Interpreting the topographic record etched into river canyons

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River canyon morphology is thought to encode information about climatic and tectonic forcing of landscapes. For this reason, bedrock canyons are a frequent target for tectonic geomorphology research. However, looks can be deceiving. In this contribution, we describe two landscapes (the Western Slope of the Central Andes and the Oregon Coast Range) with bedrock canyons that defy simple climatic or tectonic interpretation. In the first example, we exploit a natural experiment near the eastern margin of the Atacama Desert that allows direct comparison of 46 wind-affected and wind-protected canyon incision rates, and show that wind abrasion can amplify canyon head retreat rates by at least an order of magnitude above fluvial rates. Our results imply that wind can create bedrock canyons, which are traditionally thought only to form from flowing water. In the second example, we show that rates of incision at the mouth of tributary watersheds to the Smith River, OR, fluctuate over time, despite apparently constant tectonic forcing. This fluctuation is due to lateral migration of the Smith River into bedrock, which causes elongation or truncation of the lower reaches of tributaries, which in turn changes slopes and thus tributary incision rates. In addition, as meander bends along the main stem channel grow, they capture tributaries, causing sudden drainage network reorganization and impulsive base-level lowering. Thus a landscape with steady tectonic and climatic forcing may nevertheless experience significant unsteadiness because of the process of meandering itself.