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Interactive comment on "The role of mechanical stratigraphy on the refraction of strike-slip faults" *by* Mirko Carlini et al.

Anonymous Referee #1

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In their work Carlini and coworkers present meso-fault data collected in an 200 m wide exposure located in the frontal limb of the Palazzuolo anticline (Apennines, Italy). The observed meso-faults affect overturned strata and are interpreted by the authors as developed, after folding, in a strike-slip stress regime. The meso-faults include segments having different cutoff angles in weak and stiff layers. The authors interpret this cutoff variability as an evidence of refraction of the strike-slip faults during their propagation. They also suggest that strike-slip faults nucleated in weak layers and then propagated across the stiff beds.

The abstract is informative, despite it is too long. The intro is well written and provides an up to date overview of the topic. I have two major concerns about the data and their discussion/interpretation.

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1 – The strike slip origin of the faults is, at the best, not convincing. The intersection between the pink left lateral faults and green right lateral faults, as seen in the stereoplot of figure 2, exactly lies along the bedding plane and the striations along the planes of both systems are at 90° from this intersection zone. This could be taken as a textbook example of a pre-folding tilted extensional conjugate system (as shown in figure 8d, where the data are displayed after unfolding). Your paleostress analysis provides slightly different indications (i.e. Sigma 2 not lying along the bedding plane), but this could merely indicate that some of the assumptions behind the stress inversion are wrong (e.g. you have lumped in the inverted dataset structures pertaining to different events). The study of additional outcrops, with different bedding dips, is required to solve the problem: the orientation of the strike slip faults is constant at different bedding dip value = they are post folding; the orientation changes but the angular relationships with the bedding is constant = they are pre to syn folding. As pointed out by the authors, if an extensional origin is assumed the derived extension direction would be NW-SE. i.e. parallel to the trend of the belt. The authors claim that (Page 6 line 27) "the derived extensional deformation phase would have ensued during a pre- or syn-folding time and within this portion of the Northern Apennines this is not supported by any independent geological evidence, neither in literature nor from our own field observations". This is unfair with respect to the thousands of works that have documented pre to syn-folding extension oriented parallel to the trend of foredeep and anticlines in FTBelts (starts with Sterans, 1968; Dietrich, 1989), including the Apennines (Doglioni, 1995).

2 – The idea that faults has nucleated in weak layers is not supported by the presented data. Whatever the origin, post-folding strike-slip or pre-folding extensional, field photographs suggest that fault propagation has occurred throughout the linkage of pre-existing fractures, as commonly observed during fault growth (e.g. Healy et al., 2006). In detail, looking at the photographs, many could say that fault propagation has occurred by the linkage of the pre-existing (or precursory in the case of pre-folding extension) high angle to bedding fractures (those affecting the stiff layers). The authors

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suggest a different and counterintuitive history, with the nucleation of faults within the weak layers and propagation (with consequent refraction) in the stiffer layers. Honestly, there is not enough field material to discriminate between the two hypotheses (the presentation of some displacement-distance diagrams could help). At present, the evolutionary model proposed by the authors is based only on an analytical model explained in figure 9: stiff layers require higher tensile stress for failure and, if one assumes that the stress tensor is the same for adjacent layers, failure must occurr before in weak layers and then, after stress build up, in stiff layers. This is a weak argumentation, as the assumption of a constant stress tensor in adjacent layers with different mechanical properties is highly questionable: what about uniaxial or biaxial strain conditions?

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