

EGU21-6237

<https://doi.org/10.5194/egusphere-egu21-6237>

EGU General Assembly 2021

© Author(s) 2021. This work is distributed under the Creative Commons Attribution 4.0 License.



Transient landscape response to abrupt precipitation increase at the Pleistocene-Holocene transition, offshore Sumatra

Sarah Mosser¹, Anne Bernhardt¹, Mahyar Mohtadi², and Tilmann Schwenk^{2,3}

¹Institute of Geological Sciences, Freie Universität Berlin, Germany

²MARUM - Center for Marine Environmental Sciences, Universität Bremen, Germany

³Research Group Marine Technology – Environmental Research, Universität Bremen, Germany

Active continental margins play a major role in exporting terrestrial sediment to the oceans. Yet, the response of a sediment-routing system to a specific climate change is poorly quantified. The terrestrial-to-marine sediment-routing systems on West Sumatra can be used as a natural laboratory to quantify these changes. Rivers efficiently deliver sediment from the high-relief Barisan mountains to the enclosed marine forearc Mentawai Basin along this active subduction margin. The Holocene climatic history of the region is well known and shows an abrupt precipitation increase at the Pleistocene-Holocene transition (~12 ka BP) as recorded previously in $\delta^{18}\text{O}$ time-series measured on planktonic foraminifera.

Here we analyze multiple late Quaternary sediment records spanning the last 14 ka from the Mentawai Basin, offshore Sumatra. We use volumetric sediment budgets and multivariate statistics on high-resolution elemental compositions to assess changes in sediment flux and composition based on ~150 km of high-resolution sub-bottom sediment profiles (covering 435 km²) and six sediment cores. Radiocarbon ages were taken at every ~35 cm within the sediment cores.

Our results, from sediment budget calculation and sedimentation rates within the cores, show that absolute rates of sediment supply to the marine forearc basin remained constant throughout the Holocene (542-566 g/m²/yr, 68% quantile, 0.1 and 0.2 cm/yr, respectively). However, the sediment composition varies drastically with comparable patterns all over the basin. The compositional changes are characterized by an 8000-year damped oscillation between terrestrial clastic (Al, Si, Ti, Zr, Fe, K, Rb) and marine authigenic (Ca, Sr) sediment supply. From ~12 to 8 ka BP, the relative amount of clastic rock-forming elements is increasing, then decreasing from ~8 to 4 ka BP, and finally increasing again from 4 ka BP to the present. Using a dynamical system modeling approach, we link the beginning of this oscillation to the abrupt precipitation increase at the interglacial transition at ~ 12 ka BP. We interpret the oscillation to reflect a persistent erosional feedback between physical and chemical weathering caused by ongoing landscape adaptation to the abrupt Pleistocene-Holocene transition. The total amount of sediment accumulation, however, does not follow this trend. Thus, the sedimentary composition shows ongoing landscape transience, whereas the uniform sediment accumulation rates imply a landscape in steady state.

These results have two major implications for future landscape evolution: a) the time scale of landscape transience far exceeds the time scale of abrupt climate transition, b) in this study, the sediment flux to the ocean floor does not mirror landscape transience because the excess terrestrial clastic sediment is compensated by decreased deposition of marine carbonates. These implications call for the implementation of compositional changes of exported sediments into landscape evolution models since so far most landscape models focus on the amount of exported sediment.