EGU21-7270, updated on 27 Nov 2022
https://doi.org/10.5194/egusphere-egu21-7270
EGU General Assembly 2021

Deciphering paleogeography from orogenic architecture: constructing orogens by a future closure of the Indian Ocean as thought experiment

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Orogens that form at convergent plate boundaries typically consist of accreted rock units that form an incomplete archive of subducted oceanic and continental lithosphere, as well as of deformed crust of the former upper plate. Reading the construction of orogenic architecture forms the key to decipher the paleogeographic distribution of oceans and continents, as well as bathymetric and topographic features that existed thereon such as igneous plateaus, seamounts, microcontinents, or magmatic arcs. Owing to its complicated opening history, the Indian Ocean comprises a mosaic of such features that is an excellent illustration of the degree of geographic complexity that must have occurred in now-subducted oceanic realms of the geologic past and provides the ideal natural laboratory to validate interpretations of present-day orogenic architecture in terms of paleogeography. Current classification schemes of orogens divide between settings associated with termination of subduction (continent-continent collision, continent-ocean collision (obduction)) and with ongoing subduction (accretionary orogenesis), alongside intraplate orogens. Perceived diagnostic features for such classifications, particularly of collisional orogenesis, hinge on dynamic interpretations linking downgoing plate paleogeography to upper plate deformation, plate motion changes, or magmatism. Here, we show, however, that Mesozoic-Cenozoic orogens that undergo collision almost all defy these proposed diagnostic features and behave like accretionary orogens instead. To reconstruct paleogeography of subducted and upper plates, we therefore propose an alternative approach to navigating through orogenic architecture: subducted plate units comprise nappes (or mélanges) with Ocean Plate Stratigraphy (OPS) and Continental Plate Stratigraphy (CPS) stripped from their now-subducted or otherwise underthrust lower crustal and mantle lithospheric underpinnings. Upper plate deformation and paleogeography respond to the competition between absolute motion of the upper plate and the subducting slab. Our navigation approach through orogenic architecture aims to avoid a priori dynamic interpretations that link downgoing plate paleogeography to deformation or magmatic responses in the upper plate, to provide an independent basis for geodynamic analysis. From our analysis we identify ‘rules of orogenesis’ that link the rules of rigid plate tectonics with the reality of plate deformation. We illustrate the use of these rules with a thought experiment, in which we predict two contrasting orogenic architectures that may result from the closure of the Indian Ocean and subsequent collision of the Somali, Malagasy and Indian Margins in a global continental drift scenario for a future supercontinent. We illustrate that our

inferred rules (of thumb) generate orogenic architecture that is analogous to elements of modern orogens, unlocking the well-known modern geography as inspiration for developing testable hypotheses that aid interpreting paleogeography from orogens that formed since the birth of plate tectonics.