Paradigm®

Geological Uncertainty Assessment Mitigates Risk in Reserves Estimates

The Challenge

A Middle East national oil company (NOC) operating a giant oil field was conducting an integrated study to maximize reservoir performance and, ultimately, recovery. In order to perform relevant history matching under geological uncertainty, the correct analysis tool was required.

The Assessment

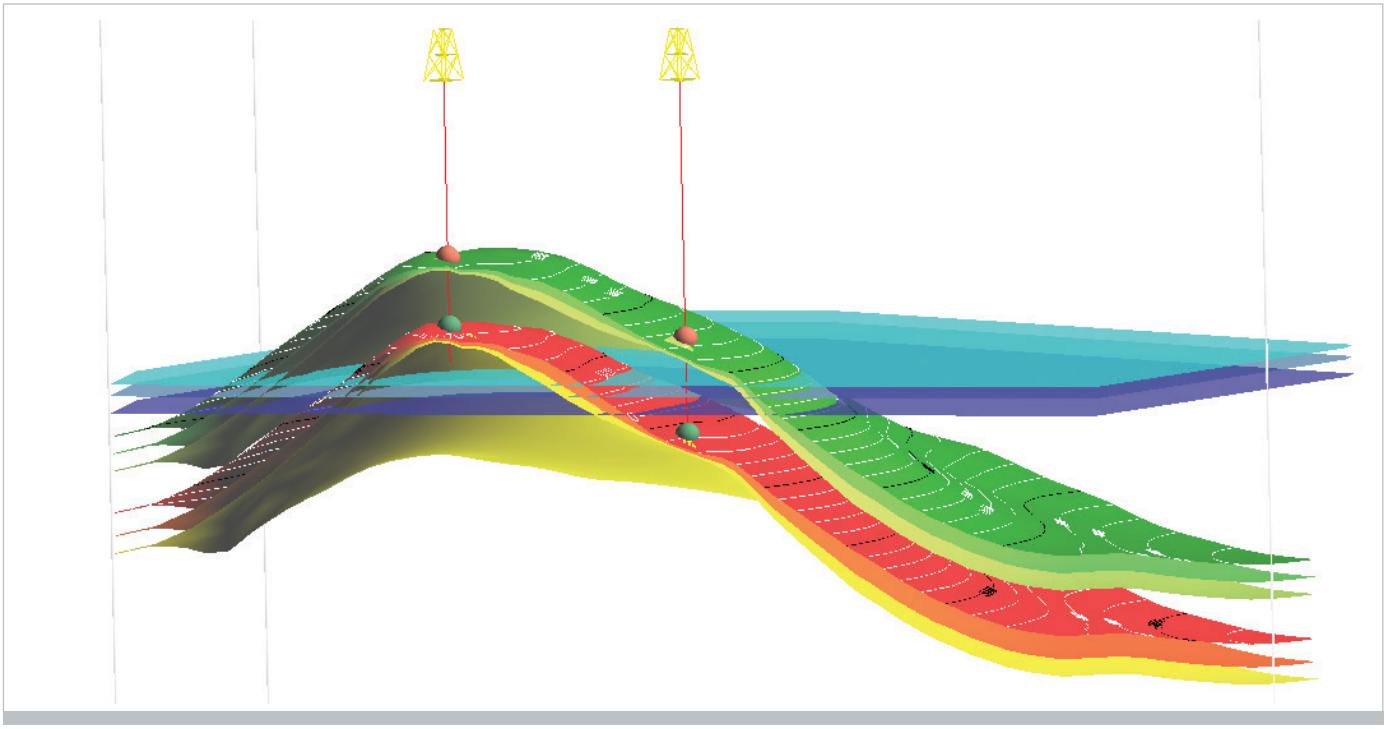
In order to achieve credible history-matching, the most critical factors impacting reserve estimates need to be determined by going beyond the traditional, static geological modeling and performing stock tank original oil-in-place (STOOIP) uncertainty analysis.

Following data gathering and after going through the initial steps to describe the reservoir, the initial static geological model can be built and an estimate of STOOIP conducted. Conventional studies typically handle uncertainty at study conclusion where time is often spent on uncertainty factors having little or no impact on the study objectives.

The objective for the NOC was to consider uncertainty and risk upfront to facilitate a better understanding of the full reservoir and focus team work on critical factors impacting reservoir STOOIP and dynamics. They established an initial uncertainty matrix involving factors such as:

- Free water level
- Facies change through porosity
- Permeability and saturation modeling
- Aquifer strength, etc.

Each factor was analyzed to determine most-likely values and ranges or boundaries. Among these factors, the ones which affected volume calculation were taken through static modeling and STOOIP uncertainty analysis.



▲ Example of structural and free water level uncertainties.

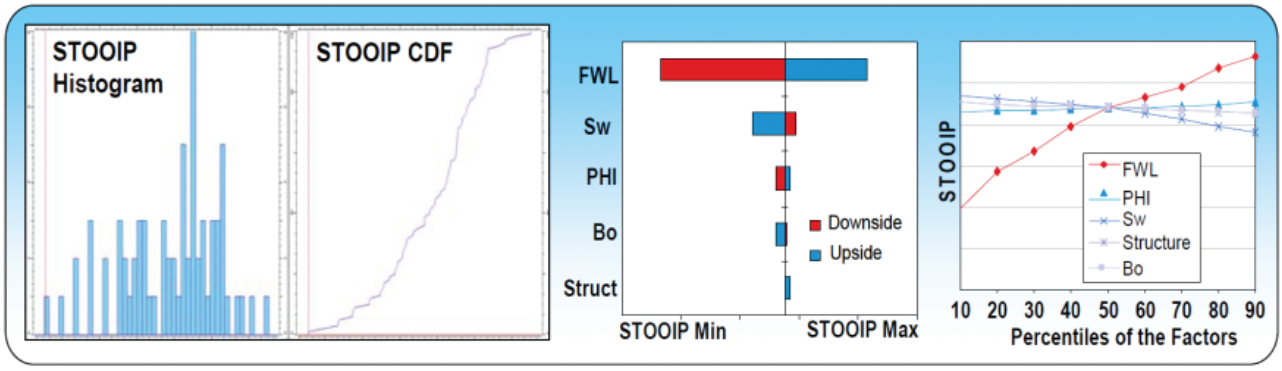
The Solution

Using Paradigm™ Jacta™, all factors possibly contributing to STOOIP uncertainties are simultaneously manipulated on a large, 60 million cell, geological model. Those factors included:

- Water saturation model
- Free water level
- Porosity
- Reservoir structure
- Formation volume factor

The unique methodology of Jacta first provided the probable realizations of the static geological model with an associated STOOIP estimate for each. The number of realizations required to establish the STOOIP distribution were then determined by the stabilization of STOOIP attributes that are continuously calculated within each new realization.

Tornado and spider charts were automatically computed to illustrate the impact of each parameter on STOOIP, when all other factors are held at their respective P50 value.



▲ Uncertainty analysis results showing the probability of STOOIP range (left) with tornado (middle) and spider chart (right).

The Results

Through this study, the company concluded that uncertainties on free water level and water saturation are drastically impacting the changes in STOOIP. Consequently, these two factors are carried forward to history matching. The other factors clearly do not influence STOOIP variations and are considered unlikely to impact the dynamic behavior of the reservoir; therefore, the likely value for subsequent study steps reduces uncertainty.

Through Jacta, a practical workflow was provided to effectively assess uncertainty, very early on in the project and within a reduced cycle time. Critical field development factors are now part of a robust methodology which proved to be very effective in making significant business decisions.