

Understanding of Reservoirs and Cap Rock Architecture: A Key Enabler of Late Water Breakthrough for Production Success in Vertical Well in Tight Fractured Unconventional Reservoirs, North Kuwait Gas Fields

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Abstract

Several vertical exploratory wells drilled and tested across these complex unconventional reservoirs assemblages of tight-fractured and organic rich carbonate formation in the North Kuwait Gas Fields. One of the vertical wells has got a prolific production history and has a significant cumulative production of hydrocarbons without any water production during the first four years of production. The well has been subjected to very high drawdown in the initial period, but there was no increase in water production, unlike many other wells in the fields.

The hydrocarbon producing tight fractured carbonate reservoirs is sandwiched by overlying salt-anhydrite of cap rock and underlying high organic rich Kerogen, a prolific source rock and a resource play. The top of the reservoir has a laminated argillaceous limestone unconformity layer transitioning with a cap rock base. Current cap rock architecture understanding infers that the occurrence of limestone stringers within the salt-anhydrite sequences, which are a potential source of water, salt, CO₂, and H₂S. This paper brings out the comparative cap rock architecture study of conventional cores in prolific producer with other wells having conventional cores across cap-base in the study area. In the prolific producer base anhydrite cycles of cap rock, above the unconformity, is unique with the salt layer sandwiched between two layers of anhydrites. The anhydrites in this core are the algal mat replaced anhydrite and immediate overlain by salt sequence, while other cores show the halite cycle either after one or two cycles of massive "nodular" and "chicken wired" anhydrite. The log based calibration was made to decipher the overlying cap rock architecture in other tested and completed wells in the same reservoirs without conventional core. Similar isolation from limestone stringers has not been found in other studied cores or in the well logs in the studied wells.