Geophysical Research Abstracts, Vol. 7, 03335, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03335

Observations and modelling of postseismic deformation following the 1997 Manyi earthquake

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Detailed spatial and temporal measurements of surface deformation following large earthquakes are crucial for determining stress relaxation mechanisms and the rheological structure of the lower crust and upper mantle. Realistic models for stress relaxation must be able to explain the observed displacement field over the entire observation period, not just at a snapshot in time. In this study we use InSAR to investigate postseismic deformation following the magnitude (M_w) 7.5 Manyi earthquake, which occurred in northern Tibet in November 1997. We use ERS-2 data to create 27 two-frame interferograms along three tracks, covering the entire 175 km long fault. The time period covered is from 8 days to almost 4 years after the earthquake. Profiles through the central track show a fairly symmetrical deformation, with a peak at about 10 km from the fault trace. The maximum line of sight displacement is $\sim$5 cm. The excellent coherence in these interferograms collectively enables us to construct a time series. Simple exponential decay functions calculated on a pointwise basis give a relaxation time of $\sim$1 year, so we can make a good estimate of the fully-relaxed displacement field. We test models that assume either Maxwell viscoelastic stress relaxation or localised afterslip on and below the coseismic rupture plane. We find that a single viscosity in the Maxwell model cannot fit the data at all dates in the time series: an increase in effective viscosity over time is required to explain the data. Furthermore, it is impossible to find an elastic lid thickness that gives both the correct wavelength and the correct amplitude of fully-relaxed deformation. Kinematic afterslip modelling provides a better fit to the observed motion. We address whether or not coseismic stress loading can produce the observed postseismic surface deformation via localised afterslip.