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3D Visualisation: A Tool for Non-Conventional Well Planning in Kuwait

Introduction

In 1996 Kuwait Oil Company acquired 2D data over the entire country, and 3D seismic surveys to cover the major producing fields. The total surface area covered 4,835 km² (>50 townships) (Figure 1). Although these 3D dataset were huge, analyzing individual 3D dataset alone amputates the regional structural geology.

Geological Setting

Structurally, the fields are predominately, faulted anticlines with four-way closure. The structures are a result of large-scale strike-slip movement. Two major strike-slip directions, along with their associated reidal and anti-reidal faults have been identified. Mesozoic and Cenozoic tectonic events have been overprinted on an earlier Infracambrian structural framework. Historically, seismic interpretation were constrained by the use of the old 3D interpretation techniques of analyzing static sections. The advent of simultaneous visualization of multiple seismic attributes (coherency, spectral decomposition, acoustic impedance, and amplitude) on the merged 3D volumes has allowed identification of subtle faults and increased the quality of well placement (Figure 1) The faults have little vertical offset, in general and were not seen using the old interpretation techniques due to their subtleness. These strike-slip faults have been confirmed from production and pressure data as pressure barriers and flow baffles. Calibration of the reservoir properties across the faults requires the detailed integration of all available data.

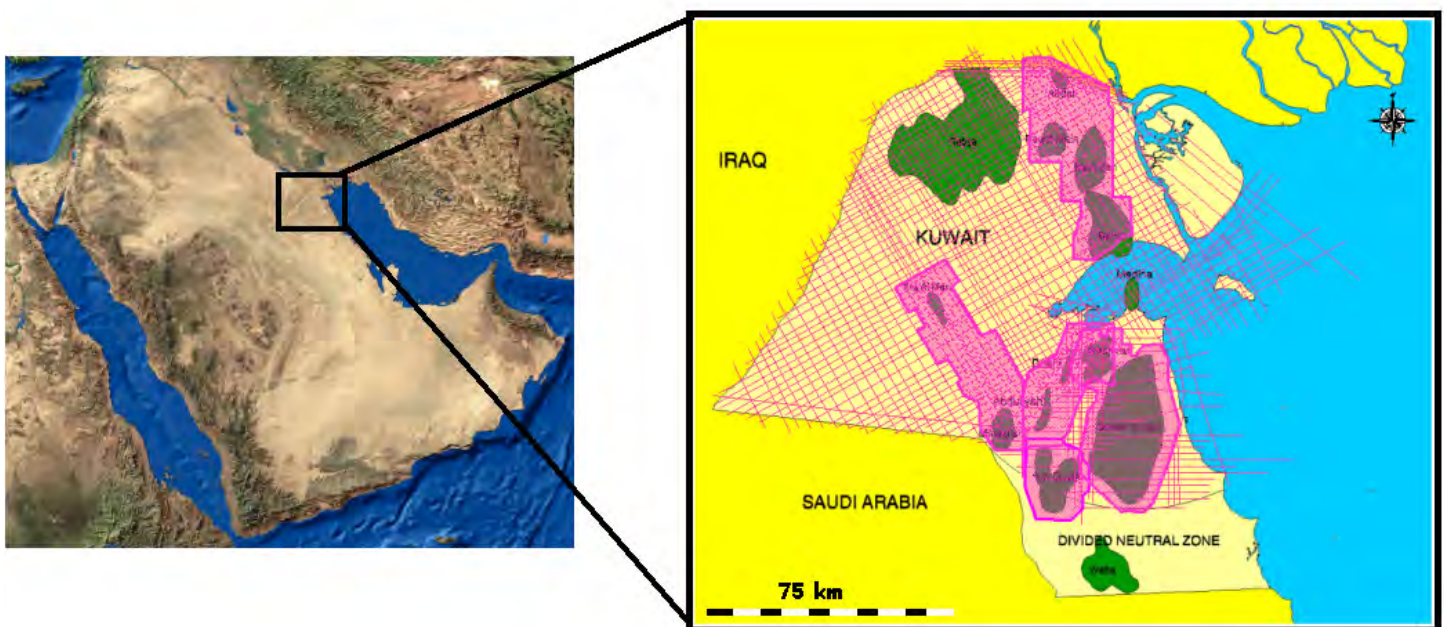


Figure 1. Location and Seismic Coverage Map

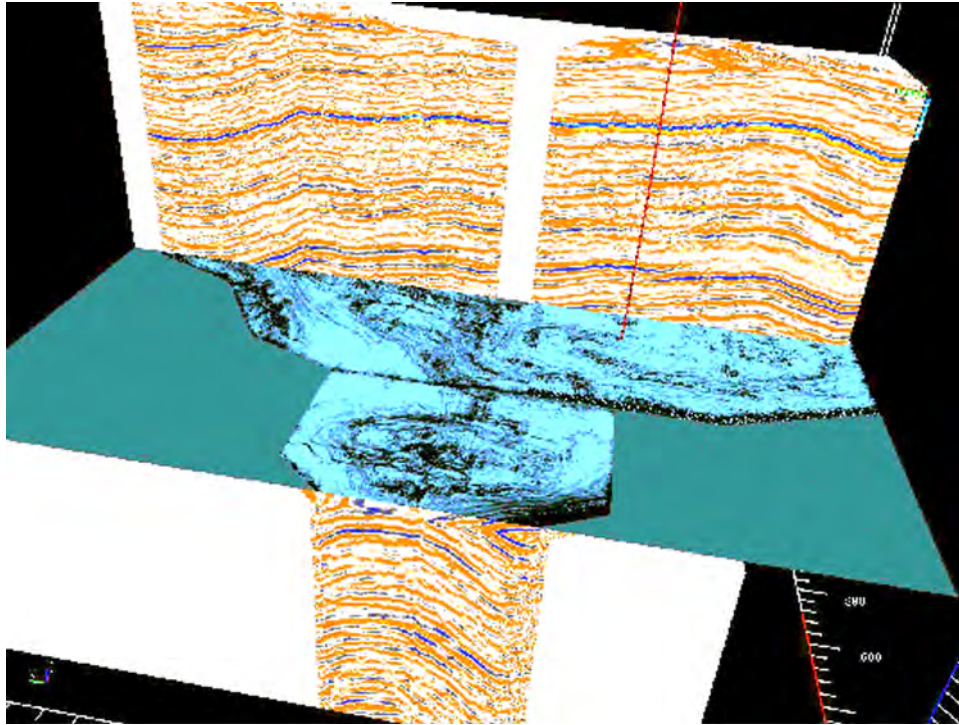


Figure 2. Multiple Datasets of the same 3D Volume

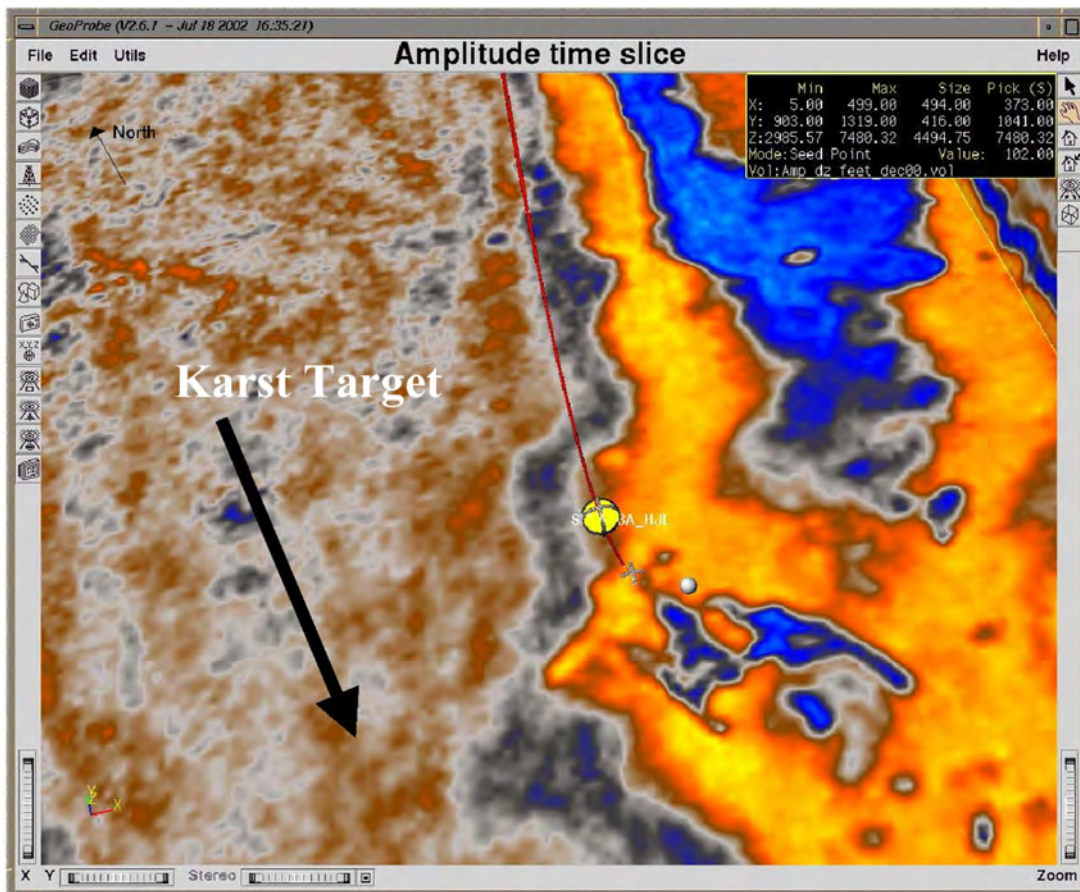


Figure 3. Water Disposal Well entering into a Karst Region of the Shuaiba

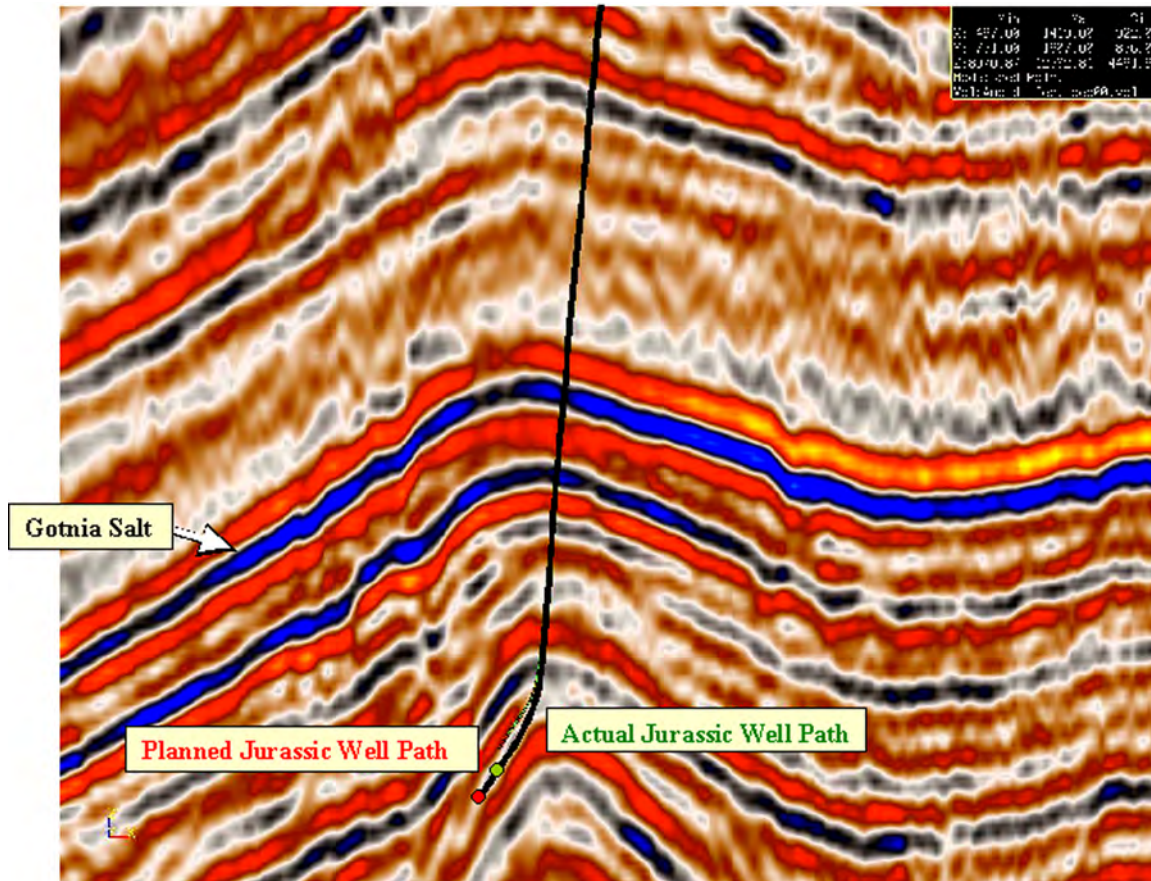


Figure 4. Jurassic Well Planned and Actual

Case Histories

During this past year, several non-conventional wells have been drilled in Kuwait in three different horizons. The wells had different technical objectives for different projects. The wells were designed to avoid the faults that have been mapped from the new seismic efforts. In all cases, the final location was chosen from the 3D visualization of the seismic.

The first project was a horizontal water disposal well in the Cretaceous Shuaiba carbonate Karst features. (Error! Reference source not found.) The well was designed without using the 3D Visualization methods. As a result, the team was unable to accurately determine where they were in the section. Without understanding where the drill bit was in 3D space, corrective action was taken. This action forced the well bore to a point too deep to be able to make any lateral possible in the target horizon. The well was terminated near the base of the horizon with virtually no lateral.

The second project was a deep sub-horizontal bedding parallel well into the Jurassic Najmah-Sargelu, which is an over pressured fractured shale. The objective was to access high API oil below the Gotnia salt (Figure 4). The third project was a horizontal infill drilling program conducted in the Cretaceous Maudud carbonate in conjunction with a seawater injection scheme.