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Detachment Anticlines and Synclines and their Impact on the Tertiary and Cretaceous Reservoirs of the Zagros Fold and Thrust Belt in Kurdistan.

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Summary

The Zagros Fold and Thrust Belt in Kurdistan is an active area for oil and gas exploration. One part of this belt is the Zagros foredeep province that lies within the Kirkuk embayment. In this area, the Cretaceous and Paleogene reservoir rocks are involved in a train of detachment anticlines and synclines that can be seen at a depth of 2-3km. The shallower Tertiary rocks at the surface and the deeper Jurassic seismic reflectors show much less shortening than these intermediate detachment fold structures.

Introduction

Intensive exploration work on these fold structures in the Zagros foredeep has resulted in successful wells at Kurdamir and Sarqala. These two projects alone have added 700+ mmboe of discovered oil to this play type. After more evaluation, the structures at Topkhana, Chia Surkh, and Kor Mor will probably add additional reserves of oil and gas. The early drilling confirmed that the long wavelength structures seen in the Tertiary rocks at the surface are not reflected in the deeper Cretaceous and Paleogene reservoir rocks. However, it became apparent that the disharmonic folding that exists between the surface and the subsurface can be explained by two different exploration models. For the development of these fields to be consistently successful the differences between these two models need to be examined and the results could be used to increase the probability of success in future drilling.

Methodology

In order to evaluate these two different exploration models more data was needed. An additional program of remote sensing and airborne geophysics was acquired. This data was then incorporated into the regional geological picture using geology maps and studies published by the Kurdistan geological community. The final phase consisted of the acquisition of additional seismic data along with local and regional surface geological map data. All the data was compiled into a series of balanced cross sections in depth.

Examples

In the foredeep province of the Kirkuk embayment the structures seen in outcrop are simple long wavelength folds. They have a wavelength of 10-20km and involve Pliocene sediments. These surface structures mask structural complexities that are seen in the reservoir rocks that are at a depth of 2-3km. The targeted Paleogene and Cretaceous reservoirs are found in these subsurface detachment fold structures and are made up of several short wavelength folds with a 2-5km wavelength. The detachments folds are imaged on seismic and can be seen in outcrop in the hinterland to the northeast of the Zagros foredeep province. At this outcrop the short wavelength folds are underlying a boundary in the Middle Miocene. This boundary marks a distinct surface that is separating the long wavelength folds on the surface from the short wavelength folds in the subsurface. It is possible to explain the nature of this boundary and the distribution of the underlying reservoirs with two different geological models.

In the first model, the short wavelength folds are bound above and below by two detachment surfaces (Fig.1). The upper detachment surface lies at the Middle Miocene boundary. The lower detachment surface is more diffuse, and lies deeper in the stratigraphic column, at the mid-Cretaceous level or deeper. These two detachment surfaces would allow a train of detachment anticlines and synclines to form somewhat independently of the rocks above the upper detachment surface or below the lower detachment surface. In the second model, the upper Middle Miocene boundary is interpreted to be an erosional unconformity (Fig.1).This surface has eroded the tops of the older detachment folds. In both models, post Pliocene folding occurred, warping all of the Tertiary and Cretaceous rocks into the long wavelength folding seen on the surface today.

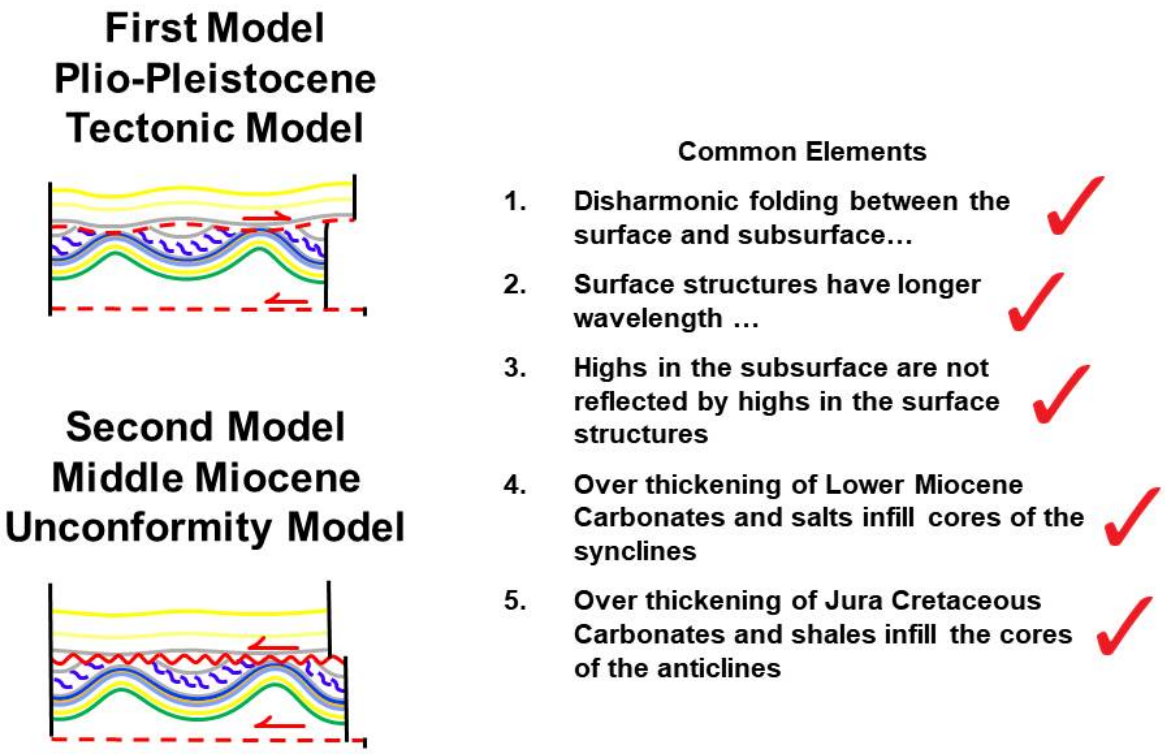

Fig.1 Diagram illustrating the two possible exploration models and the common elements between them.

Conclusions

The identification of two models for the Cretaceous and Paleogene structures in the Zagros foredeep province has led to a complex evaluation process. In both of these models, the distribution of the reservoir rocks in the detachment anticlines can be used to explain the rapid elevation change of these rocks in the dip direction. However, the distribution of the reservoir rocks in the detachment synclines could vary greatly depending on which of the two models is correct. This issue could be resolved by the acquisition of regional, high resolution seismic lines shot over these structures. This additional seismic work would help to determine if the crests of the detachment folds have been eroded either as a result of a Mid Miocene upper detachment surface as in the first model, or as a result of an unconformity as in the second model. By resolving this issue, we would reduce the reservoir distribution risk on the flanks of

the existing productive detachment anticlines, and thus significantly contribute to drilling successful oil and gas wells in this challenging geological environment.