Lower-Crustal Flow Beneath the Tibetan Plateau: Evidence from the 2001 Kokoxili Earthquake

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In November 2001 a magnitude 7.8 earthquake ruptured a 400-km long portion of the Kunlun fault, northeastern Tibet. In this study we analyse over five years of postseismic geodetic data for the Kokoxili event and interpret the observed surface deformation in terms of viscoelastic relaxation in the lower crust. A combination of GPS (first year) and InSAR observations (2-5 years) allows us to place robust constraints on lower-crustal rheology. Asymmetry exists between surface displacements on the north and south side of the fault, with the latter showing a faster rate of deformation. Displacements on both sides of the fault are well explained by a Burgers rheology, which has two time constants and so can account for both the rapid early part of the postseismic transient and the subsequent slower phase. However, to account for the cross-fault asymmetry in rate, higher viscosities are required on the north side with respect to the south side; this is consistent with a more rigid Qaidam basin to the north, relative to the Qiangtang block to the south. This result is also consistent with independent geophysical studies, for example the inference of lower crustal high conductivity south of the Kunlun fault system (Unsworth and others, 2004). The pattern of surface displacement observed in the InSAR dataset on each side of the fault is matched well by the respective Burgers models. Furthermore, the spatially simple deformation field does not require viscoelastic stratification in the lower crust. To investigate regional variability in rheological structure, we apply the southern values of transient and steady-state viscosity obtained in this analysis to the postseismic phase of the 1997 Manyi earthquake, which occurred 250 km to the west of the Kokoxili rupture (Ryder and others, 2007). We also make comparisons with viscosity constraints inferred from postseismic deformation following several moderate-to-large normal-faulting events in the northwestern and central parts of the plateau during 2004 to 2008 (e.g., Ryder and others, 2010).

References

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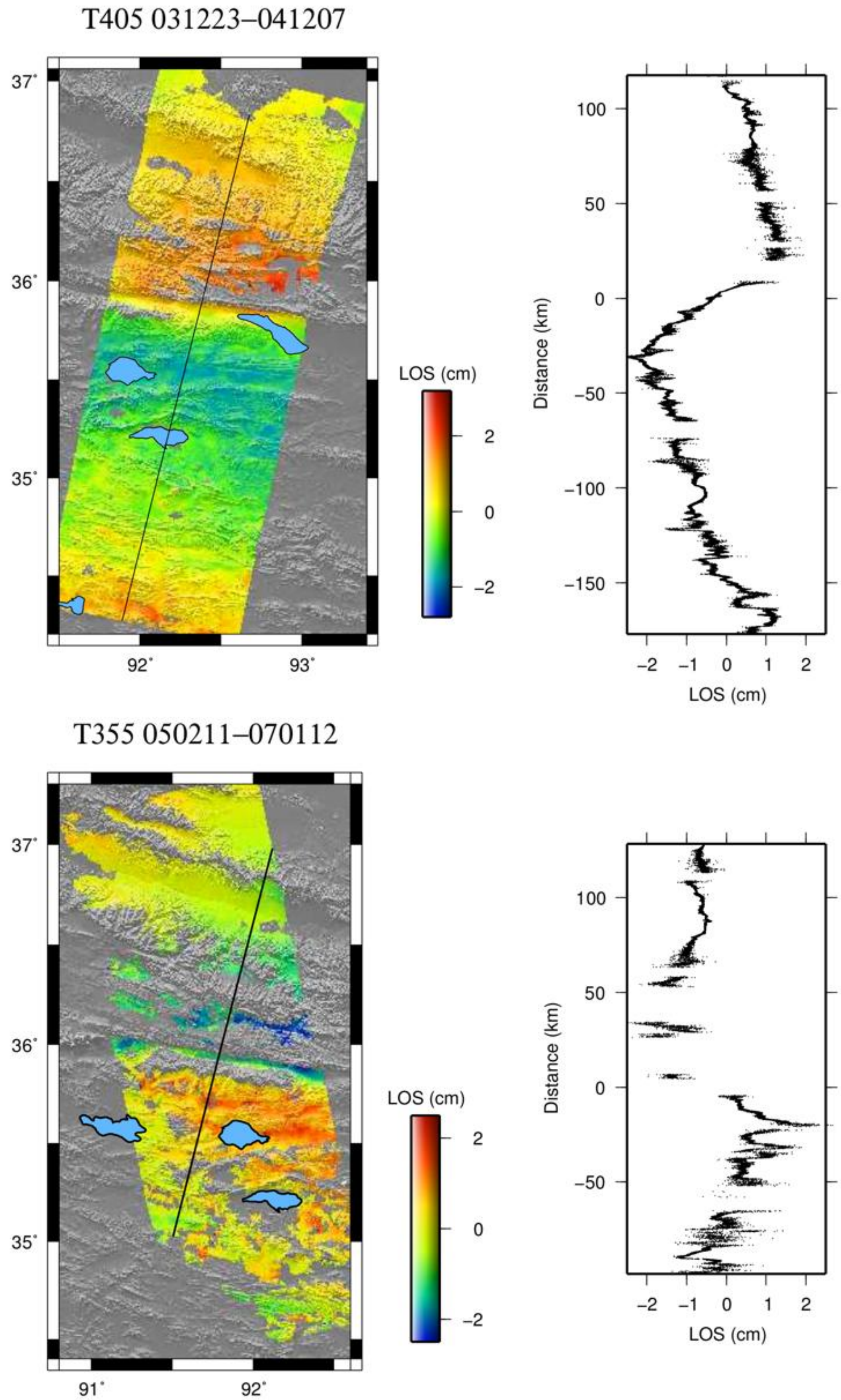

Figure 1. Postseismic interferograms for the 2001 Kokoxili earthquake, northeastern Tibetan Plateau. Black lines mark profile locations. Top: Envisat descending track 405; bottom: Envisat ascending track 355. To the right of each interferogram are line-of-sight displacement profiles. These show north-south asymmetry, which we attribute to a change in viscosity structure either across the Kunlun fault.

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