Detrital zircon study of the Yarlung-Tsangpo and Irrawaddy Rivers

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Abstract

The interactions among tectonic uplift, river erosion and alluvial deposition are fundamental processes that have shaped the landscape of the Himalayan-Tibetan orogen since its creation from early Cenozoic time. To understand these processes around the eastern Himalayan Syntaxis and southeastern Tibet, we conducted a study of riverbank sediments along the Yarlung-Tsangpo and Irrawaddy River. Detrital zircons separated from the sediments were subjected to in-situ U-Pb dating using SHRIMP II at the Beijing SHRIMP Center and Hf isotope measurements using LAM-MC-ICPMS. These results, together with the U-Pb ages and Hf isotope data that we have recently obtained for the Transhimalayan plutonic and surrounding basement rocks, allow a more quantitative examination of the provenance or "protosource" areas for the riverbank sediments.

From the upper reaches of the River in the west to the Namche Barwa Syntaxis in the east, our results indicate that the percentage inputs from the major source provenances vary significantly, e.g., those of detrital zircons from the Gangdese batholith increase from ~18% to ~50% and those from the Tethyan Himalayan sequences decrease from ~80% to <50%. Before the River flows into the Big Bend gorge, the percentage of Gangdese-derived zircons lowers to ~40%, but it arises back to ~50% in the Muotuo area. Moreover, in each part of the River, these Gangdese-derived zircons show characteristic $\varepsilon_{Hf}(T)$ values that could be correlated to the neighboring batholithic values. Strong erosional processes are suspected to have been taking place in Tibet and the eastern Himalayan Syntaxis that, in turn, implies the Yarlung-Tsangpo and Brahmaputra River system to be one of the most dynamic mountain rivers on modern Earth.

The first in situ Hf and U-Pb isotope analyses of detrital zircons from a Late Miocene sandstone in the Inner-Burma Tertiary Basin enable us to study the sedimentary source to sink relation and river system evolution around eastern Himalayas. Among 47 out of 62 dated zircons that exhibit Cretaceous and Paleogene $^{206}Pb/^{238}U$ ages, 24 grains have positive $\varepsilon_{Hf}(T)$ isotope values up to +16. Whilst zircons of such ages are common in the Transhimalayan plutons, those showing high $\varepsilon_{Hf}(T)$ values have been observed only in the Gangdese batholith, southeastern Tibet.

Our results, therefore, validate the notion that by Late Miocene time the Yarlung-Tsangpo River, which cuts across the Gangdese batholith, drained into the Irrawaddy River. We attribute this river routing to the dextral Jiali faulting that was most active in the Middle Miocene. Subsequent reorganization of the mountain rivers was affiliated with uplift of the Namche Barwa Syntaxis, resulting from enhanced headward erosion of the Brahmaputra River that eventually captured the Yarlung-Tsangpo drainage to form the modern eastern Himalayan river system.

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