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Provenance evolution of the Western foreland basin and its relationship to the exhumation of source rocks during arc-continent collision

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Late Miocene to Pleistocene sedimentary rocks in the Western foreland basin of Taiwan record the evolution of an orogenic wedge during oblique arc-continent collision between the Luzon volcanic arc and the Chinese passive margin. Our stratigraphic record reaches back to pre-collisional sediments of the Late Miocene to Pliocene, which were deposited on the Chinese passive margin. A dramatic change is observed in the Pliocene, as the depositional center shifts to a collisional basin developing on the passive margin due to the obliquely colliding Luzon Arc and input of sediment from the approaching accretionary wedge. Synorogenic sedimentation continues into the Pleistocene providing a history of material being eroded from the growing mountains to the east. We apply standard provenance analysis techniques on several stratigraphic profiles along the strike of the orogen to relate the sediments to their source and reconstruct possible distribution pathways to further enhance a paleogeographic reconstruction of the area.

Unmetamorphosed mudstones within our sedimentary record contain abundant detrital illite, chlorite and zircons. The Illite Crystallinity Index (IC) and the fission-track dating of detrital zircons provides robust information about the thermal history of source terrains, and we combine these methods to infer the timing of exhumation of metamorphic rocks in the Central Range of Taiwan. The initial input of illite minerals with high crystallinity and of zircons with reset ages (younger than 10 Ma) is recorded in the Yutengping fm. and Chinsui Shale, around 3.5 Ma in the north and around 2.5 Ma in the South, contemporaneously with a deepening and widening of the depositional basin. This is the time of deposition of the mud-dominated Chinshui shale, interpreted as the "underfilled" stage of the foreland basin. This clearly marks accelerated subsidence caused by the approach of the growing orogen. In the south, the illite crystallinity and the frequency of “reset” zircons generally increase from the base to the top of the stratigraphic sequences, thus indicating progressive unroofing of deeper source rocks from the approaching Taiwan orogen. In the north the progressive approach of the orogen is evident from an increase in the contribution of sedimentary lithic fragments towards younger time periods. However, exposure of the deeper orogen is complex, with reset zircons appearing in the Pliocene section, then disappearing upsection, only to reappear in yet younger rocks. We interpret this pattern as reflecting changes in transport paths from the Central Range to the foreland.

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