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The answers are blowin' in the wind: ultra-distal airfall zircons, evidence of Cretaceous super-eruptions in eastern Gondwana

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The Siliceous Large Igneous Province that developed along the eastern margin of Gondwana during the Cretaceous is recognised as one of the most significant volcanic provinces of its kind preserved globally. As a result of regional uplift and erosion in the last ~100 Ma, evidence of the scale of volcanism is only truly realised by examining the extensive volcaniclastics preserved in once adjacent sedimentary basins along the eastern (Great Australian Basin - GAB) and southern margin (Otway, Bass and Gippsland Basins) of Australia as well as in the rifted fragments of Zealandia. Despite growing understanding of its extent and varied evidence of explosive eruptions (multi-kilometre scale calderas and thick pyroclastic deposits), this eastern Gondwanan volcanic province has previously been considered poorly prospective for preservation of super-eruptive events (Volcanic Explosivity Index > Magnitude 8). However, work presented here on detrital zircon assemblages from new drillholes in Western Australia provides evidence for the contrary.

We report U-Pb ages and Hf-isotopic signatures of detrital zircons from drill core from the Madura Shelf, Western Australia. These zircons include a 106 Ma (Albian) component with unique eastern Australian age and Hf-isotope characteristics, which can be directly tied to the Siliceous Large Igneous Province, some 2300 km distant. Grain shape analysis demonstrates this young component experienced limited grain attrition, which contrasts with older, more abraded detrital components that are regionally present and temporally persistent. Zircon populations recovered from the new Western Australian cores have been compared with samples (i) derived directly and deposited relatively proximally (Winton and Mackunda Formations in the Great Australian Basin), and (ii) derived secondarily and deposited distally (Ceduna Delta) from the eastern volcanics. Palynology reveals the 106 Ma zircon population in the new Western Australian drillholes is syn-depositional, and adjacent sampling recognises it as stratigraphically isolated. Considering this, and the distinct lack of other significant Neoproterozoic and Phanerozoic zircon populations in the WA samples as compared to the fluvially-transported material in the GAB and Ceduna Delta, we interpret the young population to be volcanic airfall. Furthermore, the data support stable routing of sediments over 100's of millions of years on the Madura Shelf but a significant decoupling/partition from basins further east. Given the grain size and distance from source, such distal zircon emplacement requires previously undocumented 106 Ma super eruptions (>M8). An easterly source is consistent with the palaeogeographic position of Australia in the mid-Cretaceous, straddling polar latitudes. Furthermore, the 106 Ma zircons likely reflect southern hemisphere winter eruptions when tropospheric Polar-Easterly winds would have been favoured across the southeast of the

Australian continent. These data foster important understanding of super-eruptions beyond the current Cenozoic bias.