Alternative models to explain the evolution of Alpine-type collisional orogens: the importance of rift inheritance

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Many plate kinematic and tectonic models proposed for the evolution of the Alps in Western Europe are deeply inspired by present-day SW Pacific-type subduction systems. However, key features characterizing the upper plate of Pacific-type margins, such as high temperature-low pressure metamorphic overprint associated with volcanic arcs and back arc basins are not found in the Alpine domain, despite the fact that the upper plate (Adriatic plate) is very well exposed. This significant difference questions the validity of the supposed similarity between the Alpine Tethys and Pacific-type systems, especially with respect to the nature of the subducted lithosphere and the original basin width.

In our presentation we will first explore the most recent insights on rifted margins architecture and dynamics from the southern North Atlantic, Pyrenean and Alpine domains and discuss how these results may impact the plate kinematic reconstruction and geodynamic evolution of the Alpine system. Based on these observations we will propose an alternative scenario for the pre-Alpine rift evolution. Furthermore, we will show that the rift architecture exerted a major control on the structural and sedimentary evolution of the Alpine system during plate convergence (tectono-sedimentary evolution of Flysch and Molasse sequences) as well as on the final architecture of the orogen (evolution of the external massifs and along strike variations of the Alpine orogenic structure). A key result of our studies is that rift inheritance strongly controlled the final architecture of the interal parts of the orogen. The intimate link between ophiolites and remnants of thinned continental crust and the strong segmentation and diachronous evolution of the mountain belt are largely a result of rift-related tectonics and do not need to be explained by “ad hoc” models. The observation that the Alps in Western Europe developed from a complex paleogeographic domain and represent a collage of different orogenic belts and accretionary prisms that were formed diachronously along different parts of the convergent African-European system questions the comparison with classical steady-state Pacific-type subduction systems.

The structure and P-T evolution of the Dent Blanche Tectonic System (Austroalpine Domain, Western Alps): from the Permian lithospheric thinning to the Alpine subduction and collision

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The Dent Blanche Tectonic System (DBTS) is a composite thrust sheet consisting of superimposed units of polycyclic basement, i.e. Arolla and Valpelline Series, both derived from the Adriatic continental margin. These units preserve a polyphase structural and metamorphic history, comprising both pre-Alpine and Alpine cycles.

The Pre-Alpine history is characterised by a polyphased Permian (from 290 to 265 Ma) granulite-facies event (peak at 860°C, 8 kbar) in the Valpelline Series, and by Permian (~290 Ma) granitoids that intruded at 750°C, 4-5 kbar in the Arolla Series. It is therefore concluded that the Valpelline and Arolla Series are representatives of the lower and upper crust, respectively, of the Adriatic continent.

The Alpine history is heterogeneously preserved in both the Valpelline and the Arolla Series. In the Valpelline Series, previous authors described rare relics of chloritoid-mica in cordierite pseudomorphs and kyanite replacing silllimanite. The lack of extensive blueschist-facies overprint could be due to the low a(H_2O) activity and/or the lack of Alpine ductile deformation. In the Arolla Series, highly strained granitoids display glaucophane-phengite (10-14 kbar, 400-500°C) overprinted by actinolite-chlorite (2-4 kbar, 220-330°C). This transition from blueschist-facies to greenschist-facies parageneses is also seen in some metacherts.

Two main tectonic boundaries are observed within the DBTS. Firstly, the contact between the Arolla and Valpelline Series is marked by a thick (10 m) zone of mylonites that locally display blueschist-facies minerals (blue amphibole, garnet, phengite, aegirine-augite), overprinted by greenschist-facies assemblages. The dominant foliation in the Arolla-Valpelline mylonites shows a prominent NW-SE stretching lineation, and both these structures are overprinted by NE-SW trending folds.

Secondly, the Roisan-Cignana-Shear-Zone (RCSZ) is a NW-dipping shear zone, which cuts through the Arolla-Valpelline contact and separates the DBTS in two subunits, the Dent Blanche nappe to the NW and the Mont Mary nappe to the SW. It results from several deformation phases developed at blueschist (13±2 kbar, 480±50°C) then greenschist (2-4 kbar, 200-300°C) facies conditions. Within this shear zone, tectonic slices of Mesozoic and pre-Alpine metasediments are amalgamated with continental basement rocks. The occurrence of blueschist-facies assemblages along the contact between these tectonic slices indicates that the amalgamation occurred prior to or during the subduction process, at an early stage of the Alpine orogenic cycle.

The structural, petrological and geochronological data provided in this study and those available in the previous works enable us to propose a possible kinematic evolution for the current geometry of the Austroalpine domain. We will discuss the contributions of (i) the Permian lithospheric thinning, (ii) the Jurassic rifting and (iii) the subduction-collision processes in controlling the final geometry of the Austroalpine domain.

Tectonic models for Adria and the External Dinarides in the context of Jurassic-Cretaceous paleomagnetic results

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Adria is a crustal block playing an important role in the geodynamic history of the Central Mediterranean s.l. Recently, a reliable Late Jurassic – Eocene APW path was obtained for its "autochthonous" core. This can serve as a reference frame for describing displacements in its more tectonized margins, like the External Dinarides, where we also carried out systematic paleomagnetic investigation, involving Gorski Kotar and the Velebit Mts from the mainland, several islands of the Northern Adriatic basin, and further in the south, Dugi otok and Vis islands.

The External Dinarides have a complicated internal structure. That is why the tectonic models published for the area are diverse. When the different models are inspected in the