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Deformation and rearrangement of a range-transverse drainage by successive transpressional and transtensional events in Guatemala.

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Along transpressive and transtensive orogens, both range-transverse and range-parallel motions influence drainage network evolution. Under steady conditions of wrenching, drainages evolve by continued deformation and discrete rearrangements. Wrenching induces continuous lengthening and shortening of range-transverse rivers. Eventually, this continuous deformation, in association with vertical movements associated with range-transverse shortening or stretching, triggers drainage rearrangement. Rearrangement often takes the form of discrete river diversions that can occur randomly, or more frequently in clusters. River incision patterns are influenced by rock uplift and waves of incision resulting from drainage rearrangement. Clustering commonly results from the propagation of erosion in the captured catchments. The frequency, intensity, and duration of these events set the timescale over which their integrated effects can be regarded as significant in the long-term evolution of an orogen. In order to document a large-scale case of such rearrangement, we studied the growth of a 1000-10000 km2 catchment that drains a 50 km wide orogen located astride the North American - Caribbean plate boundary in Guatemala. The catchment retains many paleovalleys that we use as markers to track drainage rearrangement, bedrock deformation and erosion patterns. The reconstruction of the general architecture of the valleys and fluvial deposits, together with paleoflow and provenance analysis, 40Ar -39Ar dating of volcanic tuffs, and cosmogenic 10Be-26Al burial dating, permit to reconstruct step by step the piecemeal growth of this catchment since the Late Miocene. We show that the catchment experienced a tenfold increase in drainage area as a result of transpression during the Late Miocene and transtension since the Pliocene. Growth results from a cascade of river diversions that promoted the replacement of range-transverse drainage by a range-parallel, subsequent drainage. The intensity of these rearrangements is considerably more efficient in reshaping the drainage than drainage net passive deformation. In the studied case, the driving force of the rearrangement is the uplift along range-parallel strike-slip faults. On the other hand, strike-slip motion and periodic tectonic deflection annealing by river diversion mostly determine the propensity for the involved streams to be captured or captors. Rearrangement by diversion operates through a wealth of mechanisms, such as regressive erosion, river avulsion, karstic flow, phreatic flow, and aridification. Consequently, diversions cannot be defined as pure avulsions or pure captures. However, over the long term, diversion results mostly form the tectonic defeat of rivers and capture by regressive erosion. At shorter time scales, the other mechanisms act as powerful diversion catalysers, allowing rearrangement to proceed sufficiently quickly to overcome drainage deformation by wrenching.