CONTROL OF CAMBRIAN SALT ON STRAIN IN FAULT-RELATED ANTICLINES, ZAGROS FOLD-AND-THRUST BELT

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Introduction

The Zagros orogen is known for its spectacular fold trains. Resistant limestone anticlines control the characteristic morphology of the region. The front of the fold-and-thrust belt is characterized by salients (i.e., by larger advancement) where lower Cambrian evaporites occur at the base of the deformed succession and recesses where no such evaporites occur. In the first case, anticlines are believed to be detached along lower Cambrian salt. Regional geological studies and analogue and numerical models show that thrust faults geometry and related folds are markedly different in the two realms (i.e., in absence or presence of evaporites).

The strain (i.e., orientation and distribution of fractures in the Asmari Fm, a major reservoir rock in the petroleum system of the Zagros) in two anticlines (Fig. 1) developed in areas of the Zagros characterized by occurrence (Sim anticline) and absence (Kuh-e-Asmari anticline) of Cambrian salt at the bottom of the stratigraphic pile was investigated in the field, in order to outline major differences. The depth of deformation was constrained by means of organic matter optical analysis and X-ray diffraction of clay-size fraction, to constrain the depth at which deformation occurred. For the Kuh-e-Asmari anticline, fracture densities were compared with strain predictions from fold retrodeformation.

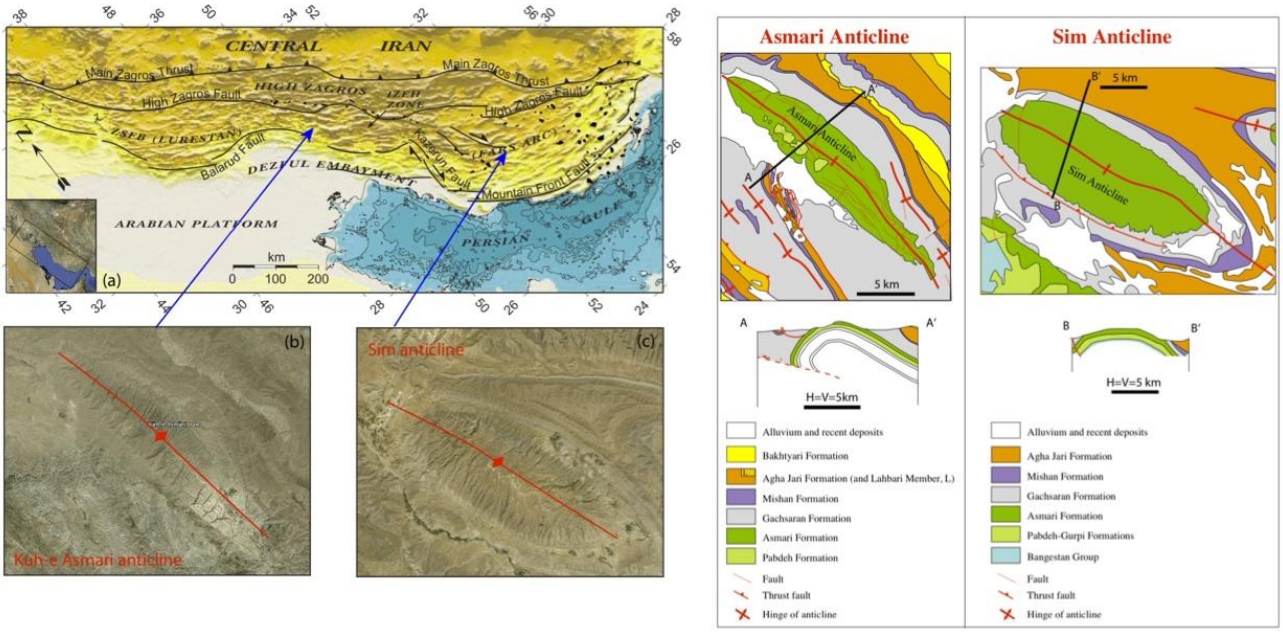

Fig. 1. *Location of the two investigated anticlines. The black dots in the top-left panel are salt diapirs. Google Earth images, geological maps and geological cross sections are shown.*

Results

In both anticlines, practically at all the locations, two conjugate (mutually cross cutting), normally perpendicular families of fractures were observed. These families are steeply dipping, one is parallel (F1) and one is perpendicular (F2) to the fold axis. Generally a third (F3) and a fourth family (F4) of steeply dipping fractures are observed. F3 and F4 fractures are at an angle of 30° with respect to F1 and F2, respectively.

On average, spacing in the Sim anticline is 2-3 times larger than that measured in the Kuh-e-Asmari anticline. No systematic variations are observed between limbs and periclinal closures in the two anticlines: in some cases spacing is larger in the periclinal closures and in other cases it is smaller than that observed along the limbs. Fracture saturation at the same locations is generally high, close to 1 or larger than 1. This generally means that the spacing distribution does not follow a Gaussian distribution and did not reach a high value of maturity. Although fracturing is immature, it is possible to observe a rough spatial distribution in both anticlines, i.e., saturation values tend to increase from the forelimb of the anticline (to the southwest) to the back limb (to the northeast) where is possible to find the highest values. In other terms, the maturity of fracturing is larger in the forelimb than in the backlimb, consistently with the fact that in the forelimb fracture spacing is smaller.

For the results of organic matter maturity analyses, the reader is referred to the companion abstract by Corrado et al. (2012). In addition, a 3D model of the Asmari anticline was built and retrodeformed to evaluate strain distribution associated with folding. Minimum volume changes were predicted along the crest, while significant dilation was predicted along the limbs and at the NE periclinal closure. A rough correspondence between the location of the more mature fracture system and the largest volume gain can be envisaged.

Conclusions

From field data and laboratory analyses it can be concluded that:

1) In the two anticlines, that have rather similar dimensions and shape, the top of the Asmari Fm was buried at shallower depths in the Kuh-e-Asmari anticline than in the Sim Anticline, as inferred from organic and inorganic thermal indicators.

2) Fracture spacing is 2-3 times larger in the Sim than in the Kuh-e-Asmari anticline. This is consistent with critical wedge theory that predicts that internal strain in mountain belts developing along a weak decollement is smaller than in belts with frictional decollement. However, the larger spacing in the Sim anticline is potentially consistent with the higher temperature (thus larger overburden) predicted for the Asmari Fm in this area.

3) Fracture saturation is quite similar in the two anticlines, and suggest that fracturing is rather immature in both structures. Local (e.g., folding) and regional tectonic (e.g., plate flexure) processes did not saturate with fractures the rocks.

4) Fold curvature possibly provides weak control on fracture distribution.

Acknowledgements

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References

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