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Hydrological response during the last deglaciation in southern Australia's arid margin interpreted from speleothem records

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The nature and timing of climatic episodes in the southern hemisphere mid-latitudes during the last deglaciation is of high interest owing to the potential role of the westerly winds in driving carbon dioxide ventilation from the Southern Ocean and the impact of its release on global warming. Terrestrial data spanning the LGM and deglaciation from the southern Australian region are sparse and limited to discontinuous sedimentological and geomorphological records with relatively large chronological uncertainties. Speleothems offer the advantage of precise chronological control and high-resolution climatic information. We present new stalagmite oxygen isotope data for Mairs Cave (32°11'S, 138°52'E), Flinders Ranges which lies in the current transitional zone between tropical and mid-latitude generated rainfall systems.

The Mairs Cave record (stalagmites MC-S1 and MC-S2) is dated by eighteen high-precision U-series measurements and spans 24 to 15 ka. The record features two intervals of high O-isotopic variability (1-2 per mil): 24-18.9 ka and 17.5-15.8 ka. Our preliminary analysis of modern rainfall isotope data (IAEA/WMO, 2006) suggests that these intervals may be characterised by more frequent events resulting from tropical (versus westerly) derived moisture. Today, such events often generate large-magnitude rainfall totals. This is supported in the speleothem record with layers of sediment, interpreted to indicate flooding of the cave, present in MC-S2 during the earlier interval (24-18.9 ka). The start of the second phase of high isotopic variability (17.5 ka) coincides with the beginning of Heinrich Stadial 1 (HS1). Our hypothesis, that high isotopic variability in the speleothem record is associated with greater availability of moisture from lower latitudes, is consistent with a more southerly-displaced inter-tropical convergence zone at the start of HS1 (e.g. Denton et al., 2010). At 15.8 ka, an abrupt increase in multiple geochemical proxies, accompanied by a ten-fold reduction in MC-S1 growth rate and termination of MC-S2, is interpreted to indicate a shift towards aridity, mid-way through HS1.

Higher effective precipitation in the Flinders Ranges landscape through the early deglacial followed by aridity at $\sim$16 ka is supported by a number of additional geomorphic archives (Fitzsimons et al., in press and references therein). The reduction in isotopic variability at 18.9 ka in the Mairs Cave record is also consistent with the southward migration of the westerly winds recorded in the Great Australian Bight (DeDeckker et al., 2012). However, the hydrological response at Mairs Cave towards the position of the westerlies appears to be complex, which may further highlight the importance of the availability of tropical moisture to the arid margin of southern Australia.

References

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