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3D Structure of collision in the Central Alps: lower-plate or upper-plate indentation?

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Combining surface geological information with P-wave tomography we constructed three orogen-scale cross sections in the western, central, and eastern parts of the Central Alps. These sections show some very significant differences in the way collisional shortening (inferred to be post-30 Ma) is accommodated. In the eastern (Engadine) section we estimate 98 km of shortening, out of which 87 km are accommodated in the upper plate, south of the Insubric Line. In the western (Simplon) section, we estimate a total of 82-92 km of shortening, 65-75 of which are accommodated north of the Insubric Line, within the wedge of accreted lower crustal material. In the central (Bergell) section we estimate 97 km of shortening almost equally partitioned between upper, Adriatic plate, and the wedge of accreted lower crustal material.

The lower crust of the Adriatic plate forms a wedge that reaches a maximum N-S extension of approximately 60 km in the Engadine section, progressively decreasing westward and completely disappearing along the Simplon section where the Ivrea body forms the northern limit of Adria. This difference of 60km in the N-S extension of the lower crust corresponds to the difference of shortening of the middle and upper crust, between Engadine and Simplon sections, suggesting that formation of a lower crustal wedge in the Adriatic plate is a direct consequence of a strong intraplate decoupling, limiting shortening to the middle and upper parts of the crust.

Whereas the Simplon section shows a classical example of upper plate indentation into a collisional wedge of accreted lower plate material, the Engadine section is a good example of lower plate indentation into an intensely deforming upper plate. The causes for this dramatic along-strike change of tectonic style within a segment of the orogen less than 200 km long, are probably due to the heterogeneous rheology of the lithosphere. The Ivrea body in the Simplon section increases the strength of the Adriatic crust and reduces its ability to develop a middle-crustal detachment. On the other hand, Barrowian metamorphism weakens the lower plate in the Lepontine area, but not along the Engadine section, favouring the localization of shortening.