

Interactive comment on “The 2018 Lake Muir earthquake sequence, southwest Western Australia: rethinking Australian stable continental region earthquakes” by Dan J. Clark et al.

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Dear Authors, I have received one review for your manuscript plus 11 answers of colleagues that declined to review it, some of them declined also after having accepted to look through the manuscript. In order to keep the review process relatively short I reviewed the manuscript and in the following I am presenting my comments on the manuscript.

The present manuscript uses an interdisciplinary approach to study the 2018 Lake Muir earthquake sequence occurred in southwest Western Australia. The sequence consists of two Mw 5.3 and 5.2 mainshocks and associated aftershocks. The Authors

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analyze the sequence mainly via interferometric wide swath SAR images, field mapping of the scarps produced by the events and earthquakes relocation and analysis. While the characterization of the seismic sequence and associated surface deformation is innovative and very interesting, the manuscript in its entire is quite confusing since the reader cannot properly understand which is the main scientific message the paper seeks to deliver: from one side there is a description of the 2018 Lake Muir earthquake sequence, and from another side there is a re-assessment on Australian seismicity. This point has been also raised by Referee 1. To improve the manuscript and make it a potential contribution for Solid Earth I suggest focusing on the characterization of the seismic sequence, its surface deformation and propose some explanation for the longer ruptures in comparison to the commonly used scaling relationships. In order to improve this part, I also suggest making a comprehensive figure where data are integrated to give the possibility to the reader to pick-up a collective picture of the entire dataset.

In the following I am highlighting some aspects that should be improved.

Title: Change in the title the part dealing with rethinking Australian stable continental region Earthquakes.

Introduction: this is an introduction focused on Australian earthquakes, lake Muir sequence, its geological and morphological settings. For an international journal it would be more appropriate an introduction presenting data on moderate magnitude seismic sequences, their associated surface deformation and surface breaks (length). At line 96 the Authors say: “LiDAR dataset (see Supplementary Information) revealed the presence of grain in the landscape”. Is it possible to better explain the meaning of grain in the landscape or add a reference for it?

Location of seismicity. As also pointed out by Referee 1, large uncertainties might affect the location of small magnitude earthquakes occurred during the sequence and therefore some sentences are not properly supported by data. Here you are some examples. At lines 285-295 the Authors infer fault geometry by aftershock distribution

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(e.g. Figure 6 and 8). To me this dataset is not enough to depict fault geometry, some good examples of fault geometry from aftershock distribution are presented in (Waldhauser et al., GRL 2004; Valoroso et al., Geology 2014; Shelly et al., JGR 2016; Chiaraluce et al., SRL, 2017).

Paragraph 3.5 Relationship between moment magnitude and surface rupture length amongst Australian cratonic earthquakes. In Figure 9.c there are only 3 data, the other panels build on Clark et al., 2014 BSSA where Length vs. M for Australian earthquakes are plotted in figure 11, and the Authors themselves at the end of the paragraph say: "The authors recognise that these relationships are highly conjectural and are based on very limited data. Consequently, the authors invite additional researchers to augment these data to fully scrutinise the legitimacy of the relationships". I suggest removing this paragraph.

Discussion

Paragraph 4.1.3 Co-location of thrust and strike-slip events: This is a quite big speculation since the resolution of the data do not allow for this, or data are not well presented to convince the reader about this. Provide an integrated picture to support the co-location. The sentence starting at line 443 and saying: "In general, the volume in which aftershocks are located corresponds to a volume of positive Coulomb stress change resulting from the main shock (Figure 8)", is not 100% consistent with aftershock distribution. I suggest to significantly reduce this part and incorporate it in the discussion on the seismic sequence.

Paragraph 4.1.4 Mechanisms for strain localisation in Stable Continental Region (SCR) crust. This paragraph is not strongly related to the data presented in the manuscript but mainly based on literature. I suggest removing this part.

Paragraph 4.2 One-off ruptures from moderate to large magnitude earthquakes in the cratonic regions of Australia. This paragraph mainly builds on earthquakes occurring in 68, 70 79, not extensively discussed in the present manuscript and as the Authors

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themselves say at line 586: "With few examples, it is not possible to draw conclusions with any certainty". In addition the final part of the paragraph is highly speculative since I agree with the Authors that systematic analysis of stress drop for recent moderate-to-large ($MW \geq 5.0$) Australian earthquakes should be undertaken to test the nature of stress drop relative to surface rupture to provide further constraint on the expected rupture dimensions of Precambrian stable continental region earthquakes in Australia. I suggest removing this part.

Paragraph 4.3 Migration of the locus of moment release in the Southwest Seismic Zone. The data presented in the manuscript: a) a seismic sequence with 2 M larger than 5 earthquakes, and b) a distribution of the seismicity from 1960 for SW Australia, are not enough to provide a solid scientific background supporting the migration of the locus of seismic moment release. I suggest deleting it.

4.4 Future use of InSAR for earthquake studies in Australia. This paragraph is more likely a technical report for scientists interested in using InSAR for earthquakes studies in Australia and therefore I consider it inappropriate as the final paragraph of the discussion. I suggest removing this part.

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