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Different styles of fault reactivation in the Central Apennines (Italy)

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The compressional reactivation of pre-existing extensional features during positive inversion tectonics is a fundamental aspect in the evolution and tectonic style of orogenic belts. In fact, pre-thrusting normal faults can be reactivated or truncated according to a shortcut thrust trajectory, thus generating complex inversion geometries.
We studied the control of pre-existing extensional faults on thrust tectonics in the Central Apennines, a fold-and-thrust belt developed during the Neogene that involves the Triassic-Miocene persistent platform, pelagic and slope carbonate successions and the overlying foredeep siliciclastic deposits. The belt building was strongly influenced by the occurrence of pre-thrusting normal faults (pre-orogenic Permian(?)/Triassic-Jurassic and syn-orogenic Neogene).
The Central Apennines are characterized by curved thrusts and related folds trending both NW-SE to WNW-ESE and N-S to NNE-SSW. We describe positive inversion geometries of some structures (Setteporte, the Sabini Mts., the Sibillini Mts., Montagna dei Fiori, the Gran Sasso range, Maiella Mt. and Casoli-Bomba) by integrating surface geological data and seismic line interpretation. In several exposures, the NW-SE and WNW-ESE trending macro-anticlines show Jurassic and Neogene normal faults in their backlimbs that have been displaced and passively translated in the hangingwall blocks of the thrust planes and commonly show a gently foreland dipping crest and a progressively steepening forelimb or are overturned toward the thrust planes. The N-S trending anticlines are box shaped in cross-section, with backlimbs affected by east-dipping reverse faults (back thrusts). The transpressive deformational context of these structures results in strain partitioning, as documented by mainly dip-slip movement along the frontal thrust and strike-slip kinematics along the back thrusts. Such structures typically show push-up geometry compatible with transpressive deformational patterns and/or reactivation of a pre-thrusting normal fault. Furthermore, the pre-thrusting normal faults were generally reactivated during the Quaternary extensional tectonic (e.g., the Sibillini Mts. and Gran Sasso range) and are compartmentalized by N-S thrusts, which inhibit the growth and propagation of active normal faults. Thus, the N-S trending tectonic lineaments assume an important role in seismic hazard assessment.
The slip tendency analysis indicates that different styles of fault reactivation depend on their orientation with respect to the subsequent compressional NE-SW trending stress field.
A three-dimensional conceptual crustal inversion model for the analyzed structures assumes the complete reutilization of pre-thrusting normal faults by thrusts in the N-S features. This causes the development of reactivation anticlines, while NW-SE pre-thrusting normal faults have been displaced by shortcuts in the upper crust, thus forming shortcut anticlines.
The cases studied indicate that positive inversion is highly selective and its mechanism strictly depends upon the orientation of pre-existing normal faults, showing that different reactivation geometries linked to the same inversion event can coexist at regional scale in curved fold-and-thrust belts.
The proposed tectonic model could be applied to deciphering the three-dimensional kinematic evolution of analogous orogenic belts. Many scale-independent lines of evidence indicate that inherited discontinuities can control the curved morphology of individual folds and thrusts or of the entire orogen.