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Research Paper

The role of structural inheritance in continental break-up and exhumation of Alpine Tethyan mantle (Canavese Zone, Western Alps)

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A B S T R A C T

The Canavese Zone (CZ) in the Western Alps represents the remnant of the distal passive margin of the Adria microplate, which was stretched and thinned during the Jurassic opening of the Alpine Tethys. Through detailed geological mapping, stratigraphic and structural analyses, we document that the continental break-up of Pangea and tectonic dismemberment of the Adria distal margin, up to mantle rocks exhumation and oceanization, did not simply result from the syn-rift Jurassic extension but was strongly favored by older structural inheritances (the Proto-Canavese Shear Zone), which controlled earlier lithospheric weakness. Our findings allowed to redefine in detail (i) the tectono-stratigraphic setting of the Variscan metamorphic basement and the Late Carboniferous to Early Cretaceous CZ succession, (ii) the role played by inherited Late Carboniferous to Early Triassic structures and (iii) the significance of the CZ in the geodynamic evolution of the Alpine Tethys. The large amount of extensional displacement and crustal thinning occurred during different pulses of Late Carboniferous–Early Triassic strike-slip tectonics is well-consistent with the role played by long-lived regional-scale wrench faults (e.g., the East-Variscan Shear Zone), suggesting a re-discussion of models of mantle exhumation driven by low-angle detachment faults as unique efficient mechanism in stretching and thinning continental crust.

1. Introduction

During last decades a large interest has been dedicated in literature to processes and mechanisms of continental break up, mantle exhumation and sea-floor spreading related to the Jurassic rifting of the Alpine Tethys (i.e., the Ligurian-Piedmont Ocean). Comparison with present-day settings (e.g., Atlantic Ocean, see Contrucci et al., 2004; Moulin et al., 2005; Red Sea, see Cochran and Karner, 2007; Norway passive margin, see Osmundsen and Ebbing, 2008) allowed to develop different models of progressive stretching and lithospheric thinning, which may drive the sharp decrease in crustal thickness and strong decoupling between upper crust and continental mantle, up to continental breakup and mantle exhumation (e.g., Brun and Beslier, 1996; Péron-Pinvidic et al., 2007; Ranero and Perez-Gussinyé, 2010; Clerc et al., 2018 and reference therein). These models were subsequently applied in different exhumed orogenic belts throughout the world as, for example, in the Alps (Froitzheim and Eberli, 1990; Manatschal et al., 2001; Manatschal, 2004; Beltrando et al., 2012 and reference therein), Apennines (e.g., Marroni et al., 1998, 2001), Pyrenees (e.g., Clerc et al., 2012; Clerc and Lagabrielle, 2014), and Betics (e.g., Frasca et al., 2016), independently by the structural and metamorphic complexities and polyphasic deformation of these regions. However, less attention has been devoted to the potential role played by pre-Jurassic structural inheritance, which may have significantly controlled the location and kinematics of the Alpine Tethys rifting and mechanisms of mantle exhumation.

Structural inheritance may produce lateral variations in crustal thickness and thus in the rheology of both the continental crust and upper mantle lithosphere (e.g., Armitage et al., 2010; Autin et al., 2013; von Raumer et al., 2013; Spalla et al., 2014; Phillips et al., 2016; Fazlikhani et al., 2017; Marotta et al., 2018; Roda et al., 2018b; Will and Frimmel, 2018). Multiple rifting events may have the same or different kinematics (e.g., Talwani and Eldholm, 1972; Armitage et al., 2010), and the rift trend may be inherited from a previous orthogonal rift stage (e.g., Bonini et al., 1997; Wolfenden et al., 2004) or may develop as the result of both specific far-field

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