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Interactive comment on "The dynamics of laterally variable subductions: laboratory models applied to the Hellenides" *by* B. Guillaume et al.

Anonymous Referee #2

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Review of Manuscript (se-2013-6) "The dynamics of laterally variable subductions: laboratory models applied to the Hellenides" by B. Guillaume and co-workers.

General Comments: The paper by Guillaume et al. investigates the influence of lateral buoyancy variations of subducting lithosphere on mantle flow, trench kinematics, upper plate deformation and dynamic topography development. A series of analogue models have been deployed to explore the relationships, mentioned above. Subsequently, the modeling results have been used to gain insight in the complex interplay between subduction processes, associated mantle flow and upper plate deformation of the Hellenic subduction system. After careful reading of the manuscript I conclude that the investigated topic is highly relevant and the experimental work is of top quality as is the way the experimental results are displayed, though the figures should be somewhat larger

in the final version! I, therefore, strongly support publication of this manuscript. Nevertheless, I 'd like to take the opportunity to bring some points to the attention of the authors, which when addressed properly, will to my opinion improve the manuscript.

1. Against the background of a "discussion paper", I believe that the manuscript will gain weight and credibility when incorporating a couple of publications, which are worthwhile to compare the results with. This can be done within the model description and discussion part. These papers are highly relevant to the investigated problem as the underlying process (subduction) is the same. On the topic of mantle flow: Schellart (2004); Schellart et al. (2011); on the topic of plate coupling and overriding plate deformation: Gerya et al. (2008), Faccenda et al. (2008, 2009), de Franco et. al. (2008), Iaffaldano et al. (2012), Luth et al. (2010, 2013); on the topic of trench depth and trench morphology Yanez and Cembrano (2004); on the topic of tear (STEP) faults: Baes et al (2011).

2. In the manuscript strong emphasis is put on the Kefalonia fault as an equivalent to the tear-fault in models 5 and 11. Scaled to nature, the Kefalonia fault is a first order structure, which should have a clear expression in the geophysical data, which seems not to be the case. Given the importance of this structure for the manuscript I suggest to explain in more detail the geologic/geophysical evidence concerning the Kefalonia fault as a lithosphere-scale feature and its proposed link to the North Anatolian fault, which is not that obvious when for example reading Brun and Sokoutis (2010). Furthermore the Kefalonia fault is displayed ad strike slip fault in fig. 10 and 11, but as thrust fault in figs. 1 and 9, which is somewhat confusing. Please explain and/or correct.

3. All of the issues addressed in this study are described and discussed using models 1,5,8 and 11. There is almost no comparison to the results of the other 7 models listed in Table 1. For example, upper plate deformation (section 3.4) is described on the basis of model 1 and model 11 (with no upper plate at all) although there is according to table 1 also models, which posses an upper plate (models 2 and 7). I would be very eager to learn how the different choice of parameters of model 1 with respect to models 2 and

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7 influences the result, particularly because the deformation of the upper plate in the Aegean region is well known and is thus important for the validation of the modeling results. In summary, it would be good to incorporate the main results of the other 7 models in a concise manner to get a feeling for the diversity of modeling results as a function of different parameter combinations.

Specific Comments:

P. 319, line 3: . . .“mantle flow and its motion is resisted by viscous dissipation in the mantle, in the slab and in the overriding plate”. One would argue that also the resistance at the plate interface as important. Please comment.

P. 323, line 24: . . .”retrograde" motion. . .., perhaps better to use different terminology here not to confuse the reader with petrologic terminology.

P. 327, section 3.3 “Mantle flow”. Along the lines of one of the “general comments”: Mantle flow is described on the basis of model 11 only. It would be interesting to learn how the tear fault (model 5) influences the flow pattern in the mantle, if at all??? Please comment.

P. 328, 3rd paragraph: In this paragraph you suggest that differential shear stresses at the base of the lithosphere are responsible for the trench parallel stretching. It is not clear to me what the source of the “differential shear stresses is”. Please explain.

P. 329, line15: I think you should avoid mixing “indentation” into the game as the

P. 329, section “Dynamic Topography”: How do you distinguish the tectonic from the non-tectonic component of topography and how big are to your opinion the error bars related to that?

P. 330, 2nd paragraph: How do the vertical motions of model 11 compare to the vertical motions of models with an upper plate?

P. 334, last paragraph: In this paragraph you place a critical assumption, namely that

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the viscous strain of your models is representative of brittle deformation in the crust in nature. To my opinion you should be a bit more cautious here, because the Aegean domain is considered as a fairly weak domain and there is no guarantee that the strain is not significantly partitioned between the layers of different strength.

P. 3y 39, line 11: This first sentence of section 4.5 is highly speculative, as the efficiency of the transmission of the mantle drag into the lithosphere is a function of the rheology at the base of the lithosphere, which we do not know. Be more modest in your formulation.

Technical Corrections:

P. 330, line 11: substitute “of” with “by”.

P. 332, lines 11/12: Here you introduce the “South and North Hellenic subduction zones”. Would be good to label these subduction zones in the pertinent Figure (Fig. 9).

P. 337, line 27: Subsitute the second “for” with “from”.

P. 338, line 3: . . .”teared” should be “torn”.

P. 338, line 23: “Our models show”. . .instead of “shows”.

Throughout the manuscript, you often use the phrase “thanks to” (3 times on p. 342). Replace with scientific writing!

Fig. 2: Would be good to add the N-direction to the figure as you describe your results in terms of the geographic coordinate system. Also provide the figure on the depth of the tank (in cm).

Fig. 6 gives the impression that the models are not fixed to the backwall, which is different to drawing of the setup in Fig. 2.

Interactive comment on Solid Earth Discuss., 5, 315, 2013.