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River captures and erosional disequilibrium along a strike-slip fault (Guatemala)

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River captures are internal instabilities of erosion systems and are inherently promoted by strike-slip faulting. A capture event can generate a wave of incision that propagates from the capture site upstream and/or downstream, resulting in an increased bulk erosion rate around the capture site. Thus, under steady boundary conditions, drainage diversions trigger pulses of erosion, sediment production, rock exhumation and isostatic rebound. A significant part of the erosion in oblique tectonics can be achieved in a state of significant departure from long-term dynamic equilibrium.

We are investigating the causes and effects of a large river capture on the oblique collision between the North American and Caribbean plates in Guatemala. Several thousands of kilometers of strike-slip displacement have been accommodated along this boundary during the Tertiary. The deformation is now concentrated mostly along the E-W Motagua strike-slip fault. Oblique tectonics is discernable within a 50 km wide topographic belt, north of this fault (Sierra de las Minas – Sierra de Chuacus range). On the northern flank of this range, deformation includes 130 km offset across the Polochic strike-slip fault, documented by both geological structures and drainage patterns. Numerous elbows and dry valleys and abandoned fluvial deposits show the progressive transformation of the initial transverse (S-N) drainage crossing the fault into a transverse-parallel (E-W) system. Drainage reorganization operated by river lengthening, captures, and avulsions. Most of this reorganization was sparked by a conspicuous capture event at about 7.5 Ma associated with the diversion of the Chixóy River.

Newly discovered conglomerates allow the reconstruction the pre-capture drainage

and its evolution since the capture event. These deposits document the expansion of the captured catchment at the expense of surrounding drainages, the demise of the transverse drainage, and the development of new drains within the captured catchment that converge towards the capture site. This expansion is still ongoing at the margins of the Chixóy basin, as documented by recent, second-order captures. Spatially, the Chixóy basin coincides with a vast zone of landscape dissection surrounded by the remnants of a pre-capture, more subdued topography. Temporally, the capture event coincides with the release of large amounts of sediments along a shoreface fed by the drainage into which the Chixóy River was rerouted. One of the most conspicuous events is the abrupt thickening of the shoreface during Messinian time (7.2-5.3 Ma). The spatial and temporal match of the capture event with this sudden detrital input and topographic dissection and drainage pattern suggest that an erosion wave was associated with the capture event and had a profound effect on subsequent landscape evolution.

Tectonically, the capture event coincides with major temporal changes in the kinematics of the Polochic Fault. Preliminary investigations reveal the development of a significant vertical component of slip. Ongoing investigations aim at studying the interplay of rock uplift with erosional unloading occurring after the capture event.