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Modeling of the European stress field: Decoupling from Asian stresses by rheological weakening

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European stress orientations are well explained in terms of regional forcing due to Atlantic ridge push and African convergence. However, application of the traditional modeling approach to a larger spatial scale indicates that the influence of the Indian-Asian collision extends far into Europe. The model prediction is that much of the European stress field should be dominated by stresses transmitted from India. This result is not compatible with the stress orientations observed in Europe. One suggestion has been that the Eastern European platform either pins the eastern edge of Europe or that it somehow shields Europe from the Himalayan stress influence. We find that these effects are likely to be minor. Instead, we suggest that it is the continental rheology which causes a decoupling of the European and Asian stress fields. We propose that lithospheric deformation is governed by a visco-elastic damage rheology in which damage lowers the viscosity. Damage increases where viscous energy dissipation is high. Simultaneous healing causes a decrease in damage. We find that there are two equilibrium states in which damage generation balances damage annealing: A state of low damage and slow deformation corresponding to a pristine plate (with Young's modulus $E = 10^{11}$ Pa and viscosity $\eta = 10^{25}$ Pa-s), and a state of high damage corresponding to fast deformation which tends to self-organize into linear shear zones. If the damage zones are sufficiently weak ($\eta \approx 10^{20}$ to 10^{21} Pa-s) the pattern of shear zones forming north of the Indian indentor causes the locally northward plate motion to be deflected eastward and results in an effective decoupling of Europe from South-east Asia. The modeled stress orientations in Europe are then as observed. Viscous, elastic, and plastic rheologies are unable to match these results. Furthermore, the rheological softening implied by our model allows Indian-Asian convergence to occur at high rates but at relatively low (i.e., geologically reasonable) stresses.