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Interactive comment on "On the mechanical behaviour of a low angle normal fault: the Altotiberina fault (Northern Apennines, Italy) system case study" *by* Luigi Vadacca et al.

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General comments:

The paper by Vadacca et al "On the mechanical behaviour of a low angle normal fault: the Altotiberina fault (Northern Apennines, Italy) system case study" presents a 2D numerical model of crustal mechanics constrained by geological, seismological, and geodetic data. The objective of this modeling study is to characterize the mechanical behavior of the greater Alto Tiberina fault (ATF) system. The fault system is complex, involving interactions between the low-angle ATF and high angle faults that cut the ATF hanging wall and sole into the low angle normal fault. Understanding the mechanical behavior of this system is important because it bears on the general, controversial

question of if and how low-angle faults slip despite theoretical arguments to the contrary. The study also has important implications for local seismic hazards.

The numerical modeling suggests that the ATF plays an important role in controlling the ongoing extension across the fault system, and that the ATF appears to be creeping at depths below about 5 km. The results also suggest that creep on the ATF may have an important influence on some of the high angle normal faults, the Gubbio fault in particular, as well as micro seismicity.

Specific comments: The numerical model is developed using a finite element representation informed by seismic reflection lines. Creeping versus locked segments of the faults are simulated by changing the elastic properties of the fault zones relative to the surrounding material. The ATF fault is parameterized as a 500 m thick zone, whereas the other faults are parameterized as 100 m thick zones. Using the finite element model, a series of numerical experiments constrained by GPS observations of crustal motion were used to test the sensitivity of the observations to features of the model, such as the distribution of creep on both the ATF and high angle normal faults.

The results show that the accumulation of crustal stress depends critically on the prescribed fault creep. An analysis of predicted stress accumulation with the pattern of micro seismicity helps to inform which among the models tested best characterize the greater ATF system. An important outcome of the study is that models for which the ATF fault is creeping below about 5 km depth seem to fit the observations better that models that do not prescribe creep to the ATF. Further questions regarding creep on the Gubbio fault remain because the fit to the observations is similar for models in which both ATF and Gubbio faults creep; it is difficult to assess whether the small reduction in WRMS (change = 0.11) is achieved simply due to the increased complexity of the model. The same argument could be made to some extent for comparison among all of the models tested. However, it is notable that Model 4A is supported by the pattern of microseismicity, in that microseismicity correlates with high stress accumulation rates in the Gubbio fault footwall. The authors may be able to devise some statistical tests for assessing the significance of differences in WRMS arising from models with different degrees of complexity.

Technical comments: The authors use the word “interested” in a way that I am unfamiliar with. Perhaps they meant “intersected”?

A table describing the models and reporting the WRMS values for each might help the reader to evaluate the differences among the models and their fit to the data.

A statistical assessment of the significance of differences in WRMS values among the various models would greatly strengthen the conclusions.

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