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Quaternary landscape evolution driven by simultaneous compression and extensional processes in the western Betics: The case of the Granada Basin

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The Granada basin is located in a key location within the western Betics, where different tectonic processes are modeling the present-day topography. Africa-Iberia NW-SE convergence with a rate of $\sim$5 mm/year is the responsible of E-W to ENE-WSW oriented folds, but recent local GPS measurements indicate a westward relative motion of 1.5-3.3 mm/year in the southwestern Andalucía, probably related to continental delamination processes. The drainage network of the Granada basin was captured by the Guadalquivir river drainage system in Quaternary times. However, landscape evolution in the basin does not respond to a simple model of headward erosion after river capture. In the NE border of the basin, the drainage network is highly incised revealing two stages of river development and entrenchment. The first stage is represented by abandoned channels slightly incised into a geomorphic flat surface defined by a calcrete, which adapted to recent open folds with N70E direction. The second stage corresponds to the present-day drainage network, which overprints the previous drainage system and presents higher incisions and a well developed pattern of headward erosion from a local base level delimited by Quaternary NE-SW normal faults. In this work we presented a detailed study of the drainage network evolution as a response of active folding and faulting. A landscape analysis using a high precision (2m) DEM obtained by LIDAR data, corroborates a very recent erosion wave that propagates in footwalls of these normal faults.
In order to establish the present-day erosion rates in the NE border of the Granada basin, two samples from the top of the calcrete were collected and dated by the U/Th method. The resulting dates are 40 $\pm$ 4 ka and 38 $\pm$ 7 ka. Using these age, we have calculated the incision and erosion rates for the late Pleistocene to present-day time span, yielding high erosion rates around 3 mm/yr. These high erosion rates and the landscape evolution are probably related to differential uplift during the Quaternary caused by the combination of active folding and faulting. The higher relief due to the activity of the NE-SW normal faults respect to the subtle topographic differences generated by the open N70 folds, as well as the very different entrenchment of the two drainage networks, point that faulting and folding are probably responding to different tectonic processes. The normal faults are the northern continuation of a major extension zone that bound the western termination of Sierra Nevada dome, where the highest elevations of the Betic Cordillera occur. The present-day activity of these faults is probably linked to crustal delamination processes.