

Combining drone-derived digital elevation models and single grain luminescence data of modern analogue deposits to reveal sediment transport pathways and geomorphic change in washover fans

Simon Matthias May, Dominik Brill, John Nikolaus Callow, Dirk Hoffmeister, Jan-Hendrik May



For further information see our publication:

JGR Earth Surface

RESEARCH ARTICLE

10.1029/2020JF005792

Supporting Information:

- Supporting Information S1

Correspondence to:

S. M. May,
mays@uni-koeln.de

Revealing Sediment Transport Pathways and Geomorphic Change in Washover Fans by Combining Drone-Derived Digital Elevation Models and Single Grain Luminescence Data

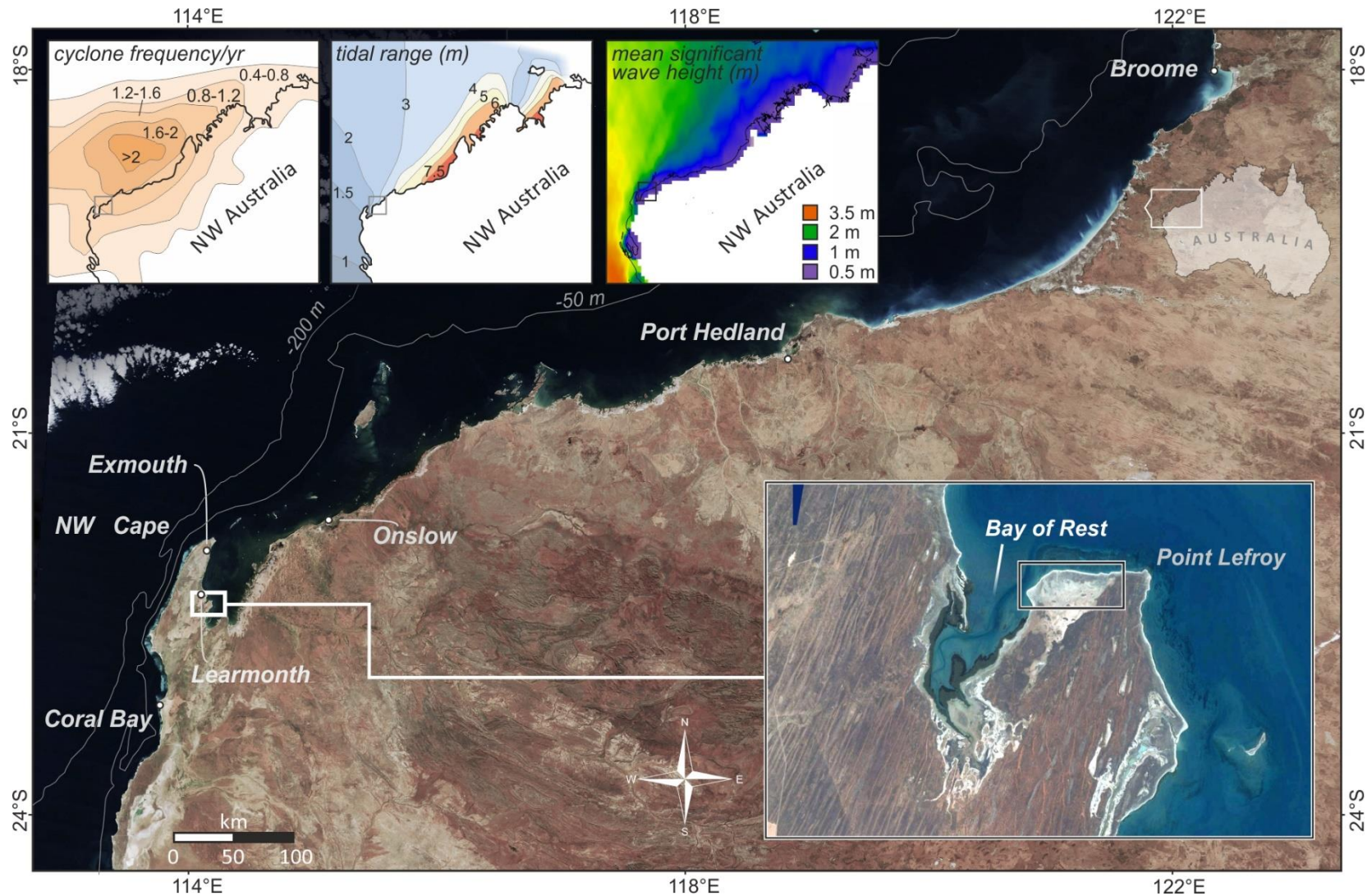
Simon Matthias May¹ , John Nikolaus Callow², Dominik Brill¹, Dirk Hoffmeister¹ , and Jan-Hendrik May^{3,4}

 **General Assembly 2021**

EGU21-1740

Study area – Point Lefroy (SW Exmouth Gulf)

- (1) Study area: Gulf of Exmouth in the NW of Western Australia
- (2) One of the most TC-affected regions on Earth

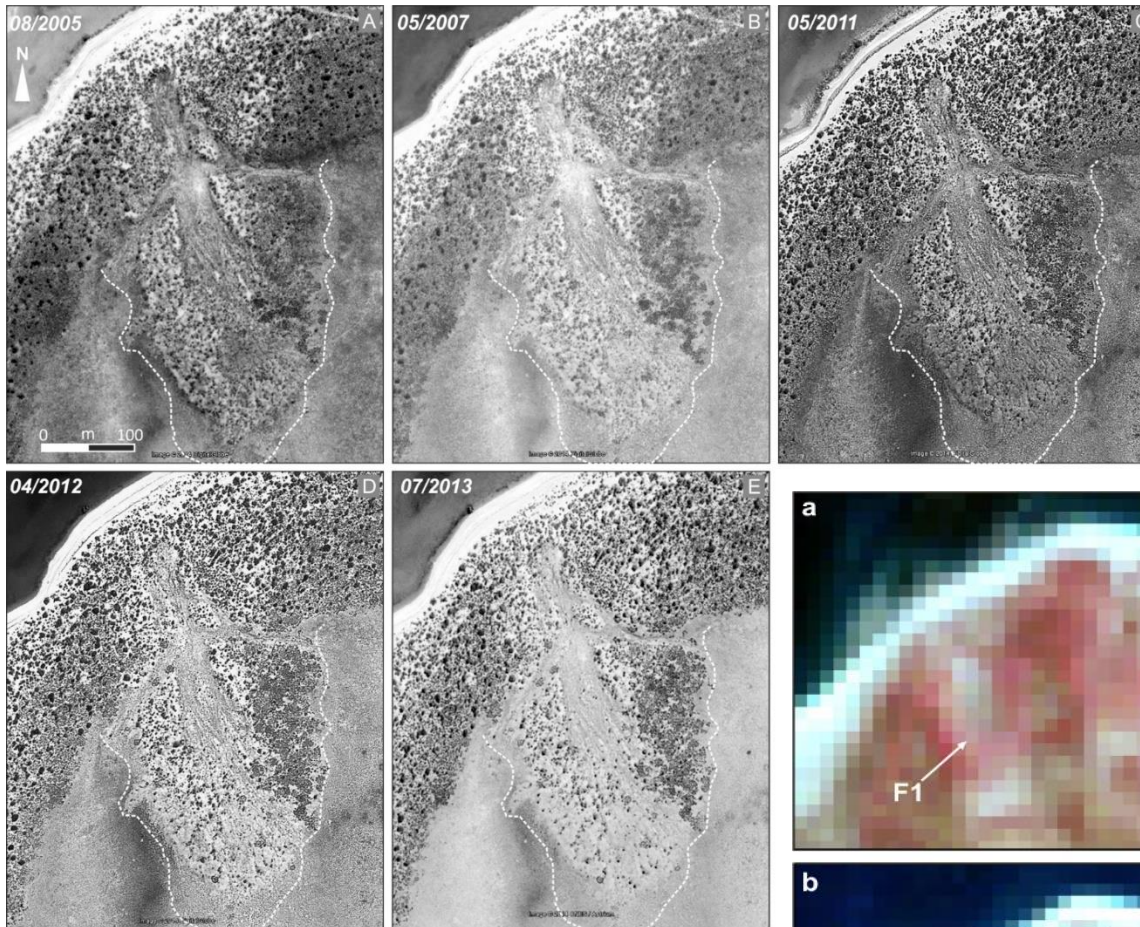


Study area – Washover fans at Point Lefroy

- (1) Large washover fans in the south-western part of the Exmouth Gulf
- (2) Size and structure: ~200 wide, 300 m long, distinct washover throat and central channel, lateral depositional banks

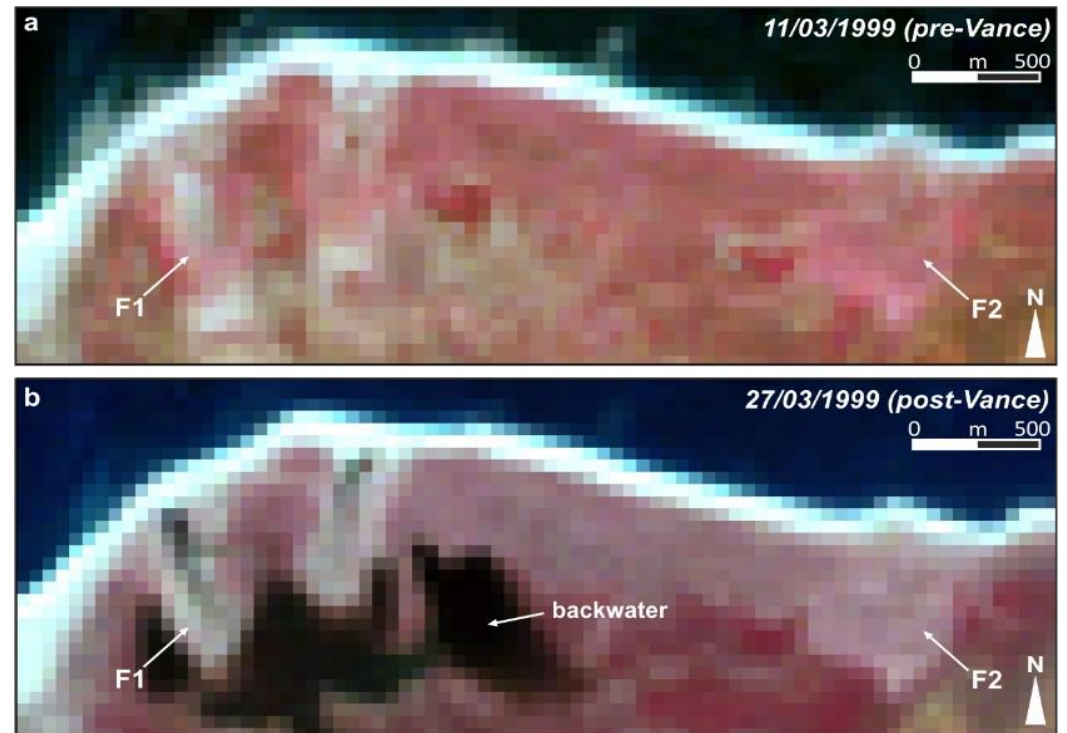


Study area – Recent activity & TC Vance 1999



(1) No activation between 2005 and 2014 (based on Google Earth images and field surveys)

(2) Last activation likely during TC Vance in 1999



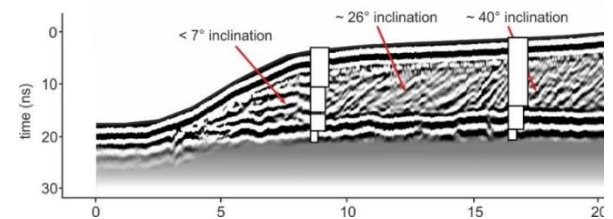
Previous studies – Stratigraphy



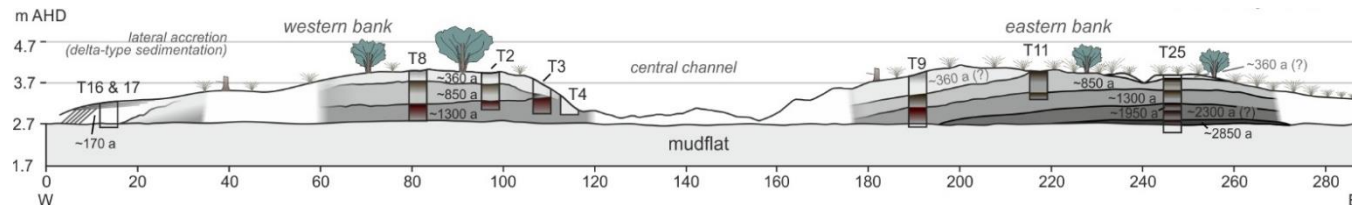
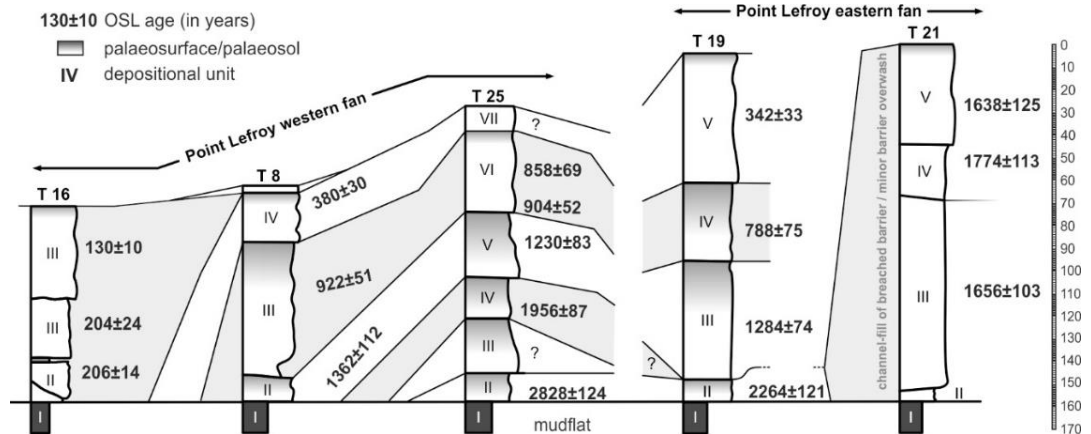
(1) Lateral depositional banks: distinct stratigraphy, with a sequence of several depositional units and intercalating palaeosols

(2) Material: shell debris and sand, corals and large mollusks

(3) GPR results evidence lateral accretion



(4) Similar depositional ages of units (this fan + further fans)



(5) Consistent stratigraphical architecture

Previous studies – Further publications...

Quaternary Science Reviews 169 (2017) 65–84

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ELSEVIER



Chronostratigraphy and geomorphology of washover fans in the Exmouth Gulf (NW Australia) – A record of tropical cyclone activity during the late Holocene

Simon Matthias May^{a,*}, Dominik Brill^a, Matthias Leopold^b, John Nikolaus Callow^b, Max Engel^a, Anja Scheffers^c, Stephan Opitz^a, Maïke Norpoth^a, Helmut Brückner^a

^a Institute of Geography, University of Cologne, Albertus-Magnus-Platz, 50923 Cologne, Germany

^b School of Agriculture and Environment, The University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia

^c Southern Cross GeoScience, Southern Cross University, PO Box 157, Lismore, NSW 2480, Australia



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Drone photogrammetry and KMeans point cloud filtering to create high resolution topographic and inundation models of coastal sediment archives

J.N. Callow,^{1*} S.M. May² and M. Leopold¹

¹ UWA School of Agriculture and Environment, The University of Western Australia, Western Australia Australia

² Institute of Geography, University of Cologne, Cologne, Germany

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*Correspondence to: Nik Callow, School of Agriculture and Environment, The University of Western Australia, 35 Stirling Highway, Crawley, 6009, Western Australia, Australia. E-mail: nik.callow@uwa.edu.au

Quaternary Geochronology 41 (2017) 134–150

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ELSEVIER



Research paper

Luminescence dating of cyclone-induced washover fans at Point Lefroy (NW Australia)

D. Brill^{a,*}, S.M. May^a, M. Shah-Hosseini^b, D. Rufer^c, C. Schmidt^d, M. Engel^a

^a Institute for Geography, Universität zu Köln, Köln, Germany

^b School of Biological, Earth and Environmental Sciences, University of New South Wales, Kensington, Australia

^c Institute of Geological Sciences, Universität Bern, Bern, Switzerland

^d Chair of Geomorphology & BayCEER, Universität Bayreuth, Bayreuth, Germany



Quaternary Geochronology 48 (2018) 91–103

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ELSEVIER



Research paper

Testing the accuracy of feldspar single grains to date late Holocene cyclone and tsunami deposits

Dominik Brill^{a,*}, Tony Reimann^b, Jakob Wallinga^b, Simon Matthias May^a, Max Engel^c, Svenja Riedesel^{a,d}, Helmut Brückner^a

^a Institute of Geography, Universität zu Köln, Köln, Germany

^b Netherlands Centre for Luminescence Dating & Soil Geography and Landscape Group, Wageningen University, Wageningen, the Netherlands

^c Geological Survey of Belgium, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

^d Aberystwyth Luminescence Research Laboratory, Department of Geography and Earth Sciences, Aberystwyth University, United Kingdom



Previous studies – TC Olwyn storm surge 2015

Modern analogue TC Olwyn (March 13-15, 2015): storm surge inside the Gulf of Exmouth

2.2.2014, 15.20 pm

< 2.4 m AHD



11.2.2015, 16.20 pm

< 2.4 m AHD



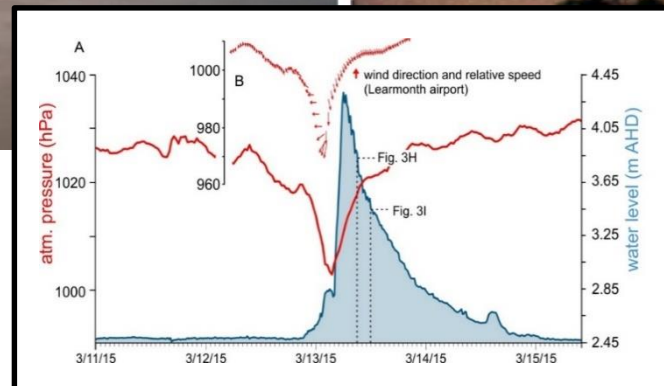
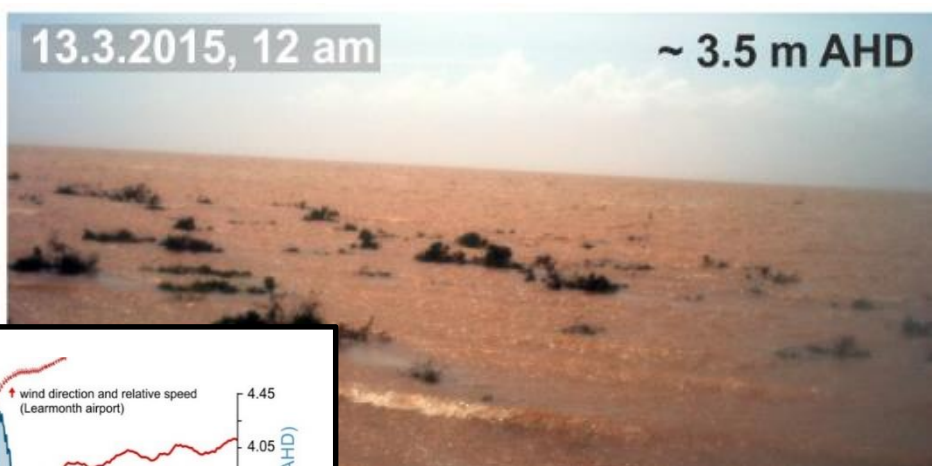
13.3.2015, 9 am TC Olwyn

~ 4.3 m AHD



13.3.2015, 12 am

~ 3.5 m AHD

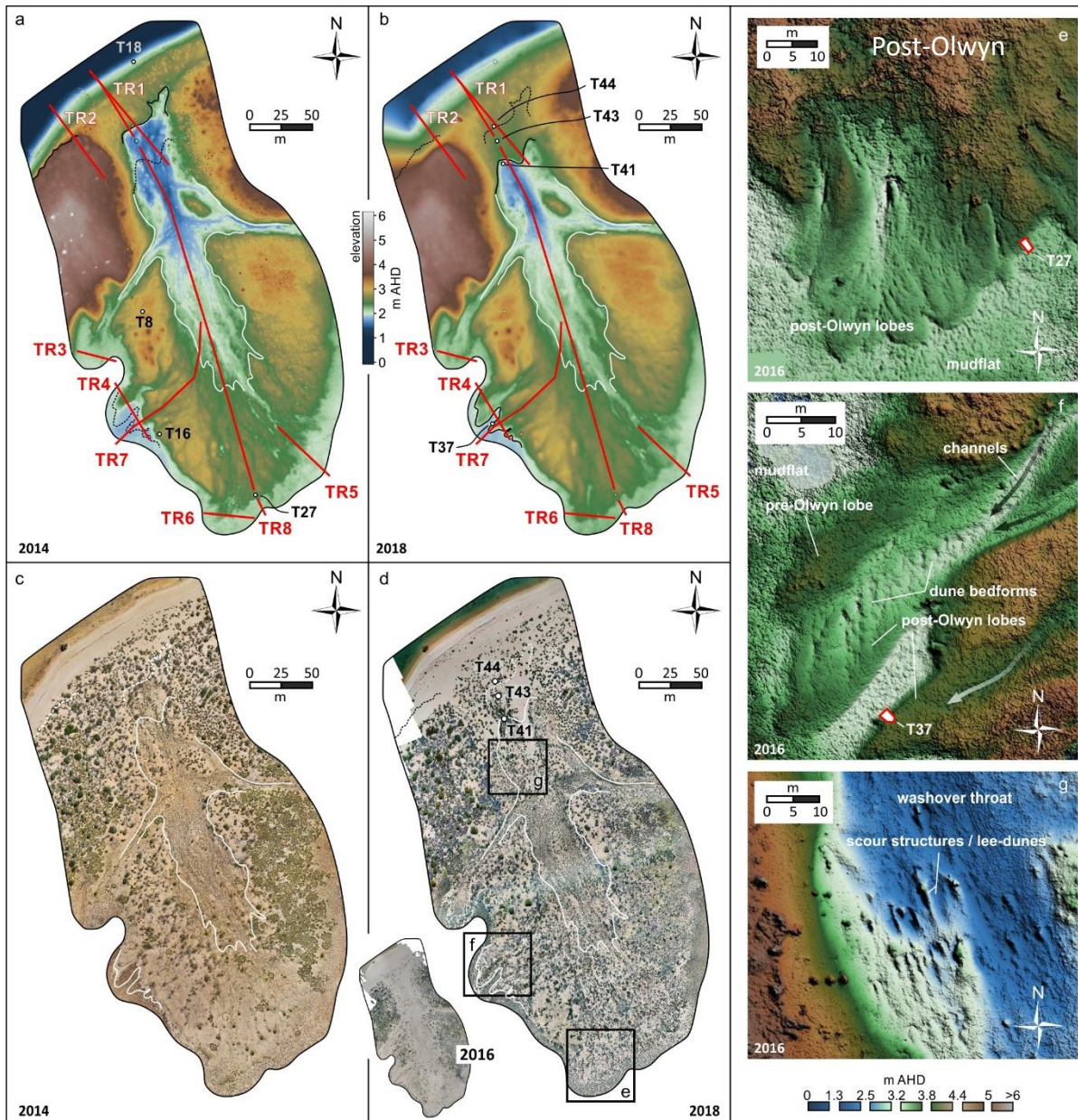


Results – Modern analogue washover deposits

Post-Olwyn survey in 2016: scour structures (left), lateral accretion of washover sediments (bottom), accretion of barrier deposits inside throat (right)



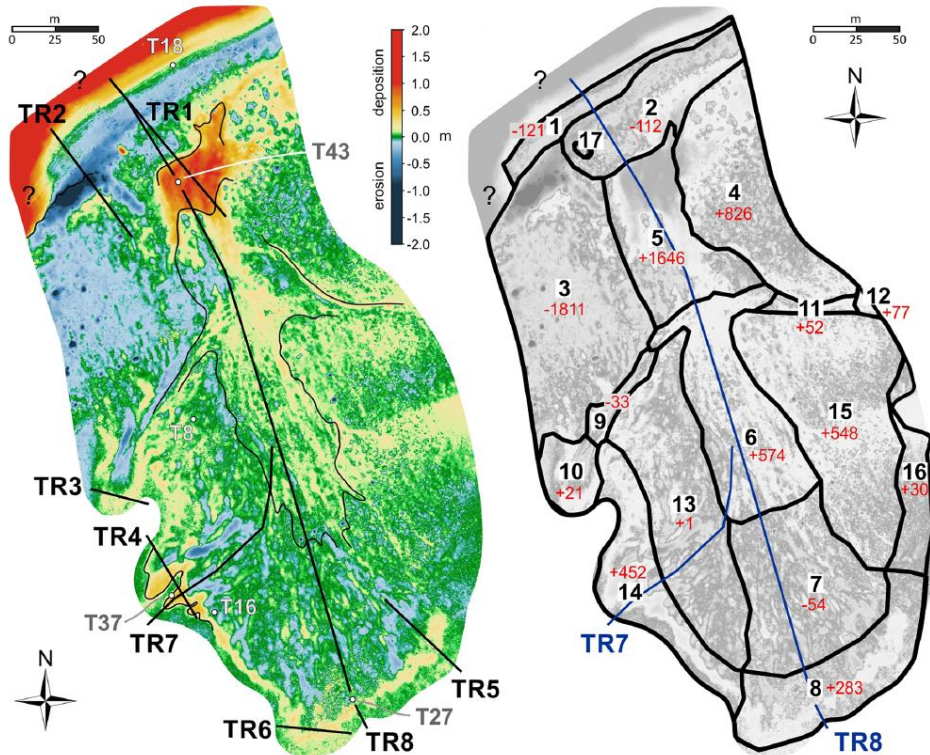
Results – UAV-based pre- and post-Olwyn DEMs



Morphological and sedimentary changes based on drone-derived pre- and post-Olwyn DEMs: independent information on sediment transport



Results – Erosion and deposition based on UAV-data

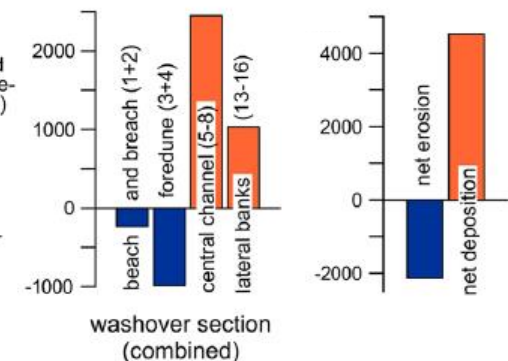
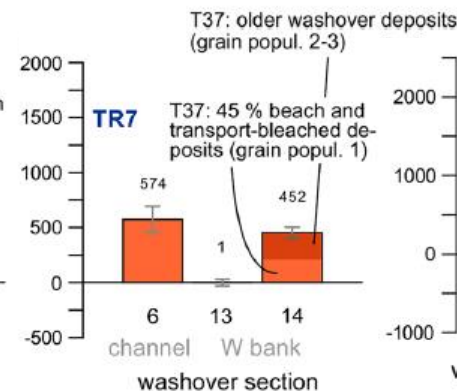
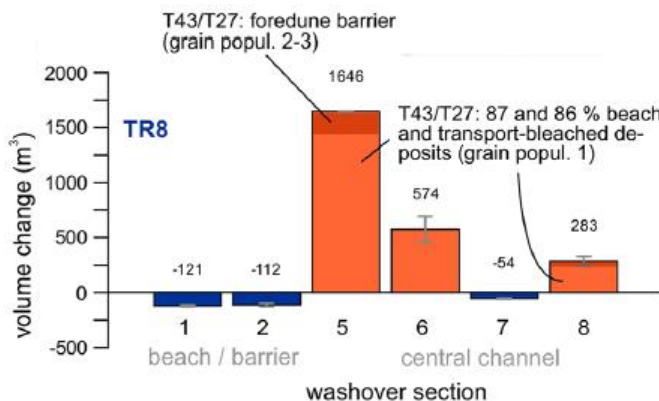


← (1) Quantification of erosion and deposition based on pre- and post-Olwyn UAV-derived DEMS

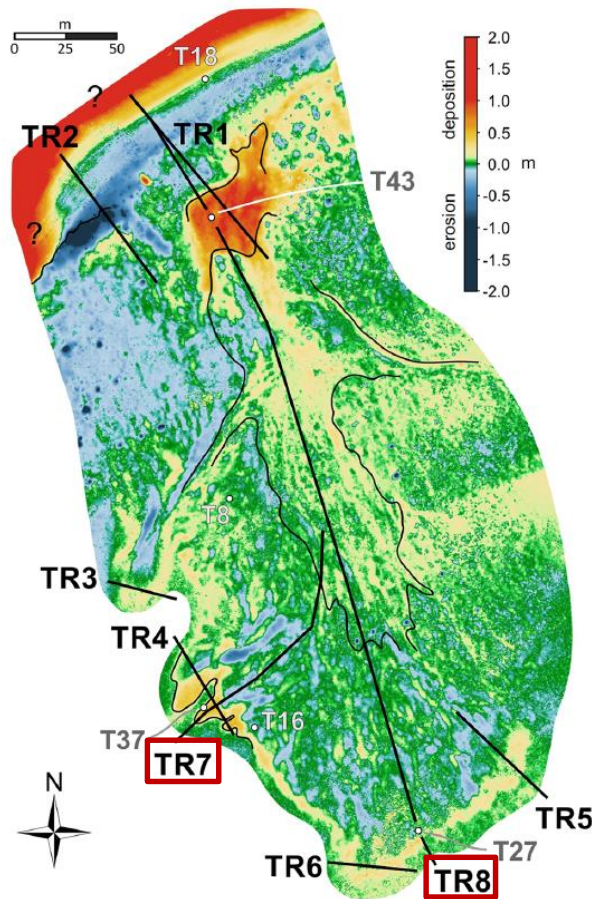
(2) Erosion: beach and foredune

(3) Deposition: central channel and lateral banks

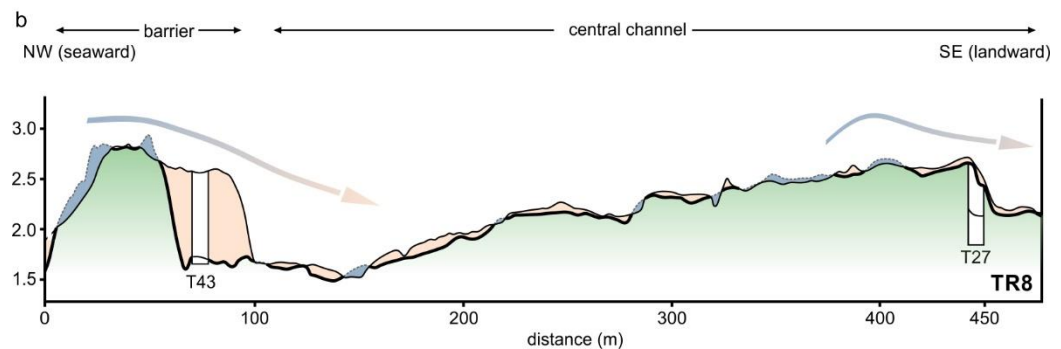
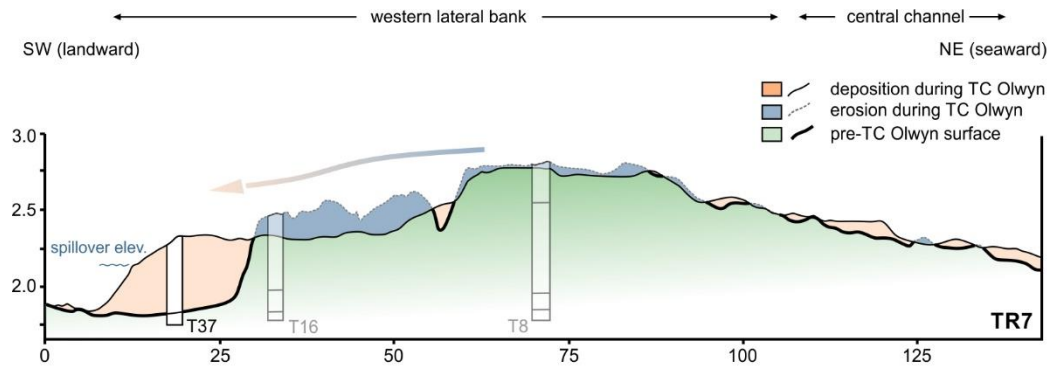
(4) Net deposition > net erosion



Results – Erosion and deposition along transects



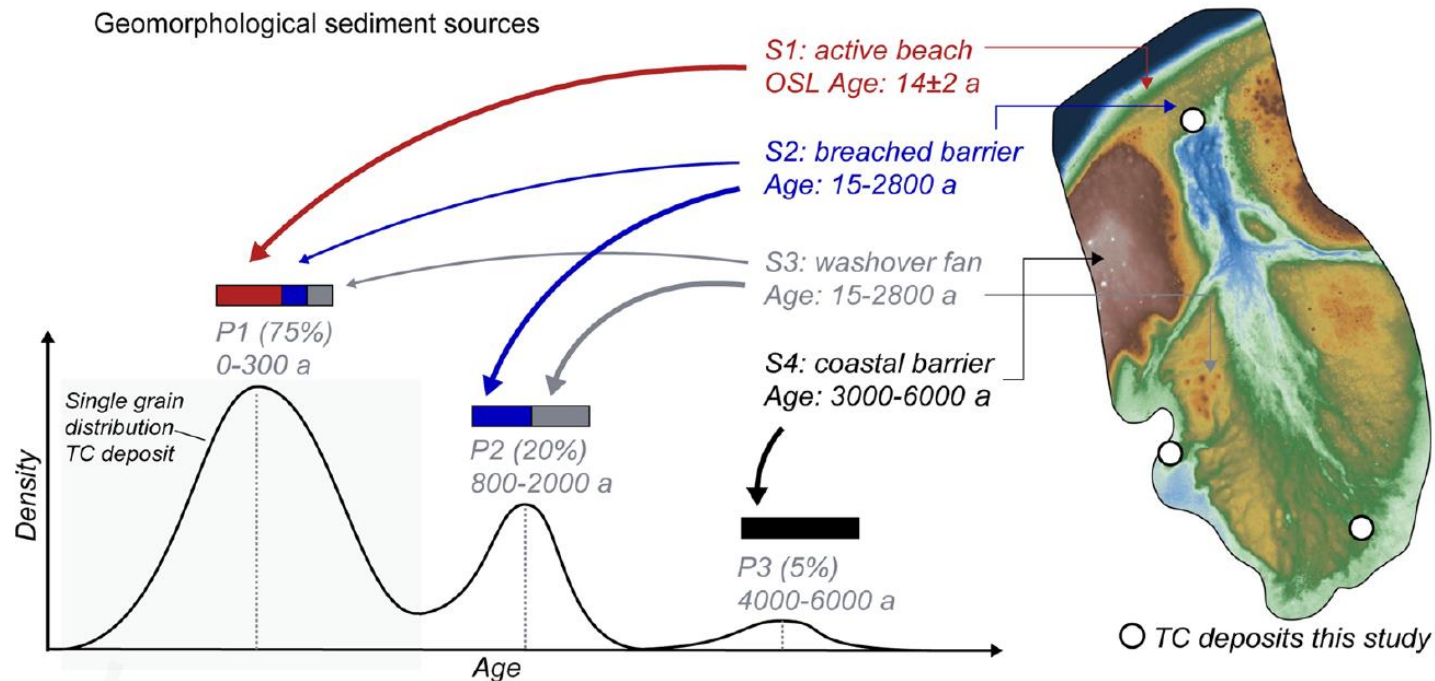
TR7: crossing the western lateral bank; lateral accretion of new sediment lobes (exemplified by T37), erosion of older depositional units



TR8: crossing the barrier, throat/central channel; accretion of barrier deposits (T43) and sediment lobes in the distal part of the central channel (T27), erosion of beach and barrier

Results – Concept of luminescence inventories (1)

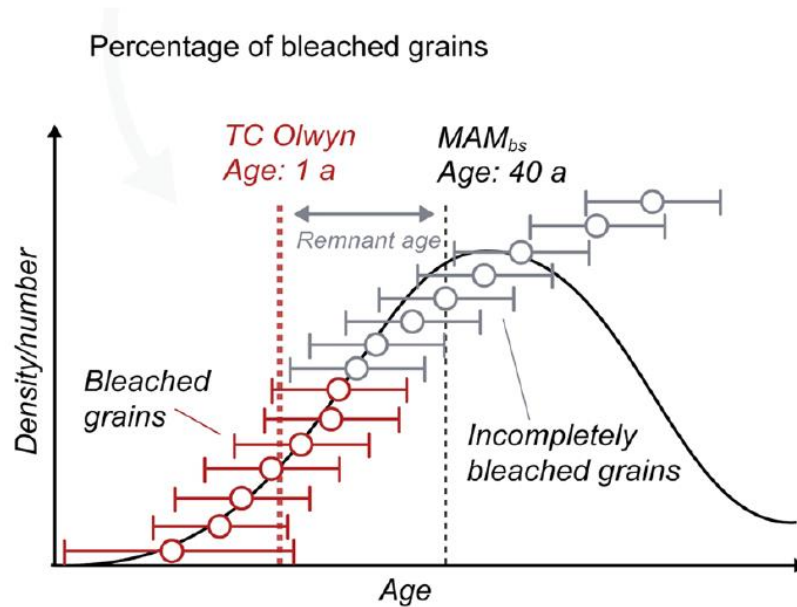
Single grain age distributions of TC deposits and their source environments (schematic)



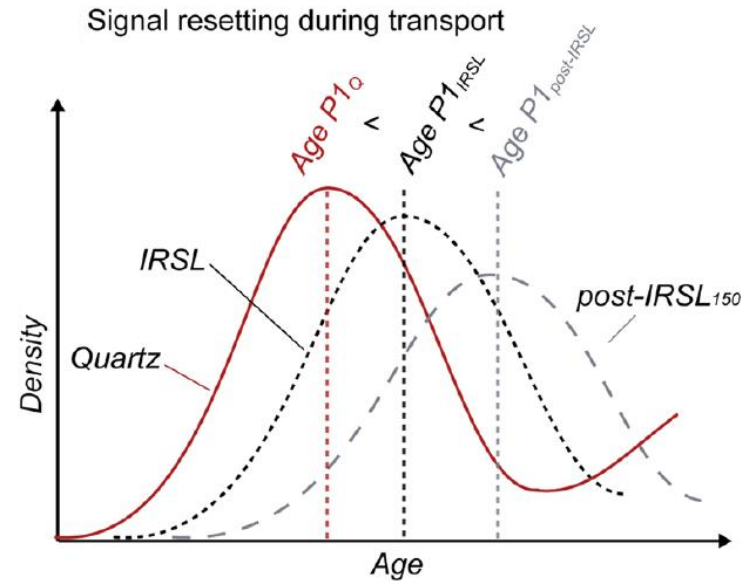
-> Comparison of single grain age distributions of TC deposits (sampling sites = white circles) with chronological information of potential source environments provides information on sediment sources (and transport pathways)

Results – Concept of luminescence inventories (2)

Comparison of single grain OSL ages with age control (left) and luminescence signals with different bleaching sensitivity (right) (both schematic)



-> Percentage of well-bleached grains (i.e., grains with ages in agreement with age control (TC Olwyn = 1 a) within 2-sigma uncertainties) used as a maximum indicator for sediment derived from the active beach

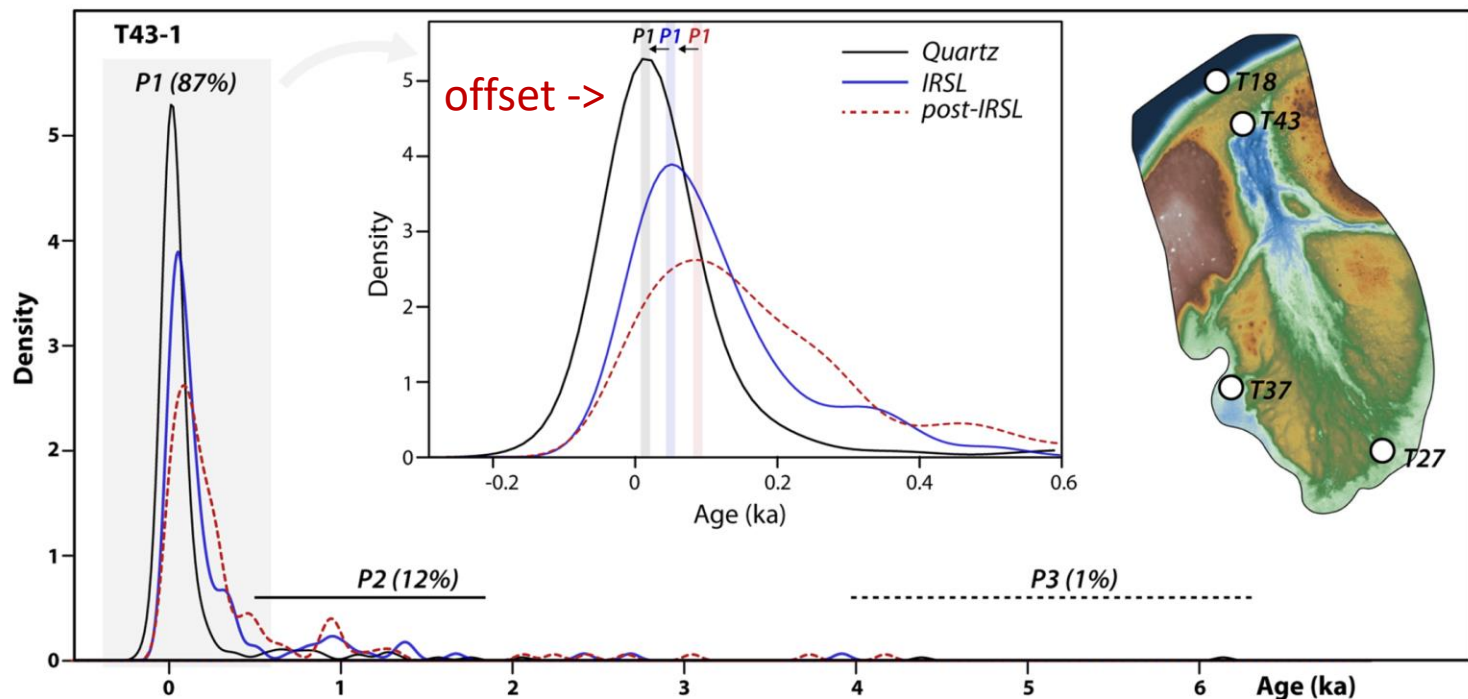


-> Luminescence ages for the same grain population but based on signals with different bleaching sensitivity (quartz, IRSL, post-IRSL) are used to infer OSL signal resetting during storm transport, which reflects transport distance or transport mode

Results – Sediment sources and transport (1)

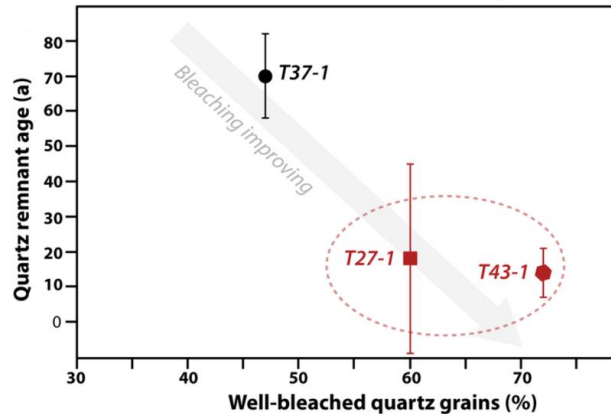
Information on sediment transport from single grain age distributions (quartz-OSL, IRSL, post-IRSL) exemplified for T43 (accreted barrier):

- (1) Large portion of sediment in accreted barrier (P1) is well bleached (source = beach); further populations (P2 and P3) derive from coastal barrier
- (2) Some but no complete signal resetting during storm-related transport is inferred from the offset between age populations of different signals (P1, P1, P1)



Results – Sediment sources and transport (2)

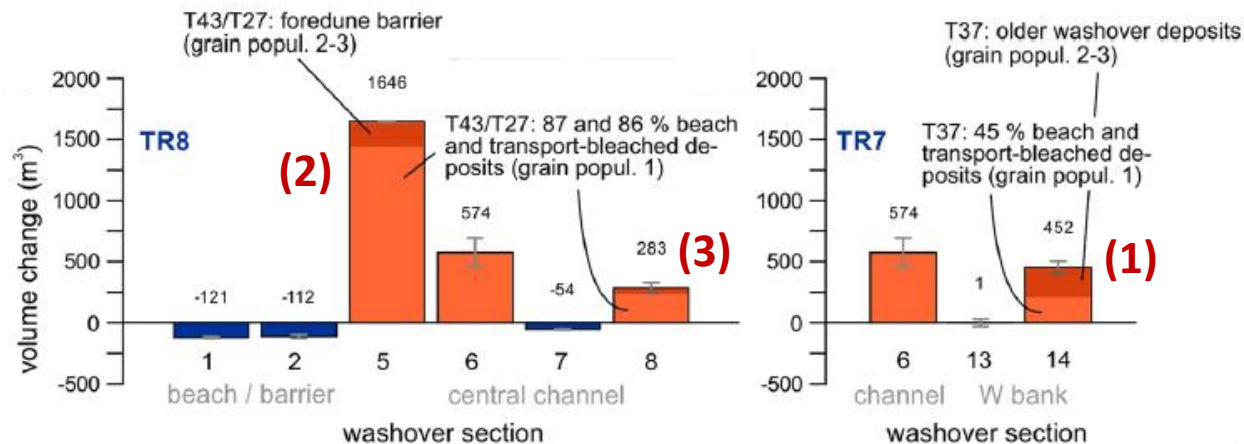
OSL age distributions (cf. slide 14) and degree of signal resetting (expressed by percentage of well-bleached grains and remnant ages, left) indicate different sediment sources, pathways and processes, depending on the position in the washover fan (bottom)



(1) Lateral banks (T37): main source older depositional units of the washover fan; short sediment transport distance, lower chance of signal resetting during TC transport (45% resetted quartz grains, significant remnant age)

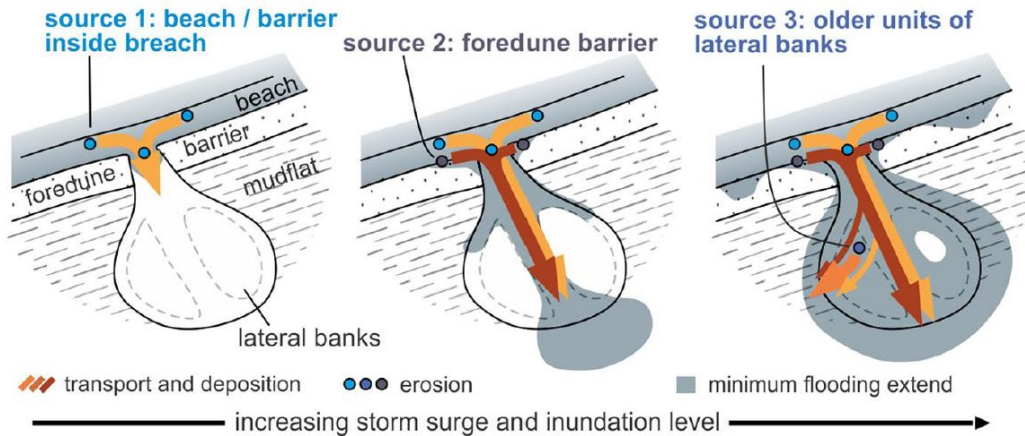
(2) Barrier accretion (T43): main source beach and younger barrier, high percentage (87%) of resetted quartz grains (insignificant remnant age)

(3) Distal central channel (T27): main source beach and older washover sediments, but long transport distance & high chance of signal resetting (86%) during TC (younger remnant age)



Conclusions – Benefit of combining drone-derived DEMs and luminescence inventories

Support the refinement of models for washover-fan formation



(1) The present as the key to the past? Luminescence inventories of modern analogue deposits help to understand hydrological and depositional processes and to evaluate/refine chronology of past events

(2) Together with luminescence-based dating of depositional units and drone-derived high-resolution DEMs, comprehensive models of washover fan formation can be established

(3) Future perspective: evaluation of existing models for hydrodynamics, sediment transport and morphological changes of the nearshore area (e.g., Xbeach, Delft3D)

