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Overview, New Insights and Future Challenges on the Lower Tagus Valley Fault Zone

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The Lower Tagus Valley Fault Zone (LTVFZ) is the tectonic feature located within the Lower Tagus Valley usually associated with the 1531 and 1909 earthquakes. Based on the analysis of these historical events and available seismograms, the magnitude estimate for the LTVFZ is at least M6.0. A number of previous studies like geophysical investigations, borehole data analyses, trenching, and seismic hazard assessments were also undertaken for the LTVFZ in the past decades. Nevertheless, uncertainties remain prevalent regarding its fault parameters including the well-studied Azambuja (AF) and Vila Franca de Xira (VFX) faults. These uncertainties most probably are due to the very slow slip rates in the region and the absence of apparent fault features that can be associated with LTVFZ aggravated by both the extensive natural processes within the southern portion of the valley together with widespread human development/modification.

However, recent geomorphic features observed during latest mapping activities along the Lower Tagus floodplains indicate recent faulting activity. Evidence was mainly observed along the Quaternary and Holocene alluvial deposits along the northwestern portion of the Lower Tagus valley. Generally, landforms along the trace show a linear feature indicative of left-lateral displacements. Numerous field investigations were undertaken to verify ground features, quantify elevation difference across the fault trace, and evaluate any possible cumulative lateral displacements. Identified geomorphic features include fault scarps, scarplets, tectonic bulges, tectonic depressions, and linear valleys. Initial calculations of mountain front sinuosity using SRTM data likewise indicate a moderately active character. Based on faulting style and change on strike southwards, there maybe at least 2 segments of LTVFZ: the Atalia-Satarem segment and the Santarem-Alhandra segment.

Although most of the previous structures identified for this region are thrust faults, the newly-identified geomorphic features indicate that the most probable active trace for the LTVFZ is left-lateral fault. Limited geomorphic evidence coupled with seismic profile interpretations also points to left-lateral faulting for AF, which appears to be more degraded. On the other hand, the existence of the LTVFZ south of the Lower Tagus Valley has been always been necessitated due to the occurrence of the 1909 Benavente earthquake. Hence, the extensive studies on VFX and AF. However, the newly-mapped trace implies a longer trace or most probably a northern segment/splay that may have generated the 1531 event. Interestingly, the trend and extent of the newly-mapped trace correlates well with the isoseismals of these known historical events in the region. It is likewise notable, furthermore, that left-lateral faulting is the expected fault kinematics in this region based on thin shell modeling previously undertaken by other workers despite conflicting principal stress directions. This new information for the LTVFZ would be an important input for hazards assessment for the cities located within and adjacent the Lower Tagus Valley. In a region like SW Iberia where slip rates are relatively very slow, future studies like trenching and detailed mapping using LiDAR could be very essential in this region to determine pre-historic events, recurrence interval, and other possible active splays.