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The Lunigiana and Garfagnana grabens (Northern Italy): geological and morphotectonic evidences of active normal faults

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We present the result of a multidisciplinary study, involving structural survey, quantitative-morphotectonic analysis and subsurface data (reflection seismics) in the Lunigiana and Garfagnana grabens, a region of active tectonics, seismicity, and suspected seismogenic reactivation of preexisting normal faults.
The Lunigiana and Garfagnana basins are located in the northern part of a series of NW–SE-oriented, early Pliocene to Quaternary asymmetric grabens that develop for nearly 80 km along the inner side of the Northern Apennines chain. Both basins, originated at the hanging wall of a NE-dipping low-angle normal faults (northern termination of the Etrurian Fault System), are bounded by conjugate NE- and SW-dipping fault systems that are synthetic and antithetic splays of the basal detachment, respectively.
Several strong earthquakes (M 5.0 to 6.5) have occurred in the area in the last millennium and recently in January-June 2013, suggesting that this is one of the most seismically active areas of the northern Apennines.
However the slow stretching rate across the grabens, coupled with the highly erodible lithology of the outcropping rocks (mostly siliciclastic deposits) and the poor exposures of recent syntectonic deposits along the fault traces, make the identification and characterization of active and possibly seismogenic faults a difficult challenge.
In this work we try to: i) better constrain the geometry of the extensional fault systems of the Lunigiana and Garfagnana grabens at the surface and at depth, ii) discriminate the youngest, likely active normal faults within the grabens and iii) infer their associated displacement. In particular we report new morphotectonic data extracted from the basins draining the Lunigiana and Garfagnana in the context of, and compared to, available geological and structural data collected in the field and available in the literature. We also pay particular attention to the knickpoints investigated in the spatial context of suspected active faults. Our analysis allowed us to conclude that the knickpoints are tectonic in origin and that the height of the knickpoint closest to the fault trace can be considered as a proxy of the fault throw accumulated during the recentmost fault activity. Furthermore in the Lunigiana, the depth geometry of the detachment and of the main high-angle normal faults has been precisely defined through a detailed interpretation of several seismic lines. The detachment fault crops out along the eastern border of the Mt. Picchiara-Mt. Cornoviglio horst and deepens under the chain down to the depths of $\sim$12-15 km.
On the basis of our analysis, we suggest that the most likely active NE-dipping normal faults are those located closest to the graben axis. The normal-oblique transfer fault, connecting the two grabens along the northern side of the Apuane Alps, is considered as a likely active fault, at least along the segment joining the westernmost boundary faults of the basins. Significative evidence of activity characterise also some of the SW-dipping antithetical normal faults, above all, the Groppodalosio and Compione–Comano faults in Lunigiana and the Corfino and Barga faults in Garfagnana.