

Solid Earth Discuss., referee comment RC2
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Comment on se-2021-91

Laurent Bollinger (Referee)

Referee comment on "Tectonic Geomorphology and Paleoseismology of the Sharkhai fault: a new source of seismic hazard for Ulaanbaatar (Mongolia)" by Abeer Al-Ashkar et al., Solid Earth Discuss., <https://doi.org/10.5194/se-2021-91-RC2>, 2021

« General comments »

This article by Al-Ashkar et al -Tectonic geomorphology and paleoseismology of the Sharkai fault- documents a newly discovered active fault in the close vicinity of Ulaanbaatar, Mongolia's capital city.

The authors mapped the surface trace of the fault using Hi-res pleiades images and estimate cumulative tectonic offsets of geomorphic features along strike. They excavated the fault, documenting quaternary sedimentary units affected by deformations, and describe the faulting associated to the occurrence of two paleoearthquakes. The geological units deformed by these two earthquakes are dated by radiocarbon dating of bulk sediments, and bracket the time of occurrence of the two earthquakes. The dating indicates that the last earthquake happened after 860+/-85 AD and that the penultimate occurred between 1515+/-90 and 945+/-110 BC.

The article exposes implications of these results in term of earthquake potential realisation along the fault / hazards. These implications fall within a large bracket of values -associated with substantial uncertainties - that mainly depend upon strong hypothesis but are clearly exposed by the authors.

I find this work relevant, the authors convincingly show:

- That some quaternary geomorphic features are offset along a >40 km-long fault

- That two earthquakes affected the young sediments exposed within the excavation
- The inter-event time deduced from the bulk sediment radiocarbon ages is a rare estimate for a fault in central Mongolia ; most of the faults being not associated with multi-earthquake records.

Overall, the manuscript is well written and the paleoseismological results clearly exposed. The claims are supported by data and illustration. The figures illustrating the morphotectonic part of the article and the trench logs are clear. The discussion and conclusions present implications at the right level, evaluating the consistency of the results (associated with substantial uncertainties) to previous ones in the vicinity (partially discarding some of the most extreme scenarios when inconsistent with the regional knowledge). I have only a few specific remarks requiring clarifications.

I therefore accept this manuscript after what I would regard as minor revisions.

Here follows a list of specific comments which need clarifications and technical corrections

%%%%%%%%%%**Specific comments**%%%%%%%%%%

Part 1 Introduction and context :

I find the introduction not well structured. Indeed, in my opinion, the succession of paragraphs from line 50 to the end of the introduction go too much back and forth (e.g. from paragraph line 50 : Ulanbaatar exposure to earthquakes, then active faults, then geology, the Ulanbaatar exposure and risk, then the targetted faults

I suggest either :

-to separate the general introduction from the local seismotectonic setting.

-or to change the order of the paragraphs of the present introduction so that the succession go less back and forth

Table 1 :

You estimated 7 cumulative offsets of geomorphic features along the fault, and found that two fall around 57 meters and three around 35 meters. I think that a discussion regarding whether the geomorphic features offset by these quantities could be related (or not) with a specific climatic events would enrich your work.

Line 289-290 and Figure 15g

The geological units logged in the trench are well described in the text. However, a point remains unclear to me : several faults are mapped as possibly affecting the base of Unit U11 (red dashed line on figure 15g). In the meantime the text mentions that « Between 0 and 3m and between 5 and 7.5m all ruptures terminate at the top of U30 and are truncated by the upper erosion surface» (see line 289-291). This is either not coherent, or the text do not sufficiently expose the observations and their uncertainties.

minor blemishes and technical corrections

Introduction :

Line 32 : why opposing strike slip and uplift ? structure and motion ? replace by « numerous strike slip structures and minor thrust or normal faults ... »

Paragraph around line 55 : Figure 2 should be referred in that paragraph, before introducing the local fault names.

Figure 2 : Gunj fault is missing on this figure. The kinematics associated to Avdar and Sharkai fault are missing

Paragraph 85 : about 1.5 million in the capital of 3.2 million : unclear, rephrase

Line 86 : insert 'airport' in « replacing the actual 'airport' too short and now too close to the city »

Line 91 : suppress « , which shows clear evidence for a major seismic activity » or replace it with something less strong. It is still the introduction and you already mention your results are clear and strong. The reader will make its own opinion.

Line 97 : with 2 earthquakes, it is difficult to speak about a « recurrence time ». An « inter-event time between the penultimate and latest earthquake » is more appropriate.

Line 102 : you mention the « very well-expressed geology » but I missed a description of the lithological nature of the bedrock along strike. Could be helpful to understand the along strike variations of morphology of the two compartments of the fault.

Line 124 : replace « the « large extensional step-over, by « a » large....

Line 148 « limiting possible records of displacement » : rephrase

Table 1 : Specify the GPS location (in geographic) of P1 to P7 , as well as the location of the trench

Table 2 (and the text) We miss an information about where the samples were sent (which laboratory ?), what was their lab number (this table could also present their Delta 13C, and recall that the radiocarbon age were determined on bulk sediments)etc .

Line 220 : Could you be more specific about the nature of the massive Carboniferous bedrock ?

Indeed, in your introduction, you mention that the lithologies exposed in the region's carboniferous rocks comprise sandstone, mudstone, conglomerates ... but I found no mention to what was found in the field along strike Sharkai fault and in the trench.

Line 257 : suppress « both »

Line 279-280 : suppress the parenthesis after 15 b-e , replace 14g by 15g

%Data and ressources

I suggest adding information on the radiocarbon dating (which lab ?) within that section.

I suggest listing the date of acquisition of the images that were used in the study (at least the date of acquisition of the images illustrating Figures 5-7-8-9-10-11-12.

%References :

I noticed that some recent references (post 2018) on faults in UB vicinity and central Mongolia are missing probably because your study took place years before the most recent works published was undertaken. Updating the bibliography with recent references will make your paper more exhaustive and up-to-date.

Line 512 : Replace Reimer, P : by Reimer, P et al., ...

Laurent Bollinger

Arpajon , 22/10/2021