Unraveling the role of ancient orogens in present-day rifting using tectonic geomorphology in Shanxi, North China

Malte Froemchen, Ken McCaffrey, Mark Allen, Jeroen van Hunen, and Thomas Phillips

malte.froemchen@durham.ac.uk @Malte_Geology

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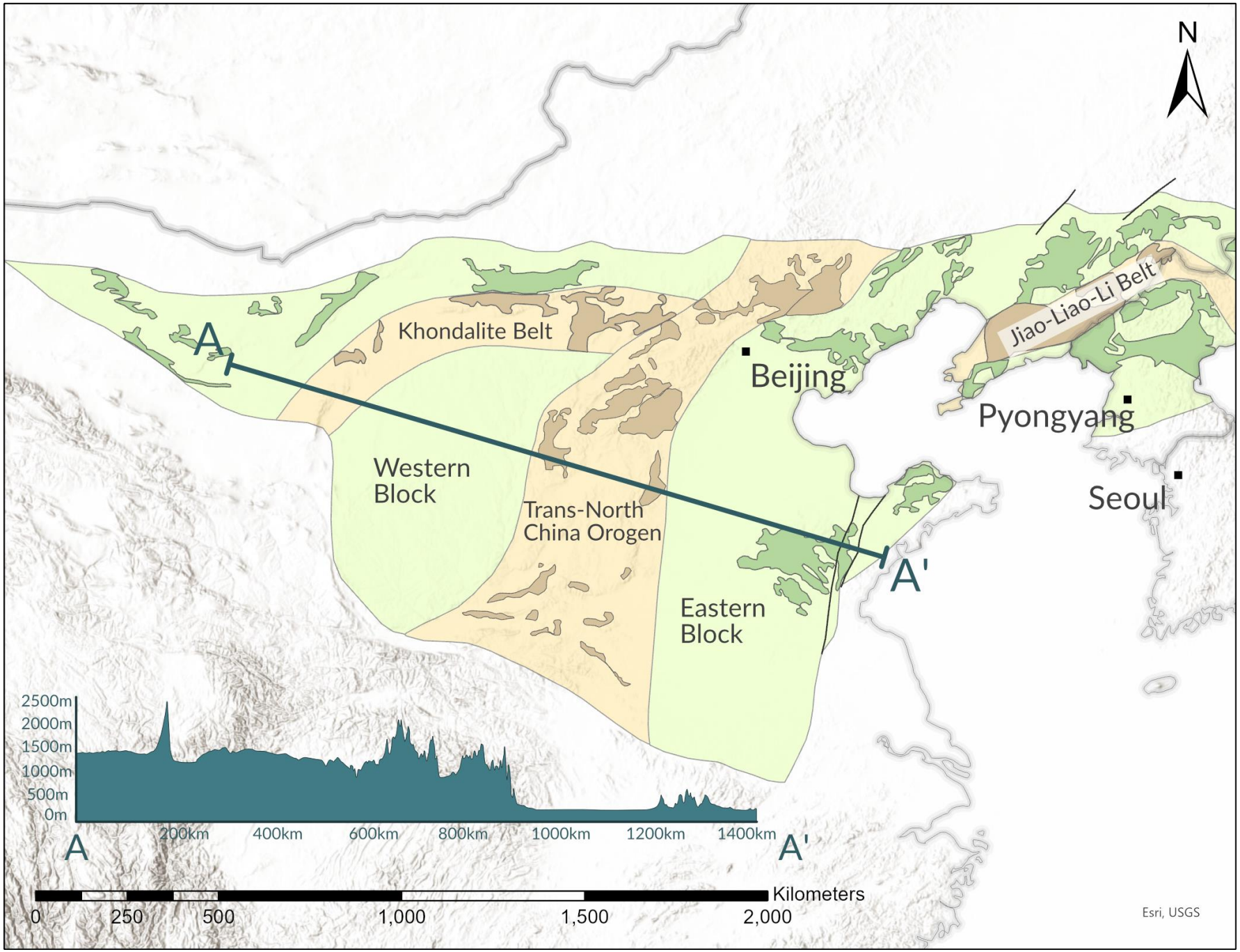


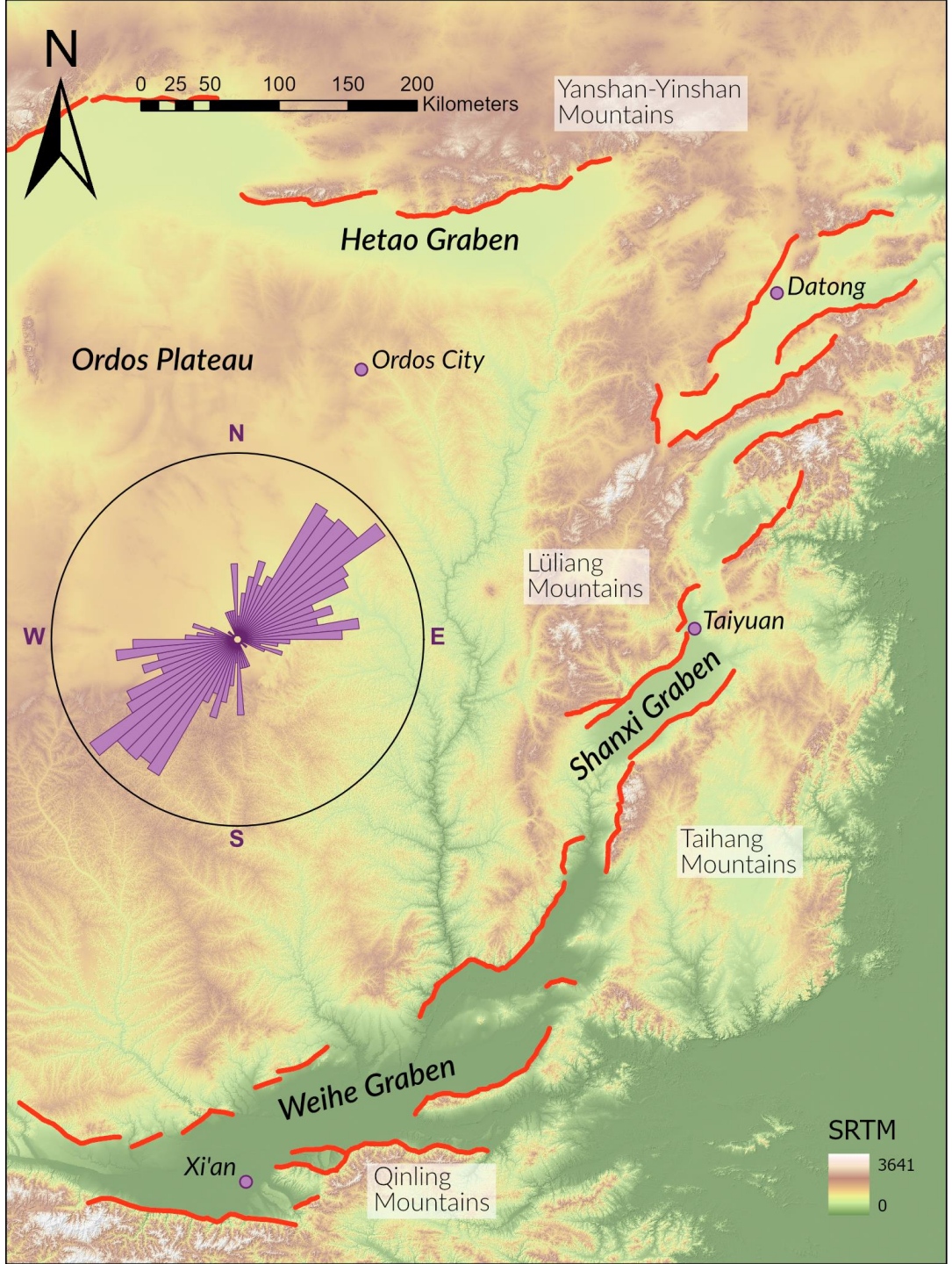
North China Craton Map

Collision of the Eastern and Western Block 1.8 Billion years ago formed the Trans North China Orogen (TNCO)
The Shanxi Graben developed right on top of the TNCO as shown in the topographic profile that shows high topographic relief in that area. The Eastern block saw a period of rifting in the early Cenozoic which formed the flat North China Plain. The Western block remains a relatively stable cratonic block.

Overview Map of the Shanxi Rift

Two main sets of faults in Shanxi: One striking mainly NE-SW with smaller faults trending broadly N-S (as shown in the Rose diagram).

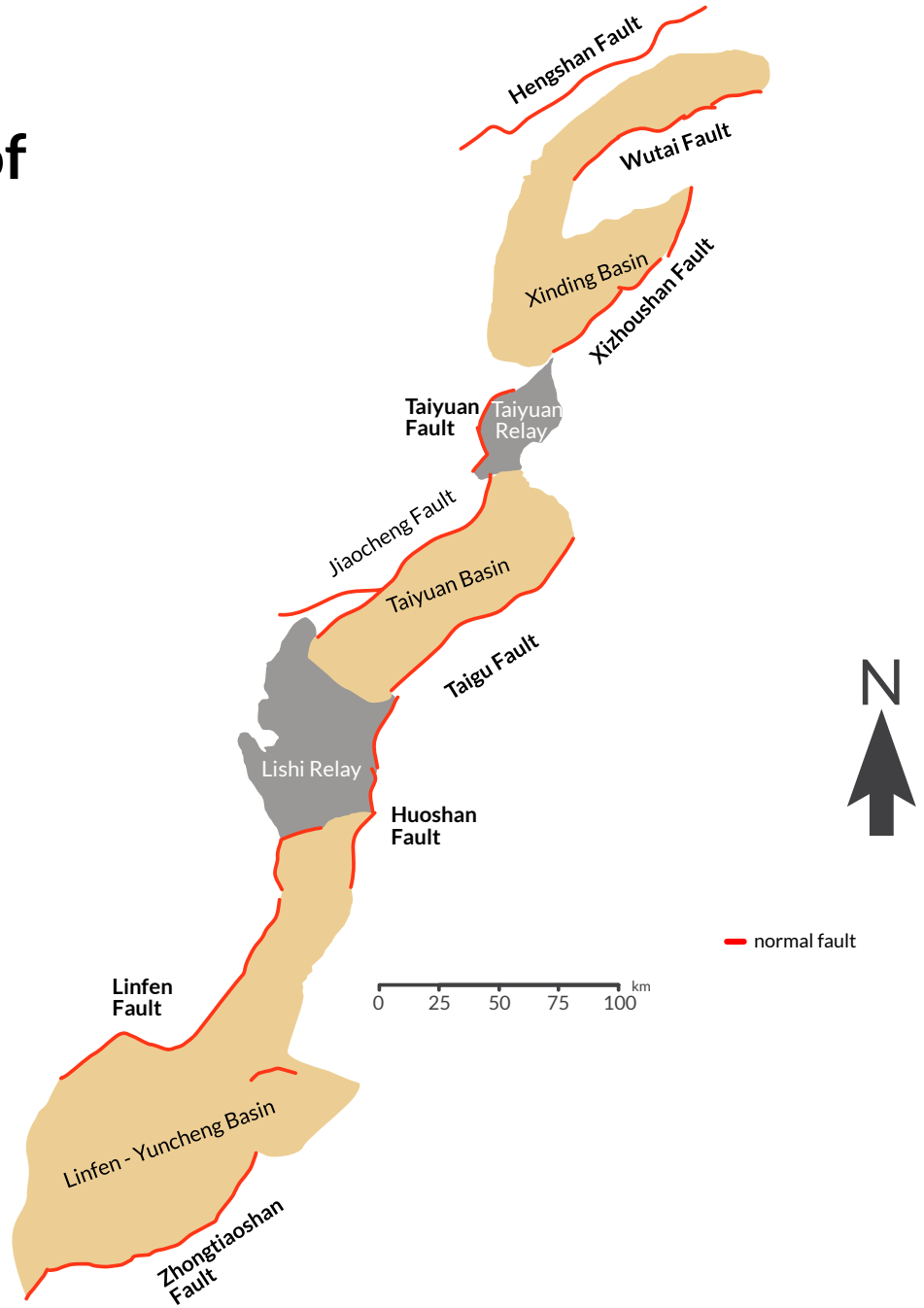
Mountainous uplifts to either side of the major basin bounding rift flanks (Taihang and Lüliang Mountains).



Rifts form around the Ordos Plateau (Hetao, Weihe, Shanxi) but the Ordos Block itself stays relatively stable with no major deformation accommodated.

Conceptual Fault Map of Shanxi

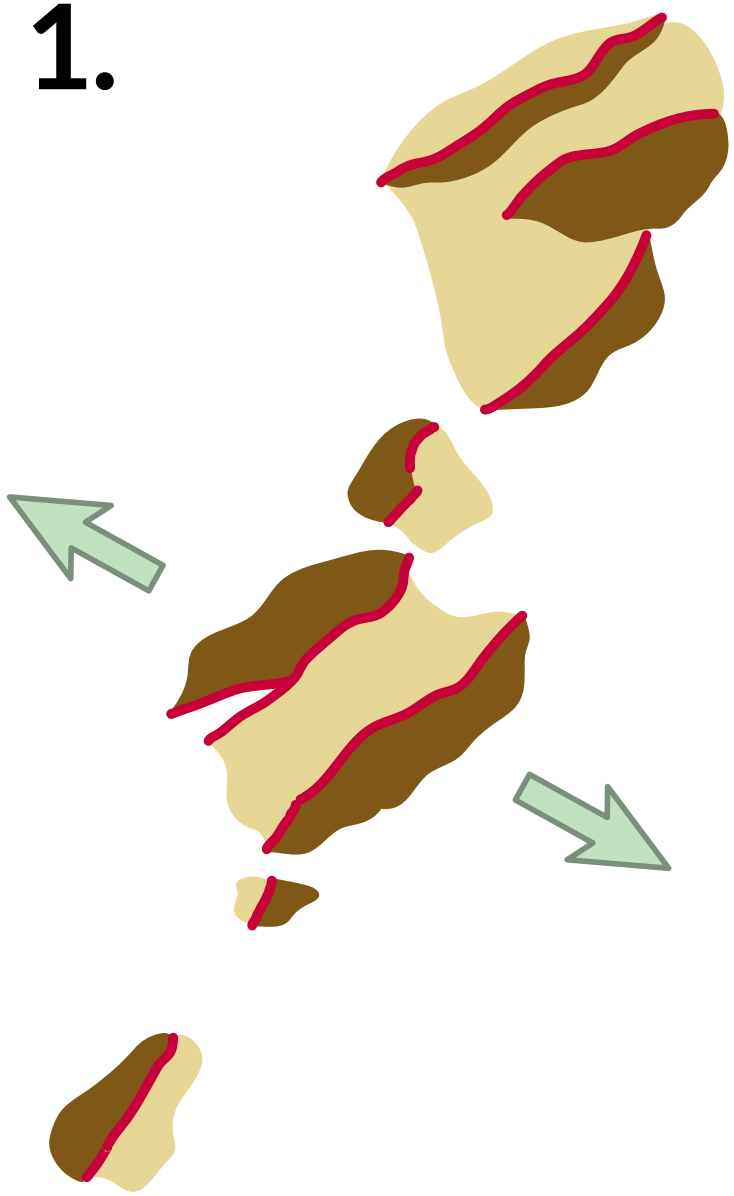
Names of the prominent large normal faults, basins and relays referred to in this study



Current Model to explain two sets of faults:

Two rift distinct rift phases with a switch in extension direction forms two different sets of faults

1.



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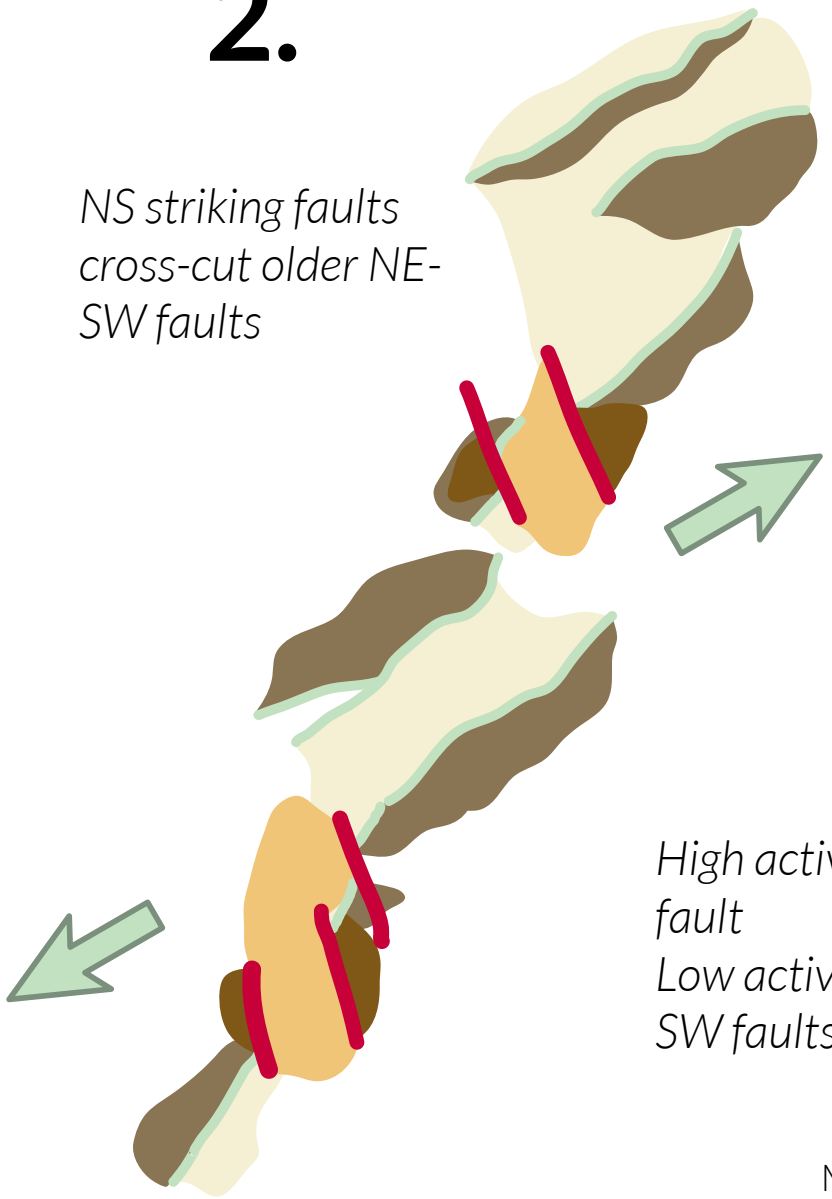


NS striking faults cross-cut older NE-SW faults

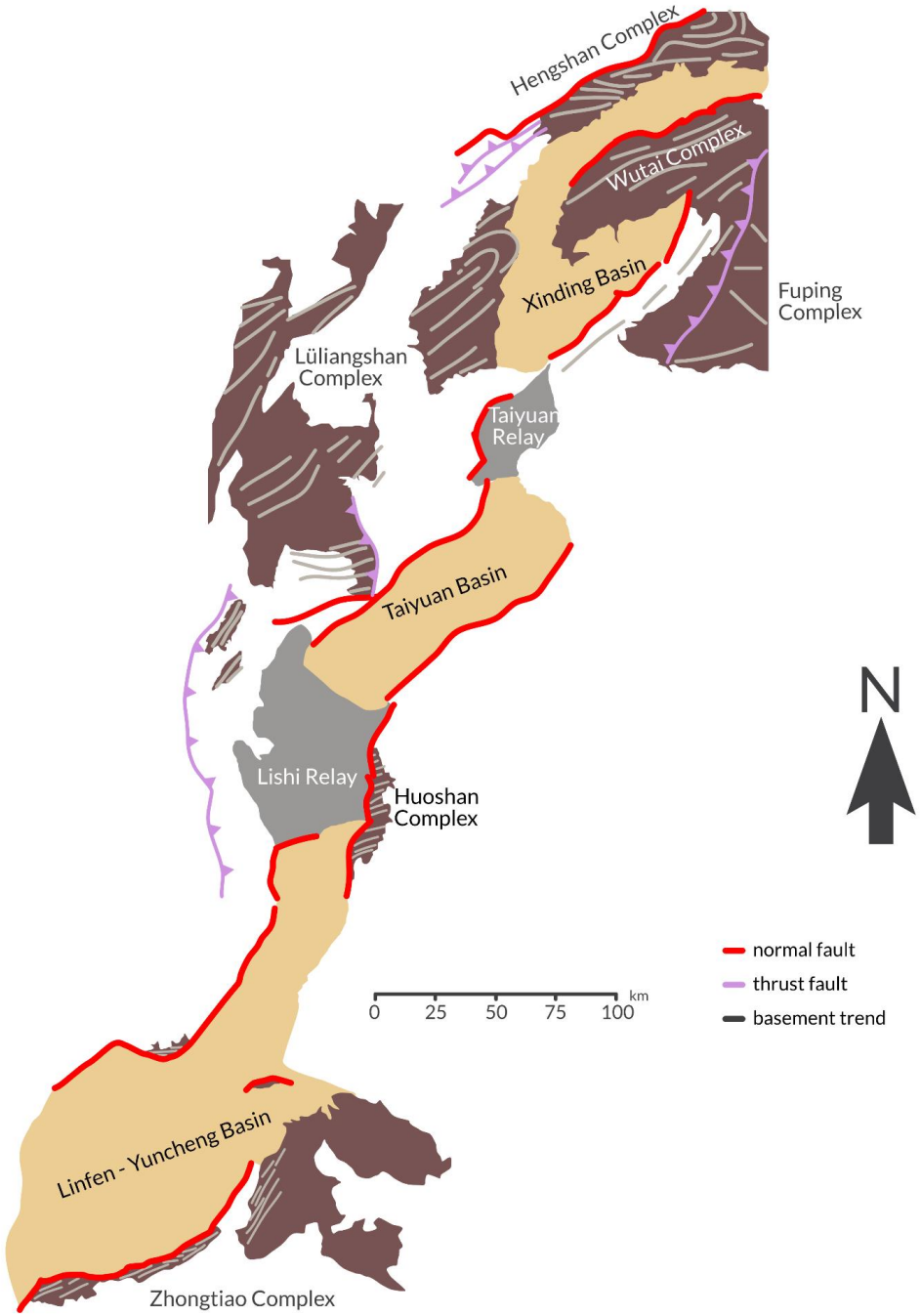
Two sets of faults with consistent length and orientation

High activity on NS fault
Low activity on NE-SW faults

Modified from Shi et al. 2015

Map showing location of Proterozoic basement and the structural trend of Proterozoic fabrics

Major rift faults in Shanxi uplifted and exposed Proterozoic and Archean basement in the footwalls. These were deformed during the formation of the TNCO. Do these fabrics influence the evolution, segmentation and orientation of the Shanxi Graben?



Data from Trap et al. 2007, Trap et al. 2009, Clinkscales & Kapp 2019, SBGMR 1989

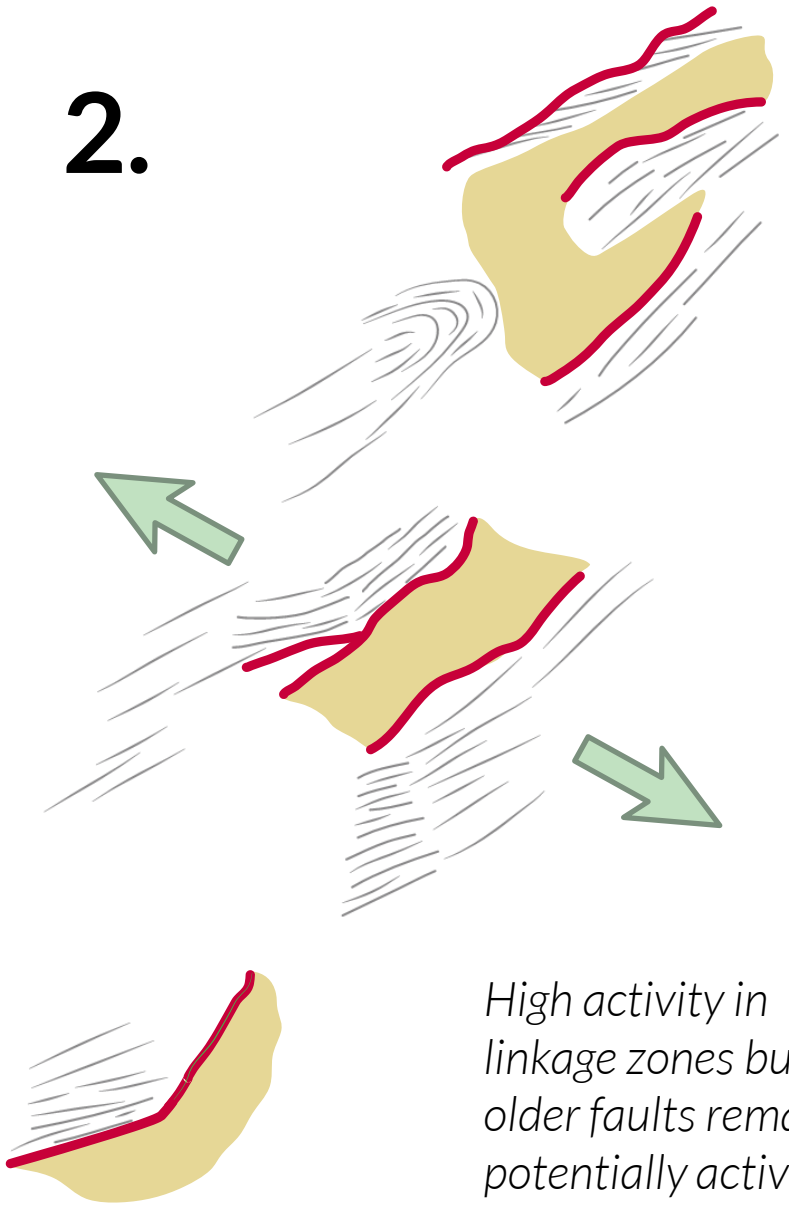
New conceptual model to explain two sets of faults:

1.

Rifting starts in heterogeneous crust that contains inherited Proterozoic fabrics

2.

Main rift faults exploit trends of basement fabrics that are preferentially orientated

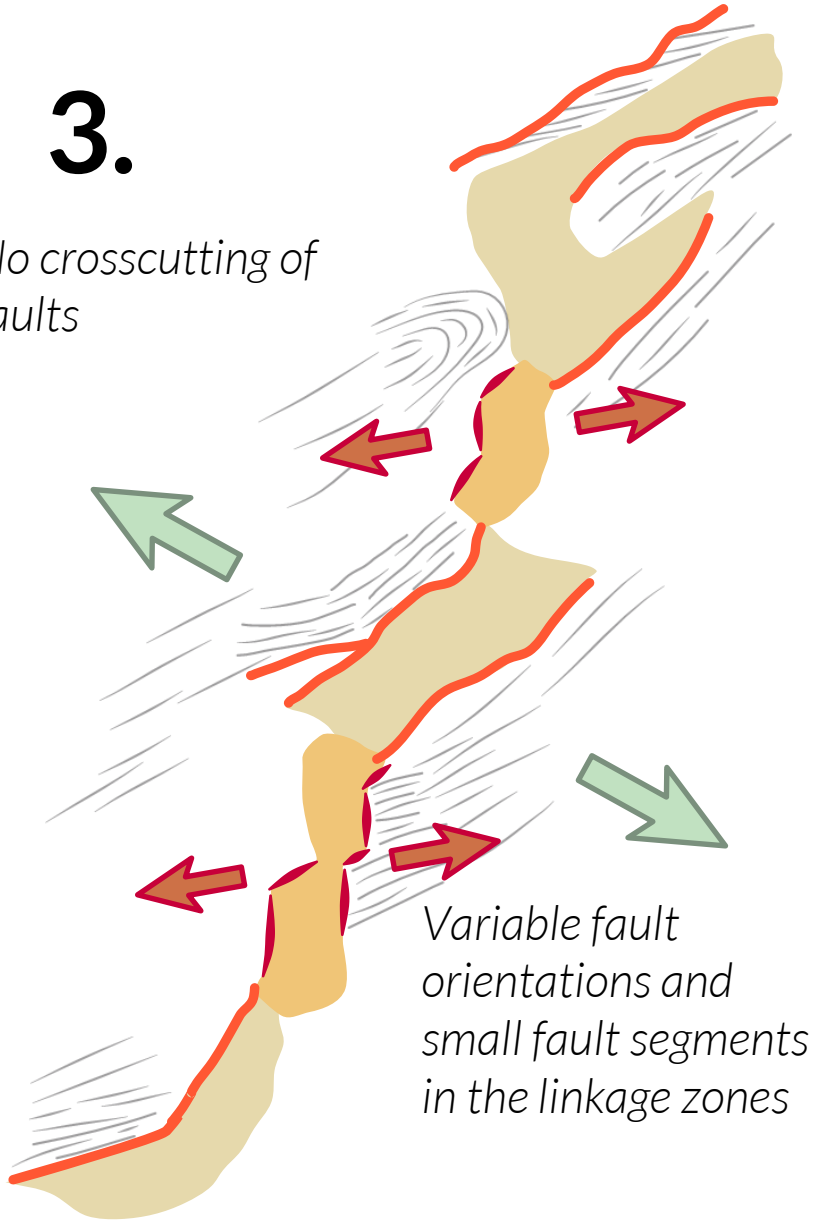


High activity in linkage zones but older faults remain potentially active

3.

Large basin faults pertubate the local stressfields leading to the formation of smaller NS striking linkage faults that cut across the main inherited fabrics

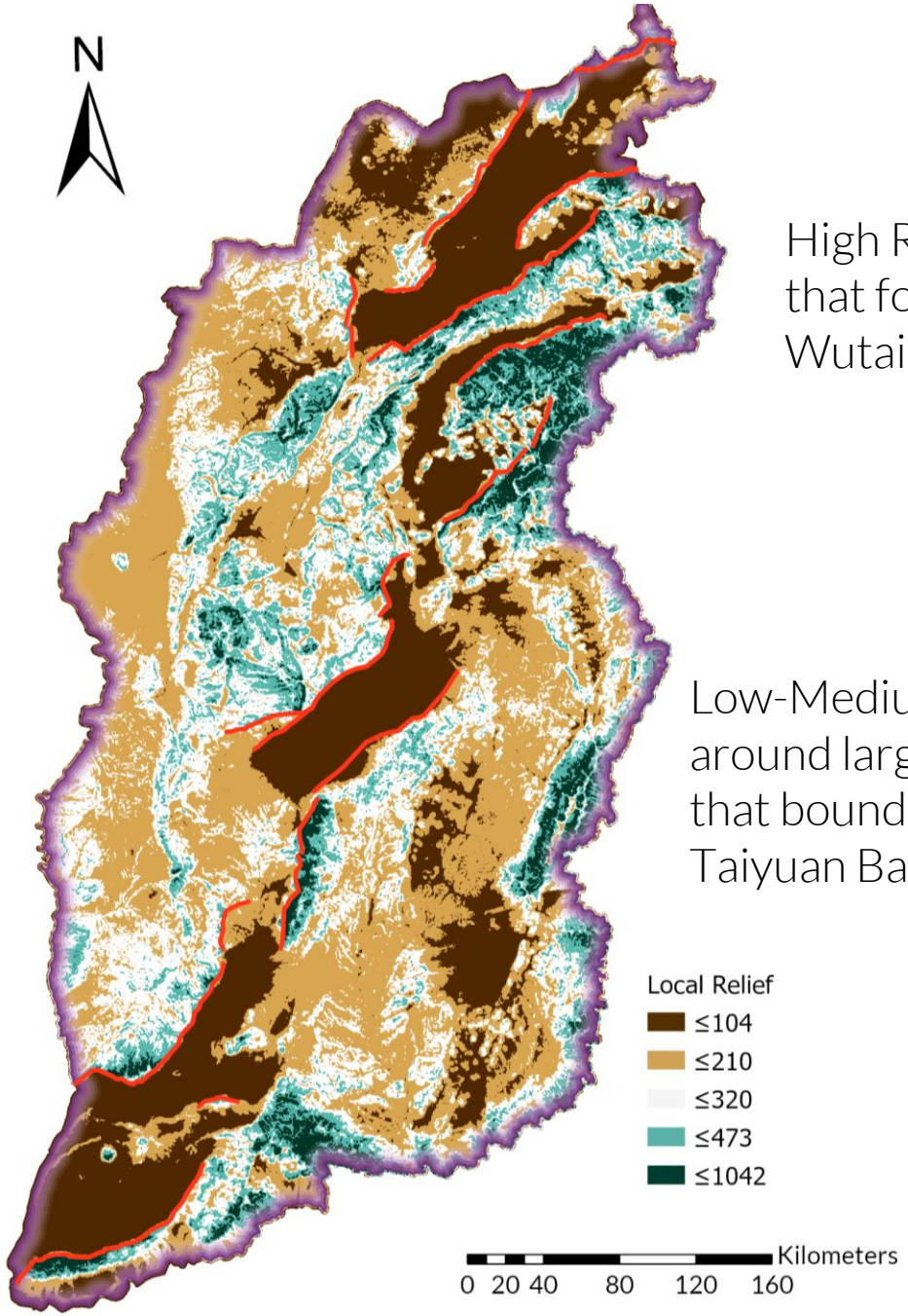
No crosscutting of faults



Variable fault orientations and small fault segments in the linkage zones

How can we investigate which model may apply? Tectonic Geomorphology!

Local Relief



High Relief around large faults that follow the Proterozoic trends: Wutai, Zhongtiaoshan, Xizhoushan

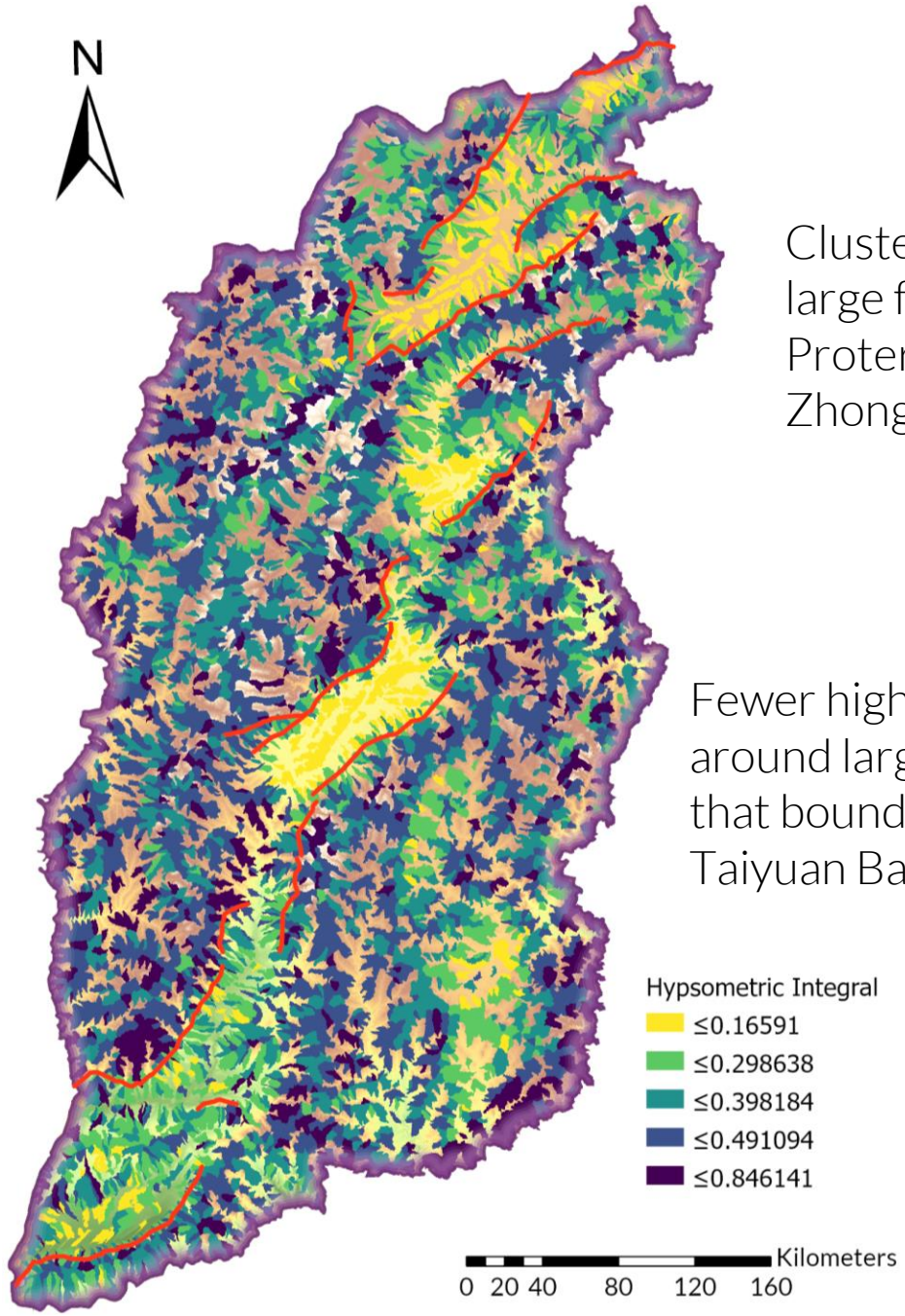
Low-Medium Relief around large faults that bound the Taiyuan Basin

High Relief around the linkage zones – Taiyuan and Huoshan

1km Radius

Hypsometric Integral

Local cluster of high HI basins around the linkage zones – Taiyuan and Huoshan



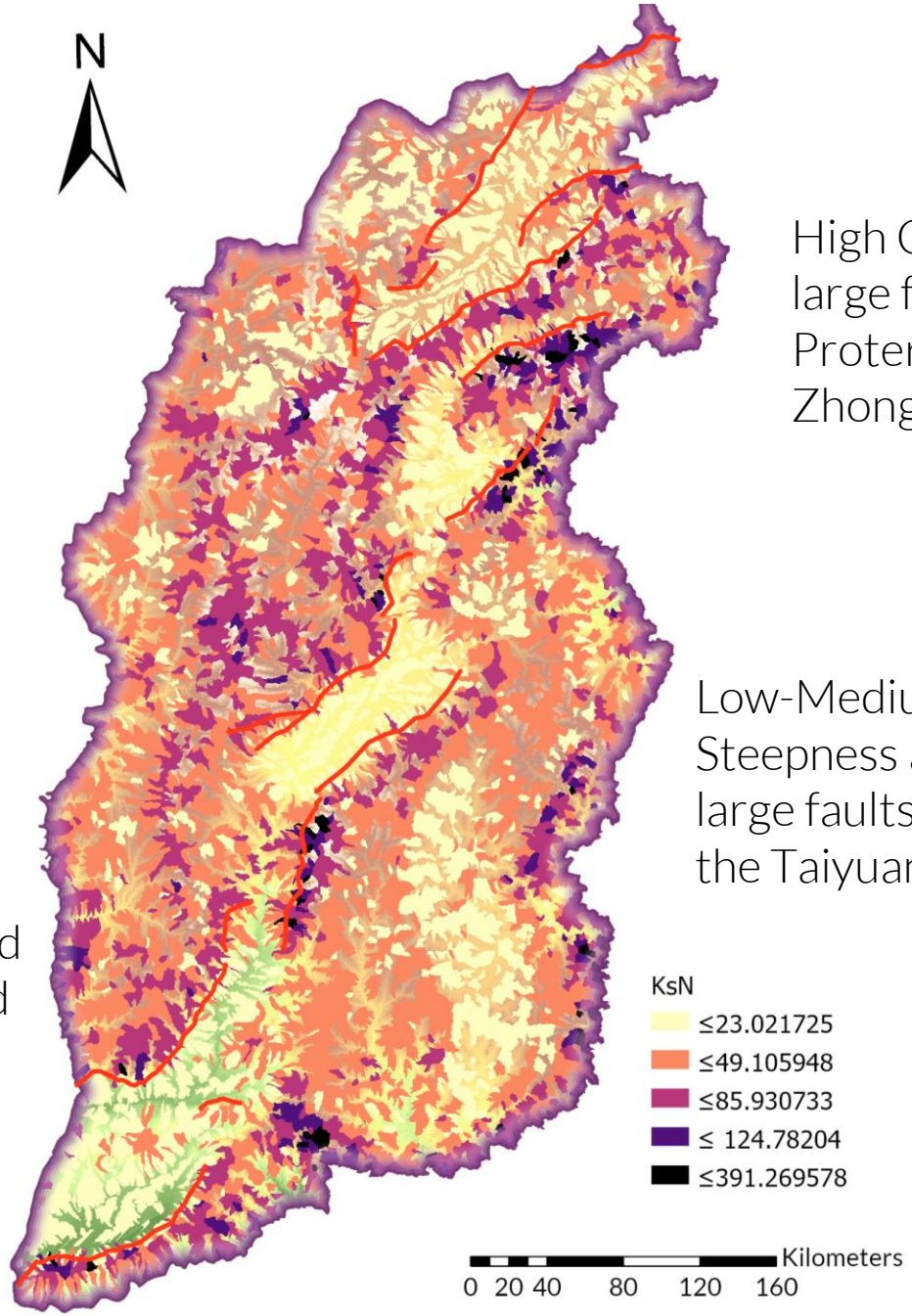
Clusters of high HI basins around large faults that follow the Proterozoic trends: Wutai, Zhongtiaoshan

Fewer high HI basins around large faults that bound the Taiyuan Basin

1st Order Drainage Basins

Channel Steepness (KsN)

High Channel Steepness around the linkage zones – Taiyuan and Huoshan



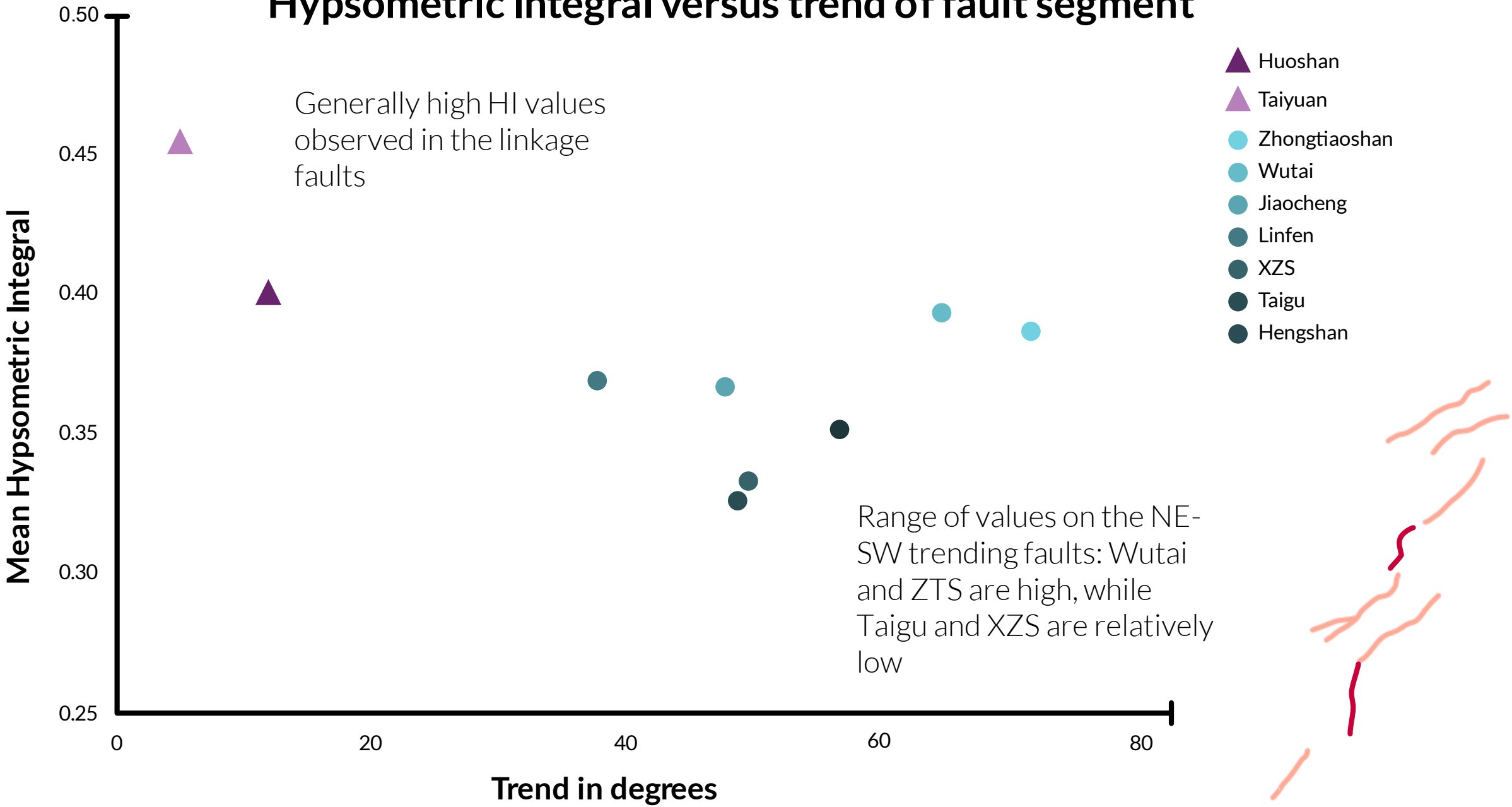
High Channel Steepness around large faults that follow the Proterozoic trends: Wutai, Zhongtiaoshan

Low-Medium Channel Steepness around large faults that bound the Taiyuan Basin

1st Order Drainage Basins

Similar in distribution to the local relief map

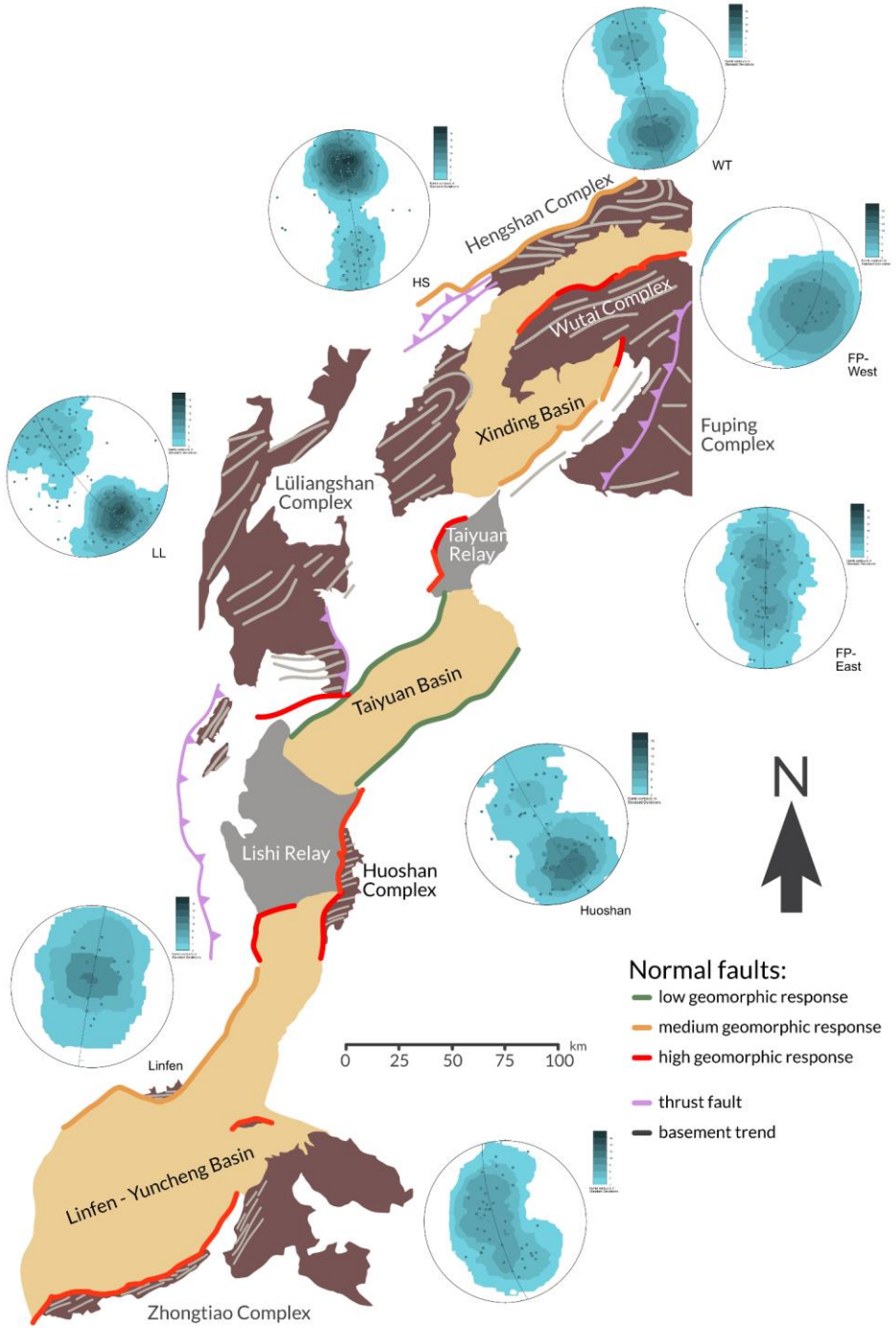
Hypsometric Integral versus trend of fault segment



Conclusions

Many faults follow trends of pre-existing structures

Geomorphic Response of Faults is distributed but concentrated in the linkage zones



Shanxi Graben may have evolved under a constant stress field with local perturbation cause faults to cross cut across the pre-existing fabrics

Map of colour coded faults according to their geomorphic response and contoured stereonets of the Proterozoic fabrics (Data from Trap et al. 2007,Trap et al. 2009, SBGMR 1989 and Clinkscales & Kapp 2019)

References

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