Incision of the Yangtze River at the First Bend Determined by Three-Nuclide Burial Dating

Details

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Abstract

On the southeast margin of the Tibetan Plateau, the evolution of the Yangtze River and its major tributaries has become an important source of data for investigating geodynamics. In particular, the timing of river incision is frequently interpreted as a proxy for the timing of surface uplift in the absence of structural evidence. We investigate the timing of the incision of the gorge at the First Bend using cosmogenic nuclide burial dating of coarse, quartz sediments from caves. Sediments were deposited when the caves were near river level and subsequently abandoned as the river incised. To resolve burial ages >5 Ma, we measured the radionuclides 10Be and 26Al, and the stable nuclide 21Ne. Results from 4 caves show that 26Al and 10Be concentrations are an order of magnitude lower in abandoned cave samples than in a river-level cave sample where deposition is active (10Be: 1.3x104 and 3.4x105 at/g). In contrast, 26Al/10Be ratios in all caves are 6.2 and indistinguishable within error. 21Ne concentrations range from 2.1x106 to 7.8x106 at/g. The results are consistent with an old age for the abandoned cave deposits, such that most of the radionuclides initially present have decayed and the concentrations that we measure today are the result of millions of years of exposure to muons. We solve for burial ages, taking into account in situ muogenic production, and find that the majority of the gorge (1 km) was likely incised between ~12 and 9 Ma. The results also require that the rate of river incision declined after the gorge was cut below the lowest elevation cave at 9 Ma. Inverse modeling of published low-temperature thermochronology (Ouimet et al., 2010) supports our burial age results. River capture near the First Bend, which likely integrated the modern Yangtze, likely occurred prior to the mid-Miocene incision of the gorge. In view of the geographic position of the First Bendjust downslope from the southeast margin of the Plateauit is difficult to explain a declining rate of river incision in terms of existing models of surface uplift by lower crustal flow. Our results may be better explained by other processes, such as the onset of faulting at Tiger Leaping Gorge. Our results highlight the challenges of using the timing of river incision as a proxy for the timing of surface uplift.
Ouimet et al. (2010), Lithosphere, 2(1), doi:10.1130/L57.1

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