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Comment on egusphere-2022-62

Marco Bonini (Referee)

Referee comment on "Control of crustal strength, tectonic inheritance, and stretching/shortening rates on crustal deformation and basin reactivation: insights from laboratory models" by Benjamin Guillaume et al., EGU sphere,
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The manuscript by Guillaume et al. presents the results of a series of analogue models addressing the role of simultaneous shortening and orthogonal extension under different rheological conditions, including the role of inherited crustal heterogeneities. The paper is concise and well written, and figure are well drafted. In addition, the aims are clearly stated, and the modeling results are analyzed through up-to-dated techniques (Particle Image velocimetry (PIV), and subsequent velocity and strain analysis). The extent of the conclusions is generally supported by the presented data, and the results may be attractive for an international readership. The manuscript is thus suitable for being published in Solid Earth (SE) after a minor/moderate revision. The issues that should be addressed during the revision are listed below and keyed to line number in the text.

General points

Conceptual simulation of indentation and lateral extrusion. In this experimental study, lateral extrusion is achieved by applying a shortening-orthogonal extension to the model. However, in this experimental procedure the system is not developing spontaneously, but its evolution is imposed by the boundary conditions (i.e., the shortening-orthogonal extension). In other models, lateral extrusion (associated with V-shaped strike-slip systems) simply resulted from a model set-up with lateral strength/thickness variations (Sokoutis et al 2000, Tectonophysics), and/or accomplished by weak lateral confinement (e.g., Ratschbacher et al., 1991, Tectonics). The authors agree on that and acknowledge the primary role exerted by a weak crust in favouring a lateral tectonic escape (Lines 403-404). On this basis, I think that some more discussion on the rationale of the modelling and its comparison with previous models would be necessary for a more in-depth comparison with the natural cases sketched in Figure 14.

Adopted terminology. The reasons of using the terms 'extrusion rate' (stretching velocity)

and 'indentation rate' (shortening velocity) should be discussed in more detail. Indentation refers to a case where the colliding block is much shorter than the indented continent. However, I cannot identify this condition in the model setup of Figure 1. So why not use the terms shortening rate and extension rate? Please comment on this.

Rheology of analogue materials. The lower crust has been simulated using PDMS silicone putty (Lines 85-86). Consequently, this silicone has a lower density than the overlying Fontainebleau quartz sand that simulates the upper crust. As correctly stated by the authors, this implies an inappropriate density ratio between upper and lower crust in the models. Density contrast in the model should be equal- or at least similar - to nature. In other terms the viscous layer is too buoyant (or the sand too heavy). This may produce a strong vertical instability that may amplify the folding of the brittle-ductile interface during shortening or extension, and ultimately affect the modelling results at some extent. Please clarify the choice of the PDMS silicone (technical advantages?).

Other points

Line 83. Was the cohesion of the sand measured in this study? If not, please provide a reference.

Lines 126-130. Please report in Table 2 the Ramberg and Smoluchowsky-like numbers (R_m , S_m) for both model and nature.

Lines 147-149. Corti et al. (2006, Spec. Paper GSA) performed similar analogue models characterised by coeval shortening and orthogonal extension, which were applied to the Sicily Channel.

Lines 180-182. The convexity observed in some models could result from a high friction of the side walls. Have you adopted any technical practices to minimize this effect?

Lines 301-305. Have you considered the possibility that these anomalous faults departing from the edges of the graben could represent only boundary effects?

Lines 413-416. It is not clear why shortening-parallel thrusting should develop in this model. Has shortening-parallel thrusting been identified in any model of this series? Please clarify. Spontaneous shortening-parallel thrusting resulted in the above-mentioned model

by Sokoutis et al (2000), which - differently from this experimental series - were isostatically compensated. This may represent a key difference with respect to the current series of models.

Lines 422-423. Please give more details about the characteristics of fault reactivation. From the tectonic setting (basin-parallel shortening) I would expect some component of strike-slip movement. What is the dominant kinematics of reactivated normal faults?

Figure 1. Please indicate the 'seeds' in the model setup.

Figure 12. What does the yellow layer at the base of the model configuration in the left panel represent? This model is referred to as purely brittle, but this yellow area is equivalent to the basal ductile silicone of the models shown in the middle and right panels. Please clarify this.