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Fracture patterns in the Zagros Simply Folded Belt (Fars) : New constrains on early collisional tectonic history

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The study of fracture patterns and their potential genetic relationships to either cover folding or basement tectonics is of key importance in the Zagros where several giant oil fields are found. In contrast to the Dezful Embayment and the Izeh zone, there is a lack of outcrop-based fracture studies in the Fars arc. We take advantage of the outstanding quality of the outcrops in the Fars Simply Folded Belt arc to carry out new observations that are used to discuss the relationships between development of the fracture network and folding/basement tectonics and, using complementary fault slip data as kinematic-paleostress indicators, to relate fracture patterns to the regional tectonic history, and in turn further constrain the (early) tectonic evolution of the Zagros. This work will ultimately improve the available fracture database in Iran and presumably help generate more realistic geological models of fracture reservoirs.

We investigate fracture data (joints, veins, minor striated faults) along a transect from the Persic Gulf to the High Zagros, i.e., through the entire Simply Folded Belt. Rather than focusing on a single fold, data collection was organized to cover a large area and several folds in order to be able to differentiate regional trends from fold-related ones, i.e., to capture the fracture trends which may be significant at the regional scale. Along the transect, running slightly oblique to the direction of shortening, we thus studied various domains, close to transfer and strike-slip fault zones (Karebass/Sabz Pushan), above basement thrusts (Surmeh-Ghir thrust), and away from basement heterogeneities in the median part of the Fars arc. Thus, we are able to discuss the influence of those structural features on the strike of (early) compressional trends recorded by the LPS-related fractures.

We find that several sets of (early) joints are present at each location. Near the transfer zones, a systematic N-S to 020°E joint set predates a 040-060°E joint set (both pre-folding), suggesting a clockwise rotation of the compression. Such rotations can be explained by the fact that the compressional trend starts to rotate once significant shortening is accommodated around the transfer zone, before retrieving the regional (and current) 020°E trend. Fault slip data indicate an opposite rotation, the second step being post-folding, highlighting a three-step evolution.

Above the basement thrusts, the chronology might be the opposite: 045°E followed by 020°E (both pre-folding). This might suggest that the first fractures are influenced by basement heterogeneities (trending effectively 135°E, i.e. perpendicular to the first joint set) that re-oriented the stress field. In such case, we can infer that the basement and cover were coupled. In a second step, with decoupling of the cover, the strike of local compression rotates to parallel the far-field shortening.

In the median part, early joint strikes seem more systematically N-S to 020°E, which tends to suggest that the compression trend was here not disturbed by stress perturbations. It is noteworthy that, in this area, no significant oblique basement faults are reported.

In conclusion, we suggest that the far-field direction of compression might have remained around 020°E during both the early stress build-up in the Arabian plate and the subsequent orogenic deformation of the Zagros belt. Deviations from this regional trend are likely due to stress perturbations around different structures often linked to pre-existing basement faults whose early reactivation likely predated cover folding. The alternative interpretation of these various stress trends as due to block rotations related to the right-lateral strike-slip fault zones is also discussed.