Neogene and active brittle deformation on Amorgos Island (Greece)

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Amorgos is the south-eastern outpost of the Cyclades Islands in the Aegean Sea, which forms part of the Neogene-Quaternary zone of crustal and lithospheric N-S upper plate extension northward of the Hellenic subduction zone and deep sea trench. Apart from subduction-related earthquakes further south, the southern Aegean is affected by frequent earthquakes sourced in the upper plate. The twin earthquakes of 9 July 1956, followed by a strong tsunami, were the strongest events of this kind in the past Century. Hypocenters are related to a NE-SW oriented normal fault bounding the Amorgos-Santorini Graben System. There are questions in the literature regarding the seismic source and fault plane solutions, especially the contribution of a transcurrent faulting component.

We have analyzed the kinematics of brittle faults exposed on Amorgos Island itself that could be related to Neogene and active extensional and/or transcurrent deformation. Seismic slip often occurs on previously existing faults. Thus, their orientations and kinematics may help shed light on the structure of seismic sources at depth. We present evidence for a complex history of faulting. Early normal detachment faults and shear zones overprint older (rare) reverse faults, and are themselves overprinted by several sets of dominantly dextral NE and SE trending strike slip faults. Youngest is a conjugate set of NE trending high-angle normal faults. These are especially frequent along the SE coast of the island, suggesting a clear spatial relationship with the 1956 rupture. They can be fitted to a moment tensor solution similar to the published solutions for the 1956 Amorgos earthquake. The kinematic solution for the population of early normal faults suggests that the whole of Amorgos Island may have experienced a 15° NNW tilt during later extension, which lets us suspect that the island could be a tilted block of a much larger fault system. Regarding long-term late Neogene to Quaternary kinematics, dextrally transtensive fault slip is required to fit the regional pattern of extensional deformation in the Aegean, and this is reflected by small-scale brittle faulting on Amorgos.