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Transient fault-slip accumulation on continental fault systems and active subduction margins

Vasiliki Mouslopoulou (1), Andrew Nicol (2), Onno Oncken (3), and John Walsh (4)

(1) National Observatory of Athens, Institute of Geodynamics, Greece , (2) University of Canterbury, Christchurch, New Zealand, (3) GFZ Helmholtz Centre Potsdam, German Research Centre for Geosciences, Potsdam, Germany, (4) Fault Analysis Group, University College Dublin, Ireland

Displacement rates on individual faults within continental fault systems depart from their million-year average rates by up to three orders of magnitude with the size of these departures inversely related to sampling length-scale (temporal and/or spatial) and to fault length. The increased stability of fault displacement rates at greater temporal and spatial scales suggests that each fault is a component of a kinematically coherent system in which all faults interact and their earthquake histories are interdependent. Where the boundary conditions of fault systems are stable, displacement rates generally become constant over time periods between 20 and 300 ka, with the length of time required to reach stability being inversely related to the magnitude of regional strain rates. Similar rate fluctuations have been recorded on forearcs of active subduction margins where uplift can vary dramatically over time. Empirical paleoshoreline data (N=282) from eight subduction margins indicate that uplift rates are generally not steady state and varied by up to a factor of 20 during the late Quaternary ($\leq$125 ka). Transient uplift rates at subduction margins are mainly a short-term (<20 ka) phenomenon that cannot be attributed to plate-boundary scale processes such as changes in the rates of plate convergence, sediment underplating or isostatic unloading. Instead, time-variable uplift rates are primarily ascribed to temporal clustering of large-magnitude earthquakes on large upper-plate splay thrust faults. Both, fault interactions and upper-plate subduction seismogenesis, have been highlighted by the recent complex 2016 Kaikōura Earthquake in New Zealand.