Aftershocks of the 2016 Mw 7.8 Ecuador earthquake reveal earthquake cycle is controlled by long-lived structures

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Abstract

Subduction earthquakes are the largest earthquakes on Earth, and arguably the most dramatic example of the forces involved in active plate tectonics. 0n April 2016, a Mw 7.8 megathrust earthquake struck the coast of Ecuador causing vast human and material losses. The earthquake ruptured a ˜100 km-long segment of the subduction interface between Nazca and South America, spatially coinciding with the 1942 M˜7.8 earthquake rupture area. Although there is a general agreement regarding the overlapping of the 1942 and the 2016 ruptures, more controversy exists in relation to the role of the 1906 M˜8.8 earthquake for the seismic cycle in this region, including the posibility of an earthquake supercycle dating from before and encompassing the 20th century ruptures.

Shortly after the mainshock, an international effort made by institutions from Ecuador, France, UK and USA, deployed a temporary network of +60 land and ocean-bottom seismometers to capture the aftershock sequence for the subsequent year. Here we present the results of the processing of this dataset, including the detection and location of more than 10,000 aftershocks and the computation of moment tensors for selected events.

Aftershocks magnitude range between 1 to 6.9, and completeness is down to 2.5. As expected, moment tensors show mostly thrust faulting at the interface, but we also observe sparse normal and strike-slip faulting at shallow depths in the forearc. The spatial distribution of seismicity delineates the co-seismic rupture area, but extends well beyond it over a ˜250 km long segment. Main features include three seismicity streaks perpendicular to the trench, at the north, center and south of the mainshock rupture. Interestingly, a similar seismicity pattern is observed during the interseismic period. This seismicity is often spatiotemporally accompanied by slow slip events both during the interseismic and postseismic periods. This common pattern suggests that, in this area, there is a perennial structural control which persists over several seismic cycles, modulating the occurrence and distribution of both megathrust earthquakes and interseismic/postseismic seismicity. Additionally, a quantitative comparison between the distribution of aftershocks and co-seismic rupture shows that the bulk of the aftershock seismicity occurs outside or at intermediate levels of

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co-seismic slip, whilst areas of maximum co-seismic slip are mostly devoid of events M>3. Our results shed a light on the processes the control the seismic cycle and the occurrence of seismicity in subduction zones.