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Interplay of plate convergence and arc migration in the central Mediterranean (Sicily and Calabria)

Nicolai Nijholt, Rob Govers, and Rinus Wortel
Utrecht University, Faculty of Geosciences, Earth Sciences, Utrecht, Netherlands (n.nijholt@uu.nl)

Key components in the current geodynamic setting of the central Mediterranean are continuous, slow Africa-Eurasia plate convergence (∼5 mm/yr) and arc migration. This combination encompasses roll-back, tearing and detachment of slabs, and leads to back-arc opening and orogeny. Since ∼30 Ma the Apennnines-Calabrian and Gibraltar subduction zones have shaped the western-central Mediterranean region. Lithospheric tearing near slab edges and the accompanying surface expressions (STEP faults) are key in explaining surface dynamics as observed in geologic, geophysical and geodetic data.

In the central Mediterranean, both the narrow Calabrian subduction zone and the Sicily-Tyrrhenian offshore thrust front show convergence, with a transfer (shear) zone connecting the distinct SW edge of the former with the less distinct, eastern limit of the latter (similar, albeit on a smaller scale, to the situation in New Zealand with oppositely verging subduction zones and the Alpine fault as the transfer shear zone). The ∼NNW–SSE oriented transfer zone (Aeolian-Sisifo-Tindari(-Ionian) fault system) shows transtensive-to-strike slip motion.

Recent seismicity, geological data and GPS vectors in the central Mediterranean indicate that the region can be subdivided into several distinct domains, both on- and offshore, delineated by deformation zones and faults. However, there is discussion about the (relative) importance of some of these faults on the lithospheric scale. We focus on finding the best-fitting assembly of faults for the transfer zone connecting subduction beneath Calabria and convergence north of Sicily in the Sicily-Tyrrhenian offshore thrust front. This includes determining whether the Alfeo-Etna fault, Malta Escarpment and/or Ionian fault, which have all been suggested to represent the STEP fault of the Calabrian subduction zone, are key in describing the observed deformation patterns.

We first focus on the present-day. We use geodynamic models to reproduce observed GPS velocities in the Sicily-Calabria region. In these models, we combine far-field velocity boundary conditions, GPE-related body forces, and slab pull/trench suction at the subduction contacts. The location and nature of model faults are based on geological and seismicity observations, and as these faults do not fully enclose blocks our models require both fault slip and distributed strain. We vary fault friction in the models. Extrapolating the (short term) model results to geological time scales, we are able to make a first-order assessment of the regional strain and block rotations resulting from the interplay of arc migration and plate convergence during the evolution of this complex region.