Exploring the seismotectonic significance of triggered shallow slip observed with the IPOC creepmeter array

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Abstract

The Atacama Fault System (AFS) is a large scale trench-parallel fault in the N-Chilean forearc. Surface ruptures indicate seismogenic faulting at shallow depths on the long-term time-scale (1ky- 100ky). Nevertheless, slip rates, recurrence intervals or mode of strain accumulation are largely unknown. With the IPOC Creepmeter Arrray we provide continuous surface displacement data to complement long-term observations and explore the bandwidth of short and long-term observations. The 10 creepmeters capture up to 30 triggered displacement events (SDE) per station per year on four different segments of the (AFS). Our data suggests that shallow fault slip is largely confined to these SDEs. A continuous creep signal in-between these SDEs is extremely small if existent at all. Since the triggering of upper crustal fault activity is an important issue in estimating the potential hazard of the AFS, we investigate its seismotectonic significance with respect to the long-term fault activity. We quantify the cumulative shallow slip triggered by earthquakes for the past 7 years and compare it to the long-term slip rates. The Mejillones fault shows extensional SDEs, resulting in a cumulative normal fault parallel slip of up to 0,14 mm/a. This rate is in accordance with the long-term fault slip rate. The Chomache fault shows a highly transient accumulation of SDEs including triggered slip from the Iquique 2014 earthquake and its aftershocks. The cumulative triggered slip is 0,2 mm for the seven-year period. The observed sense of displacement is opposite to that of the long-term record. The Salar del Carmen fault exhibits a highly transient behavior. In the one-year period prior to the Maule earthquake the total shallow slip accumulated by extensional SDEs is 0.1 mm/a accelerating with a large triggered extensional SDE to 0.4 mm/a for the 6 months after Maule. Since the end of 2010 although up to 20 SDEs are triggered/a the cumulative displacement adds up to zero. This variability in shallow slip behavior implies that each of the monitored faults reflects a different shallow slip accumulation pattern. For the Mejillones fault segment we propose that triggered slip is the characteristic style of shallow slip accumulation, whereas for the Salar del Carmen fault we determine a clear deficit in shallow slip. Investigating this shallow slip deficit in further detail taking into account duration and intervals in-between SDEs we find that the near-surface domain of these faults more likely tends to be conditionally stable to unstable.

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