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River basins as dynamic markers of crustal deformation

S. Castelltort (1), L. Goren (2), S.D. Willett (2), J.-D. Champagnac (2), F. Herman (2), and J. Braun (3)

(1) Section of Earth and Environmental Science, University of Geneva, Geneva, Switzerland (sebastien.castelltort@unige.ch, +41223796616), (2) Department of Earth Sciences, ETH-Zürich, Zürich, Switzerland, (3) LGCA, Université Joseph Fourier de Grenoble, Grenoble, France

River channels and drainage basins are textbook examples of geomorphic features that can be used as indicators of tectonic deformation. Although examples of fault-offset rivers abound and have been widely used to quantify tectonic deformation, the use of entire river basins as markers of large-scale deformation remains controversial, primarily because rivers are not passive features of the Earth's surface, but are dynamic entities capable of independent lateral incision, or discrete jumps as river capture reorganizes river networks. Through the study of river basins in the Southern Alps of New Zealand, we find that passively deformed and dynamically reorganized river basins co-exist in the same mountain range with some river basins resisting reorganization and thus documenting deformation over geological time scales (10Myr). Other river basins evolve, but the reorganization itself contains information on the distribution of the tectonic velocity field. In the Southern Alps, we find that river basins west of the main divide maintain a range-normal orientation through area capture at the main divide, whereas basins east of the main divide are deformed, providing strong quantitative measure of the distribution of both normal and transverse deformation at the plate boundary.