Geophysical Research Abstracts
Vol. 21, EGU2019-9742, 2019
EGU General Assembly 2019

Polygenetic marine terraces built over several 100 kyr: potential biases in the tectonic record

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Marine terraces are widely used to reconstruct tectonic deformation at the coasts based on their elevation and age. They are commonly dated assuming that the sediment cover (common target) shares the same age as the terrace strath and are commonly associated with individual sea level high-stands. They can however be built by successive occupation of the same platform by the ocean causing repeated episodes of erosion and deposition. We explore here the consequences of polygenetic marine terraces for tectonic reconstructions.

We work with an extensive global database of over 900 paleoshoreline sequences across the world, with particularly good coverage of MIS 5e (∼120 ka) terraces compiled by Pedoja et al., 2014. After correcting the database for sampling density, we find 60% of marine terraces document uplift rates between 0.1 and 0.5 mm/yr and an arresting high proportion of marine terraces reflect rates high rates between 0.7 and 1.2 mm/yr. This second population is not found in compilations of erosion rates (Willenbring et al.,2013) and hint at a potential inherent bias in the record of uplift rates by marine terraces.

We show the emergent complexity and non-linearity of the marine terrace record in two steps. Firstly, the elevation datums most often occupied by sea level, and thereby most likely to host wide terraces, are unevenly distributed and depend on local uplift rate; they do not necessarily correspond to sea level high-stands. Secondly, we use a model coupling tectonic deformation with wave-base erosion to identify the translation of vertical sea level rise and fall into horizontal transgression and regression of the coastline. This model sheds light on the intrinsically transient nature of marine terraces and the parameters, such as optimal uplift windows that control it.

The complex nature of marine terraces leads to potential underestimate of coastal uplift rates resulting from unrecognized mismatch between ages of sediment cover and strath. Some rock elevations will be repeatedly occupied across glacial cycles depending on local rock uplift rates. This could explain the unusual overrepresentation of marine terraces documenting uplift rates between 0.7 and 1.2 mm/yr.