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Solid Earth Discussions

Interactive comment on "Frictional slip weakening and shear-enhanced crystallinity in simulated coal fault gouges at subseismic slip rates" *by* Caiyuan Fan et al.

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The manuscript entitled "Frictional slip weakening and shear-enhanced crystallinity in simulated coal fault gouges at subseismic slip rates" describes frictional properties of coal at slip rates of 0.1-100 μm/s and crystallographic characteristics before and after the friction experiments. The authors report marked slip weakening behavior during the experiments and attribute the behavior to a shear-enhanced crystallographic development of coal based on XRD and Raman analysis. The manuscript is basically well written and their results seem sound. Hence I recommend accepting it with minor revisions.

Title: "Subseismic slip rates" makes me imagine much higher velocities of mm/s to cm/s. I would rather use "slow slip rates".

Line 15: whether vacuum dry flooded → whether vacuum dry/flooded ?

Line 35: very low friction strength → very low frictional strength

Line 92: such as friction strength → such as frictional strength

Line 221: "γ-band, 002-band and 10-band" I think the majority of readers are not familiar withγ-band. Please explain briefly, or cite an adequate reference.

Lines 256-260: Here the authors briefly explain types of data which are summarized in Table 1 and 2, however, I think it is not necessarily to mention them as a first sentence of chapter. Please consider to incorporate it in 3.1.1 and 3.2.2. Also, I'm wondering why the authors define two types of steady-state friction coefficient (μss1 and μss2), in other words, why all the mechanical data have a slight decrease in frictional strength at about 4 mm in displacement. I ask you to mention this behavior and reason for it (if possible) in the description of overall frictional behavior (Lines 263-265).

Line 265: "though this trend is not significant" Line 276: "(a-b) values may not be sensitive to effective normal stress" Here the authors mention the relationships between frictional strength (or (a-b) value) and effective normal stress. However, in Fig.3b and Fig.4b, apparent friction coefficients are plotted for each experiment (not plotted against effective normal stress (or (a-b) value)), and the trend is not visualized. Although the value of applied stress is shown individually in the figures, it is quite difficult to see any scientific meaning (relationship between X and Y axis) of the plot. The same problem can be seen in Fig. 9 and Fig. 11. I would plot apparent friction coefficients (or (a-b) values) against effective normal stress.

Line 279: "while other samples tested with DI pore water at a pressure of 15 MPa show velocity strengthening." There is an exception (S5) that exhibits velocity-weakening behavior for wet experiments. Please explain correctly.

Line 288: “the onset of the slip surface” Unclear meaning.

Line 299: Here the authors explain the strain localization during the experiment; slip on R-shear surface takes place in the early stage of deformation, and then deformation mode changes to slip on boundary and Y-shear bands in the late stage of experiment. However, authors document that R- and Y- shear bands were only observed in the sample S5 due to flat condition of the sample surface. My question is how do you know the time sequence of formation of R-, Y-, and boundary shear bands based on your observations?

Line 325: Citation of Fig. 9c should appear after Fig. 9b.

Lines 352-356: Delete first 4 lines of “Discussion” section to avoid repetition.

Line 490: “enhanced compaction rates” Do you have any direct evidences for enhanced compaction of wet sample? (e.g., thickness of the layer)

Figures

Fig. 2: I’m wondering why the background (especially for the range of 10-30 degree in two-theta) of observed intensity is so high? Is this due to a specimen holder or diffractometer used in this study?

Fig. 3b and 4b: I would plot apparent friction coefficients (or (a-b) values) against effective normal stress.

Fig. 6c: I can hardly see R- and Y-shear bands in the photograph. Please provide a magnified photograph.

Fig. 7: Description/citation of Fig. 7g does not appear anywhere in the main text.

Fig. 9: I think the horizontal axis should be an effective normal stress and/or apparent steady-state shear stress with linear scale, to indicate your data in a more scientific way. Each crystal structure parameter versus an effective normal stress and apparent steady-state shear stress should be illustrated separately using different symbol. The

information of shear strain does not seem important because the values are almost identical.

Fig. 11a and 11b: Here I also suggest the horizontal axis should be an effective normal stress and/or apparent steady-state shear stress. Also please consider plotting the crystal structure parameters and Raman parameters against frictional work (shear stress*displacement, MJ/mˆ2 or MJ/kg) stored in the sample, as you finally conclude that the improvement in crystallinity may be associated with strain energy.

Fig. 12: Please provide “Sample number and applied stress (σn, Pf)” in the figure legend.

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