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Geodetic and Seismic Constraints on Strain Accumulation on the Hellenic Subduction Zone off Crete

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We present our most recent GPS velocity solution and seismic observations to investigate the active tectonics of the Aegean region. The central and southern Aegean Sea, and eastern Peloponnese region, have internal strain rates of $< 5{\times}10^{-9}$/yr while the western and eastern sections of the Hellenic subduction zone have distinctly different motions with respect to the slowly deforming, central Aegean: The eastern part moves towards the trench with rates increasing from central Crete to Rhodes and the western part has smaller, westward motions (i.e. extending the arc). A present-day velocity gradient of $\sim$ 4–5 mm/yr of trenchward motion from west to east occurs in a narrow zone in central Crete. Recent faulting in central Crete indicates predominantly NW-SE extension with no pronounced right-lateral faulting. However, there are other clear differences between the two halves of Crete. The western side has generally higher topography and higher rates of incision, forming large canyons in the southwest, and has distinct uplifted paleo-shorelines that have been identified as relating to large earthquakes. Although earthquake damage is reported from Minoan times (1500–1100 BCE), no uplifted shorelines identified with specific earthquakes have been reported in eastern Crete. Longer observed seismic travel times beneath western Crete relative to eastern Crete may result from the presence of thick accreted material encroaching on or being subducted at the trench, which may also account for the high topography of western Crete and the permanent uplift of the 365 CE western Crete earthquake shoreline. If the 5 mm/yr differential motion in western Crete represents elastic strain accumulation due to changes in coupling of the plate interface along strike, episodic seismic or aseismic release of this strain may account for the absence of significant strike-slip faulting in central Crete. Given this assumption and the $\sim$ 35–40 mm/yr Nubia-Aegean plate convergence rate at Crete, roughly 10–15% of convergence would be contributing to strain accumulation on the segment of the arc below western Crete. This is consistent with the observed lack of seismic moment release compared to the plate convergence rate over the length of the Hellenic subduction zone.