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Insights to the distribution of slip directions along normal faults from three-dimensional finite-element models

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Normal faults in nature that are isolated and strike perpendicularly to the direction of extension exhibit a systematic variation of fault-slip direction along their length. Pure dip-slip is taking place at their centres while oblique slip is observed near their tips. The distribution of the slip vectors along the fault trace forms a symmetric converging pattern with the hanging wall moving towards the fault's centre. This pattern is commonly attributed to along- strike stretching of the hanging wall and the local stress distribution near the fault tips. We use three-dimensional finite element models of normal faults with different dimensions and dip angles to evaluate the variation of slip direction along their strike (Maniatis & Hampel, *J. Struct. Geol.*, 2008). The results show a nearly linear increase of the strike-slip component for the first three quarters of the distance from the fault centre to the fault tips. Consequently the obliqueness of the slip vectors is increasing from the fault centres to the fault tips. Based on the model data, the relationship between lateral slip and fault trace length can be approximated by a power law function for most of the fault length. Furthermore the amount of lateral slip is proportional to the amount of dip slip at the centre of the fault and inversely proportional to the fault dip-angle. These findings are summarized into simple mathematical relations that give the amount of lateral slip and the rake of the slip vector along the fault trace in relation to the geometry of a normal fault. The finite element models reveal local perturbations of the stress field near the fault tips as the main factors behind the occurrence of oblique slip away from the fault centres. A comparison of the model results with field data from central Italy shows that the displacement pro-

files and the slip vectors along the modelled faults mimic those of real normal faults reasonably well. This has implications when slip data along normal faults are used to ascertain regional stress regimes.