Drastic syn-collisional kinematic changes in the external Western Alpine arc possibly reflect the gradual development of lateral extrusion.

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We have investigated the deformation history of several areas in the French Western Alps, using field structural data together with three-dimensional imaging and modelling. We show that, in these areas, older Alpine structures are cut nearly perpendicularly by tectonic features related to younger (late Oligocene-Miocene) shortening. The latter structures roughly follow the arcuate shape of the belt, outlined by the crustal-scale « Penninic thrust », and the associated shortening is arranged radially. By contrast, the older structures show a strong discrepancy with the late Oligocene and Neogene kinematics in the southern part of the Western Alpine belt:
In the Dauphiné zone, E and SE of Grenoble, the External Cristalline Massifs and their Mesozoic cover were affected by N-S to NE-SW shortening, which produced basement uplift and continental erosion before Priabonian times. The resulting unconformity is only found to the South and to the East of the Pelvoux Massif, sealing south-verging basement thrusts. This early shortening pulse (D1) is related to Pyrenean-Provence events since it pre-dates the development of the Paleogene Alpine flexural basin. However, other compressive structures found in the central, northern and western areas of the Pelvoux massif, which are not sealed and generally north-verging, are described in the litterature as having the same origin, for the main reason that they do not fit with the main Alpine shortening direction (E-W to NE-SW).
According our data, this N- to NW-directed deformation (D2) affected all of the the Dauphiné massifs after Paleogene sedimentation and overprinted the Pyrenean-Provence features. It therefore belongs to the early Alpine history. D2 probably occurred during early Oligocene times. The tectonic cover thrust on the eastern Dauphiné zone from the SE at that time was about 10km thick according preliminary P/T estimations, which explains the occurrence of kilometric-scale basement folding.
The Pelvoux basement stack, created during this early Alpine episode, is clearly overprinted by the W- to SW-ward tectonic transport of Penninic nappes (D3, late Oligocene) coeval with divergent deviation of transport on both sides of the massif. Both kinematic data and the 3D geometry show D3 structures cross-cutting D2 structures. The circular shape of the Pelvoux massif itself is a result of such interference. Similar changes in transport direction are observed in the Subalpine Mesozoic cover (Digne nappe) and in the internal nappes (Subbriançonnais, Briançonnais and Helmintoïd Flysch nappes).
We propose that the right-angle counterclockwise rotation of Alpine shortening observed in the Dauphiné zone is a consequence of lateral escape at the western termination of the Alps : the early syn-collisional kinematics (D2) was oriented similarly as in the central part of the chain and resulted primarily from N-S Africa-Europe convergence, whereas W- to SW-ward propagation of deformation (D3) is specifically developed during the more recent history in the Western Alps, in association with westward extrusion processes, possibly enhanced by Corsica-Sardinia block rotation and the initiation of the Apeninic orogen.