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Fault weakening and onset of aseismic creep on mature strike-slip faults

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Persistent Scatterer InSAR time series analysis of the radar images of the Envisat satellite of the European Space Agency, GPS measurements and field observations reveal that central section of the Izmit fault is now creeping at a steady-state rate reaching to its full speed of up to $\sim$2 cm/yr, that is, its geodetically determined pre-earthquake slip rate. GPS measurements and InSAR time series west of Lake Sapanca show that rapid postseismic afterslip started immediately after the earthquake following the coseismic movement of $\sim$3 m. As expected, it decays logarithmically with time and appears to be in a steady-state stage over the last 5-6 years, implying that it will likely continue for decades and possibly until late in the earthquake cycle. In other words, postseismic afterslip turns into surface creep with time, which is what might also have happened along the Hayward segment of the San Andreas fault and Ismetpasa segment of the North Anatolian fault following the large earthquakes in 1857 and 1944, respectively. Therefore, the 1999 Izmit earthquake demonstrates for the first time how postseismic afterslip evolves in to stable surface creep. We attribute the triggering of surface creep to trapped pore-fluid overpressures induced by the supershear rupture propagation during the Izmit earthquake, and to the oceanic and metamorphic rocks outcropping in the earthquake region as they are largely made up of weak phyllosilicates. The aseismic slip explains the relative seismic quiescence along supershear rupture segments observed after the 1999 Izmit and possibly various other large earthquakes elsewhere in the world, suggesting that supershear fault segments might be potential sites for aseismic surface creep.