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New insights on the recent and current deformation in Central-Eastern Iran, derived from a combined tectonic and GPS analysis

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We have studied the recent to current deformation in Iran and especially Central-Eastern Iran by tightly combining tectonic and GPS analyses. Based on morphotectonic analyses of satellite images, we have identified and mapped the major active faults that dissect the entire $\approx$ 4500 km x 2500 km2 region that extends from Eastern Turkey to Western Afghanistan/Pakistan and hence encompasses Iran, emphasizing their large-scale organization and kinematic relationships. Doing so, we have identified the major fault systems that control the tectonics of Iran, especially in its central-eastern part. We have also analyzed the 11 years GPS record on the 92 stations deployed in central-eastern Iran in the framework of the Iranian-French collaboration. The GPS analysis reveals that all major faults identified as seismogenic in central-eastern Iran are indeed currently active and slipping at fast rates. The northerly-trending East Lut, West Lut, Kuhbanan, Anar and Deshir faults have a current right-lateral slip rate of 5.7 $\pm$ 0.9, 4.7 $\pm$ 1.7, 2.3 $\pm$ 1.9, 2.7 $\pm$ 1.3 and 0.5 $\pm$ 0.2 mm/yr, respectively, while the $\approx$ EW-trending Doruneh and Sedeh faults have a left-lateral current slip rate of 3.1 $\pm$ 1.8 and 1.7 $\pm$ 0.2 mm/yr, respectively. The large regions bounded by the northerly-striking faults behave as fairly rigid blocks that are all found to move towards both the N13°E ARA-EUR convergence direction and the WNW, at fast rates, in the range 6.5-12.5 and 1-5 mm/yr, respectively. Combined with the available data on the studied faults, our tectonic and geodetic results suggest that a bookshelf faulting strain transfer mechanism has been and is still operating in central-eastern Iran. The coeval dextral motion of the two major, overlapping, North Anatolian-Main Recent and Caucasus-Kopeh Dagh-Herat fault lines that embrace central-eastern Iran, induces a large-scale regional sinistral shear on either side of the region, which forces the northerly-trending right-lateral faults and the blocks they bound to rotate counterclockwise in the horizontal plane. The faults and blocks have been rotating over the last $\approx$12 Ma, at rates reaching 1.8 °/Ma, and are still currently rotating at about these rates. We estimate the sinistral shear imposed at both edges of the central-eastern rotating zone to be in the range 2.2 - 7.2 mm/yr. The Doruneh fault likely formed more recently than the other central-eastern Iranian faults, as the imposed sinistral shear was evolving from diffuse to more localized. As a consequence, the western half of the Doruneh fault currently accommodates a significant part of the imposed regional sinistral shear. Our study thus shows that the recent to current tectonics of central-eastern Iran is not only controlled by the ARA-EUR convergence, but also by the large-scale kinematics of the adjacent plates. We finally discuss the implications of the novel strain model that we propose on the seismicity that occurs in Central-Eastern Iran.