The M 6.4 Albanian earthquake of Nov. 26, 2019 and its relation to structures at the Dinarides-Hellenides junctions

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We identify the main source of the M6.4 earthquake that rocked north-central Albania on November 26, 2019 to be located within the frontal area of the basal thrust of the Dinaric-Hellenic orogen. This earthquake was easily felt some 400 km away and was the strongest to affect the eastern Adriatic coast since the M7.1 event that struck Montenegro in 1979. Already two months earlier on Sept 21-22, several M5 earthquakes hit the same area. According to the USGS and EMSC-CSEM, all 2019 events occurred within a c. 40km wide epicentral area extending along strike of the front of the northernmost Hellenides between the city of Durres to offshore of the town of Lezhë. A depth interval of 10-20 km was poorly constrained for these events, with hypocenters located below the Periadriatic Foredeep Basin made up of deformed and poorly consolidated Neogene and Pleisto-Holocene sediments. For the M6.4 event, InSAR images from the Sentinel-1 satellite indicate up to 7 cm of epicentral uplift and a centroid depth of c. 17 km for the M6.4 event.

By combining own onshore geologic mapping with previously published subsurface imaging of the top of the pre-Neogene carbonates across the convergent margin, we have identified structures associated with a large ENE-dipping blind thrust forming the base of the Neogene-to-Present accretionary wedge at the front of the northernmost Hellenides belt. The centroid depth for the M6.4 event is interpreted to lie within this basal thrust; the shallower Sep 21 M5.6 event is inferred to lie at the western end of this same thrust, which does not appear to break the surface in offshore sections. Taken together, these events point to seismic slip on a thrust plane dipping some 30° ENE.

According to geological data this thick frontal Neogene thrust wedge is not continuous across the Dinaride-Hellenides junction, but is dextrally offset in northern Albania by the Lezhë Transfer Fault that forms the northern boundary of the epicentral area activated in 2019. NE of the Lezhë Fault in northernmost Albania and Montenegro, Neogene shortening perpendicular to the orogenic front is minor (< 10 km) in industrial seismic sections, whereas to the SW, a Neogene displacement of ≥ 100 km is determined from offset Triassic salt layers in the footwall and hangingwall of the basal
thrust. The Lezhë Transfer Fault is thus interpreted to have accommodated a sudden increase of Neogene shortening along the orogenic front to the SSW. Onshore mapping indicates that this fault also transfers onshore Neogene clockwise bending of the Hellenides with respect to the Dinarides of Montenegro. It kinematically links the offshore orogenic front in the SSW to thrusting and orogen-parallel extension along the Shkoder-Peja Normal Fault in the hinterland of the coastal area. Our work suggests that seismic rupture is segmented along the Dinaride-Hellenide front, with the M6.4 Albanian and earlier M7.1 Montenegrinian events occurring in structurally and kinematically separate domains.