Releasing a reservoir of shallow strain as a possible cause of the catastropic Wenchuan earthquake, China

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Over the centuries, great earthquakes have occurred frequently in Asia, yet up-close, detailed geodetic observations of ground deformation are few. Here we present 484 ground-based measurements of surface displacement associated with the great Wenchuan earthquake of 12 May 2008. Analysis of the most comprehensive ground-based dataset and space-borne InSAR images reveal a minimum rupture length of 291 km, along which 5 shallow and 2 deep high-slip asperities are identified on two steeply-dipping ramp faults above a sub-horizontal décollement at 16-21 km depths under the Longmen Shan, and each produced moment release equivalent to a moment magnitude M_w6.9-7.4 earthquake. The rupture of those asperities with maximum slips of up to 14 meters in the uppermost 5-6 km of brittle crust may result from draining residual strain energy at shallow depths left over from previous earthquake cycles, or from cascading slip propagation across low-slip barriers either associated with past moderate earthquakes or with structure irregularities. The Wenchuan event therefore represents the latest culmination of the regional seismicity characterized by the rupture of multiple fault segments, and its atypical size that we estimate at M_w=7.96, if repeated, would occur much later than anticipated only from considerations of secular fault slip rate.

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