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Quantifying Structural Evolution

Schuman Wu[1]

[1]Saudi Aramco, Dhahran, Eastern, Saudi Arabia.

ABSTRACT

The Structural Growth Index (SGI) is defined here as the ratio of the difference in formation thickness values measured at two selected locations (one on a structural high and one in a structural low) divided by the greater of the thickness values. The growth history of a given oil field structure can be revealed quantitatively by calculating SGI for a series of consecutive geologic formations and plotting them against the geologic age represented by these formations. When a fold grows while sedimentation continues, the rock units on structural highs (e.g. on top of an anticline) will be typically thinner than the same unit in structural lows (e.g. at a syncline location) in response to reduced accommodation space. The thickness differences between structural high and structural low are governed by the magnitude of folding during the deposition of the given rock unit. SGI has been implemented in a quantitative structural characterization workflow and applied to a wide range of oil/gas fields in Saudi Arabia. Examples will be shown to illustrate the applications. Cautions need to be considered, though, when using SGI values to quantify structural growth. Interpretation of poor-quality seismic data can lead to inaccurate horizon mapping. Calculations using improperly positioned data values along the horizon will result in misleading growth history. Hence, SGI values at local anomalies (“bulls-eyes”) may not be accurate and must be avoided unless verified. The other case is when the thickness of the strata is relatively small (a few hundred feet or less), so any small change in thickness will cause a large relative change in SGI ratio because the denominator of the fraction is a small value. While the method of “Structural Growth Index” proposed in this paper is novel in terms of quantifying the amount of fold growth through geological time, it is worth noting that a similar method called “Expansion Index Method” was originally proposed by Thorsten (1963) to categorize the amount of growth on a normal fault verses depth, and a later modified version called “Dd/d” by Bischke (1994) to categorize the amount of growth between two wells to evaluate the expansion of a basin.