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Paleoenvironmental evolution in a steady state foredeep, Taiwan

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The evolution of mountain ranges to steady state is an important concept in the study of the interrelationships between climate, mountain building and topography. The young and active Taiwan orogeny situated in the western pacific typhoon belt has often been regarded as the type locality of a steady state orogeny, and an ideal case study for tectonic and climatic geomorphology. One prediction of the steady-state theory applied to mountains is the attainment of a constant sediment flux. Our aim in the present study is to estimate the material flux out of the Taiwan orogeny through its evolution.

To do so, we have studied the basin wide sedimentary facies distribution at five key stratigraphic horizons to construct detailed paleogeographic maps that include paleobathymetric information and sediment feeding systems. The maps highlight the complicated basin-wide dynamics of sediment dispersal within an evolving foreland basin.
The basin physiography changed very little from the middle Miocene (around 12.5 Ma) to the late Pliocene (around 3 Ma); the paleoenvironments were essentially maintained from the passive margin to the foreland basin stage. At 3 Ma, during deposition of the mud-dominated Chinshui Shale, the main depositional basin started to widen and deepen. This clearly marks the increased subsidence associated with the approach of the growing orogen to the east. The basin started to become filled in the late early Pleistocene when a shallow marine wedge in front of the growing orogen initiated to propagate towards the south.

We use Dionisos, a forward stratigraphic model, to simulate the evolution of the Taiwan foreland basin in terms of sediment flux (in and out of the basin) towards steady state. We constrain the model with our paleogeographic and sedimentary reconstructions. As an initial input data we utilize the paleoenvironmental maps and a primary sediment supply from the hinterland (topography). The model enables us to look at the long-term basin filling (i.e. realistic material fluxes) as well as to test the sensitivity of the basin architecture to different parameters (i.e. erosion, sediment supply and transport, subsidence, relative sea level).

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