Progress in observational geodynamics from the analysis of geological hiatus surfaces across Africa in the Cenozoic

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Geological maps contain crucial information to constrain geodynamic models, but they remain underutilized by the geodynamic community. Particularly significant are unconformable geologic contacts at continental scales: what is usually perceived as a lack of data (material eroded or not deposited) becomes instead part of the signal of dynamic topography variation over geologic time.

Here we show how we were able to use geological maps to constrain the dynamic processes in the mantle beneath Africa by understanding its Cenozoic elevation history, and by using it to distinguish between different uplift and subsidence scenarios. This was accomplished by using geological maps at the continent scale to map the spatiotemporal patterns of geological contacts, under the assumption that continental-scale unconformable contacts are proxies for vertical motions and paleotopography.

We found that significant differences exist in interregional-scale hiatus surfaces at the level of geologic series. The total unconformable area at the base of the Miocene expands significantly compared to the base of the Oligocene, strongly suggesting that most of Africa underwent uplift in the Oligocene. In southern Africa there are no marine Oligocene or Pleistocene sediments, suggesting that this region reached a high in the Oligocene, subsided in the Miocene and Pliocene, and has been high again since late Pliocene to Pleistocene. Our results therefore support a dynamic origin for the topography of Africa. Specifically, the time-scale of geologic series (at most a few tens of millions of years) is comparable to the spreading-rate variations in the south Atlantic, which have been linked to African elevation changes through pressure-driven upper mantle flow.