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The impact of post-depositional processes on tsunami deposits - A quantitative analysis for tsunami hazard assessments

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Sandy tsunami deposits are essential stratigraphic markers to document the impact of tsunamis in the geologic record. Tsunami sands are also the only record of past tsunamis that can be interrogated to retrieve quantitative information about the causative tsunami event. Inversion of flow speed and flow depth from tsunami deposits is often employed to understand a tsunami event better and evaluate the impact of different tsunami events in the same stratigraphic sequence or geographic area.

After deposition, like any other deposit, sandy tsunami deposits are exposed to a series of processes that alter the deposits, collectively called post-depositional processes. These post-depositional processes can change the characteristics significantly. If tsunami deposits are employed to gain quantitative insights into a past event, these post-depositional processes can potentially alter respective inversion results. The influence of post-depositional processes on the inversion of flow depths and speeds has been considered but remains understudied.

To gain more insight into the influence of flow speed and flow depth inversions, we present a new model to simulate different post-depositional processes, such as erosion, bioturbation, winnowing, compaction, and dissolution of minerals. We employ stochastic processes for all these sediment alteration possibilities on a grain-size distribution level. In this context, we use a large number of reference grains for each grain-size class in a given deposit and calculate an individual grain's fate depending on the post-depositional process. This new model allows us to consider different combinations of processes to simulate different sedimentary environments and to quantify the influence of different post-depositional processes with time. We employ the established TSUFLIND model to invert flow speed and depth from the altered grain-size distribution.

Our results indicate how individual post-depositional processes have a more significant influence on inverted flow speeds and depths than others, but they also show how they can influence each other to have a more substantial impact on the sum than individually. Furthermore, our results shed light on potential uncertainties any inversion of the flow characteristics might have depending on the sedimentary environment in which the tsunami deposit was created. In turn, this contributes to a better understanding of uncertainties in tsunami hazard assessments that include tsunami deposits.