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Solid Earth
Discussions

Interactive comment on "The influence of detachment strength on the evolving deformational energy budget of physical accretionary prisms" *by* Jessica McBeck et al.

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General comments:

This article presents a set of laboratory compressive sandbox experiments in association with a detailed analysis and discussion of the mechanical work of the sand pack. During the experiment, the authors monitored forces on the back wall using pressure plates and particle displacement on the side using digital image correlation (DIC). The paper is innovative from the technical point of view. Indeed, using back wall force measurements and DIC, and calling on mechanically motivated assumptions, the authors managed to estimate individual components of the mechanical work in a laboratory

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Discussion paper

experiment. The conclusions confirm the theoretical predictions that were developed in previous publications by the authors. The paper is well organized, the language is good, and the figures are clear. Figures representing graphs are well used (Fig. 3, 4, 8) and are useful to the discussion. Some of the figures showing the experiment and DIC analysis are used more anecdotally (Fig. 2, 5). The literature review is mainly focused on the previous work of the authors and could benefit from being a bit broader, especially regarding older works. In conclusion, this paper is an interesting contribution to the mechanical work of compressive tectonic systems. The focus of the paper is adapted to the journal Solid Earth. I support the publication of this manuscript after some minor corrections.

Arthur Bauville

Specific comments:

As stated above, the literature review is a bit authors-centric. I would like to suggest some readings to broaden a bit the introduction. I listed them at the end of this review.

Fig. 2 and 5 are just used in passing, as a support to Fig. 3 and 4. They could be used a bit better. For example Fig. 2 could be the object of a small paragraph that discusses the dynamics of the experiment and the main events happening before to dive into Fig. 3. In addition, the pre-faulting and post-faulting phases are important events in Fig. 4. The limit pre-post faulting could be indicate on Fig. 2 as well.

Methods A value for the basal friction in the glass and sand detachment experiments should be given here already (it's only given much later in the text).

5.59: "We calculated the incremental shear strain fields of each of the views of the sand pack using the curl of the incremental displacement field. " The curl of the incremental displacement field must be the vorticity*char_time, i.e., the rotational part of deformation instead of strain. In 2D the vorticity is a scalar while strain is a tensor. Please explain better what the quantity delta shear strain corresponds to: invariant of the incremental strain tensor? abs(vorticity)? 6.96. Following the previous comments, here, what do you call the shear strain field? the shear strain tensor field of the displacement curl field?

Discussion 12.62-65. Here you argue that using lithostatic pressure as the traction on the fault may lead to underestimating Wfric. It would be nice to have an estimate of how much that is. For example, an upper estimate can be given by considering that sigma1 is horizontal and deviatoric stresses are such that yielding occurs. Doing some back of the enveloppe trigonometry on the Mohr-Coulomb diagram I get: Sigma_n = Sigma_mean- (Pl*sin(phi)*tan(phi))/sin(1-phi) where Pl is the lithostatic pressure and phi is the friction angle (you might want to double check my math). Using a friction angle of 30° it simplifies to Sigma_n = 2*Pl - (Pl*sin(phi)*tan(phi))/sin(1-phi).

That yields Sigma_n/Pl = 1.35; and at the end of the experiment Wext/(Wgrav+Wfric+Wint)=1.35. That's pretty nice :)

Sigma1 is probably not horizontal which gives you some latitude to put Wprop and Wseism.

Also, the discussion would be a bit more general if you expressed the deficit in percentage in addition to giving the values in mJ.

Technical corrections

2.42: Ritter et al., 2018 -> ref missing 3.72: "In these numerical accretion simulations, all of the work components increase during underthrusting. The development of the new forethrust increases Wint, but decreases Wfric by a greater degree, which correspondingly decreases Wext (Del Castello and Cooke, 2007)." The second sentence seems to contradict the first one.

4.05 Missing citation for Dotare et al., 2016. Possibly miscited. Do you mean this paper?: Yasuhiro Yamada, Tatsuya Dotare, Juergen Adam, Takane Hori, Hide Sakaguchi. Initiation process of a thrust fault revealed by analog experiments. Geophysical Research Abstracts, 2016, 18 4.25. Reverse the order of citations 9.60. Fig. 3 is cited before Fig. 2. The paragraph can be easily rearranged to avoid that.

9.69. Earlier work could be cited (e.g. Vermeer, 1990)

9.88. Unneeded reference to Fig. 5B 9.93. There is no Fig. 5C 9.94 primary->primarily 10.5. Here you can refer to Fig. 5

Minor comments on figures:

Fig. 3 Panel A has a lot of curves. The curve from exp E374 is hidden behind the others which is a bit unfortunate. Since E373 and E374 are the most important, the drawing order could be changed (i.e. as in the legend). Using thinner lines for E375, E376 could also improe readability Panel B etc-E the light blue curve is hard to distinguish from the grey background

Suggested readings

Vermeer P. (1990). – The orientation of shear bands. – Géotechnique, 40, 223-234.

Le Pourhiet, Laetitia. "Strain localization due to structural softening during pressure sensitive rate independent yielding."ÂăBulletin de la Société Géologique de FranceÂă184.4-5 (2013): 357-371.

Dahlen, F. A. "Mechanical energy budget of a fold-and-thrust belt."ÂăNatureÂă331.6154 (1988): 335.

Gutscher, MarcâĂŘAndré, et al. "Episodic imbricate thrusting and underthrusting: Analog experiments and mechanical analysis applied to the Alaskan accretionary wedge."ÂăJournal of Geophysical Research: Solid EarthÂă103.B5 (1998): 10161-10176.

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