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Generic Models of Linear and Non-linear Visco-elastic Surface Deformation above a Fault

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The ground displacements measured in the vicinity of a large strike-slip earthquake are potentially important in diagnosing the state of stress on the fault and in the medium surrounding. The co-seismic displacement is determined by the immediate elastic response of the medium and the slip function on the fault-surface. The post-seismic displacement is determined by a combination of post-seismic creep on the fault, visco-elastic relaxation in the surrounding medium, and possibly poro-elastic deformation. There are strong indications from previous earthquake studies that the visco-elastic relaxation involves non-linear mechanisms, which produce faster deformation in the early stages and slower deformation in the later stages than would occur with a linear creep mechanism. In this study we examine a simplified model of a strike-slip fault cutting a 3D block, and compute the surface displacement versus time functions for a range of different constitutive relations. We examine linear and non-linear Maxwell visco-elasticity, and compare with the generalized linear Maxwell visco-elasticity. The effect of non-linearities in the elasticity (finite strain theory) is also considered. We use the von Mises flow function in describing the non-linear Maxwell visco-elastic creep models in which viscous creep strain-rate is proportional to the nth power of the deviatoric stress (formulated using the 2nd invariant of the stress tensor). We describe analytical solutions used to validate the 3D code, and then consider the effect of the exponent n on the time histories of the surface displacement fields above the fault. We aim here to compare these numerical models with observations from actual fault systems obtained using InSAR and GPS data. Among the factors affecting the sur-

face deformation patterns are near-surface layering, and lateral variation of material properties, as well as irregularities on the fault surface. In principle, the comparison of observations with theory should provide a better understanding of the physical response of the sub-surface, together with a better understanding of the earthquake cycle as it operates on specific fault systems.