
Slip dynamics and morphology of a major creeping fault step-over at the eastern end of the Tianzhu seismic gap (Haiyuan fault, China), from InSAR

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Résumé

Advances in geodetic monitoring have revealed slow deformation transients and complex interactions between aseismic and seismic events. The Haiyuan Fault (northeast China) provides a valuable natural laboratory for exploring fault slip behavior and its underlying mechanisms, due to its dual slip modes with both locked segments capable of generating major earthquakes and creeping segments (1,2). We focus on a 35 km long creeping section located at the junction between the western end of the 1920 Mw 7.9 earthquake rupture and the eastern termination of a known seismic gap, revisiting the spatial distribution and temporal evolution of creep using ERS, Envisat, and Sentinel-1 data.

We use Sentinel-1 displacement time series spanning 2015 to 2022, processed with the FormTerre FLATSIM service (3), including two ascending and three descending tracks. We extract linear and seasonal components from the time series, then decompose the linear term into fault-parallel horizontal and vertical velocities. Creep signatures are clearly visible in both line-of-sight and horizontal velocity maps. Surface creep reaches up to 5 mm/yr horizontally, with lateral variations. Localized subsidence of ~6.5 mm/yr is observed in the extensional relay zone at the eastern edge of the creeping segment. We invert the InSAR velocity maps using CSI software (4), incorporating GNSS data to constrain slip distribution along the seismogenic zone. The inferred creep distribution is compared with earlier ERS and Envisat results to evaluate temporal variations in the creep rate. For each track, we also examine the cumulative relative creep using the LOS and decomposed horizontal and vertical time series, and Principal and Independent Component Analysis. We isolate specific temporal patterns, distinguishing the extensional relay zone from the western portion of the

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creeping segment. Transients, consistent across all tracks, involve both horizontal creep and subsidence bursts. These observations shed light on the morphology and slip partitioning within the fault step-over zone. Ongoing work explores the tectonic and hydrological mechanisms driving these transients.

(1) Gaudemer et al., 1995, doi.org/10.1111/j.1365-246X.1995.tb01842.x

(2) Jolivet et al., 2012, doi.org/10.1029/2011JB008732

(3) Thollard et al., 2021, doi.org/10.3390/rs13183734

(4) Jolivet et al., 2020, doi.org/10.1029/2019GL085377

Mots-Clés: Haiyuan Fault, aseismic creep, transient deformation, time series analysis, InSAR