A unified numerical model for the simulation of the seismic cycle for normal and reverse fault earthquakes in Italy

CONTENTS

• The dynamics of the preparation, initiation, occurrence, and evolution of earthquakes (i.e., the seismic cycle) are governed by several physical mechanisms and parameters that are often unknown.

• Understanding these mechanisms is crucial for developing new techniques and approaches for earthquake monitoring and hazard assessment.

• We contribute to the existing knowledge of the seismic cycle dynamics of a single fault plane by developing a first-order numerical model capable of jointly simulating quasi-static crustal interseismic loading, coseismic brittle-elastic distortions, and postseismic relaxation for extensional and compressional earthquakes in Italy.

• We simulated the interseismic, coseismic, and postseismic phases of two seismic events in Italy: the 4 April 2009, Mw 6.1 L'Aquila normal fault earthquake and the 20 May 2012, Mw 5.9 Emilia reverse fault earthquake.

MATERIALS & METHODS

• InSAR data

• L'Aquila 2009 earthquake InSAR coseismic ground displacements

• Emilia 2012 earthquake InSAR coseismic ground displacements

• Numerical model

• Section A'-A' (Figure 1a): L'Aquila 2009 earthquake model

• Section B'-B' (Figure 1a): Emilia 2012 earthquake model

• Conceptual sketch

• Interseismic phase

• Coseismic phase

• Postseismic phase

RESULTS

• Pore pressure

• Observed

• Modeled

• Volumetric strain

• Distance (km)

CONCLUSIONS

• The stress gradient generated by the lithostatic transition during the interseismic phase yields dilatation of the base of a locked normal fault, with the formation of cracks and pore pressure increase, and contraction at the base of a locked thrust fault, with crack closure and pore pressure decreases.

• This partitioning of the interseismic stress and strain at the transition between the latter and plastic fault segments promotes the coseismic subsidence and uplift of the hanging wall in extensional and compressional regimes, respectively.

• The observed postseismic relaxation (when the model is driven by porepressibility) shows further ground subsidence and uplift for normal and reverse faulting earthquakes, respectively, in agreement with the fault style.