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Growth and linkage of the quaternary Ubrique Normal Fault Zone, Western Gibraltar Arc: role on the along-strike relief segmentation

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Strain partitioning modes within migrating orogenic arcs may result in arc-parallel stretching that produces along-strike structural and topographic discontinuities. In the Western Gibraltar Arc, arc-parallel stretching has operated from the Lower Miocene up to recent times. In this study, we have reviewed the Colmenar Fault, located at the SW end of the Subbetic ranges, previously interpreted as a Middle Miocene low-angle normal fault. Our results allow to identify younger normal fault segments, to analyse their kinematics, growth and segment linkage, and to discuss its role on the structural and relief drop at regional scale.
The Colmenar Fault is folded by post-Serravallian NE-SW buckle folds. Both the SW-dipping fault surfaces and the SW-plunging fold axes contribute to the structural relief drop toward the SW. Nevertheless, at the NW tip of the Colmenar Fault, we have identified unfolded normal faults cutting quaternary soils. They are grouped into a N110˚E striking brittle deformation band 15km long and until 3km wide (hereafter Ubrique Normal Fault Zone; UNFZ).
The UNFZ is divided into three sectors: (a) The western tip zone is formed by normal faults which usually dip to the SW and whose slip directions vary between N205˚E and N225˚E. These segments are linked to each other by left-lateral oblique faults interpreted as transfer faults. (b) The central part of the UNFZ is composed of a single N115˚E striking fault segment 2,4km long. Slip directions are around N190˚E and the estimated throw is 1,25km. The fault scarp is well-conserved reaching up to 400m in its central part and diminishing to 200m at both segment terminations. This fault segment is linked to the western tip by an overlap zone characterized by tilted blocks limited by high-angle NNE-SSW and WNW-ESE striking faults interpreted as “box faults” [1]. (c) The eastern tip zone is formed by fault segments with oblique slip which also contribute to the downthrown of the SW block. This kinematic pattern seems to be related to other strike-slip fault systems developed to the E of the UNFZ.
The structural revision together with updated kinematic data suggest that the Colmenar Fault is cut and downthrown by a younger normal fault zone, the UNFZ, which would have contributed to accommodate arc-parallel stretching until the Quaternary. This stretching provokes along-strike relief segmentation, being the UNFZ the main fault zone causing the final drop of the Subbetic ranges towards the SW within the Western Gibraltar Arc. Our results show displacement variations in each fault segment of the UNFZ, diminishing to their tips. This suggests fault segment linkage finally evolved to build the nearly continuous current fault zone. The development of current large through-going faults linked inside the UNFZ is similar to those ones simulated in some numerical modelling of rift systems [2].

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[1]Peacock, D.C.P., Knipe, R.J., Sanderson, D.J., 2000. Glossary of normal faults. Journal Structural Geology, 22, 291-305.

[2]Cowie, P.A., Gupta, S., Dawers, N.H., 2000. Implications of fault array evolution for synrift depocentre development: insights from a numerical fault growth model. Basin Research, 12, 241-261.