Pore pressure control on the thickness of the seismogenetic crust in continental extensional regimes: insights from recent earthquake and swarm sequences in the Apennines

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Abstract

A major control on the mechanisms and processes which govern how earthquake cycles produce topographic and geological structures is given by the thickness of the seismogenetic crust. It is generally accepted that in extending continental lithosphere temperature-controlled processes govern the transition from the elastofrictional regime in the upper crust to visco-plastic deformations in the middle-lower crust. Pore pressures variations, however, are also considered to play an important role in various processes such as earthquake nucleation, aftershock sequences and aseismic slip associated with swarm sequences. Background seismicity in extensional continental setting is frequently characterized by sub-horizontal alignment of low-magnitude events at various depths, that are frequently interpreted as sub-horizontal shear zones (Gulf of Corinth, Northern Apennines). In this work I use geodetic and seismological data from recent swarms and earthquake sequences in the Northern Apennines (together with informations from boreholes and seismic reflection lines) to investigate the role of such structural features on controlling the thickness of the seismogenetic crust. Inversion of geodetic data show that fault slips associated with both seismic (2016-2017 earthquake sequence) and aseismic events (2013-2014 Gubbio swarm sequence) are systematically confined above the sub-horizontal low-seismicity alignments. Modelling of interseismic deformation in the same areas, additionally suggests that the thickness of the elastically-coupled upper crust in the interseismic period is limited at depths by the sub-horizontal low-magnitude alignments. I suggest that distinct stratigraphic horizons have a significant role on the mantainance of supra-hydrostatic pore pressures at depths and on the thickness the seismogenetic crust. The similarity with other continental extensional settings also suggests that the described process could be of general relevance.

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