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Impact of Strike-Slip Faulting on The Reservoirs of Kuwait

Introduction

The oil fields of Kuwait are located on the northern Arabian plate, southwest of the Zagros deformed belt. Over the past decade several large 3D seismic surveys have been acquired over all the producing fields (Figure 1). The majority of the data are of high quality and respond well to the recently developed interpretive imaging techniques.

Geological Setting

The producing fields of Kuwait are giant fields. They are composed of stacked carbonate and clastic reservoirs. Structurally, the fields are predominantly faulted anticlines with four-way closure (Figure 2). The structures are a result of large-scale strike-slip movement associated with a number of Mesozoic and Cenozoic tectonic events overprinted on an earlier Infracambrian structural framework

Technical Approach

Individually, the existing seismic surveys were insufficient to resolve the extent of the faulting. The ability to generate a consistent structural fault model necessitated the merging of the existing seismic coverage (Figure 3).

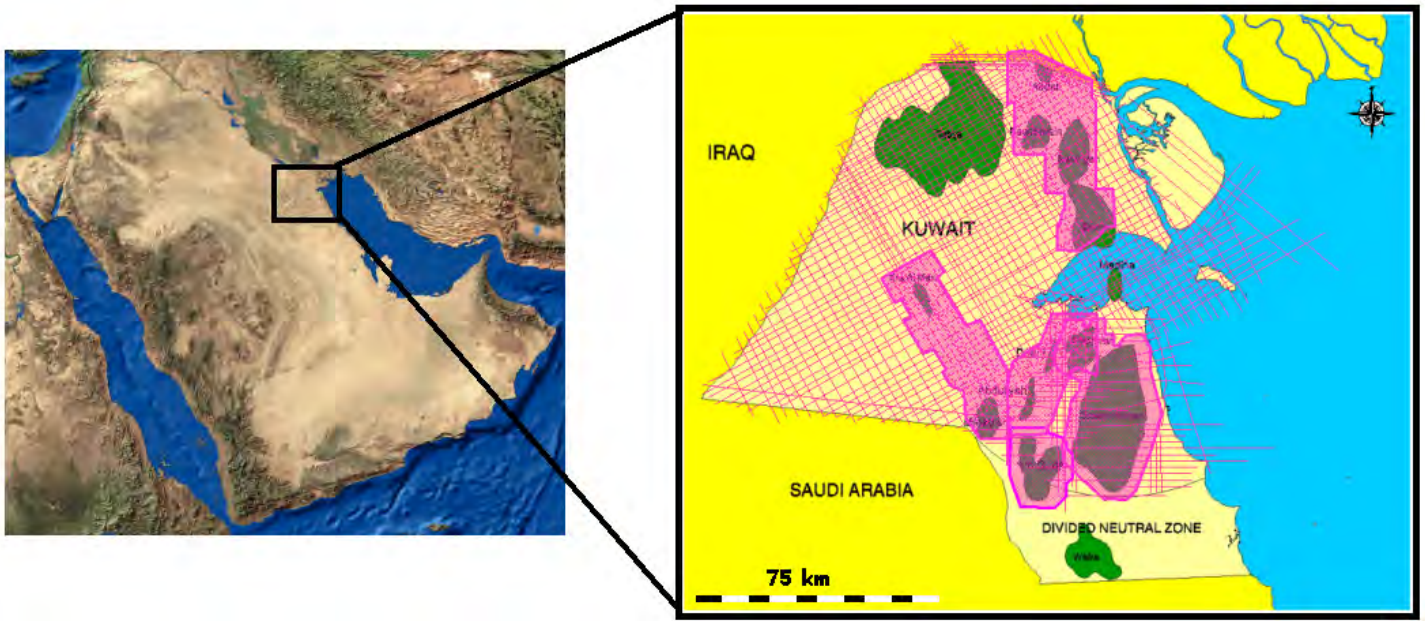

Figure 1. Location Map

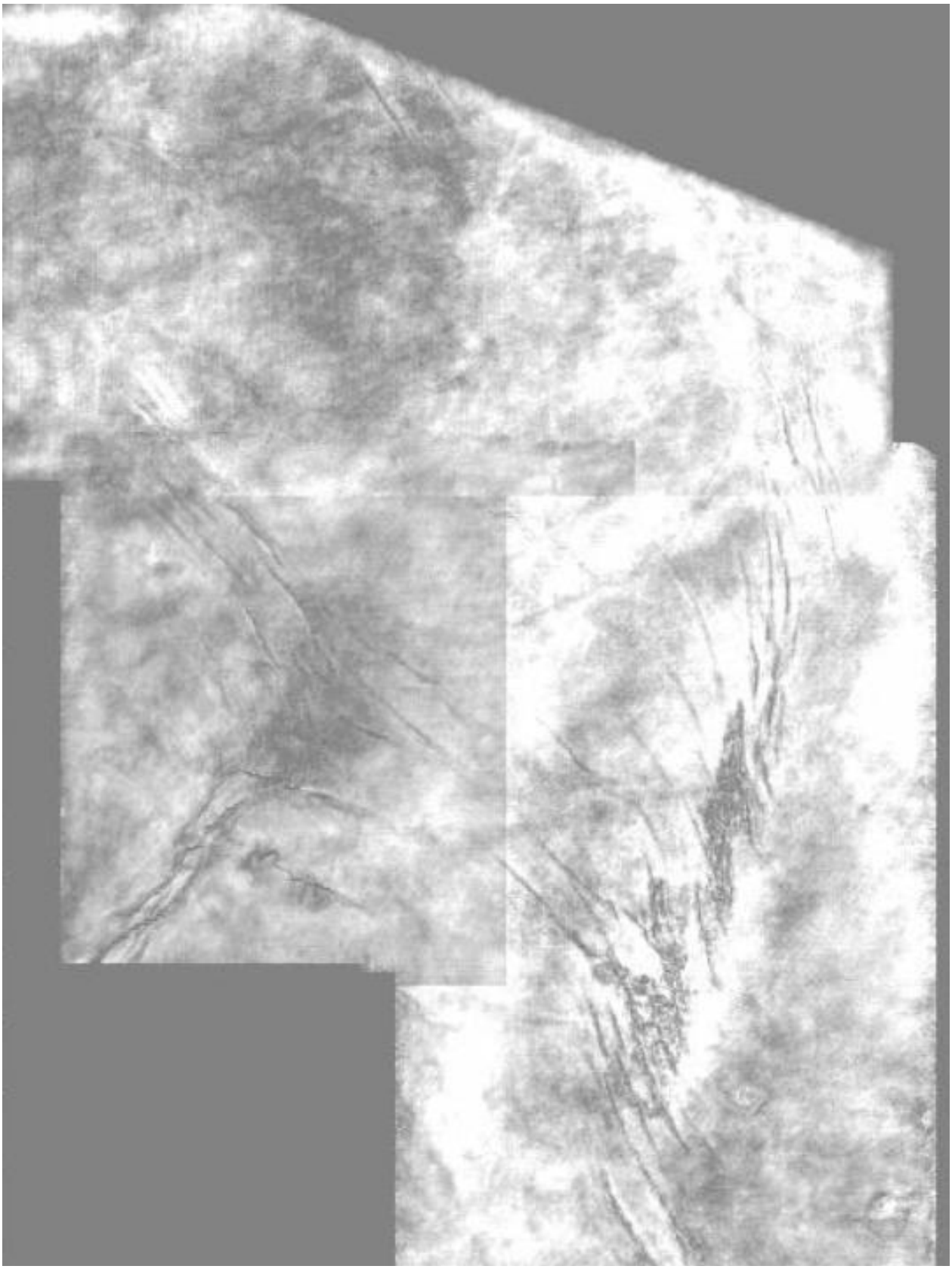

Figure 2. Spectral Decomposition Image of Raudhatain and Sabriyah Fields

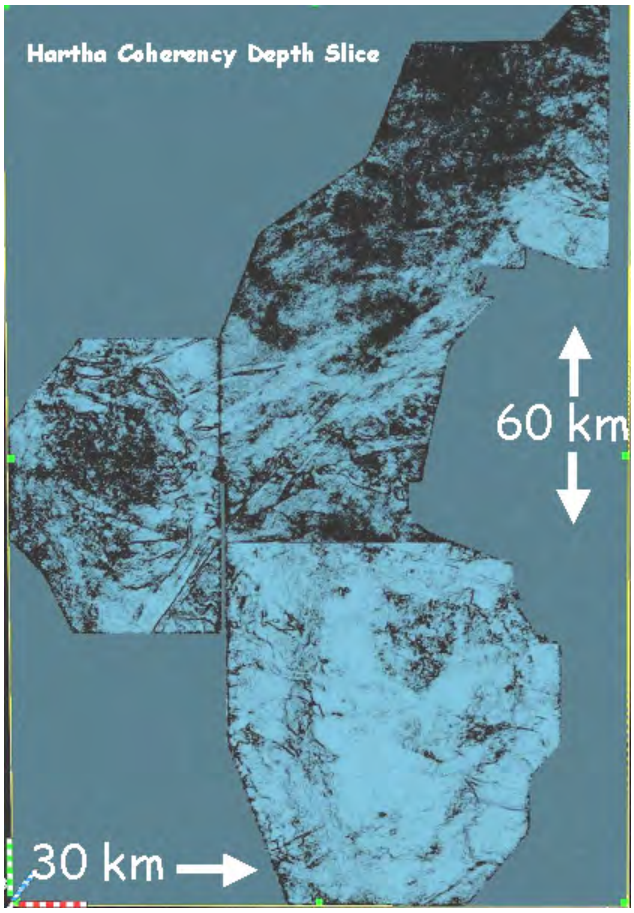

Figure 3. All existing West Kuwait 3D surveys merged into a single cube. This image is a coherency Depth Slice of the Tertiary Hartha showing faults cutting across all 3 surveys

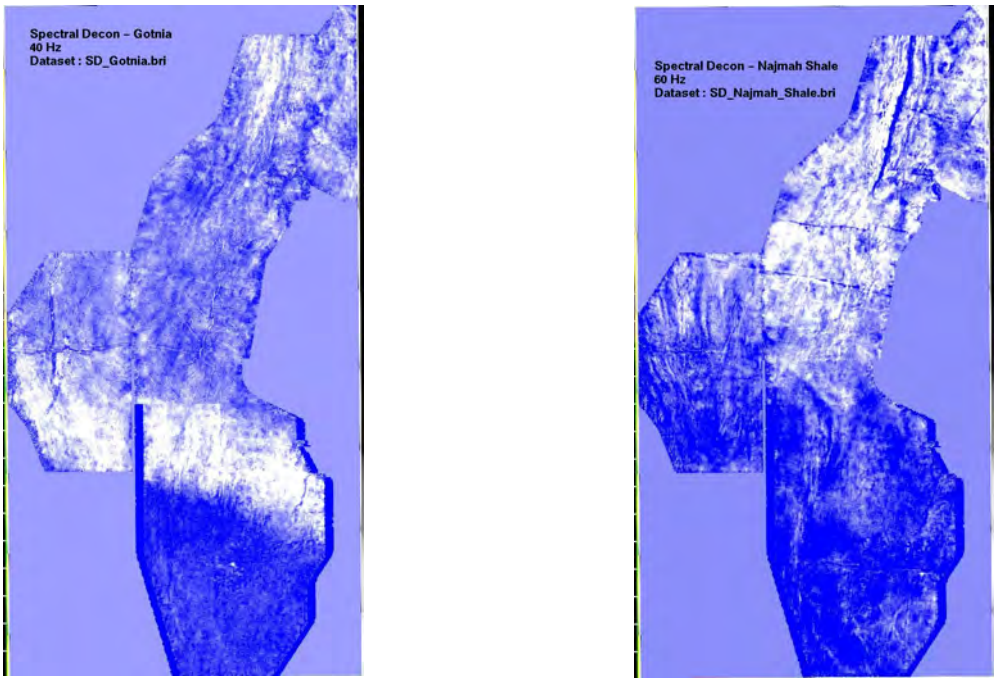

Figure 4. Spectral Decomposition on the Jurassic Gotnia and Najmah

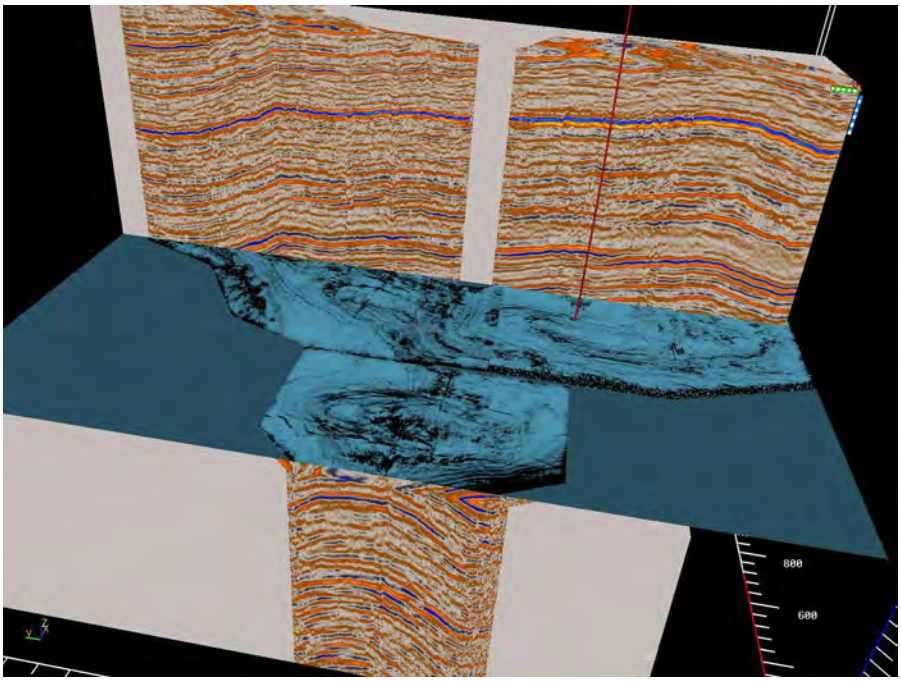

Figure 5. A 3D image of the Faults in the Jurassic Gotnia with the offsetting vertical sections.

Regional faults can now be tracked into the producing fields where they significantly impact production and field development (Figure 4). The concurrent use of coherency, spectral decomposition, and amplitude volumes is key in the fault interpretation.

The ability, within visualisation software, to pan rapidly through depth slices and identify fault transects has proven to be a critical step in the interpretation (Figure 5). The resolution and quantification of the faults requires the integration of all available data including quantitative dipmeter, core, and wireline data. Despite the generally small vertical throws, the faults compartmentalise pressure and act as baffles to horizontal fluid flow. Production anomalies detected by full field dynamic modeling can be better explained with the inclusion of this fault network.

Observations

In the deeper Jurassic sections, high angle wells have been drilled adjacent to the identified faulting. The net result has been an increase in the number of intersections between the well bore and the fractures. In the shallower Cretaceous reservoirs, the new fault geometries better explain the pressure difference due to production. The onset and delay of water production has also been explained by these faults. One of the remaining challenges is to characterize the trends of the faults into barriers, baffles and conduits.

Conclusion

The overall result of the re-interpretation is a much more integrated team using an integrated 3D model. These models have resulted in a better understanding of not only the geophysics and geology, but also the production. In addition to better planned wells, these models have influenced our injectivity and maintenance program.

Acknowledgements

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