Fault structural immaturity and shallow slip deficit in the Qinghai-Tibetan Plateau

Élyse Gaudreau[1], Jinrui Liu[2], Edwin Nissen[1]
[1]University of Victoria, Victoria, Canada
[2]China Earthquake Administration, Beijing, China

Fault structural immaturity has been linked with the delocalization of near-surface coseismic slip and greater shallow slip deficits (the systematic reduction in near-surface slip compared to at depth), but exact relations remain obscured since a combination of complex factors may affect slip localization and modelled slip distributions. We explore the relationships between proxies for fault maturity (such as cumulative offset, fault geometry complexity, and slip rate), near-fault coseismic surface deformation measured in the field and from geodetic data sets, and coseismic slip models inverted from geodetic data. We focus on the Qinghai-Tibetan Plateau, a rapidly deforming region which regularly hosts shallow earthquakes on well-studied strike-slip faults spanning a wide range of maturities, and thus provides a rich data set. For the best studied events (2021 M_w7.4 Maduo and 2022 M_w6.6 Menyuan earthquakes), comparison of static slip models from different research groups reveals that geodetically-inferred slip models of surface-rupturing earthquakes are often inconsistent within the upper 1 km of the fault (whether or not near-fault SAR range offsets are jointly inverted with farther-field InSAR displacements), and in areas where the fault geometry is complex (e.g. fault segment boundaries). This highlights that the chosen model fault geometry and decisions made during subsequent static slip modelling have much more influence on the slip distribution than the choice of input data. The wide range of static slip models and shallow slip deficits for a single earthquake, particularly where the fault geometry is complex, demonstrates that these models and normalized slip profiles must be interpreted with caution. This is particularly important for immature faults which are associated with more macroscopic geometrical complexities than their mature counterparts.