Active tectonics and seismicity in the Calabrian Arc subduction complex (Ionian Sea)

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The Calabria Arc (CA) is the narrowest subduction-rollback system on Earth, and it has been struck repeatedly by destructive historical earthquakes often associated with tsunamis. In spite of the detailed earthquake catalogue, the source parameters of most historic earthquakes are still debated, especially for earthquakes that may have been generated offshore.

The subduction system is characterized by an irregular plate boundary reflecting the presence of continental blocks, indenters, and different rates of continental collision. Convergence between Eurasia and Africa produces both compressive and transtensional deformation in the offshore accretionary complex. Shortening occurs along the outer deformation front and along splay faults accommodating differences in rheology and basal detachment depth. Two oppositely dipping strike-slip/transtensional fault systems, i.e., the Ionian (IF) and Alfeo-Etna (AEF) faults produce deep fragmentation of the subduction system and the collapse of the accretionary wedge, in agreement with geodetic models suggesting plate divergence in this region. Transtensional lithospheric faults segmenting the subduction system are punctuated by mantle-rooted diapirism driven by arc orthogonal rifting, collapse of the accretionary wedge, and deep fragmentation of the subduction system along pre-existing Mesozoic transform faults.

Seismological observations in the Western Ionian Sea highlight the presence of earthquake clusters along wide and deep-seated active tectonic structures, which were proposed as likely seismogenic sources for large magnitude historic earthquakes/tsunamis in the region. Low to moderate magnitude earthquakes occurring offshore were relocated using a new 1D velocity model for the Ionian Sea, constrained by geological and geophysical observations, which included data collected by NEMO-SN1 seafloor observatory. Seismological data from NEMO-SN1 were integrated with observations carried out by over 100 land stations of the INGV network, and led us to compile a map of 3D distribution for over 2600 events. 3D locations and focal mechanism analyses allowed us to highlight local lithospheric structure. Although seismicity appears scattered in a wide corridor of deformation within the subduction system, we observe alignments of events
along main fault systems with strike-slip and extensional mechanisms. Moreover, results from seismological data analysis, i.e., misfits in the 3D distribution of hypocenters and tomographic maps, could be explained by the presence of an anomalous area between the two structures, characterized by thinned lithosphere probably caused by incipient rifting, as suggested by seismic reflection images and geodynamic interpretations.