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Active tectonics, paleoseismology and associated methodological challenges posed by the slow moving Alhama de Murcia fault (SE Iberia)

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The Alhama de Murcia fault (AMF) is a 87 km-long left-lateral slow moving fault and is responsible for the 5.1 Mw 2011 Lorca earthquake. The characterization of the seismic potential of seismogenic strike-slip slow moving faults is necessary but raises huge methodological challenges, as most paleoseismological and active tectonic techniques have been designed on and for fast moving faults. The AMF is used here as a pilot study area to adapt the traditional geomorphological and trenching analyses, especially concerning the precise quantification of offset channels. We: 1) adapted methodologies to slow moving faults, 2) obtained, for the first time, the slip rate of the AMF, and 3) updated its recurrence period and maximum expected magnitude. Morphotectonic studies aim to use the measured tectonic offset of surface channels to calculate seismic parameters. However, these studies lack a standard criterion to score the analysed features. We improved this by differentiating between subjective and objective qualities, and determining up to three objective parameters (lithological changes, associated morphotectonics and shape, and three shape sub-parameters; all ranging from 0 to 1). By applying this methodology to the AMF, we identified and characterized 138 offset features that we mapped on a high-resolution (0.5×0.5 m pixel size) Digital Elevation Model (DEM) from a point cloud acquired in 2013 by airborne light detection and ranging (lidar). The identified offsets, together with the ongoing datings, are going to be used to calculate the lateral slip rate of the AMF. In three-dimensional trenches, we measured the offsets of a buried channel by projecting the far-field tendency of the channel onto the fault. This procedure is inspired by the widespread geomorphological procedure and aims to avoid the diffuse deformation in the fault zone associated with slow moving faults. The calculation of the 3D tendency of the channel and its projection onto the fault permitted us to calculate the net, the lateral and the vertical offset of a buried paleochannel (15.97 +2.53/-0.77, 15.92 +2.52/-0.79 and 1.35 +0.15/-0.12, respectively) with high precision taking into account the uncertainties associated with the reference points identified in the trenches. In addition, the paleoseismological analysis provided evidence of up to ten seismic events. Finally, we dated the units affected by the fault activity. We sampled units exposed in the trenches and alluvial fan exposed surfaces. Dating analysis are in progress, but preliminary results (small amounts of pedogenic carbonate with U-series) permitted us to calculate the maximum net, lateral and vertical slip rates of 1.31 +0.23/-0.11, 1.30 +0.23/-0.12 and 0.11 $\pm$0.01 mm/yr, respectively, concluding that the AMF is faster than considered and that its reverse component is very low. A radiocarbon age of 25.8 – 25.2 kyr cal BP yield recurrence periods of 5.0 – 5.2 ka. By empirical relationships application, we estimated maximum moment magnitudes between Mw 6.5 and Mw 7.5.