Geophysical Research Abstracts
Vol. 16, EGU2014-5391, 2014
EGU General Assembly 2014

Formation of retro-wedges during collision

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We challenge the generally accepted view that continent-continent collision results in doubly verging orogenic wedges with well-developed retro-wedges on the overriding plate. In fact we argue that retro-wedge formation is restricted to specified rheological conditions within the lower and upper plates as well as the plate contact; thus being the exception rather than the rule during collision.
In this contribution we use simple lithospheric-scale analogue experiments to infer favourable rheological conditions for the development of retro-wedges. In intermediate temperature lithospheres represented by three layer models, brittle crust, ductile crust and upper mantle, the contact between the colliding and neutrally buoyant continents is weak and represents the inheritance of a former subduction boundary. The degree of plate coupling however is not constant and is together with the rheological structures of the lower and upper plates, in particular the presence of decoupling horizons, key variable in this study. Plate boundaries are in all experiments orthogonal to the convergence direction.
All models with strong decoupling at the plate boundary and different levels (at the Moho or the brittle-ductile transition) of the incoming plate lead to the evolution of mountain belts, where deformation propagates outward, in the direction of the incoming plate, by successive imbrication of upper crustal thrust sheets. Under these conditions, which are typical for subduction-dominated orogens like the Carpathians, the Dinarides or the Apennines, no significant retro-wedges with large-displacement retro-shears develop.
Transfer of strain to the upper plate, a pre-requisite for the formation of retro-wedges, is favoured when the degree of plate coupling is high and when the upper plate contains decoupling horizons (e.g. at the Moho level or the brittle-ductile transition). Under such conditions large-scale retro-shears develop and deformation propagates outward on the upper plate to form a retro-wedge.
These experimental results provide insight in past rheological conditions of doubly verging mountain belts, like some parts of the Alps demonstrating that retro-wedge formation is only possible under restricted rheological conditions.