Slip Tendency and Cumulative Fault Displacement

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The Hidden Valley fault (HVF) in South Central Texas, USA is a well-exposed example of Oligocene to Miocene faults (Balcones Fault Zone) cutting Cretaceous carbonates. Sub-horizontal bed-parallel pavements adjacent to the HVF are cut by networks of small-displacement (≤ 2 m) normal faults. The surfaces of these faults are clearly visible and are commonly decorated with slickensided slip indicators in the form of striations, grooves, ridges and swales, or fibrous calcite. High-resolution stratigraphic mapping of displaced beds < 0.1 m to ~ 1 m in thickness, and close inspection of faulted strata permit precise measurements of displacement parallel to slickenlines on exposed fault surfaces. Slip surfaces representing approximately 100 faults were identified, measured (strike, dip, displacement, and rake), and surveyed (using a real-time kinematic differential global positioning system). Interactions between faults indicate that they form a coherent, bed extending network across the exposed bedding surface. Using this dataset we have developed a stress inversion method that uses only fault orientation and displacement magnitude. This method employs the conceptual link between slip tendency and fault displacement - faults in high slip tendency orientations are likely to experience more slip per slip increment, and to accumulate more slip over time than faults in low slip tendency orientations. Our motivation was to develop a method that addresses the common oil industry challenge of stress inversion using only subsurface (seismic reflection and well data) information for which fault slip vectors are generally not obtainable. Because our dataset includes slip vector information, we also inverted the field data using inversion methods that rely on this information. Our results compare favorably with those from other methods.