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Deep crustal faults and the origin and long-term flank stability of Mt. Etna : First results from the CIRCEE cruise (Oct. 2013)

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The relation between deep crustal faults and the origin of Mount Etna, the largest and most active volcano in Europe has long been suspected due to its unusual geodynamic location. Results from a new marine geophysical survey offshore Eastern Sicily reveal the detailed geometry (location, length, dip and orientation) of a two-branched 200-km long, lithospheric scale fault system, long sought for as being the cause of Mount Etna. Using high-resolution bathymetry and seismic profiling, we image a 60-km long, previously unidentified, NW trending fault with evidence of recent displacement at the seafloor, offsetting Holocene sediments. This newly identified fault connects NE of Catania, to a known 40-km long, offshore-onshore fault system dissecting the southeastern flank of Mount Etna, generally interpreted as purely gravitational collapse structures. Geological and morphological field studies together with earthquake focal mechanisms indicate active dextral strike-slip motion along the onshore and shallow offshore portion of this 40 + 60 km long segment. The southern 100 km branch of the fault is associated with a sub-vertical lithospheric scale tear fault showing pure down to the East normal faulting and a 500+m thick elongate basin marked by syn-tectonic Plio-quaternary sediment fill. Together they represent two kinematically distinct strands of the long sought "STEP" (Subduction Tear Edge Propagator) fault, whose expression at depth controls the position of Mount Etna. Both 100-km long branches of the fault system are mechanically capable of generating magnitude 7 earthquakes (e.g. - like the 1693 Catania earthquake, the strongest in Italian history, causing 40,000 deaths). We conclude this deep-rooted lithospheric weakness guides gradual down slope creep of Mount Etna and may lead to long-term catastrophic flank collapse with associated tsunami by large-scale mass wasting.