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Solid Earth Discussions

Interactive comment on "A reversed hierarchy of active normal faults: the 6 April 2009, M_w 6.3, L'Aquila earthquake (Italy)" *by* L. Bonini et al.

Anonymous Referee #1

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The manuscript reinterprets geologic, geodetic and seismological data to propose that: 1) the causative fault of the L'Aquila 2009 earthquake is a blind fault controlled at depth by pre-existing discontinuities and 2) co-seismic surface breaks are the result of either crustal bending over the uppermost portion of the master fault or stress concentration near its upper tip. This interpretation is linked with an analogue model that reproduces a blind fault at depth and the newly formed surface faults generated by co-seismic deformation. I think that manuscripts that propose new ideas and/or concepts that are far away from the main research stream are fundamental for scientific advancement, however the presented manuscript: 1) is not based on solid data that support the blind-fault hypothesis of the causative fault of the L'Aquila earthquake; 2) does not take into account and/or mention all the previous works that disagree with a blind fault model.

In the following I am going to better explain my criticism.

Three independent research lines suggest that L'Aquila earthquake did not occur on a blind fault. This is supported by 1) field geology (e.g. Boncio et al., GRL, 2010; Vittori et al., BSSA 2011; Gori et al., 2012, Italian Journal of Geosciences; Lavecchia et al., 2012 Italian Journal of Geosciences); 2) co-seismic slip models from DInSAR (Atzori et al., GRL, 2009), GPS (Cheloni et al., 2010, GJI), joint inversion of strong motion and GPS data (Cirella et al., GRL, 2009); 3) aftershock distribution (Chiaraluce et al., 2011 JGR; 2012 JSG). So, before saying that the L'Aquila earthquake occurred on a blind fault, it would be worth to critically mention and re-interpret the data presented in the above manuscripts. For field geology: if the surface breaks are newly formed surface faults, not linked with the deep structure, why the Paganica fault, where these breaks have been documented, has a displacement of about 100 m and the same kinematics of the mainshock (Boncio et al., 2010; Lavecchia et al., 2012)? For models: why all the co-seismic slip models depict a continuous fault plane that slips also in the very shallow (< 2 km) fault portion (Atzori et al., GRL, 2009; Cheloni et al., 2010, GJI; Cirella et al., GRL, 2009). For aftershocks: the absence of aftershocks in the 2-3 km of the crust can be also related to the velocity strengthening behaviour of faults at shallow crustal depth (e.g. Scholz 1998, Nature, Figure 2). For L'Aquila sequence, aftershocks are present up to 1 km depth (Chiaraluce et al., 2012), and the numerous shallow faults depicted by aftershocks alignment can represent fault splays that are typical in the hanging-wall block of normal faults (e.g. Sibson 2000, Journal of Geodynamics).

The analogue model is not constrained by data. The analogue model reproduces a 3 km thick sedimentary sequence. Why the sedimentary rocks are only 3 km thick? In the same region the CROP11 seismic profiles shows that sedimentary rocks are very thick, more than 10 km (Patacca et al., 2008, Tectonics). In addition, the borehole Varoni (drilled by Eni 30 km north of L'Aquila) encountered dolomites at 5700 m. What is the lithology located below the 3 km thick sedimentary sequence where the blind fault is positioned? Why the sedimentary sequence is decoupled from what is located below?

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Are surface breaks formed by surface bending a common feature of the Apennines or this is a new interpretation proposed in the manuscript? Can the Authors better explain/document this point? The fact that the major earthquakes of the Apennines occur in the proximity of intermountain basins bounded by normal faults is not consistent with normal faulting produced by surface bending. Can the Authors comment on this? The Authors propose that earthquake was caused by a blind fault, controlled at depth by pre-existing discontinuities. What are these pre-existing discontinuities?

Interactive comment on Solid Earth Discuss., 5, 117, 2013.