Structural analysis of the Posht Jangal anticline in Lorestan zone, in the Zagros fold- thrust belt

Somayeh Derikvand*

Corresponding author: Islamic Azad university- Khorram abad branch
E-mail address: Derikvand_sss@yahoo.com

Abstract

In this paper, geometry analysis of Posht Jangal anticline is carried out that Posht Jangal anticline is located at the east of Kouhdasht, in Zagros fold and thrust zone and on the basis estimate its Dehram group closure. In this horizon, geometry of anticline are determined, based on geometry analysis its surface horizons and three structural traverses perpendicular to the fold axis is carried out, because there aren't the subsurface structural data for geometry analysis of anticline on its Dehram horizon. Geometry and kinematics analysis miner folds are shown geometry of these folds is chevron in core and they are open in the highest surface fold. This geometry is similar detachment folds geometry and it is analyzed with geometry test and on based amount of shortening in Zangul anticline. On this basis Garu formation is the factor of detachment geometry of fold in Dehram horizon. This state that with due attention to calculate closures Dehram horizon of Zangul anticline is oil suitable structure for explorations searches.

Introduction

The Zagros Orogen formed by continental collision between the Afro-Arabian continent and the Iranian microcontinent in Late Cretaceous to Tertiary time (Berberian and King, 1981). Numerous fold-and-thrust belts are formed by detachment of sedimentary layers above an incompetent unit, such as shale or evaporate. If the detachment zone is thick enough, the development of detachment folds (i.e. 'an unfaulted fold train above a through-going detachment'; Dahlstrom, 1990) is expected. The Zagros Mountains of Iran resulted from the opening and then the closure of the neo-Tethys ocean between the Central Iran domain and the Arabian plate (Berberian and King, 1981; Alavi, 1994). Within this orogenic belt, the external zones, the so-called «Zagros Simply Folded Belt» (ZSFB) (Stocklin, 1968; Falcon, 1969; Blanc et al., 2003; Sherkati and Letouzey, 2004; McQuarrie, 2004 ;) (Fig. 1) The Zagros fold and thrust belt in iran is known for spectacular anticlines that display whaleback geometries. This mountain belt in Iran is formed by fold trains involving the Proterozoic to recent sedimentary cover with a thickness of 6-11 Km (Stoclin, 1968; Colman- Sadd, 1978).

Discussion

Posht Jangal anticline is located at the NW-W of Khorram Abad city, in Lorestan zone, in the Zagros fold- thrust belt. The oldest Formation crop out at Posht Jangal anticline is the Ilam Formation, which is overlaid by Gurpi, Amiran, Tale zang, Kashkan, Asmari and Bkhtyari Formations. Like the other fold-thrust belts, deformation in the Zagros is governed by thrust faulting and related folding. However the thrust faults are almost blind and have no surface evidences. Geometry and kinematics of the Posht Jangal anticline is carried out in this study. For this purpose three structural traverses perpendicular to the fold axis are studied for measurement and collection of structural data. Based on these data, three structural cross sections across the anticline are constructed. The geometrical construction shows that the position of the significant inter mediate detachment can be estimated by geometry of the anticline at surface. The pattern of the axial surfaces can help to estimate the position of the intermediate detachment horizon. According to the resulted sections we can recognize 3 significant detachment horizons. Because of displacement surface, folds with material flow from limbs to hinge region cause development Rabbit ear folds and Pseudo similar folds in this Formation. Garu Formation is one of the basic median detachment surfaces in Lorestan zone that controls geometry of surface folding style of the structure of the regional oil fields. Four different geometric and kinematic models may be used to describe the kinematics of individual detachment folds involving a homogeneous competent unit detached over a ductile unit. Model 1 (Mitchell and Woodward, 1988) is a self-similar mechanism such that limb dip is kept constant and limb lengthening causes fold amplification. Model 2 (De Sitter, 1956) keeps limb length constant and anticlines grow purely by limb rotation. Model 3 (Dahlstrom, 1990) is based on the law of conservation of area for both the competent and the ductile unit, and both limb rotation and limb lengthening accommodate shortening. In model 4 (Blay et al., 1977), both limb rotation and limb lengthening are responsible for fold amplification, but the point of intersection of the axial surfaces that delimit the fold is fixed such that it occurs on the detachment surface. Two principal equations govern the kinematics of a homogeneous competent unit involved in a detachment fold formed by any of these mechanisms:

$$U = Lb\ \mathrm{Sin}\,(\upsilon b) = Lf\ \mathrm{Sin}(\upsilon f) \qquad (1)$$

$$S = Lb[1- \mathrm{Cos}(\upsilon b)] + Lf[1- \mathrm{Cos}(\upsilon f)] + Lt[1- \mathrm{Cos}(\upsilon t)] \qquad (2)$$

$$\gamma = 90° - (\upsilon b/2) - (\upsilon f/2)$$

$$\delta = 180° - \upsilon f - \gamma \qquad (3)$$

where u is the uplift; Lb, Lf, and Lt are the backlimb, forelimb, and top length, respectively; υb and υf are the forelimb and backlimb dips, respectively, S is the shortening and γ being the half interlimb angle and δ the angle between the axial plane and the detachment (or the dip of the axial plane when the detachment is horizontal).. υb and υf range from 0 to 180°, and overturned beds occur when $90° < \upsilon b, \upsilon f \leq 180°$. Equation 1 reflects that fold uplift must be equal in both limbs. Equation 2 implies that the limb length before folding is equal to the fold wavelength plus the shortening. For a quantitative geometric analysis of detachment folds, it need to be known forelimb length, backlimb length, forelimb dip, backlimb dip, uplift, interlimb angle, and axial plane dip, shortening, dip of the fixed axial plane and half interlimb angle can be calculated by solving the appropriate equations previously given. The variables needed can be directly measured in the field and from cross sections perpendicular to the fold axis. A graphical method has been designed to determine the remaining parameters. Using a graphical method requires several steps. First, the following ratio (Rl) must be calculated:

$$Rl = \frac{\mathrm{Sin}(vf\,)}{\mathrm{Sin}(vb)} \qquad (4)$$

This ratio corresponds to the backlimb/forelimb length ratio. The fold geometry must be plotted as a point on the graphs in Figure 3a and b, which gives the fold shortening. Once the shortening is known, the graphs in Figure 3c–e can be used to obtain the uplift, interlimb angle, and axial plane dip, respectively. Every point on the diagrams represents one particular fold form. The angular values shown in the graphs are real values in degrees, but the linear values have been normalized according to Lb = 10 units. The actual shortening (S) can be derived by using the following simple equation:

$$S = \frac{\text{Calculated Shortening Lf}}{10} \quad (5)$$

When these values are plugged into the equations, the calculated results are consistent with the geometry of the folds analyzed. For instance, the backlimb dip measured from the kinklike section is 51°, spectively. When these values are plugged into equation 1, the calculated uplift is 2470 m, which is consistent with the uplift value of 2471 m directly measured from the kinklike section and the calculated shortening is 2624 m. This value coincides with the shortening measured directly from the kinklike section. The values measured from the kinklike sections were also plotted in the graphs in Figure 3 to test the graphical method described. The results obtained are consistent with the geometry of the fold analyzed and with the values obtained when using the numerical method. The good correspondence between the geometry of the Posht Jangal anticline analyzed and the predictions of the numerical and graphical technique supports the viability of the geometric analysis. The constructed structural contour map of the anticline reveals a vertical closure of 200 m and horizontal closure 1/667 km2 in the Posht Jangal anticline. (Figure 4)

CONCLUSIONS

The cross sections of Posht Jangal anticline show that intermediate detachment in sedimentary units is also involved in to folding. The main detachment surface responsible for folding of the Posht Jangal anticline is deep detachment surface in Cambrian shales. Although evidences of folding in younger Formations of anticline nucleus that they are formed in its limbs, show that median detachment surfaces are influenced development of the folds. The Gourpi Formation has been considered as upper detachment surface. Because of displacement surface, folds with material flow from limbs to hinge region cause development Rabbit ear folds and Pseudo similar folds in this Formation. Garu Formation is one of the basic median detachment surfaces in Lorestan zone that controls geometry of surface folding style of the structure of the regional oil fields.

REFERENCES

1- Alavi, M., (1994), Tectonics of the Zagros orogenic belt of Iran, new data and interpretations. Tectonophysics. 229, 211-238.

2- Berberian, M., King, G.C., 1981. Towards a palaeogeography and tectonics evolution of Iran. Canadian Journal of Earth Sciences 18, 210±265.

3- Blay, P. K., J. W. Cosgrove, and J. M. Summers, 1977, An experimental investigation of the development of structures in multilayers under the influence of gravity: Journal of the Geological Society of London, v. 133, p. 329–342.

4- Colman-Sadd, S.P., (1978). Fold development in Zagros simply folded belt, Southwest Iran. American Association of Petroleum Geologist Bulletin, V. 62, No. 6 b, 984-1003.

5- Dahlstrom, C.D.A., (1990). Geometric constraints derived from the law of conservation of volume and applied to evolutionary models for detachment folding. AAPG, Bulletin, V. 74, No. 3, 336-344

6- Falcon, N.L., (1961). Major earth-flexing in me Zagros Mountains of southwest Iran. Quarterly Journal Geological Society of London, 117, 367-376.

7- McQuarrie, N., (2004). Crustal scale geometry of the Zagros fold-thrust belt, Iran. Journal of Structural Geology., Vol. 26 (3), 519-535.

8- Mitchell, M. M. and Woodward, N.B., (1988). Kink detachment folds in the southwestern Montana fold and thrust belt. Geology, 16, 162-165

9- Poblet, J.A. and McClay, K.R., (1996). Geometry and kinematics of single layer detachment folds. AAPG Bulletin, 80, 1085-1109.

10- Sherkati, S. and Letouzey, J., (2004). Variation of structural style and basin evolution in the central Zagros (Izeh zone and Dezful Embayment), Iran. Marine and Petroleum Geology, Vol. 21, No. 5, 535-554.

11- Stocklin, J., (1968). Structural history and tectonics of Iran: a review. AAPG Bulletin, 52, 1229-1258.

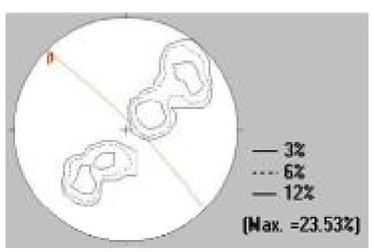

Figure 1—Equal area stereo plot of the bedding of the Posht Jangal anticline

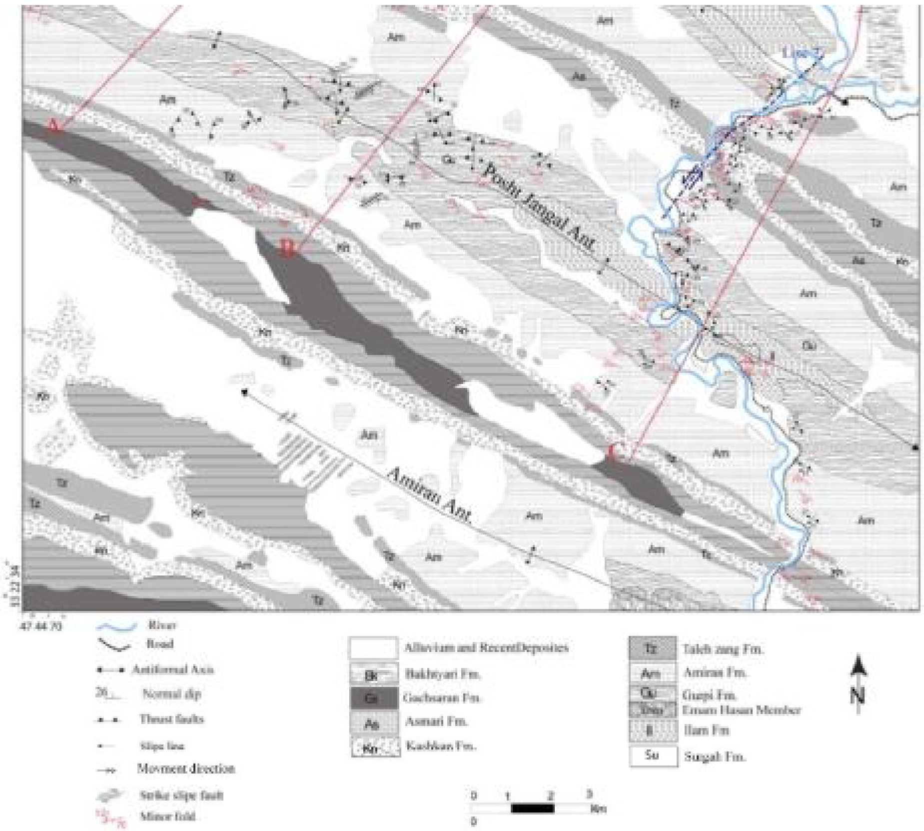

Figure 2- Structural map

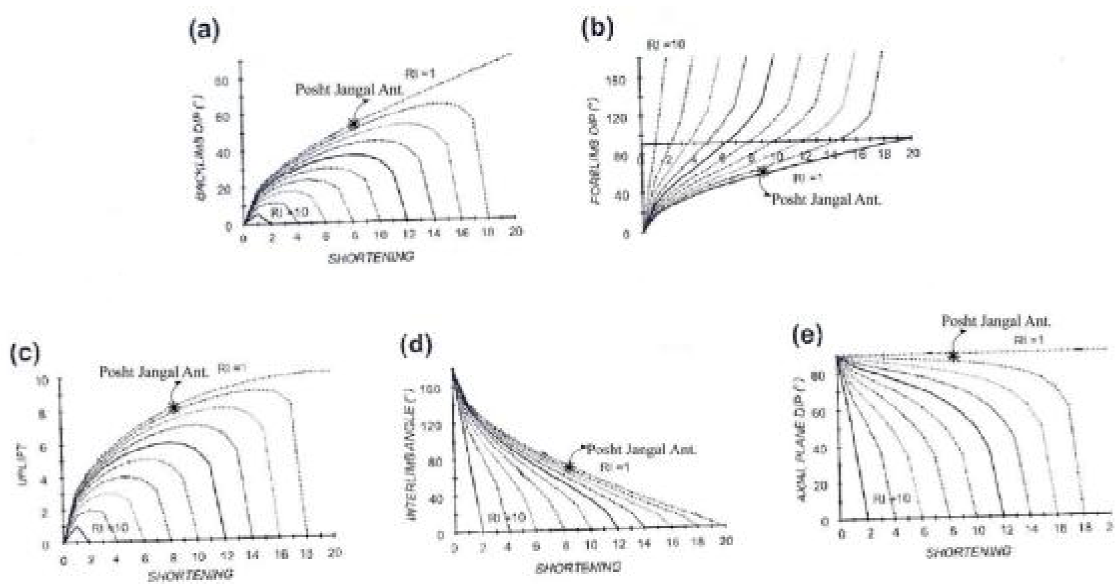

Figure 3—Graphs used to determine the geometrical parameters of Posht Jangal anticline. The curves plotted in the graphs correspond to the following values of Rl from right to left: 1, 1.11, 1.25, 1.43, 1.67, 2, 2.50, 3.33, 5, and 10.

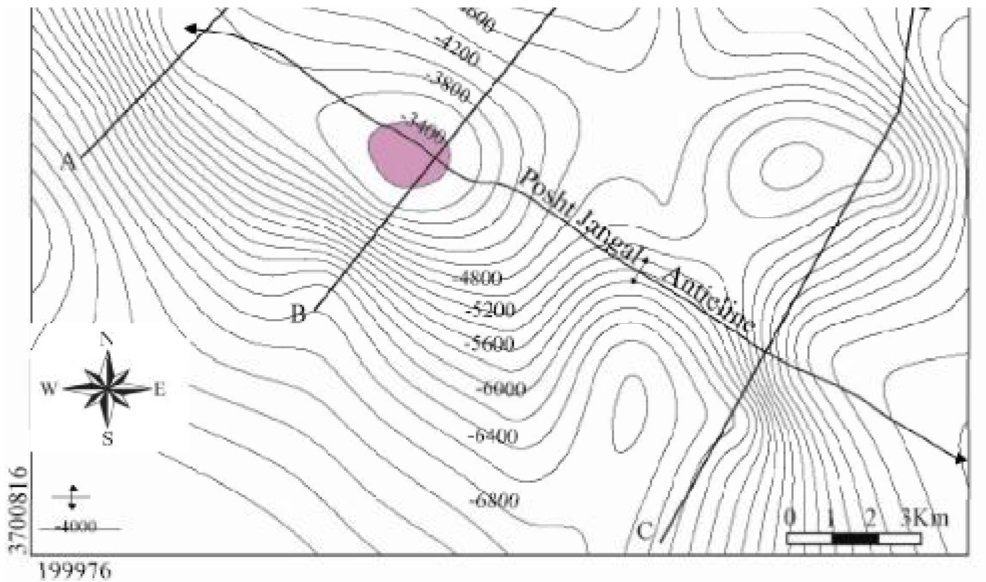

Figure 4 - UGC map