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Postseismic deformation during three years after the 2003 Bam, Iran earthquake from InSAR time series

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The 26 December 2003 Mw 6.6 earthquake that devastated Bam, Iran involved several meters of slip on a previously unknown fault beneath the city. Outstanding surface conditions for InSAR and frequent coverage by Envisat ASAR provide an opportunity to map the ground deformation and its time history in the three years since the earthquake. Envisat data from nearly opposite lines of sight allow separation of vertical from horizontal east-west motion. Postseismic surface deformation after the 2003 earthquake is one order of magnitude smaller than the coseismic deformation, so the signal in individual interferograms is affected strongly by atmospheric variations. Time-series analysis of the interferograms better separates temporally random atmosphere from ground deformation. Deformation decayed with a time constant of about 1/3-1/2 year after the earthquake, somewhat longer than the short decay time of postseismic afterlip from the September 2004 Parkfield, California earthquake. The Bam distribution of deformation indicates at least two different processes were involved, at different depths in the crust. A narrow zone above the main coseismic slip rupture of the 2003 earthquake moved downward in the months afterward. Subsidence was not restricted to the compressional steps in the coseismic rupture so poroelastic rebound effects cannot explain it. This deformation is restricted to the area of surface ruptures so it is related to the response of the surface layer to the stress applied by coseismic slip below. Longer wavelength deformation at the southern end of the main subsurface coseismic rupture inferred from InSAR is best explained by thrust and strike afterslip on the main fault plane or a nearby structure at depths between about 1 and 6 km. Deep afterslip, large-scale poroelastic rebound, and viscoelastic relaxation effects are smaller than the noise level of the InSAR time series.