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# Contact Mechanics reveals fundamental mechanism underlying East-West asymmetry in India-Asia and Adria-Europe collisions

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A comprehensive, quantitative understanding for the European Alpine and the Himalayan orogeny is still a matter of debate. Although there are, without doubt, communalities in the asymmetry of both orogens, their interpretation has never been attempted within a common framework. As an example one observes presently in the Himalayan collisional belt that deformation in the East comprises predominant lateral displacements. These have been linked to various mechanisms such as continental escape or mid-crustal lateral or frontal extrusion. However, the West clearly shows none of this pattern and bears a strong signature of thrust tectonics. A similar dichotomy appears to hold true for the Alps although deformation styles are somewhat different.

A quantitative link for East-West asymmetry in India-Asia and Adria-Europe collisions can be obtained from basic contact mechanics when reducing the problem to its most basic mathematical form. This is a geometry described by only two singularity points. For the Himalayan example the singularities are very prominent and seen as the great synthaxes. Analytical solutions for such full collisions describe three different cases: (1) thickening trajectories on the maximum shear stress trajectories of a thin sheet, (2) classical escape tectonics, (3) more widespread continental extension. All three modes can be found to be in equilibrium for a given contact pressure, however, this equilibrium can only be maintained if the indented plate is perfectly homogeneous. If, like in real nature, the plate is not perfectly homogeneous, or the boundary conditions are not perfectly ideal, asymmetric deformation kicks in and simple quasi-static equilibrium solutions cannot be obtained. A loss in symmetry is always accompanied with a rotation of the indenter. Analytical approximate solutions can only be derived for case (2) tectonics, because for case (1) and (3) the dynamic nature prohibits a classical quasi-static equilibrium of forces. However, positive work for case (2) solution requires that an escape to the east is always accompanied by a counter-clockwise rotation of the indenter: This asymmetry applies to both the Himalayan and the Alpine indentation problems. An application of this simple analytical solution to a comprehensive geodynamic data set in both the Himalayas and the Alpine can be used to throw light on fundamentals of asymmetric rotations within orogenic belts.