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From magmatic accretion to mantle exhumation in the Tyrrhenian basin: New data challenge conceptual models of continental back-arc extension

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The Tyrrhenian Sea constitutes a young, well-preserved example of Mediterranean back-arc oceanic basin. It opened mainly between Tortonian and mid-Pliocene as a response to the E-SE migration of the Apennines- Calabrian subduction system. We present a new interpretation of the crustal affinity and tectonic structure of the central Tyrrhenian basin, which considerably differs from previous ones, using coincident wide-angle and multi-channel seismic reflection profiles and gravity data acquired in the MEDOC-2010 survey. The basin displays three distinct basement domains with different petrological affinity based on their velocity and velocity-derived density structure. The first domain includes the continental crust of Campania and the conjugate Sardinia margin, where extension has thinned the crust from 20 km under the coastline to 13 km in 60 km. The second domain, that includes the Cornaglia Terrace and its conjugate Campania Terrace, displays an unequivocal, although spatially variable, magmatic signature that can be interpreted as either magmatically intruded or back-arc-type oceanic crust. A sharp transition is observed between this domain and the central, deepest part of the basin, which shows a seismic signature that is characteristic of exhumed mantle rock domains. Several large seamounts of the third domain (e.g. Vavilov) are underlain by 10-20-km-wide, relatively low velocity anomalies interpreted as younger magmatic bodies locally intruding the exhumed mantle. The juxtaposition of continental crust, magmatic crust and exhumed mantle with further volcanic intrusions challenges not only previous models for the formation of the Tyrrhenian and other Mediterranean back-arc basins, but also well-established conceptual models of continental extension. We illustrate that this particular configuration of crustal domains can be explained as a sequence of back-arc spreading phases controlled by the variations in the relative location of the spreading axis and the active volcanic arc due to the migration of the subduction system over a depleted upper mantle source.