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Evidence of active deformation in the Adriatic foreland (Southern Italy): integration of on- and off-shore seismotectonic and stratigraphic data along the Molise-Gondola shear zone

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The active tectonics of the Southern Apennines of Italy (Calabrian Arc excluded) is mainly characterized by SW-NE extension, which accounts for large earthquakes generated by NW-SE striking normal faults. However, the 2002 Molise earthquakes occurred along an E-W striking right-lateral seismogenic structure located to the NE of the Southern Apennines axis. This and other lines of evidence suggested that the frontal part of the chain and the adjacent foreland are affected by E-W striking, right-lateral active faults systems. The 2002 Molise seismic sources, in particular, are located along the western part of a regional fault system, the Molise-Gondola shear zone (MGsz). On land, this system is mainly represented by the Mattinata Fault, an important structure of the foreland that has already been intensely investigated from a regional, structural and seismotectonic point of view. A polyphase activity (since Mesozoic times) has been recognized, and the complex fault kinematics is still matter of debate. Nevertheless, most investigators agree on a present-day activity with right-lateral sense of motion, as confirmed by the focal mechanism of the 19 June 1975 earthquake, GPS data, geomorphological and paleoseismological investigations. Indeed, the Mattinata Fault has already been interpreted as the source of historical earthquakes (e.g., 493 AD, 1875), and instrumental seismicity is normally recorded within the first 25 km of the crust of the Gargano area. These data indicate that inherited E-W striking high-angle fault systems are solicited under the present-day stress field.

Off-shore the Gargano Promontory, the Mattinata Fault seems to be aligned with a regional (ca. 150 km in extent) E-W to NW-SE oriented deformation belt (known in the literature as Gondola Line), including a main fault and fold system known as Gondola Fault and Gondola Ridge, respectively. In the past, this structure has been investigated using multi-channel seismic reflection profiles and well-log data. Several investigators proposed a Mesozoic origin for the Gondola Line, followed by a complex pattern of repeated re-activation during the Cenozoic. Kinematics and timing of post-Mesozoic re-activation are still debated; however, most investigators agree that only deposits older than Miocene appear severely deformed, whereas Plio-Pleistocene units yield little or no deformation at all. This multi-history deformation pattern shown along the Gondola Line closely resembles the long-term complex evolution recorded along the Mattinata Fault, except for the lack of significant seismicity. Therefore, although one could expect the Gondola Line to be subjected to the same stress field responsible for recent re-activation of the Mattinata Fault, direct evidence is not available from historical and present-day seismicity. However, in recent years, evidence of recent tectonic deformation off-shore Gargano has arisen from very-high resolution seismic stratigraphy based on a dense grid of Chirp-Sonar profiles. These data allowed the identification of low amplitude fold systems and shallow sub-vertical faults propagating in middle-late Pleistocene and Holocene deposits, particularly along the E-W (on the continental shelf) and NW-SE (on the slope) segments of the Gondola Line. Several of these faults either affect Holocene units younger than 5.5 ka (based on bio-chronostratigraphic analyses from core samples), or even offset the seafloor.

Altogether, both recent seismicity related to E-W dextral strike-slip tectonics along the westernmost part of the MGsz and along the Mattinata Fault itself, and very recent ($<$ 5.5 ka) deformation features along the Gondola Line, suggest that the MGsz as a whole is being actively deformed, although variably along-strike. In order to verify this hypothesis, we attempt a comparison between on- and off-shore data supporting recent activity along E-W oriented foreland structures. The integration of such heterogeneous yet complementary datasets may contribute to discuss late Quaternary tectonics of the Southern Apennines foreland domain, and provide comprehensive (on-shore / to / off-shore) scenarios for investigating recent / active tectonics of the MGsz and evaluating its possible seismogenic character.