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Distributed deformation in the Zagros fold-and-thrust belt: insights from geomorphology

Ahmed Obaid (1,2) and Mark Allen (1)

(1) Department of Earth Sciences, Durham University, Durham, UK (a.k.obaid@durham.ac.uk; m.b.allen@durham.ac.uk), (2) Department of Earth Sciences, Baghdad University, Baghdad, Iraq

The Zagros fold-and-thrust belt is part of the active Arabia-Eurasia collision zone, and is an excellent region to study the interactions of tectonics and landscape. In this work we present results of a geomorphic analysis covering the entire range, coupled with more detailed analysis of the Kirkuk Embayment, Iraq. This particular region is a low elevation, low relief region of the Zagros, important for the enormous oil and gas reserves held in late Cenozoic anticlinal traps.

Constraints from published earthquake focal mechanisms and hydrocarbon industry sub-surface data are combined with original fieldwork observations in northern Iraq, to produce a new regional cross-section and structural interpretation for the Kirkuk Embayment. We find that overall late Cenozoic shortening across the Embayment is on the order of 5%, representing only a few km. This deformation takes place on a series of anticlines, which are interpreted as overlying steep, planar, basement thrusts. These thrusts are further interpreted as reactivated normal faults, on the basis of (rare) published seismic data. The regional earthquake record confirms the basement involvement, although detachments within the sedimentary succession are also important, especially within the Middle Miocene Fat'ha Formation.

Overall, the Zagros is sometimes represented as having a few major thrusts each persistent for 100s of km along the strike of the range. However, these faults are very rarely associated with major structural relief and/or surface fault ruptures during earthquakes. We have analysed the hypsometry of the range and find only gradational changes in the hypsometric integral of drainage basins across strike. This contrasts with regions such as the eastern Tibetan Plateau, where published analysis has revealed abrupt changes, correlating with the surface traces of active thrusts. Our interpretation is that the hypsometry of the Zagros reflects distributed deformation on numerous smaller faults, rather than major uplift on a small number of laterally continuous nappes.