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Amount and distribution of collisional shortening in the Alpine Chain: implications for slab geometries at depth

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Collisional shortening across the entire Alpine belt has often been estimated in the Central Alpine sections, using sedimentary markers in the Southern Alps and more loosely constrained line-length balancing techniques in the Penninic and European domains. In the western Alps shortening has been assessed along numerous sections in the External Zone (European basement and cover), but shortening estimates for the entire Chain were always derived by projections of shortening amounts obtained in the Central Alps, either by assuming the amount of dextral displacement along the Insubric Line (Schmid and Kissling, 2000), or resolving the inferred amount of Central Alpine shortening on an assumed convergence direction in the western Alps (Handy et al., 2010).
In the present study we estimate collisional shortening in the entire Alpine Chain, by reassessing displacements along the main structures of the orogen, without extrapolating displacements from one segment of the chain to the other. We note that collisional shortening progressively increases from less than 90 km in the south-western Alps, to nearly 200 km in the western Central Alps, where the Alpine chain starts to strike in an E-W direction. Therefore, we conclude that the convergence direction during the collisional phase must have been oriented NNW, as suggested by paleomagnetic studies, rather than WNW, as often inferred by tectonic investigations. The distribution of shortening described above is consistent with the distribution of collisional metamorphism: where the largest amounts of shortening are accommodated the nappes affected by the highest T of metamorphism are exhumed.
The distribution of collisional shortening can also be used to constrain the interpretations of tomographic models on the geometry of slabs at depth. If the estimates of shortening are correct, along-strike variation of shortening are significant both along the upper and the lower plates. Based on these values it can be suggested that the central Alpine slab, well visible in all tomographic models, may largely consist of subducted European continental plate. In contrast, the eastern Alpine slab, in the area underlying the Tauern Window cannot be derived from the South-alpine continental plate, due to shortening amounts that are by far too small in this area, compared to the imaged slab length. Below the western Alps, some tomographic models image a slab break off whereas others image a continuous slab. Only the upper part of this slab, whether broken off or continuous, can be derived from the European plate based on the small amounts of inferred collisional shortening.

References:
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