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Timing and mechanisms of Hellenic forearc uplift constrained by the E-Crete marine terraces

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The island of Crete, laying at the center of the fastest converging plate boundary in Europe, is a key site to understand the mechanisms of uplift and growth of forearc regions above their subduction zones. A well-developed set of marine terraces lay directly below km-wide marine paleo-platforms in eastern Crete. Taken together with recently uplifted marine sedimentary basins they record vertical motion on Miocene-Recent time scales and thus provide essential clues on Crete's tectonic evolution. To quantify this vertical motion, we combined tectono-morphologic analysis of a 2-m resolution digital surface model with detailed fieldwork. We dated 5 out of 21 mapped terrace levels with 36Cl cosmogenic nuclides, and two samples from elevated marine sediments near the topmost paleo-platforms with biostratigraphy. We find a large-scale (∼20 km) northward tilt of the palaeo-strandlines that increase in tilt angle with elevation from 0.3° to 2.1° between the lowest and highest continuous marine terrace. We interpret the 36Cl-dated terraces to span ∼330 ka, which requires a surface denudation correction for marine terraces older than ∼125 ka. Extrapolating the uplift rates of those terraces until the upper rasa indicates an onset of terrace uplift ∼1.2 Ma. This is similar in timing to the 1.5-1.0 Ma age estimated for the main onland basin-bounding fault obtained by extrapolating the Holocene fault scarp height to the total throw. Our biostratigraphic and field constraints indicate that before this phase of regional, tilted uplift and E-W extension, vertical tectonic motions were absent or minor between the Late Miocene and Late Pliocene/Early Pleistocene. This suggests a major tectonic change in subduction boundary conditions around 1.5-1.0 Ma. We discuss possible mechanisms that may be responsible for this change, including sedimentary underplating, slab dynamics and escape tectonics, and place our results within a larger framework of observations on tectonic changes within the Hellenic forearc.