AAPG Datapages/Search and Discovery Article #90255 © 2016 AAPG/SEG International Conference & Exhibition, Barcelona, Spain, April 3-6, 2016

Reservoir Characterization by Integration of Outcrop Analog with In Situ Stress Profiling of a Fractured Carbonate Reservoir

Jon Gutmanis[1]

[1]GeoScience Limited

Abstract

This presentation describes a case history where outcrop information was used to help interpret the relationship between lithology, structure, and current tectonics in a challenging 'stress sensitive' reservoir setting. We describe firstly the methodology of building in situ stress profiles for wells and the benefits to be derived by integrating them with static fracture data, fluid type, and flow distributions; and secondly the value of studying representative outcrop analogs.

In situ stress profiles have been constructed from data acquired in deep exploration and appraisal wells in the Zagros petroleum province. The profiles used sonic and density log data, formation rock properties from core, pore pressure profiles, and leak-off data to estimate the magnitudes of the 3 three principle stresses (Sv, SHmax, and Shmin). The azimuths of SHmax and Shmin were obtained from induced fractures seen in the image logs.

Rock types in the drilled Tertiary-Cretaceous-Jurassic-Triassic sequence varied from very strong massive carbonates, through interbedded carbonates and mudstones, to weak mudstone dominated intervals as well as anhydrite dominated intervals. Consequently the models show large variations in stress regime and stress anisotropy with depth due primarily to this wide range in rock strengths and stiffness (Figure 1). A geomechanical zonation can be identified including intervals dominated by high stress anisotropy and strike-slip conditions; and other intervals of low stress anisotropy and normal conditions. This zonation is to a large degree mirrored by variations in both fracture intensity and azimuth as derived from image log interpretation. Observed patterns of fracture flow are consequently influenced by these conditions.

High quality analog exposures of folds in the Spanish Pyrenees record clear evidence for a similar geomechanical zonation within the ancient stress field, now 'fossilized' but seen in the deformation pattern. This is compared with, and used to interpret, the sub-surface information described above. The geomechanical zonation developed by this approach may be incorporated in reservoir modeling and also in the planning of new wells both for stability and optimum fracture related production.