



# A NEW LOOK AT AN OLD WELL

## PROBABILISTIC AND DETERMINISTIC RESERVES SIMULATIONS

[www.knowledge-reservoir.com](http://www.knowledge-reservoir.com)

When determining reserves, it doesn't have to be an "either or" situation. Knowledge Reservoir recently completed a project with a major oil company in which the age old question of which is better, probabilistic or deterministic calculations, was answered with a resounding "Why not both?"

### WHAT WE'RE WORKING WITH

The determination of future petroleum production is an inexact science subject to uncertainties dictated by natural forces, economic conditions, and unforeseen actions of man. Any prediction of volumes and/or rates of oil, natural gas, or associated fluids is an estimation fashioned from an understanding and analysis of subsurface petroleum deposits which are hidden within the earth and examinable only by indirect means and able to be physically sampled only sparsely by drilled well bores. Each petroleum-bearing rock body is uniquely constructed by nature and contains unique mixtures of fluid hydrocarbons. Commonalities among petroleum accumulations permit scientific generalities and mathematical analogies to be formulated and applied in the analysis of future performance of petroleum reservoirs. However, the many variable features of each reservoir defy exact assessment, either quantitatively or effectively, denying us the ability to closely model and predict future reservoir behavior. Therefore, all computations of future petroleum production, whether identified as reserves or by any other term, are estimates. The precision of the estimate is determined by multiple factors, including time on production, quantity and accuracy of production records, density and number of wells, data from logs and cores, pressure history, and other sources.

### DETERMINISTIC APPROACH TO RECOVERY ESTIMATES

The deterministic approach utilizes single discrete values for recovery parameters used to calculate single values of OOIP, OGIP, and oil and gas recovery. These recovery parameters are as follows:

- Area (A)
- Net pay (h)
- Porosity ( $\Phi$ )
- Water Saturation ( $S_w$ )

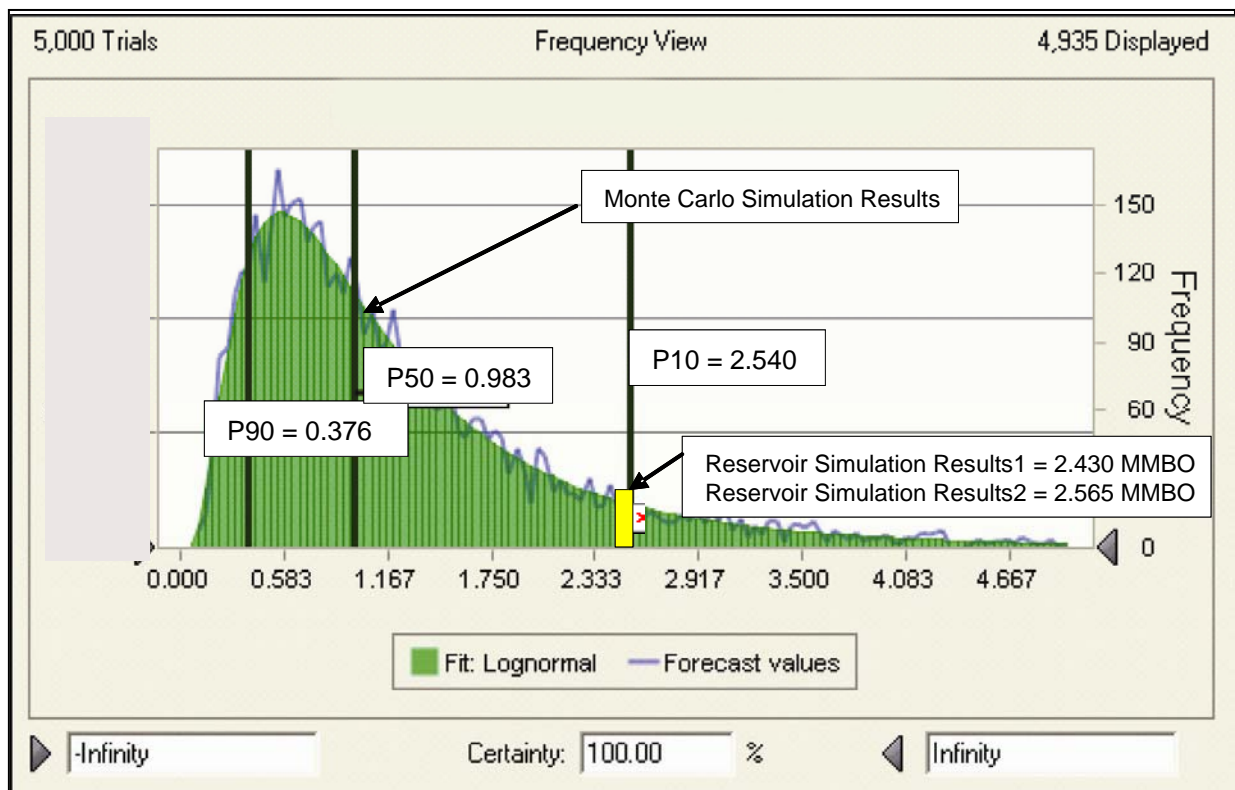
- Formation Volume Factor ( $B_o$  or  $B_g$ )
- Recovery Factor (RF)

While these values may vary throughout the reservoir in a reservoir simulation model, each cell is defined by single discrete values of each parameter. Accordingly, each cell in the model has its own single discrete values of OOIP and OGIP. The sum of the individual OOIPs and OGIPs, across all cells of the simulation model, yields the total volume(s) for the reservoir.

## PROBABILISTIC APPROACH TO RECOVERY ESTIMATES

In the deterministic approach, single discrete values of  $A$ ,  $h$ ,  $\Phi$ ,  $S_w$ ,  $B_o$ ,  $B_g$ , and RF are used to calculate single values of OOIP, OGIP, and oil and gas recovery, with no other possible values for each recovery parameter. The Probabilistic Approach, however, defines a range of possible values for each recovery parameter, calculates multiple outcomes (5000 calculations in the project cited here), and presents the results in the form of probability distributions for OOIP, OGIP, and oil and gas recovery.

Figure 1 below depicts the resultant Monte Carlo simulation oil recovery probability distribution. These deterministic values represent a probability value on the probability distribution of approximately 10%; i.e., there was a 10% probability that the actual results would be greater than that indicated by reservoir simulation.



## WHAT WE ENDED UP WITH

- The Monte Carlo simulation included in its range of possibilities, a small P90 area whose limits were defined by a conservative view of reservoir parameters, as well as a larger P10 area encompassing the area used in the previous reservoir simulation.
- The Monte Carlo simulation included in its spectrum of possibilities, recovery factors used in the previous reservoir simulation.

- Differences in areas and recovery factors between those values used in the reservoir simulation and Monte Carlo simulation should be considered carefully as a single value from the deterministic reservoir simulation cannot be reasonably compared to a distribution of values from a Monte Carlo simulation.
- The deterministic results from reservoir simulations are within the range of possible outcomes from the Monte Carlo probability distributions, albeit at lower probability values.

**With guidance and experience of Knowledge Reservoir consultants, determining reserves at year end or for potential transactions doesn't have to be a stressful event. We can work with your organization to give you quality results and peace of mind.**

#### Contact Us

**Email:** [info@knowledge-reservoir.com](mailto:info@knowledge-reservoir.com)

**Phone:** +1 713 586 5950

**Fax:** +1 713 586 5955