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Spatio-temporal variability of locking along the southern Hellenic subduction margin

Vasso Saltogianni (1), Vasiliki Mouslopoulou (2,1), Onno Oncken (1), Andrew Nicol (3), Michael Gianniou (4,5), and Stelios Mertikas (6)

(1) Deutsches GeoForschungsZentrum GFZ, Potsdam, Germany, (2) National Observatory of Athens, Institute of Geodynamics, Athens, Greece, (3) University of Canterbury, Christchurch, New Zealand, (4) Hellenic Cadastre, Athens, Greece, (5) University of West Attica, Athens, Greece, (6) Technical University of Crete, School of Mineral Resources Engineering, Chania, Greece

Active subduction of the African plate beneath the Eurasian plate along the Hellenic margin in Eastern Mediterranean occurs at rates of ∼35 mm/yr and is primarily accommodated aseismically. Despite its aseismic character, large-magnitude earthquakes on the Hellenic forearc do occur, with the 365 AD M ∼8.5 mega-event being the most widely documented. These large earthquakes can episodically break thrusts, which splay from the plate interface and release elastic strains accumulated on the plate-interface zone. The current pattern of interseismic strain accumulation along the southern Hellenic margin is crucial, as it controls the locus and timing of future large earthquakes south of Crete. Here, we use a ∼10 year record of continuous GPS displacements from 22 permanent stations on Crete, together with empirical fault slip-rate information, to construct a kinematic back-slip model. Output from the model constrains the locking pattern along the southern Hellenic forearc and quantifies the degree of slip-rate deficit on the plate-interface and associated splay-thrust faults. Modeling reveals two main areas of locking in the crust south of Crete and mainly offshore, at depths between 20 and 40 km, with the eastern asperity accommodating approximately twice the elastic strain (∼29%) elastic strain of the shallower western asperity (∼16%). The along strike heterogeneity in the interseismic strain accumulation is consistent with the millennial uplift pattern revealed from uplifted paleoshorelines, which have been interpreted to indicate spatial (and temporal) clustering of large-magnitude earthquakes along the Hellenic forearc. Assuming a constant geodetic moment accumulation rate, the recurrence intervals of large-magnitude (M∼8) earthquakes are estimated to be ∼1500 and ∼2000 years along the eastern and western Hellenic forearc, respectively. Although the time elapsed since the large AD 365 event in western Crete is about 1700 years, seismic and tsunami hazard is believed to be more elevated in the east as this segment has experiencing a long period (∼4 ka) of seismic quiescence.