene higher sea stand.

The technique presented here is a minimally destructive method for constructing high-resolution climate records from stalagmites. Additionally, it represents an important tool for identifying the most appropriate plane along which to cut a sample for conventional geochemical analysis. Without this information, geochemical analyses could accidently measure carbonate that is not directly on the growth axis and therefore subject to varying amounts of kinetic enrichment. Intriguingly, the results of the CT scanning also raise the possibility that apparent hiatuses in sectioned stalagmites may reflect a rapid shift in the location of the growth axis rather than a climate-related drying.