Geophysical Research Abstracts
Vol. 21, EGU2019-1213-1, 2019
EGU General Assembly 2019

Penetrative and Shortening strain from the Himalayan fold thrust belt: A study across scales

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Estimates from regional balanced cross-sections reveal that the folded thrust system of the Himalayan orogen accommodates ∼197-545 km (∼68-81%) of the convergence-related shortening (Parui and Bhattacharyya, 2018 and references therein). A significant component of the convergence-related shortening is also accommodated by penetrative strain that are generally not incorporated in such estimates. We integrate results from penetrative strain from regional thrust sheets and a regional balanced cross-section through the Sikkim Himalayan fold thrust belt (FTB) to examine strain partitioning across scales.

In the Sikkim Himalaya the folded thrusts of the Main Central thrust (MCT), the Pelling-Munsiari thrust (PT), the Lesser Himalayan duplex (LHD), the Ramgarh thrust (RT), the Main Boundary thrust (MBT) and the Main Frontal thrust (MFT) have accommodated ∼403-450 km (∼80-81%) of minimum shortening. The highest translation is recorded by the hinterland thrusts of the MCT (∼91-101 km), the PT (∼86-98 km), and the RT (∼58-65 km); minimum displacement decreases in the frontal thrusts (∼2-32 km). The RT-PT system acts as the roof thrust of the LHD. We estimated the shortening strain (Mitra, 1994) from individual thrust sheets and did not find a systematic variation in it. Although the displacement on individual thrusts vary systematically and significantly from the internal to the frontal thrusts, the shortening strain remained similar in the internal (∼79-95%) and frontal thrust sheets (∼75-87%).

We quantified 2D and 3D grain-scale strain from deformed quartz grains from these thrust sheets following Fry, Rf-φ and the best-fit 3-D ellipsoid Mathematica program. Preliminary results indicate that the finite strain decreases from the internal thrusts sheets (Rf ∼1.6-2.21) to the frontal thrust sheets (∼1.39-1.58). To compare shortening strain with the penetrative strain of the corresponding thrust sheets, we calculated finite strain percentage by restoring the strain ellipse into a circle with the same area. The finite strain percentage remains high in the internal thrust sheets (∼35-42%) and it progressively decreases in the frontal MBT (∼25%) and the MFT (∼19%) sheets. Therefore, the penetrative strain is lower than the recorded shortening strain in each of the studied thrust sheets. Additionally, the penetrative strain records greater variation from the internal to the external thrust sheets than the shortening strain.

References:
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