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Subaqueous speleothems from the Flinders Ranges, South Australia, as palaeohydrological archives for the arid zone

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Australia is the driest continent outside of Antarctica yet relatively little is known about its long-term moisture history. Many local palaeoclimate archives suffer preservation problems, particularly in the arid centre of the continent, where weathering and erosion leave behind an incomplete record. In an attempt to redress the paucity of arid-zone palaeoclimate records, we investigate 'pendulites', subaqueous speleothems that grow episodically according to fluctuations in local groundwater levels. At Mairs Cave (central Flinders Ranges, South Australia), pendulites have formed around stalactites. During the first sustained episode of drowning, the stalactite is veneered by subaqueous calcite, sealing it and preventing further stalactitic growth after water levels fall. Once sealed, the pendulites only record periods of persistent drowning, assumed to correspond to major pluvial episodes.

Age data from two pendulite samples collected from close to the ceiling where the highest water levels have reached reveal two main groundwater 'high-stand' phases centred on ~67 and ~48 ka, coincident with Southern Hemisphere summer insolation maxima. This suggests that precession-driven southward migration of the ITCZ resulted in regular and persistent incursions of tropical air masses to the central Flinders Ranges. Trace element, stable isotope and growth-rate changes reveal that these orbitally controlled growth intervals are superimposed by regional climate responses to Dansgaard-Oeschger and Heinrich events. The results from Mairs Cave shed new light on the moisture history of central Australia, in particular the competing influences of tropical and middle-latitude circulation systems. This provides a precisely dated regional palaeoclimate template for reconstructing ecosystem changes, understanding human migration/dispersal patterns of the first Australians, and the progressive demise of megafauna. We also highlight the utility of subaqueous speleothems more generally as important archives for investigating arid-zone palaeoclimate.