Author’s Response

Topic Editor decision (Patricia Cadenas Martínez)

Dear authors of manuscript Egusphere -2023-2563,

I went through the revised manuscript, the track-changes version, the supplementary file, the interactive discussion and the reviews. The manuscript is data-driven, properly contextualises the study, describes the data interpretation and the achieved results, and discusses the implications for better understanding the evolution of the studied area.

I think that the manuscript will benefit from a last review and rewriting to fix three minor main points:

> *We thank the editor for their positive review and helpful comments on the manuscript. We have addressed the points raised and changed the manuscript accordingly. Our responses to each point are in cursive with line references behind:*

1) In section 4, maybe the authors can move the comparison of the geomorphic index to a summary paragraph at the end of section 4 or at the beginning of section 5 to summarize the results and introduce the discussion. In the current version, analysed geomorphic index are compared in different paragraphs in sections 4.2, 4.3, and 4.4. It may make difficult to follow the description of the geomorphic index themselves and the comparison is distributed in different paragraphs. A summary paragraph may provide an excellent introduction for the discussion.

> *We have added a paragraph summarising the results of the geomorphic analysis at the start of the discussion to make it easier to follow and serve as an introduction to the discussion.*
>
> *“The quantitative analysis of the geomorphic response of the main rift faults has shown that the Wutai, Xizhoushan, Shilingguan and Huoshan faults show the highest geomorphic response (Fig.7; Table 1), they are classified by high HI (mean HI > 0.35), ksn (mean ksn >60) and RI values (mean RI > 250). Of those the Shilingguan and Huoshan faults are located within the RIZs and exhibit N-S as well as NE-SW trending fault segments. The Taigu and Jiaocheng faults that have the lowest geomorphic responses and show low values for all three geomorphic indices (mean HI < 0.3; mean ksn < 40; mean RI < 200). In between these two groups are the Hengshan, Zhongtiaoshan and Luoyunshan faults, described as medium geomorphic response in Table 1. In the following we will discuss the significance of these results and discuss*

the possible influence of the pre-existing structures described in section 4.1." (Line 382-389)

2) Maybe the authors can move the description and classification of the RIZs that is currently in section 5.2 to the introduction and focus section 5.2 to apply this to the RIZs along the studied zone and discuss the implications for the studied parameters. This may provide the reader a background about RIZs in the introduction and may enable the authors to discuss straightforwardly their results in the discussion section.

We have moved the highlighted parts about the classification of RIZs from the discussion to the introduction to improve the readability of the manuscript.

"As RIZs evolve, they can become breached and eventually link up the rift basins (Kolawole et al., 2021a). RIZs can also be classified on their evolution stage (Kolawole et al., 2021a), i.e. whether the RIZ is unbreached, partially breached, recently breached, or breached. This is assessed based on two observations: 1) Presence of a breaching fault that extends from one rift segment to the other segment, and 2) Presence of an established physical linkage of depositional environments of both rift segments (i.e., drainage connection between both segments). Recently breached and breached RIZs have an established breaching fault and connect the drainage of two different rift segments, but breached RIZs shows less topography due to increased subsidence during the longer time period since the RIZ was breached. Unbreached RIZs show no apparent structural connection and no drainage connection, while partially breached RIZs may have a breaching fault partially connecting the rift basins but the drainage integration has not occurred yet." (Line 59-68)

3) The study addresses different points so maybe the authors can enumerate the conclusions or distribute the information in paragraphs considering the topic (e.g., summary of the study, applied geomorphic indices and results, interpreted basins and RIZs, fault activity and seismic hazard, structural inheritance, tectonic model,...)

We have numbered our conclusions now, with each point addressing a specific topic: 1. And 2. Geomorphic indices; 3. RIZ evolution and seismic hazard 4. Inheritance control on rift evolution; 5. Tectonic model/ general summary:

"We applied three different geomorphic indices (R_l, k_{sn} and HI) to analyse the fault distribution and the geometry and occurrence of rift interaction zones (RIZs) along the Shanxi Rift to discuss the distribution of tectonic activity and

understand the role structural inheritance has played in its evolution and the seismic hazard posed by active faults within it. Based on our results we conclude the following:

1. *Geomorphic indices are a powerful tool to evaluate the fault evolution and activity and the segmentation of the Shanxi Rift.*
2. *Our study shows that lithology has a strong influence on the overall geomorphic signal of faults, as those with Paleoproterozoic crystalline basement in their footwalls have overall higher geomorphic values compared to faults with Palaeozoic-Mesozoic metasediments in the footwalls. However, comparing faults with similar basement geology can circumvent this problem. We found that overall HI is less sensitive to these variations of lithology compared to Relief and k_{sn}. Therefore, HI may be more suited to evaluating the tectonic influence on landscapes.*
3. *Within the Shanxi Rift, the RIZs that link the well-developed large Xinding, Linfen and Taiyuan basins, are the most active zones and show most signs of active drainage reorganisation. This has major implications for seismic hazard assessments as it hints towards zones which show more complex and more active patterns of faulting due to the strain concentration in the RIZs, experiencing increased seismicity. Linkage of the basins seems to be progressing towards the north, as shown by the increasing breaching status of the RIZs towards the south, which is possibly controlled by their initial geometry.*
4. *Structural inheritance has played a key role in the evolution and segmentation of the Shanxi Rift. The collision of the two component blocks of the NCC created a lithospheric scale weak zone, the Trans-North China Orogen (TNCO), which preferentially accommodates strain. The individual sub-basins of the Shanxi Rift form en-echelon aligned along a broad N-S trend which coincides with an upper mantle anisotropy fabric – a lithospheric manifestation of the TNCO. The mantle anisotropy is oblique to the NW-SE extension direction, while the NE-SW trending crustal fabrics are perpendicular to the extension direction. Early rift faults*

nucleated along NE-SW orientated basement fabrics, establishing basins arranged along the inherited N-S trend. As the boundary faults grew, they began to interact and form RIZs. Within these RIZs, the crustal basement inheritance further influenced and segmented the breaching faults and aided linkage across the basins. The faults within the RIZs both follow and crosscut pre-existing fabrics in the crust, creating a "zig-zag pattern" of small, segmented faults that eventually link up into singular throughgoing fault zones. Therefore, structural inheritance of pre-existing Precambrian basement fabrics and a locally rotated stress field resulted in the complex pattern of faulting observed in the RIZs.

5. *Our geomorphic study supports a constant strain field during the formation of the Shanxi Rift with minor changes of the extensional vector. We propose that the Shanxi Rift is a type-example of an oblique rift, with an observed pattern of faulting influenced by a postulated upper mantle anisotropy, crustal basement fabrics, as well as pre-existing faults." (Line 683-715)*

The reviewer provides some minor suggestions throughout the manuscript for a last review. I provide some further suggestions in the attached annotated pdf. Hope it helps.

Thanks for the further suggestions in the annotated pdf. We went through the manuscript and addressed these, the comments of the reviewer are addressed below.

Review (Peng Su)

We thank the reviewer for their positive review and constructive suggestions on the manuscript. We have changed the things mentioned and also addressed the minor suggestions in the annotated pdf. References to the changed lines are in brackets.

I just found some minor issues in your manuscript this time and most of them are technical corrections. I suggest you check the whole manuscript once again carefully. Please see the following comments and the attached file.

We have changed these minor issues and technical corrections in the manuscript. Thanks for highlighting these.

A relatively general issue, which I am not sure whether you need to change: The faults' names used in this manuscript are mostly not the names that the Chinese scholars used. For example, the basin border fault of the Linfen Basin is named the Luoyunshan Fault rather than the Linfen fault. The Luoyunshan Fault separates the Luoyun Shan (Shan = mountain) and the Linfen Basin.

Thank you for highlighting, we have changed the name of the Linfen Fault in the manuscript to Luoyunshan Fault.

Lines 660-663 (Figure 11): In the file "egusphere-2023-2563-author_response-version1.pdf", it says that you have "removed the mention of specific time steps"， but I still find there are "pre-Miocene", "Late Miocene", "Early Quaternary-present" in Figure 11 and these time steps have no references in the figure caption. Moreover, I suggest giving more details of Figure 11 in its figure caption. For example, make it clear about what the three different kinds of arrows denote respectively in Figure 11.

Thank you for noticing. We must have forgotten to include the updated figure, we have corrected this now and have updated the figure caption to make it more comprehensive. (Line 675-681 and Fig.11)