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Response of active faults within fault arrays in extensional tectonic settings to mass redistribution on Earth's surface due to erosion and sedimentation

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Mass redistribution by erosion and sedimentation creates loads that can influence the rate of crustal deformation. Here we combine landscape-evolution modeling with three-dimensional geomechanical models to investigate how erosion and sediment deposition may affect the slip behavior of active faults in extensional tectonic settings. Our numerical modeling implements erosion and sedimentation by using the CASQUS Software (Kurfeß & Heidbach, Computers & Geosciences, 2007). CASQUS links the landscape evolution model CASCADE (Braun & Sambridge, Basin Research, 1997) to models solved with the commercial finite-element software ABAQUS.

Basic models consisting of an elastic upper crust with a single normal fault show that apart from the amount of fault slip induced by the far-field extension an additional portion of fault slip can be attributed to the mass redistribution due erosion and sedimentation. Thus normal faults in models with surface processes exhibit higher slip rates than faults in models without surface (Maniatis et. al, EPSL, 2009).

Beginning with these simple models we move to more complex tectonic settings that include fault arrays forming graben and/or horst structures. The results show that the topography resulting from the slipping faults influences the courses of rivers in the model. Also, the spatial distribution of erosion and sediment deposition affect the slip behavior of different faults in the tectonic settings to different degrees. To analyze the effect of the surface processes on the fault slip rates in more detail, fault geometry, position of the faults in the tectonic settings, far-field extension rate and the parameters controlling erosion and sedimentation are varied in a series of experiments.