Deformation Pattern and Mapping of Earthquake ruptures of the 6 February 2023 M7.8 & M7.6 earthquakes (Türkiye) through sub-pixel correlation method on InSAR

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Extended Abstract

Introduction

We used C-band SAR (Sentinel-1) data in order to extract information about the ground displacements that occurred due to the 6 February 2023 Mw=7.8 (01:17:35 UTC) and M7.6 (10:24:49 UTC) earthquakes in southeast Türkiye. We retrieved the ascending and descending satellite data (in SLC format) from the Alaska Satellite facility and from the Copernicus Hub of ESA. We used differential SAR (DInSAR) and the sub-pixel correlation methods to retrieve the surface motions in both range direction and in azimuth (along satellite track) direction. We processed the SAR images using the open-source (ISCE) v2 software (https://github.com/isce-framework/isce2) and we applied pixel offset tracking through the cross correlation of the amplitude of the primary (before the earthquakes) and the secondary (after the earthquakes) images. Here, we present the pixel offset method results and our interpretations.

Results and Discussion

The pixel offset method gave us the capability to map the surface rupture extent of the left-lateral strike-slip fault segments along the East Anatolian Fault Zone (EAFZ; from Adiyaman to Antakya; Fig. 1) and the E-W oriented Sürgü fault (SF; ruptured during the M7.6 event; Melgar et al. 2023; Tsironi and Ganas, 2023). We also identified the splay fault known as Nurdâğı-Pazarçık fault which is also left-lateral (NPF; Melgar et al. 2023), where the rupture process began and a second splay fault in the area of Adiyaman near the main trace of EAFZ (see position 60 along the profile C-C’). Thus, we mapped the total 2023 rupture length of the EAFZ which is ~ 400 km. Based on displacement profiles (see lines A-A’, B-B’ and C-C’ in Fig. 1) we suggest that the maximum displacement was ~ 7 m in the range direction (along the central area of EAFZ and SF) (Fig.1: see position 25 along the profile B-B’). Such large offsets were reported by field surveys (e.g. Golberg et al. 2023). The ruptures of SF and EAF seem to not be connected at the surface. The surface rupture of the SF turns towards north at the east endpoint of the rupture. Also, at the western termination of SF, another (orthogonal) branch of fault rupture was identified.

An extraordinary element of the complexity of the rupture is the identification of a complex structure where the EAF 2023 rupture seems to penetrate a possible pull-apart basin between two rupture segments of the main fault, in the area near the city of İslahiye. Also, the maximum displacement of the NPF (the splay fault) was found ~ 1 m. It is necessary to clarify that the total displacement field as mapped by InSAR has occurred by the combined motion of the two mainshocks, as well as, possibly by some large-magnitude aftershocks and post-seismic afterslip.
Figure 1: Displacement map produced by pixel offset method of descending track. Positive values show range increase, negative values range decrease, respectively. The black lines show the traced ruptures. The dashed lines indicate the cross-sections. We constructed cross-sections through our displacement data in order to estimate the maximum displacement on the ground surface. We estimated that the maximum displacement was about 7 m in range direction in some places where the maximum slip of the ruptures occurred (section B-B’; central area of EAF and SF). Also, the maximum displacement of the NPF was approximately 1 m (section A-A’). The total displacement occurred by the two main earthquakes as well as possibly by some large-magnitude aftershocks.

Key words: Active faults, Türkiye, ruptures; InSAR; earthquakes

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References

