Geophysical Research Abstracts, Vol. 9, 04331, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-04331

Normal faulting in oblique-spreading rift systems quantified by means of DEM analysis

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Oblique rifting systems such as the northern Main Ethiopian Rift (nMER) or the Reykjanes Peninsula system (RPS) are spreading along a direction not perpendicular to the rift axis. The produced tectonic structures are very conspicuous since (1) crustal deformation mainly occurs within en-échelon zones being both magmatically and tectonicaly active and (2) the fractured surface exhibits atypical fault profiles with hanging walls tilted off the fault face and monoclinal bending coeval to fracture formation. It is yet not clearly understood how fault growth evolves and how the interaction of volcanism and faulting influences the surface patterns.

For exemplary sites in the nMER and RPS we introduce tools for the investigation of structures via remote sensing. High-resolution DEMs generated from remote sensing stereo pairs allow a quantitative analysis of the morphologies of normal fault and monocline systems. The distribution of accumative displacements is derived by applying simple mathematical algorithms to the DEM: (1) gradient filtering and (2) summation of vertical offset amounts. Enhancing the morphological effects of fault overlapping and interaction, the accumulative displacement distribution enables us to detect zones where deformation is concentrated.

We create plots of accumulative displacement against fault length from digitalized fault lines in order to recognize segmentation patterns. Since initial segments of a fault accumulate vertical offsets over a longer time than the younger segment-interlinking fault sections, the vertical displacement in the initial segments is potentially higher. Thus, the correlation of accumulative displacement with the main fault strike is indicative for either left or right stepping of former separated fault segments. This is crucial for oblique-spreading rift zones, since stepping patterns determine the shear sense of oblique-slip displacement.