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Active normal faulting, erosion, and growth of topographic relief during continental extension: The central Menderes Massif (Western Turkey)

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In tectonically active regions, faulting and surface processes act in concert to shape the Earth's landscape. Yet, in regions with marked extension and detachment-faulting, tectonic denudation has often been considered to be the sole mechanism for the exhumation of rocks from mid-crustal levels, while erosion was assumed to be negligible. The central Menderes Massif – located in the backarc of the Hellenic subduction zone – undergoes active N-S-directed extension and is ideally suited to test the relative importance of normal faulting and erosion to rock exhumation. Two previous studies used catchment-wide 10Be erosion rates and low-temperature thermochronology to show that erosion has contributed significantly to the exhumation of the metamorphic rocks even during rapid phases of detachment faulting (Buscher et al., 2013; Wölfler et al., 2017). These two studies focused on single transects through the two E-W-trending mountain ranges that form the central Menderes Massif. Here we present 10Be erosion rates for another 31 catchments that allow us to document the spatial pattern of erosion across the entire massif. In addition, we report local 10Be erosion rates from amalgamated clast samples, which were collected on 14 ridge crests covered by a thin mantle of regolith or soil. Taken together, these new 10Be data provide insight into how topographic relief has evolved in different parts of the central Menderes Massif. Catchment-wide erosion rates are generally high and range from 100 to 430 mm/kyr, whereas the erosion of mountain ridges proceeds at rates of only 50–90 mm/kyr. The much slower erosion of ridge crests, compared to those for the adjacent catchments indicates that local relief grows at rates of about 50–200 m/Myr and 150–350 m/Myr in the northern and southern mountain range, respectively. We interpret the increase in relief to be caused by ongoing faulting on the graben-bounding normal faults of the Gediz and Büyük Menderes Grabens, which causes footwall uplift and concomitant river incision. Our findings correlate well with the spatial distribution of steady-state channel elevations and are further supported by normalized steepness indices of the channels in the study area.

References

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