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On the potential asthenospheric linkage between Apenninic slab rollback and Alpine topographic uplift: insights from P wave tomography and seismic anisotropy analysis

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The role of surface and deep-seated processes in controlling the topography of complex plate-boundary areas is a highly debated issue. In the Western Alps, which include the highest summits in Europe, factors controlling topographic uplift still remain poorly understood. In the absence of active convergence, recent works have suggested a potential linkage between slab breakoff and fast uplift, but this hypothesis is ruled out by the down-dip continuity of the Alpine slab documented by recent tomographic images of the upper mantle beneath the Alpine region (Zhao et al. 2016). In order to shed light on this issue, we use a densely spaced array of temporary broadband seismic stations and previously published observations to analyze the seismic anisotropy pattern along the transition zone between the Alps and the Apennines, within the framework of the upper mantle structure unveiled by P wave tomography. Our results show a continuous trend of anisotropy fast axes near-parallel to the western alpine arc, possibly due to an asthenospheric counterflow triggered by the eastward retreat of the Apenninic slab. This trend is located in correspondence of a low velocity anomaly in the European upper mantle, and beneath the Western Alps region characterized by the highest uplift rates, which may suggest a potential impact of mantle dynamics on Alpine topography. We propose that the progressive rollback of the Apenninic slab induced a suction effect and an asthenospheric counterflow at the rear of the unbroken Alpine slab and around its southern tip, as well as an asthenospheric upwelling, mirrored by low P wave velocities, which may have favored the topographic uplift of the Alpine belt from the Mt Blanc to the Ligurian coast.

Zhao L. et al., 2016. Continuity of the Alpine slab unraveled by high-resolution P wave tomography. J. Geophys. Res., doi:10.1002/2016JB013310.