Role of the Adria plate structural heterogeneities on the dynamics of the Central-Western Mediterranean region

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In the geodynamic context of the slow Africa-Europe plates convergence, the Central-Western Mediterranean region has been involved in a complex subduction process, which in the last 30 Myr was characterized by the rapid retreat of the Ionian slab, the opening of back-arc extensional basins (i.e., Liguro-Provençal, Algerian, Alboran, and Tyrrhenian basins) and episodes of slab lateral tearing, segmentation and break-off. A proper modelling of 3-D mantle flow evolution beneath the Mediterranean could provide important clarifications about the complex mantle dynamics of this region and help us understanding the interaction between surface tectono-magmatic processes and mantle convection patterns.

The mantle flow and its relations with plate horizontal and vertical motions can be determined by measuring seismic anisotropy generated by strain-induced lattice/crystal preferred orientation (LPO/CPO) of intrinsically anisotropic minerals. Seismic anisotropy is widespread in the Mediterranean and it shows an intricate pattern that likely has some relations with the recent (20-30 Myr) behavior of subducting slabs. The extrapolation of the mantle flow from seismic anisotropy is neither simple nor always warranted, especially at subduction zones where complex and non-steady-state 3D flow patterns may establish. A promising approach, which helps reducing the number of plausible models that can explain a given anisotropy dataset, is to compare seismic measurements with predictions of numerical and experimental flow models (Long et al., 2007). Recently, Faccenda and Capitanio (2013) and Faccenda (2014) have extended this methodology to account for the non-steady state evolution typical of many subduction zones, yielding mantle fabrics that are physically consistent with the deformation history.

In this study, we apply a similar modelling approach to the complex Central-Western Mediterranean convergent margin. We use the wealth of observations from the Mediterranean region available in the literature to design and calibrate 3D thermo-mechanical subduction modelling. We test different initial configurations defined at 30 Ma according to the paleogeographic and tectonic reconstructions derived from (Lucente and Speranza, 2001; Carminati et al., 2012; van Hinsbergen et al., 2014) in order to optimize the fit between predicted and observed slabs position and obtain a final model configuration resembling the present-day surface and deeper structures.

In particular, here we want to evaluate the influence on rollback rates, trench shape and the occurrence and timing of slab tears (Mason et al., 2010) of structural heterogeneities within the
Adria plate as proposed by (Lucente and Speranza, 2001). In all models, subduction migrates south-eastward driven by the subducting oceanic lithosphere, and slab lateral tearing or break-off occurs when a continental margin enters the trench. More importantly, we show that the presence of a stiffer continental promontory in central Adria together with a thinned continental margin in the Umbria-Marche region plays a fundamental role on (i) the development of a slab window below the Central Apennines, (ii) the retreat of the Northern Apenninic trench till the Adriatic Sea, and (iii) the retreat of the Ionian slab till the present-day position.