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Incision rate of the Yellow River in notheastern Tibet constrained by cosmogenic isotope dating (10Be, 26Al) of fluvial terraces: implications to catchment evolution and plateau building

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Unlike the other large southeast Asian rivers draining off the southeastern margin of the Tibetan plateau (like the Yangtse, Mekong, etc), the Yellow river flows towards the northeast and almost perpendicular to the active structures and mountain ranges, crosscuting a series of basins and ranges from the Eastern Kunlun in the south towards the Gobi Ala Shan in the north. Between Gonghe and Lanzhou, the Yellow River shows its steepest gradient. Over a length of 400 km it crosses at least 5 NW-SE striking, actively growing Plio-Quaternary ranges. Between these ranges, remnant sediment fills and fluvial terraces testify of a previous phase of basin fill in the absence of a large draining and eroding river. The high and flat paleo-base levels of the Gonghe and Guide basin, together with the Qinghai Lake basin, all at roughly the same elevation (i.e., 3200-3250 m) are best explained by the existence of a common closed basin dammed by the Riyue Shan, prior to or during the upper Yellow River catchment emplacement. Presently, the Yellow River has incised a 500 km-long gorge from the Kunlun Fault in the south to the Linxia basin in the northeast, eroding partially or totally the more than 1000 m thick Quaternary sediments piled up in the basin and incising steep walled gorges across the successive ranges in between, like, for instance, the Longyang gorge across the Waliguan range. The base level drop of the Yellow River has left a spectacular set of about seven major terrace levels across the 50 km-wide Gonghe basin together with strath terraces carved in the Waliguan range bedrock. The terraces across the Gonghe basin extend southwest of Gonghe city, have lengths of about 50 km and are 5 to 10 km wide, and dip gently to the northeast sub-parallel to the present slope of the Yellow River. On the contrary, the bedrock straths, still covered by cobbles, on either side of the EW striking Longyang gorge, dip to the west in opposite sense of the present slope of the Yellow River, attesting for ongoing tectonic uplift and tilting of the Waliguan range. Cosmogenic isotope dating of surface and subsurface samples from the presently perched basin paleo-baselevel and one of the highest terrace across the Gonghe basin indicate that incision of the Yellow River at this locality started 150 ka ago at an average rate of 4 mm/yr. Two of the straths terraces along the gorge have minimum ages of 65 and 80 ka respectively, in agreement with a river incision rate of 4 mm/yr and about 1 mm/yr of tectonic uplift. Whether the straths and fill terraces are synchronous and whether they correlate with cold/dry or warm/wet episodes of climatic changes need further dating and modeling of the exposure ages. A paleo-Yellow River could to responsible for the rapid sedimentary filling of closed basin up to 3200 m a.s.l. that are now part of the Tibetan plateau. At a first order, these results indicate recent and rapid changes in river drainage evolution in northeastern Tibet, and a strong imbrication, of fluvial dynamic, tectonics and climate in shaping the northeastern edge of the Tibetan plateau.