Cenozoic tectonic development and paleogeography in the Taiwan region

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Taiwan is a collisional mountain belt developed in East Asia, linking two opposite dipping subduction zones of the Ryukyu subduction zone to the NE and the Manila subduction complex to the south, respectively. The Cenozoic tectonic development of the Taiwan region is related to the opening of the South China Sea and the collision of the Luzon volcanic arc with Eurasian passive continental-margin. This paper outlines the tectonic development, from continental rifting through formation of passive continental-margin to arc-continent collision, and its corresponding paleogeographic evolution in the Taiwan region.

During the Paleogene (around 58-37 Ma), the study area experienced continental rifting with two NE-trending arrays of rift basins floored by Mesozoic sedimentary basement. The outer belt is characterized by marine rift basins as it locates in the outer margin, facing the open ocean. The cratonward and inner rift belt (presently underlying the western half of the Taiwan Strait) is characterized by mixed marine and non-marine rift basins. Infills for both rift belts are predominant mudstone with occasional sandstone and volcanic layers.

During the rift-drift transition that occurred around 37-30 Ma in the late Eocene to early Oligocene, a transient crustal uplift occurred in the rifted outer margin, which led to erosion and development of the breakup unconformity. The rifting was most intense along the present-day continent-ocean transition off southern Taiwan, leading to continental breakup at ~30 Ma and spreading of the South China Sea oceanic crust.

During the post-breakup stage around 30-6.5 Ma (early Oligocene to late Miocene), the Taiwan region experienced broad thermal subsidence with two anomalous rifting events occurred especially in the outer margin during ~30-21 Ma and ~12.5-6.5 Ma, respectively. These two rift events are accompanied by extrusive volcanisms because of lithospheric stretching. Anomalously thick (up to a few km) submarine volcanics formed immediately following initial seafloor spreading are especially evident in the deep-water area of the thinned continental crust off SW Taiwan. Paleogeography of this northern passive continental margin of the South China Sea is similar to the present-day continental margin off the Pearl River of South China. The post-breakup sediments were accumulated in fluvial, coastal, shelf, slope to deep-sea setting with submarine fans. Eustatic sea-level changes exerts the first-order control on the distribution of facies belt and hence paleogeography.

Since ~6.5 Ma, Luzon volcanic arc of the Philippine Sea Plate has overridden the passive continental margin with the formation of the collisional Taiwan mountain belt. The Taiwan orogeny created a foreland basin by loading and flexing the underlying rifted margin. Pre-existing crustal inhomogeneity in the forms of rift centers and basement highs exerts the first-order control on foreland basin geometry with deep foreland developing on top of pre-existing rift centers and shallow foreland overlying basement highs. The overall vertical foreland succession shows a deepening- followed by shallowing-upward succession (coastal/inner neritic–outer neritic–fluvial settings), reflecting competing rates of tectonic subsidence and sediment supply. The basal deepening trend (~6.5-3 Ma) reflects the growing and advancing loads of the proto-Taiwan mountain belt with sediments sourced mostly from continental interior (i.e. China) and paleo-environments evolved from fluvial to outer shelf settings; the upper shallowing and coarsening upward succession (~3 Ma to present-day) records the rapid growth and denudation of the orogenic belt and filling-up of the foreland basin with paleo-environments evolved from outer shelf to braided river settings. Notably, the presence of the spectacular upper Pleistocene, ~1 km-thick succession of braided-river conglomerates at the top of the foreland basin in central Taiwan indicates a delicate balance between basin subsidence and sediment supply during the latest stage of foreland basin development.