

Quantitative Workflow for Structural Characterization, Examples from Saudi Arabia

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ABSTRACT

This study presents a quantitative workflow for structural characterization and shows two oil field examples in Saudi Arabia. The basic process in this workflow is to map faults and interpret a complete set of horizons using well data and seismic amplitude and discontinuity volumes. Through rigorous QC process, the interpretations are used to quantitatively the structural development and the nature of faulting through geologic history. The two major petroleum systems in Saudi Arabia are in the Jurassic and Silurian Periods. To reveal areas of upside potential for exploration and development opportunities within these petroleum systems, it demands a thorough understanding of the structural growth and the tectonic events through geologic time. Key horizons must be mapped using well logs, formation tops and amplitude seismic data. These key horizons are carefully analyzed and isochore or isochron maps are created to reveal tectonic events and structural developments through the entire sedimentary section, ideally from the basement to the Pre-Neogene unconformity. For mapping faults, seismic discontinuity volumes were generated to enhance the delineation of faults and their correct positions. Depending on the feasibility of the depth conversion, formation thickness will be represented by isochore or isochron maps, and input for quantitative analysis. The amount of structural growth was quantified and plotted through geologic times. Two examples from Saudi Arabia are presented here to illustrate the application of the workflow. In a Central Arabia example, the major event is the “Hercynian” deformation that is characterized by reverse faulting with a maximum compression oriented to the WSW-ENE direction and related structural traps developed along the leading edge of the reverse faults. The second structural development took place in the Early-Middle Triassic Period that enhanced existing traps, and characterized by reverse faulting indicating a maximum compression oriented to the WNW-ESE. This event attenuated but continued in Late Triassic Period. Due to the uplifting of the Arabian shield, the Cretaceous through Early Tertiary sections have been eroded in the areas covered by 3D seismic surveys. The second example is chosen to compliment to the first example in the Late Mesozoic to Cenozoic time span. It clearly depicts the impact of the tectonic events of the Late Cretaceous and the Pre-Neogene to most of the oil fields in the East Province of Saudi Arabia.