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Use of Cosmogenic Nuclide ^{10}Be Concentrations for Estimating Rates of Escarpment Retreat

Yanyan Wang and Sean D. Willett

ETH Zurich, Geological Institute, Department of Earth Sciences, Switzerland (yanyan.wang@erdw.ethz.ch; swillett@erdw.ethz.ch)

Escarpments, including the great escarpments of rift margins represent transient landscapes where migration of the water divide on top of the escarpment drives transience. The degree of transience depends on the velocity of this divide migration. Many in-situ cosmogenic nuclides derived erosion rates of escarpment-draining basins have been reported to be around tens of meters per million years. These stand in contrast to many numerical modelling studies that propose that escarpments retreat landward with velocities around 1km/Ma. Retreat velocities calculated from these numerical models depend on empirical parameters, diffusion and advection models that are used to characterize the landscape evolution, and need to be calibrated against rate data. Here we propose a method that uses in-situ cosmogenic nuclide concentrations to calculate directly the velocity of horizontal migration of the escarpment. Our method is based on mass balance, recognizing that cosmogenic nuclide concentrations reflect mass flux out of the earth, but not necessarily in a vertical direction. The integration time scale of ^{10}Be concentration ($\sim 10^4$ years) can be calculated in terms of the escarpment retreat velocity and the horizontal projection of the drainage basin surface onto the escarpment face. We present results from the Western Ghats, India using published cosmogenic nuclides ^{10}Be data from S.K. Mandal et al. (2015). Mandal et al. report catchment averaged erosion rates of 20 to 120 m/Ma. Our result show that converting these to horizontal retreat rates implies retreat rates on the order of 200 to 2000 m/Ma. The spatial variability of escarpment migration rates correlates well with the distance of the escarpment to the coastline: escarpment segments with higher migration velocities are further away from the coastline than these that have lower migration velocities. The mean distance from the coastline is consistent with our calculated escarpment velocity and a retreat time of 65 Ma, consistent with the timing on India-Seychelles rifting. The escarpment migration velocity also correlates positively with the escarpment relief as predicted by theory. We find evidence that capture of plateau-draining rivers induces transients in escarpment retreat, with a net acceleration.