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OSL chronology of onshore cyclone deposits at Point Lefroy (Exmouth Gulf, Western Australia) – Implications for washover fan formation and regional cyclone activity

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Although frequently occurring, little is known about the geological imprint of (pre)historical tropical cyclones (TCs) in Northwestern Australia. Large washover fans at Point Lefroy (Exmouth Gulf) provide unambiguous morphological evidence of flooding by TCs capable to overtop and breach the local coastal barrier. Based on ground penetrating radar, unmanned aerial vehicle survey techniques, as well as geomorphological, sedimentological and chronological investigations, this research aims at reconstructing the formation of the washover fans, and understanding their significance for recording past TC activity. The stratigraphy of the washover fans is characterized by multiple depositional units, which are separated by palaeosurfaces with initial pedogenesis. Combining the chronostratigraphical record of the different washover fans at Point Lefroy is assumed to reflect the regional TC magnitude-frequency pattern, reaching far beyond historical records.
While reworking of calcareous faunal remains biases the application of radiocarbon dating, we carried out optically stimulated luminescence (OSL) dating in order to establish a robust chronology of TC-induced washover deposition. OSL dating was challenged by spatially heterogeneous dose rates within the poorly sorted mixture of quartz and coral fragments, by incomplete signal resetting, and by sediment mixing during and, most likely, after transportation. However, by successfully constraining the contribution of each of these factors – using a combination of single-grain quartz dating, quasi-continuous luminescence profiling, spatially resolved dose rate determination, and dose rate modelling – the final chronology gives insight into the evolution of the geo-archive and, ultimately, into the local to regional TC history.
Based on up to three sediment profiles from each fan structure, two different washover fans were OSL dated. While contemporaneous deposition at both landforms suggest that the two geomorphological features were activated by the same TCs, both vertical and lateral accretion with shifting areas of reactivation and abandonment are inferred by combining geomorphology, sedimentology and chronostratigraphy. Identical ages (within uncertainties) and more or less constant quasi-continuous age proxies within individual washover units indicate that each of them is most likely the result of one or a few TCs within a comparatively short period of time (i.e. several decades). The compilation of all ages from Point Lefroy allows for establishing a local long-term TC record. It suggests distinct phases of increased storm-induced deposition at ∼150, ∼400, ∼900, ∼1200-1500, ∼2000 and ∼2500 years ago. Our results are in good agreement with TC activity phases identified in a speleothem from the nearby Cape Range peninsula, which may indicate a regional relevance of our record.