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Improved Coseismic Deformation Observations of the 1995 Mw 7.2 Gulf of Aqaba Earthquake based on ERS and JERS data

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The Mw 7.2 earthquake that occurred on the Dead Sea Transform (DST) in the Gulf of Aqaba on November 22, 1995 was the largest earthquake to occur in the area for at least 400 years. Several published studies have focused on estimating the source parameters of this earthquake, but the reported models differ significantly. Some suggest that two or even three en-echelon segments of the DST within the gulf ruptured in the earthquake, while others report that only the segment between the Elat and Aragonese deeps was activated. The earthquake's location under the waters of the Gulf of Aqaba means that near-field data are limited. In addition, no coseismic GPS or conventional geodetic measurements are available. Therefore, InSAR observations have been the key data, along with seismic data, in estimating the source parameters of this earthquake. However, previous InSAR studies did not include all existing coseismic SAR data and were also based on sub-optimal data-processing strategies. Here, we improve the previous InSAR studies of the Gulf of Aqaba earthquake by (1) adding previously unused coseismic InSAR data, (2) using more recent data processing methods as well as along-track Multiple Aperture Interferometric (MAI) observations, and (3) estimating the source fault geometry and slip using more reliable InSAR data.

In this study, we include two previously unused InSAR datasets, one ascending ERS image pair (track T114) and one descending JERS dataset (Path 254). The inclusion of these data provides a more complete map of the coseismic deformation field, compared to previous studies. In addition, we improve the earlier InSAR data processing work by carefully removing orbital errors with a 2D quadratic model after masking out the coseismic deformation and we avoid using images with strong atmospheric signals. Furthermore, we use MAI to constrain better the north-south coseismic displacement component, which was the main displacement component of this primarily left-lateral strike-slip earthquake.

Published source model estimations based on InSAR measurements all have a single planar fault, but the reported sets of fault parameters are significantly different from one another. The fault dip, in particular, has a large range of values in these studies, from 65 to 80 degrees (to the west). Our new dataset provides better constraint of the dip angle than earlier studies, as the data coverage on the Egyptian side of the gulf is much improved, which is also where the largest coseismic deformation is observed in the InSAR data. We find an optimal dip of 79 degrees to the west on a fault striking N199°E. The peak left-lateral strike-slip is found to be roughly 3 m and the seismic moment 6.43×10^{19} Nm, corresponding to Mw 7.2, agreeing with seismological estimates. Ongoing work includes source parameter estimation on multiple fault segments and its connection with surface faulting observed along section of the Saudi coastline.