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Ivrea mantle wedge and arc of the Western Alps (II): Kinematic evolution of the Alps-Apennines orogenic system

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Integration of geological and geophysical data on the deep structure of the Alps (Kissling et al. 2017) reveals that the deep-seated Ivrea mantle played a crucial role during the formation of the arc of the Western Alps. Exhumation of the mantle beneath the Ivrea Zone to shallow crustal depths during Mesozoic rifting led to the formation of a strong Ivrea mantle wedge; its strength exceeds that of surrounding mostly quartz-bearing units, and consequently allows for indentation and wedging of a quasi-rigid Ivrea mantle wedge into the Western Alps during Alpine orogeny. A first early stage (pre-35 Ma) of the West-Alpine orogenic evolution is characterized by top-NNW thrusting in sinistral transpression causing at least some 260km displacement of internal Western Alps and E-W-striking Alps farther east, together with the Adria micro-plate, towards N to NNW with respect to stable Europe. It is during the second stage (35-25 Ma) that the Ivrea mantle wedge played a crucial role by accentuating the arc. This stage is associated with top-WNW thrusting in the external zones of the central portion of the arc and lateral indentation and wedging of the Ivrea mantle slice beneath the already existing nappe pile towards WNW by some 100-150km. The final stage of arc formation (25-0 Ma) is associated with orogeny in the Apennines leading to oroclinal bending in the southernmost Western Alps that by now became parts of the Apenninic orogen, in connection with the 50° counterclockwise rotation of the Corsica-Sardinia block and the Ligurian Alps.

The lithological composition of some tectonic units originating from the Alpine Tethys (Piemont-Liguria Ocean) found in the Alps and the northern Apennines has much in common. The non-metamorphic parts of the Piemont-Liguria derived units form the upper plate of the Western Alps that is devoid of Austroalpine elements, while the lower plate includes highly metamorphic units derived from the same Piemont-Liguria Ocean. This points to a lateral transition from continent-continent collision in the Central and Eastern Alps to intra-oceanic subduction in the Western Alps during Alpine orogeny, leaving large parts of the Piemont-Liguria Ocean that belong to the Adria microplate open until about 25 Ma. It is these parts that from now on formed the highest tectonic units in the Apennines, namely the Ligurides. However, internal units of the Northern Apennines previously suffered Alpine-type shortening associated with an E-dipping Alpine subduction zone. They became " backthrusted" to the NE during Apenninic orogeny commencing in the Late Oligocene. Apenninic orogeny is associated with a change in subduction polarity from Alpine E-directed subduction, previously affecting the Internal Ligurides and other parts of the Northern Apennines, towards NW-directed subduction and roll back of the Adria slab beneath Northern Apennines, pulled by the negative buoyancy of those parts of the old oceanic lithosphere of the Piemont-Liguria Ocean that remained unaffected by Alpine orogeny.

Reference:
Edi Kissling, Stefan M. Schmid, Tobias Diehl (2017). Ivrea mantle wedge and arc of the Western Alps (1): Geophysical evidence for the deep structure. Abstract Volume EGU 2017.