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Characterizing the seismic potential of a slow moving fault by integrating different techniques: the Alhama de Murcia fault (southeastern Betics, Spain)

Marta Ferrater (1), Maria Ortuño (1), Raimon Pallàs (1), Hector Perea (2), Stephane Baize (3), Eduardo García-Meléndez (4), José J. Martínez-Díaz (5), Anna Echeverria (1), Giorgi Khazaradze (1), Thomas Rockwell (6), Warren D. Sharp (7), Ramon Arrowsmith (8), Alicia Medialdea (9), Edward Rhodes (9), and Eulàlia Masana (1)

(1) RISKNAT Group. GEOMODELS. Departament de Dinàmica de la Terra i de l'Oceà, Facultat de Ciències de la Terra, Universitat de Barcelona, c/ Martí i Franquès, s/n, 08028 Barcelona, Spain (eulalia.masana@ub.edu), (2) Barcelona Center for Subsurface Imaging (B-CSI), Departament de Geociències Marines - Institut de Ciències del Mar - CSIC, 08003 Barcelona, Spain, (3) Institut de Radioprotection et Sûreté Nucléaire - Seismic Hazard Division (BERSSIN), BP 17, 92262 Fontenay-aux-Roses, France, (4) Área de Geodinámica Externa, Facultad de CC. Ambientales, Universidad de León, Campus de Vegazana s/n 24071 León, Spain, (5) Departamento de Geodinamica, Universidad Complutense, Instituto de Geociencias IGEO (UCM, CSIC), 28040 Madrid, Spain, (6) Department of Geological Sciences, San Diego State University, San Diego, CA 92182, USA, (7) Berkeley Geochronology Center, Berkeley, CA 94709, USA, (8) School of Earth and Space Exploration, Arizona State University, Tempe, AZ 85287-6004, USA, (9) Department of Geography, University of Sheffield, Sheffield S10 2TN, UK

Slow moving faults (<1 mm/yr) are usually silent and, thus, difficult to detect and characterize as the techniques (paleoseismology and active tectonics), are not completely suitable for low activity areas (i.e. need of dating methods covering longer time periods, less preserved surface expression, etc.). Adapting methodologies to slow moving faults is a need to enhance the knowledge of the seismic hazard in these, often highly populated, areas (such as Western Europe). The left lateral, NE-SW striking, Alhama de Murcia fault (AMF) is located in a diffuse plate boundary (southeastern Betics, Spain) and considered slow. The fault has been divided into 4 segments, being the two southern ones the more geomorphological and seismically expressive (from north to south: Lorca-Totana and Goñar-Lorca segments). The seismogenic nature of these two segments has been stated by previous paleoseismological studies and by the occurrence of few historical and instrumental earthquakes (the most prominent, the Mw 5.2, May 2011). In spite of this, its seismic parameters are poorly constrained and little is known concerning its slip-rate. We aim, here, to characterize its slip-rate and to better constrain its seismic parameters. To this end, we estimated the slip-rate based on measurements of the offset on both, surface and buried channels. Offset channels (up to 138) were described and measured on a detailed (0,5 x 0,5 m pixel size) DEM based on high-resolution airborne light detection and ranging data. These were classified and selected owing to their quality. To calculate the slip-rate, their maximum age was estimated based on the age of the alluvial fan in which the offset channels were entrenched. In three dimensional trenches, at El Saltador site (Lorca-Totana), we measured the offsets of two buried channels of different age by mathematically constructing a straight line fitting the reference points observed in the trenches and projecting the far-field tendency of the channel onto the fault. This was inspired by the widespread geomorphological procedure and aimed to avoid the observed diffuse deformation in the fault zone. It allowed us to precisely calculate the 3D components of the offset and the associated uncertainties. The trenching survey also provided evidence for 10 events, the longest record ever described in this fault. The age of the buried channels and paleoevents was constrained by U-series (pedogenic carbonate), OSL (quartz and feldspar) and Radiocarbon dating. In the 3D trenching, this yielded a surprisingly high net slip-rate of 0.9 ± 0.1 mm/yr (since 20ka), with a major strike-slip component (0.9 ± 0.1 mm/yr) compared to the dip-slip (0.1 ± 0.0 mm/yr). In the surface offset channels, we got even larger values at Goñar (max 1,7 mm/yr). We estimated a maximum slip per event ($\sim$6 m), a max magnitude for the Lorca-Totana segment (Mw 6.3 based on slip-rate and 7.7 based on the slip per event) and an average recurrence period (5 ka). The strike slip-rate, together with GPS results that include the Palomares fault (horizontal deformation of 1.5 ± 0.3 mm/yr), corroborate that the AMF plays the main role in this active system.