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New constraints on the Western Alpine wedge 30-20 My ago from multi-method provenance analysis of foreland basin deposits

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In absence of sediment storage, foreland basins directly receive the erosional products of mountain belts, recording the timing of tectonic emplacement and exposure of units because of instantaneous sediment transport on geologic time scales. Based on sediment records in the Oligocene Alpine foreland basin on both sides of the Western Alps, we can constrain the early formation of this mountain belt.
Development of the late Cretaceous to Eocene early Alpine subduction wedge (Piedmont zone), with a south facing subduction, was followed by collision and incorporation of the European margin (Briançonnais zone) into the orogenic wedge (internal Alps) during the middle Eocene. Westward movement of the Apulian plate and indentation of the European plate created an orogenic wedge with high topography in the Western Alps during the Oligocene (ref. in Handy 2010). This kinematics caused refolding and backthrusting of the internal alpine nappe stack, giving it its characteristic fan shaped structure (Tricart 1984).
This contribution is the continuation of studies on “exotic” pebbles in the Alpine foreland basin (Termier 1895 in Chauveau & Lemoine 1961), on detrital thermochronology (Bernet et al. 2009), serpentinite Raman analysis (Schwartz et al. 2010) and radiolarian fauna on pebbles (Cordey et al. submitted). Here, we look at the erosion of the Oligocene-Miocene orogenic wedge with the help of petrologic and geochemical analyses of basalt pebbles from the pro- and retro-side foreland basins of the Western Alps, with the aim to constrain the kinematics of obduction of oceanic crust.

Today, only remnants of the Oligocene Alpine foreland basins are preserved (e.g Barrême, Montmaur or the Torino hills). Analysis of different pebble types points to distinct sources of varied metamorphic grades.

In the pro-side basins (Barrême and Montmaur), geochemical analysis of detrital basalt pebbles show a predominance of low metamorphic pillow-lava basalt pebbles with a strong similarity to the Chenaillet obducted ophiolite and magma-poor ocean-continent transitional (MP-OCT) characteristics. We think that pebbles derived from this kind of tectonic unit. These pebbles appear in the Barrême basin during the late Rupelian and disappear at the end of the Rupelian. Low metamorphic ophiolite pebbles are essentially pillow-lava fragments and some gabbro pebbles. Low metamorphic serpentinite pebbles are absent. In contrast, Raman analysis on serpentinite pebbles and sand grains from the same late Rupelian molasse indicate a high-grade metamorphic source (Schwartz et al. 2010). On the Italian side, in the Torino hills, the first low-grade metamorphic ophiolite pebbles appeared massively during the Rupelian.

We think that the appearance of obducted ophiolites in the sediments is a marker of the shift in direction of Oligocene convergence during which high topography developed on the accretionary wedge (Schwartz & al 2010).

During the late Rupelian, the synchronous appearance of a large quantity of high-grade metamorphic schist and low-grade ophiolite pebbles from the internal Alps on both sides of the orogen is a paradox. Tectonic windows in the obducted ophiolite unit structurally above the eastern high-grade metamorphic blue schists in the Western Alpine nappe stack can explain the erosion of both units in the same period. Because the structural detachment level of the obducted ophiolite is just under the pillows-lava and gabbro complex (Graciansky et al. 2010), the emplaced obducted ophiolites have no peridotite basement. The presence of the pillow-lava and gabbro complex is discontinuous in the MP-OCT rift type. That is why the obducted ophiolite was discontinuously exposed on the accretion wedge. The proximity of the obducted ophiolites to the Apulian plate, the detrital pebble MP-OCT geochemical characteristics and the large geographic distribution of low-grade metamorphic ophiolite pebbles

hints at a widespread distribution of the obducted ophiolites on the accretion wedge during the Oligocene.