Uncertainty Quantification in a Micro-Porous, Fractured Limestone Reservoir (Kharaib Formation, Lekhwair Field, Northwest Oman)

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The paper presents an integrated-iterative workflow to manage uncertainties and sequentially improving predictability. It is illustrated at a microporous, fractured limestone reservoir, covered by poor quality seismic. The workflow includes: i) Uncertainty Identification (Chart) ii) Uncertainty Quantification and Ranking (Experimental Design, Monte Carlo Modeling, Distribution Curve, Tornado Chart) iii) Uncertainty Mitigation (Decision Tree, Data Acquisition) iv) Revised Uncertainty Ranking and Mitigation (repeat step ii and iii) Field performance and previous models were used to estimate the key uncertainties on STOIIP and recovery. Several simple static models were constructed and simulated, changing ONE uncertainty at the time. Historic production was used to select meaningful models. Simulation also revealed the key uncertainties: fracture properties, saturation behaviour and top structure. Experimental design provided a matrix to guide construction of deterministic models by combining uncertainties in a statistically meaningful way. Alongside a workflow was set up to vary theses uncertainties probabilistically (Monte Carlo). A STOIIP distribution curve was generated and P15/50/85 values determined. Deterministic models with STOIIP's close to the P15/50/85 values and additional models were simulation to provide an production forecasts envelope. A decision tree was established to guide data acquisition in new wells. Well results revealed good predication of saturation and fractures except along faults. Top structure uncertainties were under-predicted, particularly along faults. Well results were used to update models. New wells will probe structure and fractures at fault but disregard saturation. The workflow is an ‘evergreen' method that provides statistically meaningful production forecast and iteratively reduces uncertainties to optimize field development.