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Active tectonics of the Binalud Mountains, a key puzzle segment to describe Quaternary deformations at the northeastern boundary of the Arabia-Eurasia collision

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In northeast Iran, the Binalud Mountains accommodate part of active convergence between the Arabian and Eurasian plates. This fault-bounded mountain range has been considered a key region to describe Quaternary deformations at the northeastern boundary of the Arabia-Eurasia collision. But, the lack of knowledge on active faulting hampered evaluating the geological reliability of tectonic models describing the kinematics of deformation in northeast Iran. Morphotectonic investigations along both sides of the Binalud Mountains allowed us to characterize the structural and active faulting patterns along the Neyshabur and Mashhad fault systems on the southwest and northeast sides of the mountain range, respectively. We applied combined approaches of morphotectonic analyses based on satellite imageries (SPOT5 and Landsat ETM+), STRM and site-scale digital topographic data, and field surveys complemented with in situ-produced 10Be exposure dating to determine the kinematics and rate of active faulting. Three regional episodes of alluvial surface abandonments were dated at 5.3±1.1 kyr (Q1), 94±5 kyr (Q3), and 200±14 kyr (S3). The geomorphic reconstruction of both vertical and right-lateral fault offsets postdating these surface abandonment episodes yielded Quaternary fault slip rates on both sides of the Binalud Mountains. On the Neyshabur Fault System, thanks to geomorphic reconstructions of cumulative offsets recorded by Q3 fan surfaces, slip rates of 2.7±0.8 mm/yr and 2.4±0.2 mm/yr are estimated for right-lateral and reverse components of active faulting, respectively. Those indicate a total slip rate of 3.6±1.2 mm/yr for the late Quaternary deformation on the southwest flank of the Binalud Mountains. Reconstructing the cumulative right-lateral offset recorded by S3 surfaces, a middle-late Quaternary slip rate of 1.6±0.1 mm/yr is determined for the Mashhad Fault System. Altogether, our geomorphic observations reveal that, on both sides of the Binalud Mountains, the relative motion between central Iran and Eurasia is partly taken-up by dextral-reverse oblique-slip faulting along the Neyshabur and Mashhad fault systems. This faulting mechanism implies a long-term rate of ∼4 mm/yr for the range-parallel strike-slip faulting, and an uplift rate of ∼2.4 mm/yr due to the range-normal shortening during late Quaternary. Our data provide the first geological constraints on the rate of active faulting on both sides of the Binalud Mountains, and allow us to examine the geological reliability of preexisting tectonic models proposed to describe the kinematics of active deformation at the northeastern boundary of the Arabia-Eurasia collision. Our results favor the northward translation of central Iran with respect to Eurasia through strike-slip faulting localized along distinct crustal scale fault systems rather than systematic block rotations around vertical axes.