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Heterogeneous Post-Seismic Deformation 3 years after the 2016 Mw 7.8 Pedernales Earthquake, Ecuador

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We use GPS data of Ecuador´s national continuous geodetic network to constrain post-seismic deformation associated with the destructive 2016 Mw 7.8 Pedernales, Ecuador subduction earthquake. The main shock produced a maximum co-seismic slip of 6 m with a southward rupture of 2 main asperities (Nocquet et al., 2017, NatureGeosc). Maximum post seismic afterslip has been strongest immediately to the N and S updip of the rupture with up to 0.6 m of localized slip measured within the first 30 days (Rolandone et al., 2018, SciAdv). Three years following the earthquake, the near field GPS stations are still mildly affected by a post-seismic signal that trends seaward, as are GPS stations out to 300 km in the Amazonian region. In the volcanic arc two hundred km east of the source, we observe distinct variations in the vertical (recording both inflation and deflation) and horizontal components. Thus, resumption to megathrust locking has not occurred along the Pedernales section of the Ecuadorian margin.

As summarized by Klein et al, (2016: Geophys. J. Int.), post seismic deformation depends principally on three mechanisms: 1/ Poroelastic rebound; 2/ Afterslip on the main rupture zone; 3/ Viscoelastic relaxation in the mantle. Sun et al, (2018: JGR) stress that the magnitude of the EQ plays a fundamental role, since a stronger shock leads to greater mantle perturbation. They provide examples of 10 class 8 to 9+ EQ's in which they compare and model the evolution of GPS-registered post-seismic trends. Perhaps the case most analogous to that of Pedernales is the 2007 Mw 8.0 Pisco Earthquake which had reversal of seaward to landward trends, as registered by GPS, in only 1.5 years to resumption of megathrust relocking. Clearly the Pedernales examples given here have now exceeded that time period by 2, and a possible explanation is relative slowness of relocking due to subduction of seamounts on a ridge (ie Carnegie). In southern Peru the resumption of locking has taken longer than in patches to the north, perhaps due to the subduction of the Nazca ridge, as suggested by Villegas-Lanza et al., (2016, JGR); and Wang & Bilek, (2014, Tectphys).

The aim of this work is to compare the Pedernales trends that are well-constrained with GPS, with other large earthquakes, as a guide to deciphering deeper processes and to track the route to resumption of locking along the megathrust. Also, by providing a snapshot of ongoing post-seismic deformation, particularly in Ecuador´s Sierra region, where weakened lower crust beneath the volcanic arc may be influencing the observed deformation, we hope to identify patterns which are common in other volcanic areas. Modelling with a finite element model, done by Sun et al (2018, JGR), could help discriminate the primary relaxation mechanisms: ie viscoelastic, aseismic processes, or poroelastic rebound that may be contributing to the observed GPS patterns related to this stage of the post-seismic period. Heterogeneity in post seismic deformation patterns has been observed in other subduction zones and our work gives insight on continuing relaxation then resumption to locking processes in the post Pedernales earthquake phase.