The Aegean region presents one of the best examples of distributed continental extension in the upper plate of a rapidly retreating oceanic slab. We present new paleomagnetic data from Early Miocene to Pliocene terrestrial sediments and volcanics in Central Greece that constrain the history of vertical-axis rotation along the central part of the western limb of the Aegean arc. The present-day pattern of rapid block rotation within a broad zone of distributed deformation linking the right-lateral North Anatolian and Kephalonia continental transform faults initiated after Early Pliocene time, resulting in a uniform clockwise rotation of $24.3 \pm 6.5^\circ$ over a region $>250$ km long and $>150$ km wide encompassing Central Greece and the western Cycladic archipelago. Pliocene initiation of rapid clockwise rotation in Central and Western Greece reflects the propagation of the North Anatolia-Kephaliaonia Fault system through the previously extending Aegean Sea region in response to entry of dense oceanic lithosphere of the Ionian Sea into the Hellenic subduction zone and consequent accelerated slab rollback. Comparison of our results with the published paleomagnetic dataset indicates that the Aegean geometric arc formed in two short-duration pulses characterized by rapid vertical-axis rotation and strong upper-plate deformation.