Solid Earth Discuss.,
https://doi.org/10.5194/se-2020-117-RC3, 2020

Solid Earth
Discussions
Open Access

Interactive comment on "Coseismic fluid–rock interactions in the Beichuan-Yingxiu surface rupture zone of the Mw 7.9 Wenchuan earthquake and its implication for the fault zone transformation" *by* Yangyang Wang et al.

Catriona Menzies (Referee)

catriona.d.menzies@durham.ac.uk

Received and published: 28 September 2020

Wang et al report on alteration of fault rocks due to co- and post-seismic fluid-rock interactions and provide XRD data confirming mineralogical changes and XRF data illustrating chemical changes, mostly of major elements. The manuscript requires some significant work to put it into context, fully use the data they present as evidence for their findings, discuss their data and findings with reference to other studies of similar processes to bring the work up to publishable level. Currently there is significant assumption throughout the discussion that coseismic heating and thermal pressurisation

Printer-friendly version

Discussion paper

drive the changes/ variation they report with no investigation of alternative processes, nor the use of their data to provide succinct evidence of these processes, this is clearly a significant flaw and renders the manuscript unpublishable in its current form.

From the outset, the English in the abstract is poor, and throughout it does not improve significantly, often with the meanings of sentences flipped due to poor English/ grammar/ wrong words used. For example, "contents of some elements" (line 464); here I think they mean the elemental composition of the rock, but how it is written makes it read as if it is the contents of the actual elemental make up they are measuring and that is entirely wrong and misleading. There are numerous examples throughout and without prior knowledge of geochemistry/ alteration/ fluid-rock interaction the meaning would be misconstrued by readers.

The overall principles of the paper are there, focussing on the alteration of primary minerals within a fault zone relating to both coseismic and postseismic hydrothermal/ fluid-mediated reactions, but there are key steps of the scientific method missing. Before this manuscript can be published it needs:

- Writing tidied up; grammar and correct use of terminology elements, oxides, components, concentrations, etc, etc are mixed up throughout. LOI is referred to as a component of the rock - when it is a measurement of the volatile content of the rock before and after heating, which is made up of H_2O, CO_2, etc etc.

- Introduction needs to be improved; it requires an overhaul of the geological setting and putting into context with published work (not just of work in the geographical area/ same fault zone).

- Systematic descriptions need to be made clearly and linked in with figures better. Some more figures would help with this as well as a summary figure of all observations. These observations are crucial for understanding this system and drawing comparisons with others and should be a main focus as an output from this paper.

Main technicalities that require attention:

- There is confusion about smectite - is it present or not? Is it primary in the rock and becomes illitised? It is stated that the conditions are not favourable for its formation hydrothermally, but there is confusion within the writing that makes the role of smectite here confusing for the reader (me).

- Define the protolith rock better and show that it is the same protolith in the gouge and wider fault zone - this must be done before any mass change calculations can be made

- Mass gain/ loss and isocon analyses: Group elements in figures - ie by colour to different "generations" or types of alteration that you describe. Such alteration should be systematically described before you investigate mass changes. Careful of language regarding loss/ gain; enrichment/ depletion. It is the loss of elemental components from the system (oxides as presented) that you are quantifying. It would be good to show an isocon plot of gouge vs wider fault zone (representative) as it is likely the gouge formed from the wider fault zone and this would be interesting to test. Additionally, throughout the results and discussion mass loss is referred to on many occasions without any reference to possible volume loss which may be important when thinking about the mechanical stability of the system. You could do this by looking at the reactions driving the loss and relative densities of different phases involved if you do not have densities of the different rocks measured. However, fig. 6 indicates there is also some mass gain happening - this should be discussed in context with reactions and mass losses that are suggested to occur. Can you split LOI into H2O and CO2 roughly by assuming all CO2 is attached to Ca? This would be rough but an estimation (with error bars) would be nice, plotting LOI like this is not very meaningful and may be misleading - for example you state the gouge has less H2O than surrounding fault zone, despite it having a significantly higher proportion of clay - how can this be? I think here you are ascribing lower LOI to lower H2O, when in reality your documented breakown of calcite in the gouge means the lower LOI is due to loss of CO2, not H2O.

Printer-friendly version

Discussion paper

- Where is there evidence that the reactions and changes you note in the fault zone (in the near surface) are due to the most recent Wenchuan earthquake and not previous earthquakes when these rocks were at a deeper level? For example, the chloritisation reactions you describe would need to be at at least 150C which is very unlikely in the near surface where they have been sampled. Perhaps this was not the aim, but the way it is presented indicates that the changes you document are due to the recent Wenchuan earthquake in shallow subsurface. Please clear this up.

- Link breakdown of specific minerals to what you show in your mass loss/ gain analyses better - can you link this to relative timing based on your petrological observations? This can then help to develop and test your hypotheses on coseismic and postseismic reactions and the drivers for these reactions.

- Evidence needs to be presented for the coseismic reaction drivers - stated as thermal pressurisation and dehydration drives mass loss - 1. what is the evidence for either of these processes (you need to tie it all together) 2. how do these processes contribute to mass loss? What reactions do they facilitate and how? There is literature on this which should be investigated and discussed along with the discussion of these data. What are the possible alternative processes that may drive the changes you see?

- The current discussion of data needs to be improved, relating the presented data to the proposed mechanisms better as well as drawing on the vast literature to discuss these findings in context with different processes elsewhere. Only once this is done can conclusions about the effect of fluid-rock interactions and coseismic reactions on seismic slip be commented on. The final discussion section requires a complete rewrite to satisfy this.

This is by no means an exhaustive review, some considerable work is required before the finer details can be finessed, and attending to those in this review would be largely irrelevant given the substantial rewrite required.

Interactive comment on Solid Earth Discuss., https://doi.org/10.5194/se-2020-117, 2020.