What can we learn from a geodetic source catalogue related to Mw ≥ 5 normal-slip faulting events in Tibet

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Summary: To explore how the N-S rifts play a role in response to the E-W extension in Tibet, we propose a geodetic source catalogue related to Mw ≥ 5 normal-slip events in Tibet during the past three-decades by using InSAR observations. In comparison to the GCMT catalogue, this independent catalogue consisted of 27 normal-slip faulting events with magnitude of Mw 5.3-7.1 exhibits a well robustness for detailed rupture characteristics of small-and-moderate earthquakes (e.g., rupture location, depth, dip and strike angle, and detailed slip distribution). These events delineate a northward bowl-shape along a symmetry axis of 87º E at striking of 20º, and their slips are concentrated at depths of <10 km. Various factors, including topography, tectonic structures, as well as deep lithospheric dynamics, have been used to any possible relationships related to the normal-slip faulting event behaviors in Tibet.

1. Introductions

- **N-S normal-slip faulting role in Tibet**

Geodetic measurements reveal a N-S shortening rate of 10-14 mm/yr across the central Tibetan, and which are transformed into E-W extension rate of 25 mm/yr and an uplift rate of 1-2 ±1.5 mm/yr.

✓Accommodating half of the total E-W extension, as well as the major strike-slip faults

✓Small scale structure and spatial dispersive

✓Low slip rate for each single one (< 5 mm/yr, most of 1-2 mm/yr)

✓Associated with small/moderate events (Mw 5-6)

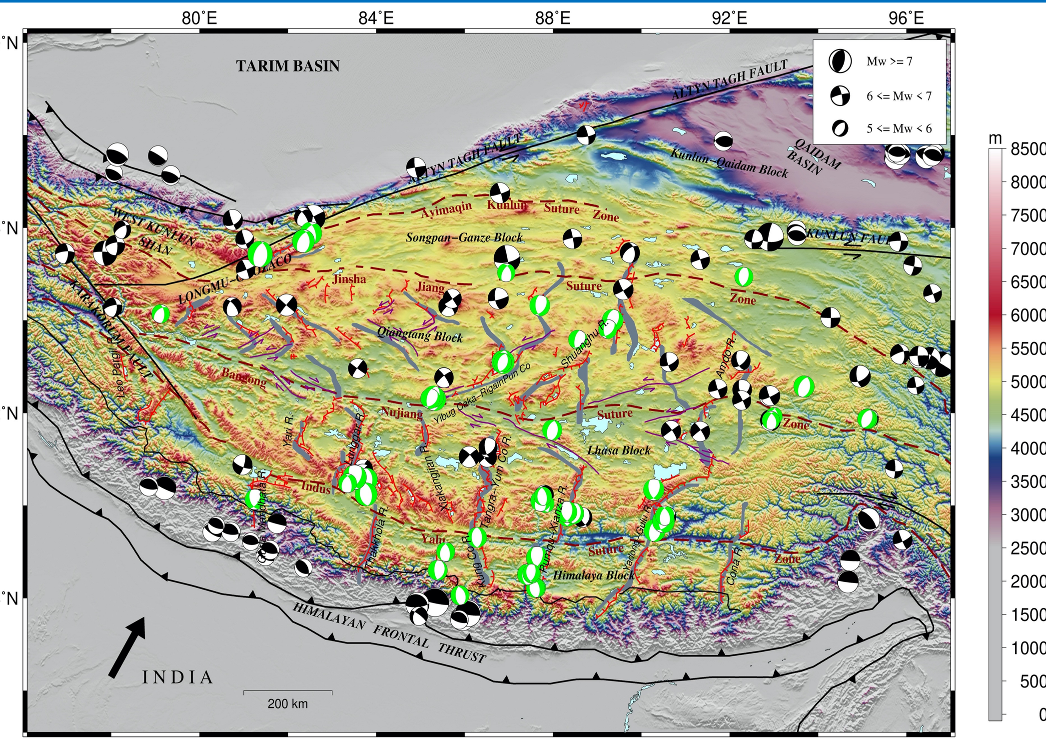

Fig. 1 Tectonic setting of the Tibetan Plateau and its seismicity in the past three-decades (M ≥ 5.0) derived from the GCMT catalog. Green beachballs denote the normal-slip faulting events. Dark red dashed lines indicate the suture zones in the plateau. Grey belts show the rifts and grabens. Thick black lines show the major thrust-slip and strike-slip boundary faults, and thin red lines indicate the normal-slip faults.

2. Geodetic source catalogue production

- **Preliminary event screening with interferograms**

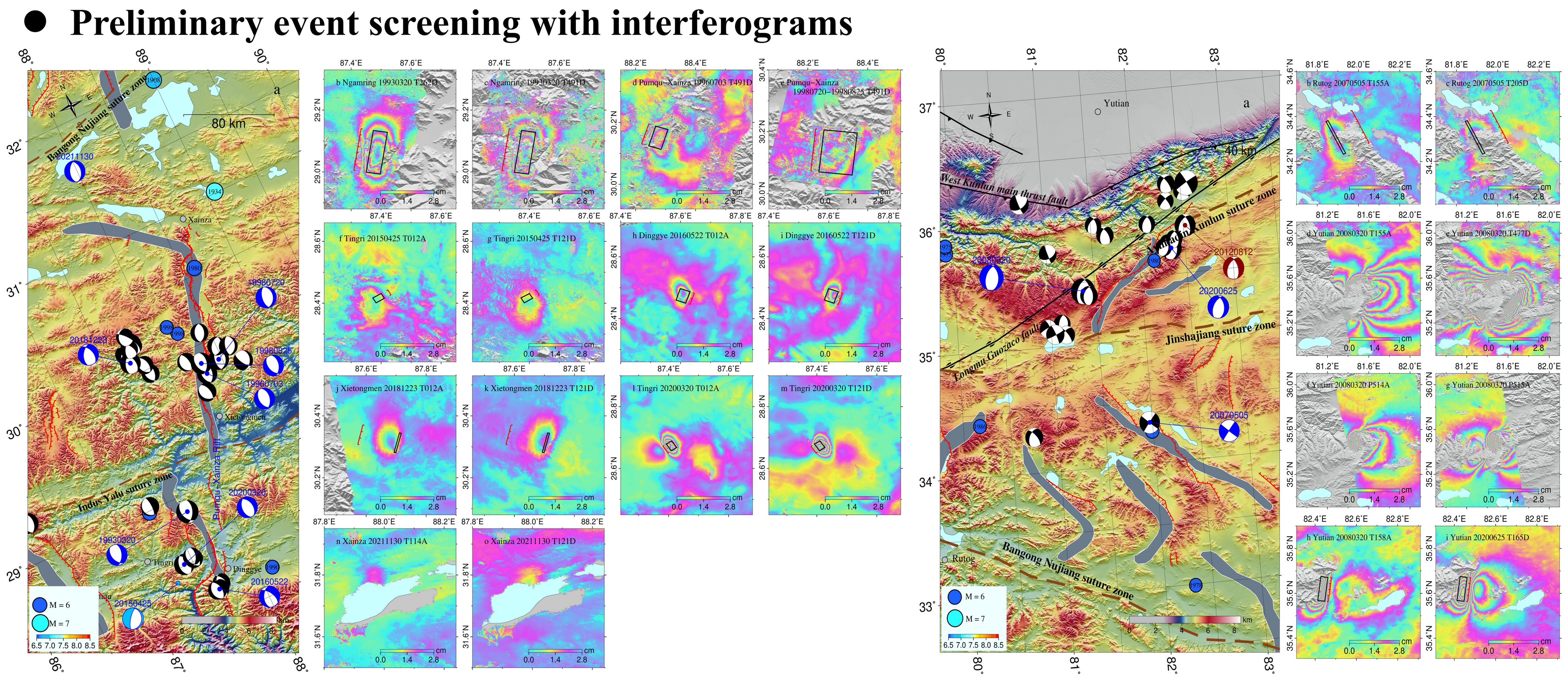

Fig. 2 Tectonic setting and the interferograms of available normal-slip events (Pumqu-Xianza and Yutian region)

- **Geodetic source inversion strategy**

✓GBIS inversion for the uniform-slip model

✓SDM inversion for the distributed-slip model

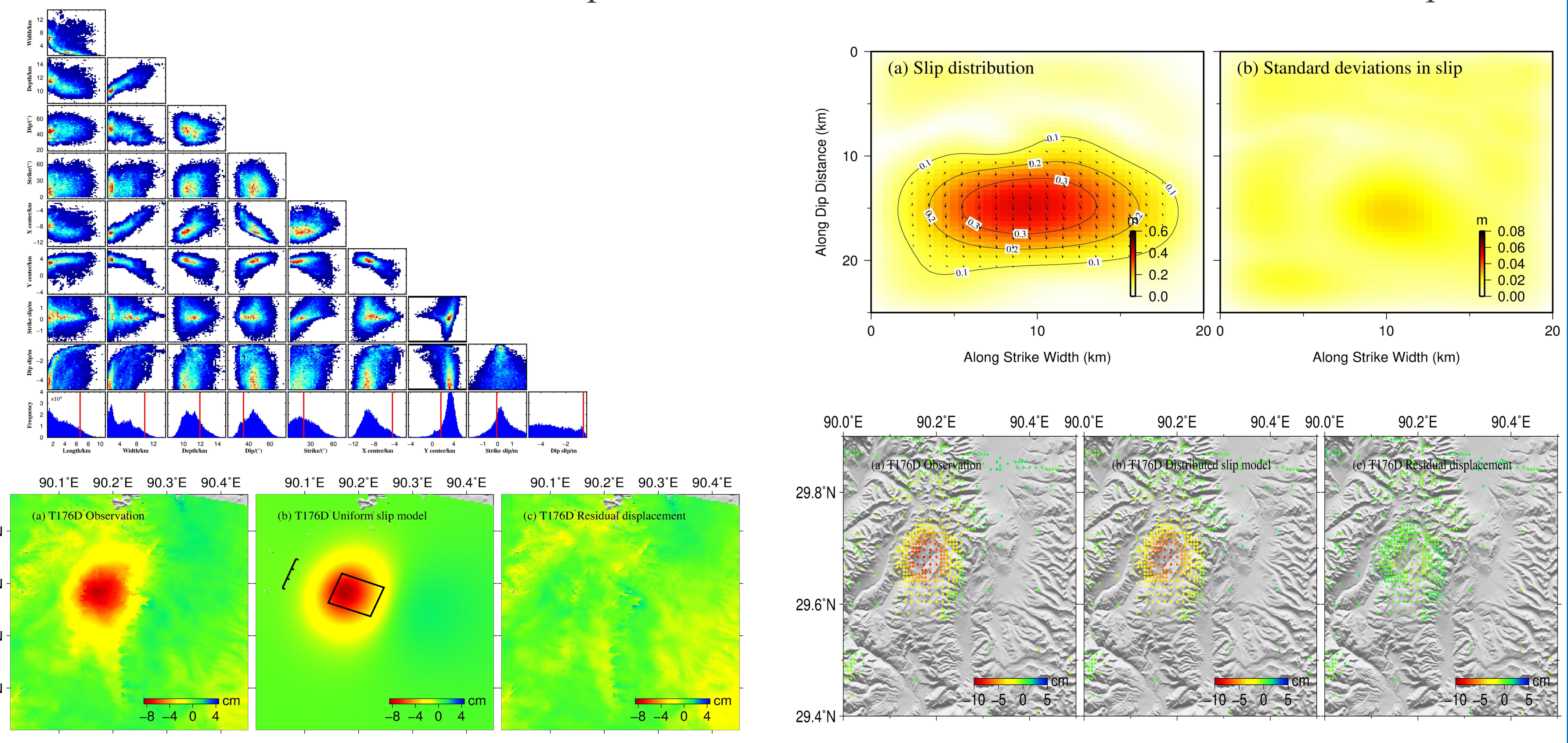

Fig. 3 In case of a geodetic source derived from a two-step strategy (uniform-slip and distributed slip)

- **Slip distribution models**

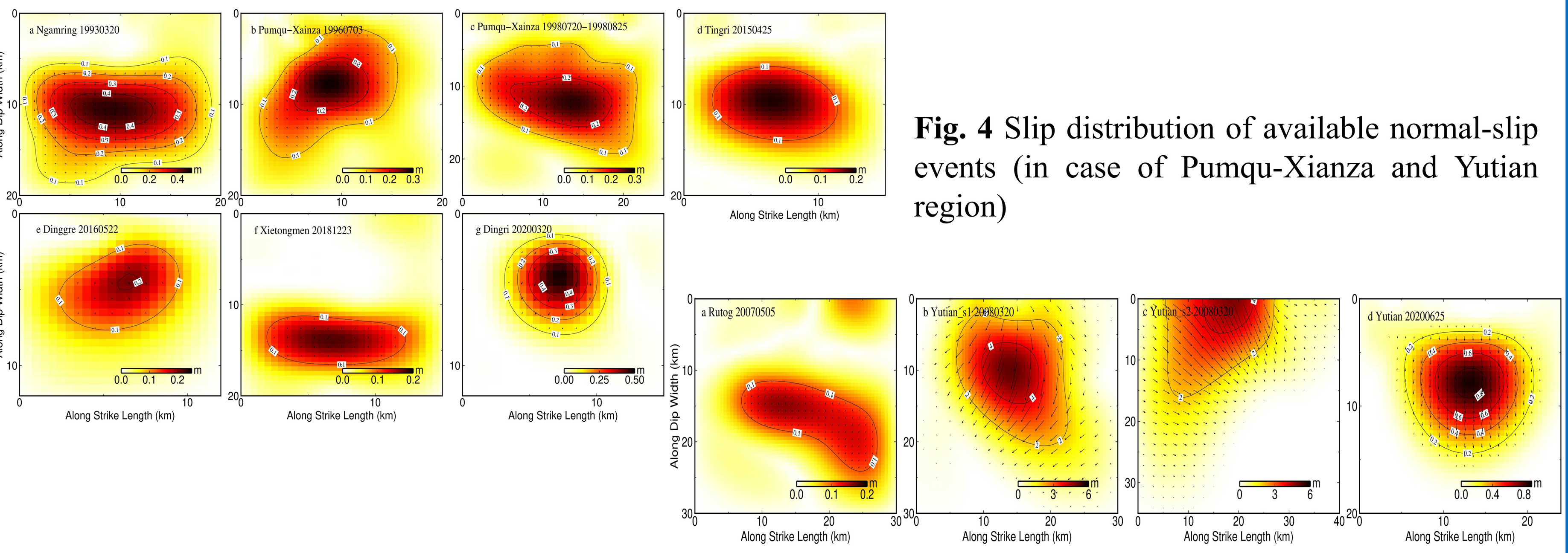

Fig. 4 Slip distribution of available normal-slip events (in case of Pumqu-Xianza and Yutian region)

3. Normal-slip faulting events and their implications

- **Events' pattern and its relationship to the topography**

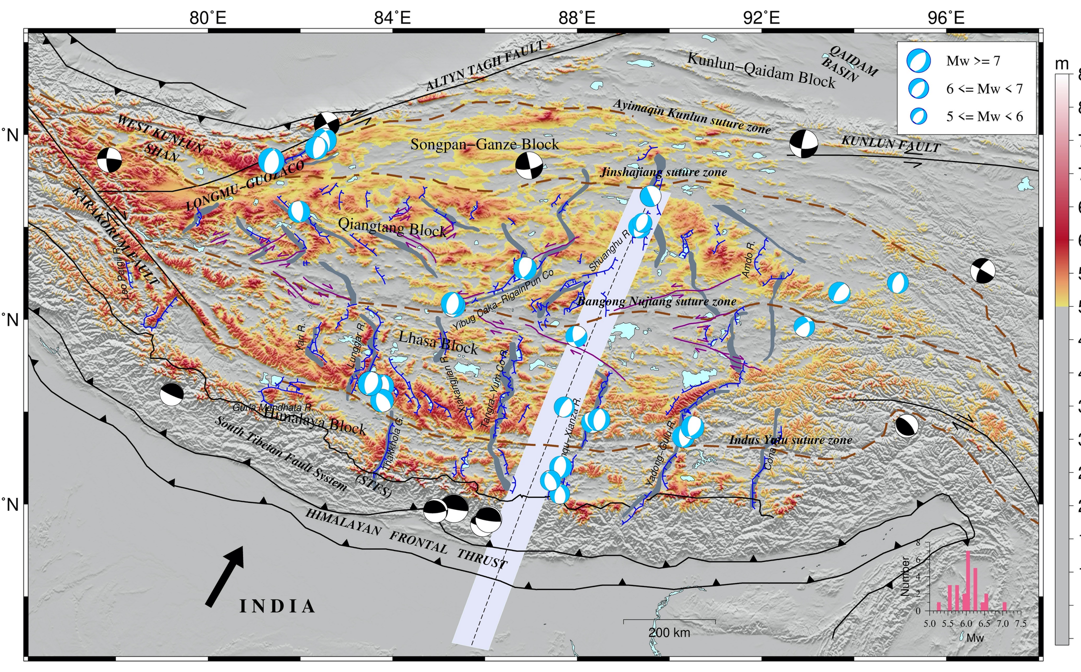

Fig. 5 Normal-slip faulting catalogue and local topography in Tibet

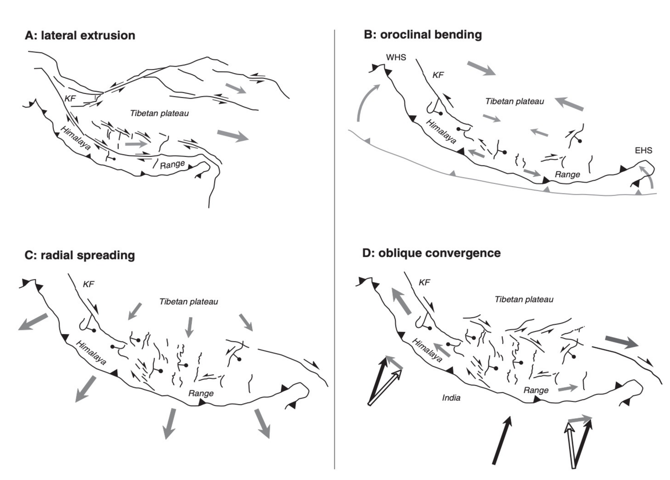

Fig. 6 Different deformation pattern suggested by Styron et al. (2011)

- **Extensional features in southern Tibet vs. northern Tibet**

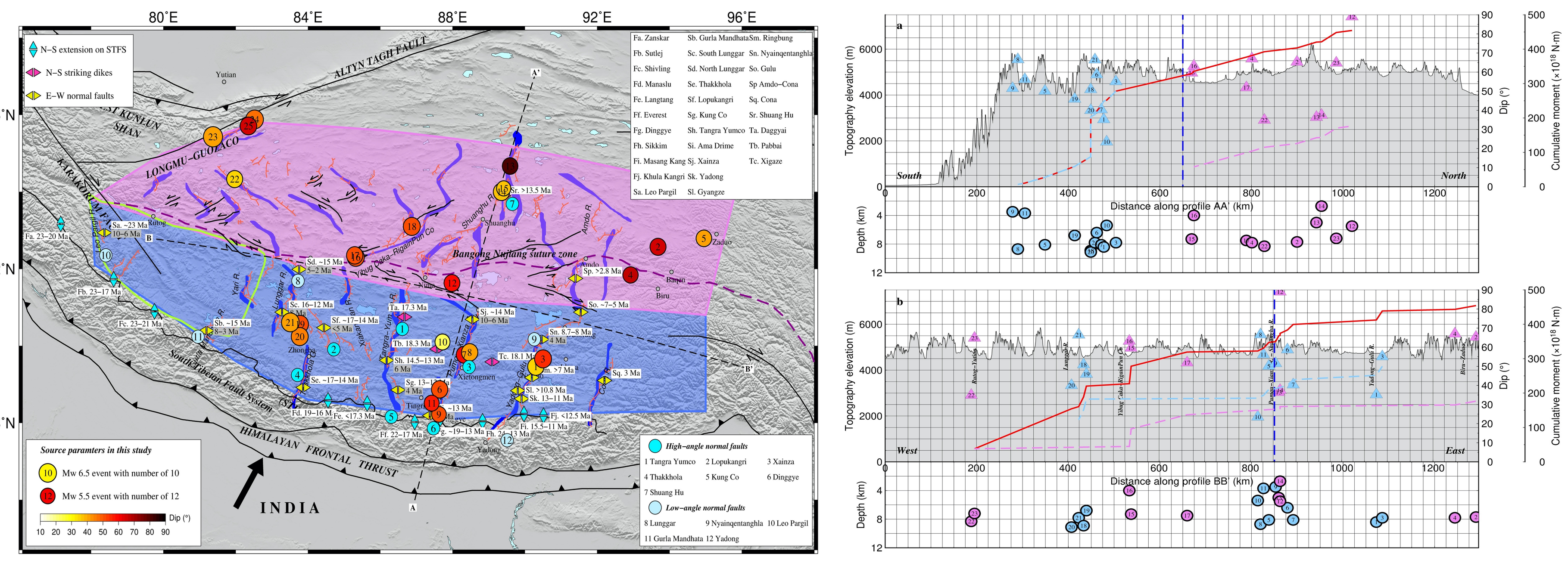

Fig. 7 Spatial features of the normal-slip faulting source parameters

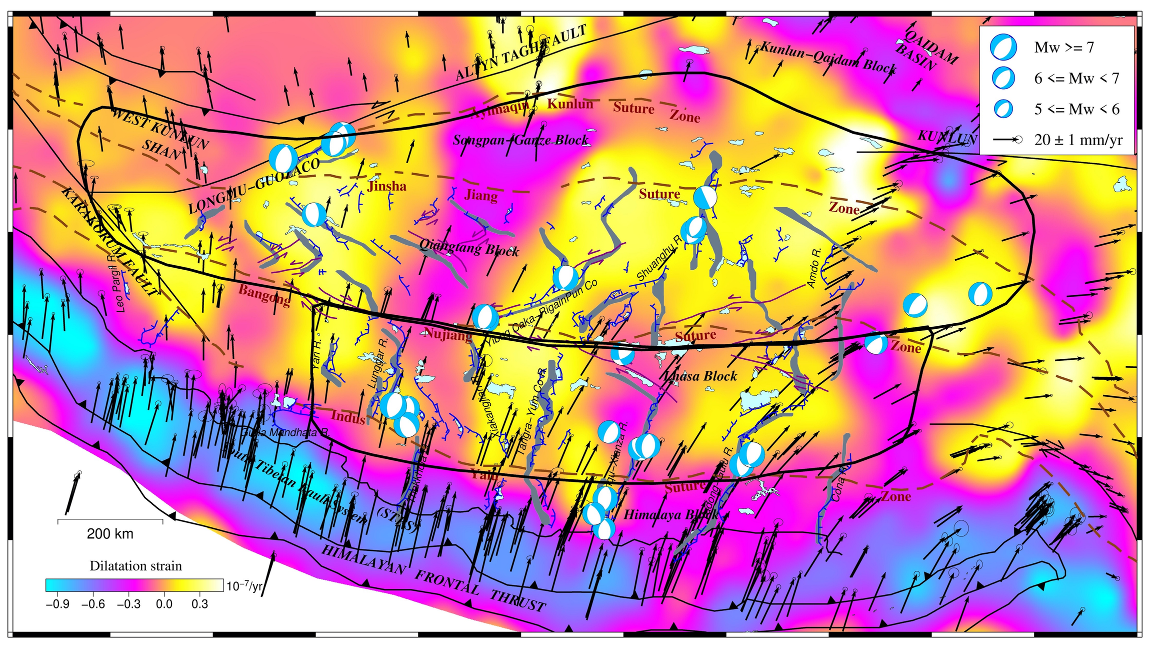

Fig. 8 GNSS velocities and dilatation strain (strain field is from Zheng et al., 2017)

✓Dip angles: approximate axial symmetry in south, but varied change in north ((developed vs. developing, old vs. young)

✓Location distribution: concentrated along the rifts in south, but discrete widely rifts and unknown secondary faults in north

✓Accumulated released seismic moment: high in south vs. low in north

✓Dilatation strain: small area in south vs. large area in north

- **Deep lithospheric dynamics and its possible affects to the shallow extension**

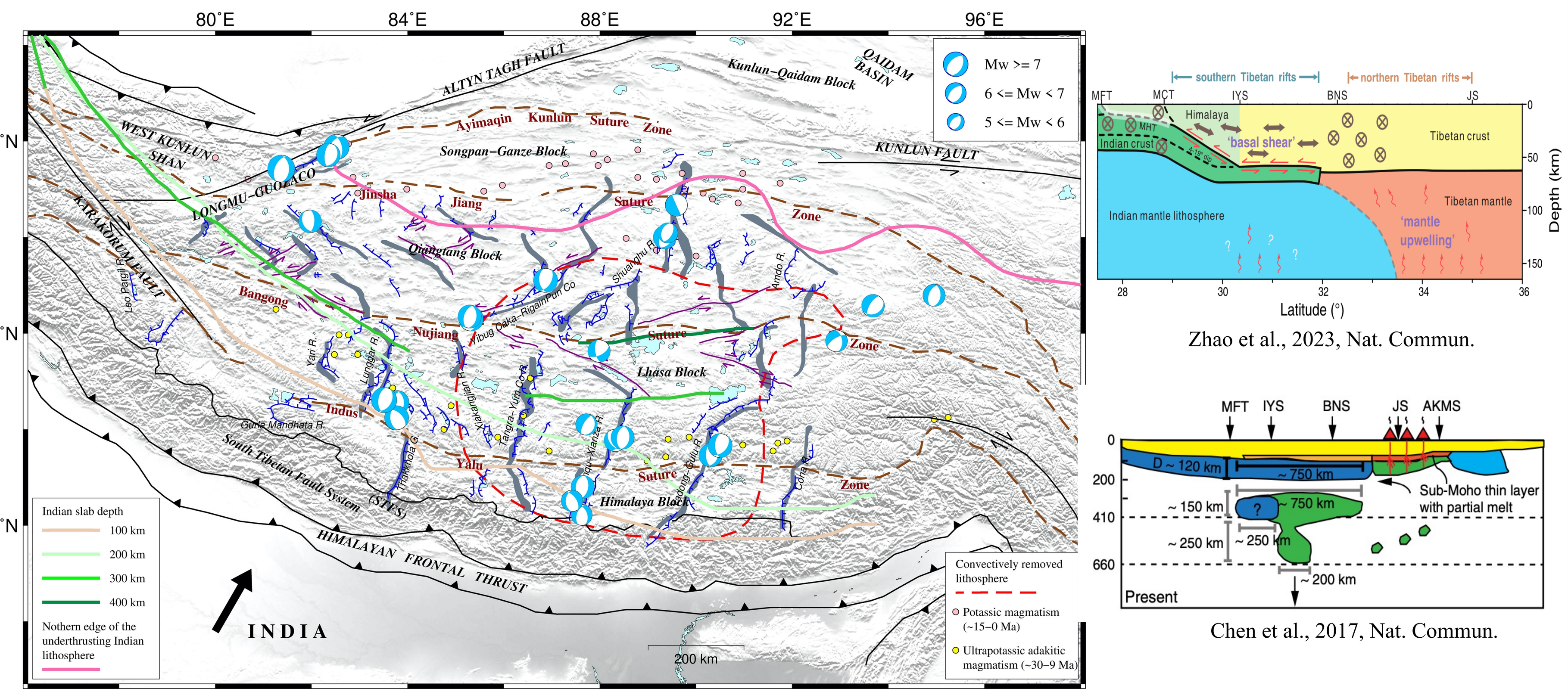

Fig. 9 Deep Indian lithospheric structures beneath the Tibet related to the shallow normal-slip faulting events

4. Conclusions

- 1. ICMT catalog exhibits a great potential to improve the focal mechanism of small and moderate events in contrast to that from GCMT and USGS.
- 2. Normal-slip faulting events shows a strong relationship to the gravity potential energy, and their northward bowel-shape pattern should be corresponding to the oblique convergence?
- 3. Different extensional features are shown in southern and northern Tibet, which should support the northward Indian plate shear force and the mantle upwelling?
- 4. Deep delamination dynamics can produce far-field crustal deformation and magmatism, which partly impact the shallow extensions?

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