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Quantifying subsidence of the Sunda shelf (SE Asia) from coral reef morphology

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The vertical motions of the lithosphere have deeply shaped the geography of SE Asia over the last 5 Myrs. The wide continental Sunda and Sahul platforms have been periodically inundated in the West and Southeast, respectively, whereas myriad of islands have emerged in the more central region of "Wallacea". The long wavelength pattern of vertical motion is mirrored by the coastal geomorphology, which displays a striking bimodal repartition throughout the area. Sequences of uplifted terraces, notches and cliffs are prominent in Wallacea - and attest for its general uplift. Conversely, emerged paleo-reefs are absent above modern reefs and wide alluvial plains dominate coastal areas surrounding Sunda and Sahul shelves and suggests that subsidence prevails.

In order to quantify the subsidence of the Sunda shelf, we used a probabilistic approach based on a numerical model that reproduces the development of coral reefs sequences trough time, in response to relative sea level variations. The model accounts for growth reef rate, sea level variations, sub-marine erosion and subsequent sedimentation. This method enables to evaluate the field of parameters (slope, vertical rate, reef growth rate) that satisfyingly reproduce the observed morphology. Comparison of the predicted and observed morphologies of the island of Belitung (Sunda shelf) yields short-term subsidence rates ranging from -0.20 to -0.45 mm/yr. Because the shelf is really shallow (typically - 30 m, and up to -120 m), such subsidence rates set the timing of the drowning of Sundaland. It implies that the platform would have been permanently emerged recently, even during period of high sea level stand.

The slower, long-term Neogene subsidence of SE Asia, responds to the subduction dynamics of the Sumatra-Java slab. We tested the possibility that the collision of the Australian continent with the Banda Arc modified this long-term behavior. Because the transition from oceanic subduction to continental collision modifies the subduction dynamics, subsidence rates should have increased in the Sunda shelf and decreased in Wallacea. Subsidence over most part of Wallacea came indeed to an end in the last 5 Myrs, when the australian margin collided with the Banda arc, and uplift has taken over in the most recent period of time. We use three-dimensional subduction numerical models to show how the Australian collision has modified dynamic topography in the overriding plate, and suggest that the pattern of dynamic topography variations following Australia-Banda collision could have contributed to differential vertical deformation in SE Asia.