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Characteristic slip behaviour of the Tabas fold system in eastern Iran: evidence from the 1978 M_w 7.3 Tabas-e-Golshan earthquake

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We use historical optical and modern satellite images to investigate the 1978 M_w 7.3 Tabas-e-Golshan earthquake in eastern Iran. Cross-correlation of images in 1974 and 1991 reveals a shortening component of ∼2.9 m on the Tabas fold, which is a combination of coseismic and post-seismic deformation. Image cross-correlation also shows ∼0.3 m shortening from 1991 to 2013. Using 6 pre-earthquake aerial photographs acquired in 1956 and a SPOT-6 stereo data set in 2013, we generate a pre- and post-earthquake digital elevation model (DEM) respectively, and by differencing the two DEMs, we measure a vertical displacement of ∼4.7 m. Models of the surface deformation field imply a total slip of 7 m from 1974 to 2013 on a 50° dipping fault, from a depth of 0.1 km to 6 km at the base, the majority of which (∼6.5 m) occurred prior to 1991. The slip appears to dissipate in the near surface. Our results, combined with the previous InSAR observations, indicate time-decaying shallow post-seismic afterslip, from ∼8 cm/yr in 1991-1996 to ∼5 mm/yr after 1996. Comparison of the fault slip model with the terrace heights measured from the SPOT-6 DEM suggests that the Tabas fold system exhibits a characteristic slip behaviour. Such behaviour would require a magnitude M_w 7.3 earthquake every ∼3500 years to accommodate the previously estimated shortening rate of ∼1.0 mm/yr. This study highlights the usefulness of historical imagery in investigating past earthquakes, thus providing new information about faulting in continental regions.