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Out-of-sequence thrusting and normal slip re-activation in the Mt. Camicia Thrust, Gran Sasso Range, Central Apennines, Italy

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The Gran Sasso Range, in the Italian central Apennines, is a carbonate-rock massif developed by thrusting and folding in Plio-Pleistocene times. Thrust sheets involve the sedimentary successions that were located at the paleo-geographic transition between the Lazio-Abruzzi carbonate platform to the South and the Umbria-Marche pelagic basin to the North. Thrust faults generally strike almost E-W and have a top-to-the-North tectonic transport direction, and are dissected and locally reactivated by the Quaternary Campo Imperatore high-angle extensional fault system. The Mt. Camicia Thrust outcrops on the eastern side of the Gran Sasso Range and is characterized by younger-on-older rocks (the Upper Cretaceous Rudist Limestone Fm. in the hanging wall is tectonically juxtaposed onto the Upper Triassic Bituminous Dolostone Fm. in the footwall). Such a stratigraphic separation led to controversial interpretations that included (i) Late Pliocene out-of-sequence thrusting; (ii) Late Pliocene tilting of a pre-orogenic extensional fault zone; (iii) Quaternary extensional faulting. To constrain better the geometry and kinematic history of the Mt. Camicia Thrust, we performed new detailed structural mapping and microstructural studies. Our results indicate that: a) in the fault core, deformation was mainly accommodated by cataclasis, with footwall dolostone survivor clasts embedded in a mostly hanging wall-derived carbonatic fine-grained matrix; b) striations, S-C and locally C' structures indicate a top-to-the-North tectonic transport direction, i.e. out-of-sequence thrusting; c) the structural fabric in both fault core and damage zones indicates late-stage normal slip reactivation that caused formation of large volumes of poorly cemented protobreccia; d) extensional collapse promoted permeability enhancement testified by late dissolution features, dedolomitization, and meteoric and speleothemic cements precipitation. The structural evolution (from compressional to extensional kinematics) of the Mt. Camicia Thrust can be compared with that of other thrust-faults in the Central Apennines and may provide an exhumed analogue of the fault network at depth that has being producing the recent earthquake sequences in the nearby L'Aquila (2009, mainshock Mw 6.1), Amatrice (2016, Mw 6.0) and Norcia (2016, Mw 6.5) areas.