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Experimental model of a doubly-vergent wedge under erosion in oblique collision: wedge dynamics and development of the drainage network

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Rivers have been recognized for long as markers of localized horizontal deformation in strike-slip context and used to estimate fault slip velocity. However, in oblique collision, deformation is not always partitioned on major faults only: it can be distributed over larger areas, as it is the case in the Southern Alps of New Zealand. The rivers draining the Southern Alps tend to rotate with respect to the main range axis, and recently, the rotation of the river network has been used in numerical model to determine the distribution of horizontal motion accommodated across the range (Castelltort et al, NGeo, 2012). To go further and better investigate the behavior of rivers in such context, we develop an analogue experiment, based on the Southern Alps case study.

We used a sand-box setup with a rainfall system to model the evolution of a drainage network over a doubly-vergent orogenic wedge growing in a context of oblique convergence. To model the weak lower part of the crust which is involved in the collision, we developed a new analog material. This new granular mixture has a ductile behavior and allows the propagation of the deformation insuring a continuous growth of the wedge. However, when it reaches the surface, erosion takes place and drainage pattern can develop on its surface. To model the brittle behavior of the upper crust, we used another granular mixture, developed by Graveleau et al, Tectono, 2011). These experiments enable us to investigate the drainage network deformation through time and are in very good agreement with numerical model results. We are even able to go further and to discuss the competition between the passive rotation (due to the distribution of deformation) and the lateral erosion of the river channels.

References:

Castelltort et al, NGeo, 2012. River drainage patterns in the New Zealand Alps primarily controlled by plate tectonic strain.

Graveleau et al, Tectono, 2011. A new experimental material for modeling relief dynamics and interactions between tectonics and surface processes.