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Abstract

The 1994 and 2004 Al Hoceima earthquakes are the largest to occur in Morocco in the last century and so can give valuable insight into the tectonics of this poorly understood area. On May 26th 1994, a Mw6.0 earthquake caused great damage and two deaths and on February 24th 2004 a Mw6.5 earthquake killed over 600 people with 40,000 made homeless. Preliminary studies using aftershock locations and surface observations have been unable to identify conclusively the fault plane for either earthquake. ENVISAT ASAR acquisitions were used to construct both ascending and descending track interferograms for the 2004 earthquake and a pair of ERS SAR acquisitions were used to produce a coseismic interferogram for the 1994 earthquake.

Both earthquakes have strike-slip mechanisms with nodal planes striking NW–SE and NE–SW. They are an excellent illustration of the symmetry present in both seismological and geodetic analysis of moderate-sized buried earthquakes and the difficulties in distinguishing between the fault plane and the auxiliary plane. For the 2004 earthquake, we initially use a uniform slip model and produce models assuming each of the nodal planes is the fault plane. Both models fit the first order deformation pattern well and have similar misfits to the data. However, the NE–SW model has an unrealistically high slip-to-length ratio and we reject this model. We carry out tests on synthetic data for a buried strike-slip fault in which the orientation of the fault plane is known a priori and find that, independent of geometry, missing data and correlated noise, models produced assuming the auxiliary plane to be the fault plane have very high slip-to-length ratios.

We conclude the fault plane that ruptured in the 2004 earthquake was the NW–SE striking nodal plane and slip was right-lateral and refine the model to include distributed slip. A relocation of the aftershocks using the InSAR models as absolute locations of the 1994 and 2004 mainshocks is consistent with this conclusion and suggests that the 1994 earthquake occurred on a NE–SW fault. We propose the earthquakes happened on a pair of conjugate faults striking at 25 degrees and 115 degrees in contradiction to previous tectonic models of the Al Hoceima region which propose a bookshelf model of block rotation with NNE–SSW left-lateral faults.