U-Series Comminution Ages Constrain sediment transfer in the Tropical Small Mountainous River: Zhoushui River, Taiwan

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Uranium-series “comminution age” combined with Sr-Nd isotopes are applied to sediments from different geomorphic units in the Zhuoshui River catchment in central Taiwan Island, and to late Quaternary sediments in the estuary, with the attempt to investigate the change of sediment residence time and its response to external forcings.

The sediment residence time derived from comminution age for colluvial sediments (~140 kyrs) is noticeably longer than that in fan-terrace sediments (~100 kyrs) and modern river sediments (~40 kyrs), indicating long storage on the low-relief surface in upstream highland regions. Over the past 30 kyrs, the residence time of estuarine sediment displayed large variations, ranging from 21 to 172 kyrs, which reveals a mixing between the “old-supply” of colluvial deposits and the “fresh-supply” of modern river sediments derived from landslide erosion. The synchrony between sediment residence time and past ENSO variability indicates that the paleo-sediment supply and removal pattern in the Zhuoshui catchment was dominated by the influence of extreme climate events impacted on the normal monsoon climate. During the cold-dry glacial period with weak typhoon activity, the sediment was dominated by “fresh-supply” derived from hillslope and/or earthquake-triggered landslide erosion. Whereas, the enhanced typhoon activity during the last deglaciation initiated extensive mass movement (e.g., debris-flow), which was able to flush most of the colluvial and/or terrace sediments out and resulting in an increased proportion of “old-supply” at the outlet. When typhoon activity was depressed since the Holocene, the increased monsoon rainfall enabled efficient delivery of freshly eroded materials, consequently “fresh-supply” became dominant again. Overall, this work provides new insights for the first time into how river/hillslope processes, landscape evolution and sediment transfer in tectonically active regions responds to external climate perturbations on various temporal scales.