Numerical Modelling of Intracontinental Mountain Building and Drainage Evolution in the Atlas

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The Atlas Mountains are part of an intraplate alpine orogen characterized by a very small strain rate and tectonic shortening (< 30 km in 40 m.y.). Because the slight crustal thickening cannot explain the observed topography, a remarkable lithospheric thinning has been proposed below these mountains. Generally, main rivers in mountain belts flow perpendicular to the chain following the regional slope. In contrast, the drainage pattern in the High Atlas is dominated by longitudinal rivers (parallel to the strike, following the main structures, folds and thrusts).

The aim of this work is to study the influence on drainage pattern of a lithospheric mantle thinning beneath a compressional mountain belt characterized by a small shortening rate. We use geodynamical and kinematical numerical models where deep and surface processes are coupled. The model links conservation laws of moment, mass and energy at lithospheric scale with constitutive equations of rocks (rheology) and assumed boundary conditions of the velocity field. Erosion and fluvial transport of sediments and flexural isostasy are calculated coupled with the lithosphere deformation. We investigate numerically the role of two mechanisms on the resulting drainage evolution (1) the strain rate of tectonic shortening, and (2) the timing and geometry of a mantle source uplift, asthenospheric plume or lithosphere root removal. These models show that drainage pattern reorganization occurs after a rapid uplift due to the lithosphere thinning.