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Combining SAR Interferometry and offset tracking methods to measure near field coseismic deformation; application to the 12 December 2017 Mw 6.2 Hojedk earthquake in Iran

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The study of crustal deformation associated with the earthquakes is important for a better understanding of tectonic processes and evaluate how continental lithosphere behaves physically in response to plate tectonic forces. The active deformation of the Iranian plateau results from the collision between Arabia and Continental Eurasia at a rate of 25-30 mm/yr. To the east of 58°E, most of the convergence (about 20 mm/yr) is accommodated by the Makran subduction zone with the small remaining shortening taken up by mountain ranges in NE Iran. West of 58°E, part of the shortening (about 7 mm/yr) accommodates by a mixture of thrust and right-lateral faulting in Zagros mountain range. This different mechanism between Zagros and Makran causes $\sim$14mm/yr of N-S right-lateral shear between central Iran and Helmand block as a part of the Eurasian rigid plate, across eastern Iran. This NS shear is accommodated on N-S right-lateral faults on both sides of the Lut block in Eastern Iran such as Dehshir, Anar, Kuhbanan, East Lut and West Lut faults. Consequently, these faults have a crucial role in accommodating N-S right-lateral shear between central Iran and Afghanistan.

On 12 December, 2017, a thrust earthquake with a magnitude of Mw 6.2 occurred near Hojedk in the Kerman region, southeastern termination of Lakar Kuh fault. This fault is located between Kubanan and West Lut faults with slip rates of 4.4 ± 0.4 and 3.6 ± 1.3, respectively. No geologic and geodetic slip rate are estimated for Lakar Kuh fault. The earthquake has been occurred on the blind segment of southeastern termination of Lakar Kuh fault while after earthquake surface rupture can be seen on Sentinel Optic image. The main shock was followed by two other large earthquakes on the same day with magnitudes of Mw 5.0 and Mw 5.9.

We exploit all the coseismic Sentinel-1 pairs including two ascending and two descending tracks to measure coseismic deformation associated with this event. We use SAR tracking-based method coupled with interferometric analysis to resolve the near filed decorrelation problem which is a common issue in dealing with large displacements close to the fault. The processing is followed by combining both interferometric and offset tracking results to generate the coseismic displacement field. We apply Bayesian analysis to invert the final displacement field and infer combination of orientation, location and slip on rectangular uniform slip fault plane. Slip distribution analysis is done by applying Tikhonov regularization to solve the constrained least-square method with Laplacian smoothing approach. Our results suggest that the main deformation related to 12 December 2017 Hojedk earthquake occurred as a result of WNW-ESE thrusting faulting. The main rupture is concentrated at a depth between 8 and 10 km, characterized also by a shallow rupture reaching the surface. The surface rupture is also obvious in the 10-meter resolution of the Sentinel-2 optical image acquired after the earthquake. It indicates the significant crack ruptures the Earth's crust with the length of 5 to 8 kilometers.