



The Emilia 2012 seismic sequence: hints on incipient basement-involved deformation in the foreland of the Northern Apennines (Italy)

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The deformation front of the Northern Apennines is buried under the sediments of the Po Plain and was formed mainly during the Pliocene. The remarkably arcuate shape of the thrust front contrasts with the linear northwestern trend of the pede-Apennines, where recent deformation is documented by both geological and geodetic evidence. This study presents new geological and seismological data that are used to assess the structural style of the Ferrara Arc, a sector of the Northern Apennine front that was hit by two strong earthquakes on May 20 (MW 6.1) and May 29 (MW 6.0), 2012. The proposed interpretation is based on a dense grid of commercial seismic profiles and exploration wells, and high-quality relocation of $\sim 5,300$ earthquakes (the Emilia sequence). The seismicity was used to calibrate new one-dimensional and three-dimensional local V_p and V_s velocity models for the area. On the basis of these new models, the initial sparse hypocenters were then relocated in absolute mode and adjusted using the double-difference relative location algorithm. Seismicity distribution is elongated in the W-NW to E-SE directions, reaching a depth of 10-12 km. The aftershocks of the May 20 mainshock appear to be distributed on a rupture surface that dips $\sim 45^\circ$ SSW, and the surface projection indicates an area ~ 10 km wide and 23 km long. The aftershocks of the May 29 second mainshock followed a steep rupture surface that is well constrained within the investigated volume, whereby the surface projection of the blind source indicates an area ~ 6 km wide and 33 km long. The analysed multichannel seismic profiles highlight the presence of relevant lateral variations in the structural style of the Ferrara folds that developed during the Pliocene and Pleistocene, and also show the occurrence of a Mesozoic extensional fault system in the Ferrara arc, which in places has been seismically reactivated. These geological and seismological observations suggest that the 2012 Emilia earthquakes were related to ruptures along blind fault surfaces that are not part of the Pliocene-Pleistocene structural system, but are instead related to a deeper system that is itself closely related to re-activation of a Mesozoic extensional fault system.

The implication is that the Emilia 2012 seismic sequence was related to activation of a new deformation system that has developed since the late Pleistocene and that affects the deeper structural levels within the Adriatic crust. This interpretation has major relevance for the seismotectonic characterization of the Po Plain, because the location and extent of the Ferrara folds, that were formed during the Pliocene-Pleistocene, cannot simply be used to estimate the seismogenic potential of the Ferrara Arc region.