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A mixed seismic–aseismic stress release episode in the Andean subduction zone

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Abstract

In subduction zones, stress is released by earthquakes and transient aseismic slip. The latter falls into two categories: slow slip and afterslip. Slow-slip events emerge spontaneously during the interseismic phase, and show a progressive acceleration of slip with a negligible contribution of synchronous tremors or microseismicity to the energy, or moment release[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12]. In contrast, afterslip occurs immediately after large and moderate earthquakes, decelerates over time, and releases between 20 and 400% of the moment released by the preceding earthquake[13, 14, 15, 16, 17, 18]. Here we use seismic and GPS data to identify transient aseismic slip that does not fit into either of these categories. We document a seismic–aseismic slip sequence which occurred at shallow depths along a weakly coupled part of the Andean subduction zone[19] in northern Peru and lasted seven months. The sequence generated several moderate earthquakes that together account for about 25% of the total moment released during the full sequence, equivalent to magnitude 6.7. Transient slip immediately followed two of the earthquakes, with slip slowing at a logarithmic rate. Considered separately, the moment released by transient slip following the second earthquake was more than 1,000% of the moment released during the earthquake itself, a value incompatible with classical models of afterslip. Synchronous seismic swarms and aseismic slip may therefore define a stress-release process that is distinct from slow-slip events and afterslip.

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