

# Integrated Reservoir Characterisation – Are we doing it?

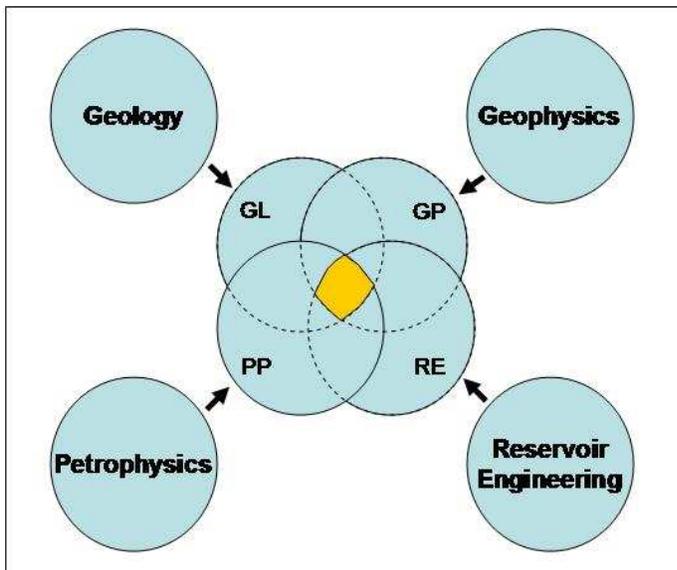
Rainer Tonn and Russ Macnab, EnCana Corp., Calgary, Canada

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## Introduction

Hardly anybody in the exploration community will challenge the statement that an integrated reservoir characterization will lead to superior technical results. The subsurface can be characterized with independent tools: Geology, Petrophysics, Geophysics, and Reservoir Engineering. Each method has its limitations and uncertainties. Combining (i.e. integrating) will reduce the solution space to a smaller space consisting of the overlapping zone. Obviously, we arrive at more accurate results. The graph conceptually illustrates this fact.



The solution space of an integrated reservoir characterization

Even though it is acknowledged that an integrated study is adding value to the interpretation it is not always done. Sometimes even individual parts are “disintegrated”, e.g. surface seismic is not fully combined with borehole seismic. This paper will discuss the main issues of an integrated study: technical challenges and economic justification.

## Integrated Reservoir Characterization – Can we pay for it?

From an economic standpoint the issue at hand is essentially one concerned with the value of information. As the information at discussion is the information of a more complete understanding of the potential resource, we need to ask ourselves if this information has economic value, and if so can we quantify the value? The economic value of the information is determined by a careful examination of the value derived and the costs to acquire the information.

Let's say that we embark on an extensive process to do an integrated reservoir characterization. In order for this incremental information to have real economic value, it must have an influence on how you proceed in a way that will decrease costs, increase profits, or reduce the risk of a venture. Improved reservoir characterization could lead to cost reductions through the drilling of fewer wells to develop the field. Profits can be affected as the result of a more optimum well placement that results in higher production rates and/or increased ultimate recovery. Risk assessment and risk management are impacted by decisions to drill or not drill, or by proceeding with a pilot development rather than a full development. A pilot development will decrease the profit of a venture if risk is not considered, but if a pilot development helps determine the optimum development of a project or indeed whether a project should proceed further, then the after risk assessment of profit could well be increased. All of these decisions are affected by our assessment of the resource, and could be influenced by an integrated reservoir study.

Once it has been determined that an integrated reservoir characterization will add information with economic value, then the cost of acquiring this information needs to be determined. The costs we need to include are all of the costs incremental to proceeding

without the integrated reservoir characterization. The direct costs of the integrated approach include items such as additional data to be acquired, specialized software and additional hours spent on the characterization. There are also indirect costs associated with the characterization. In addition to the wage cost of the professionals involved, there is an opportunity cost involved as these individuals will not be available to work on other projects. There is also a time value cost, as the extra time to complete the characterization may cause a delay in the startup of the project. All of the incremental costs of proceeding with an integrated reservoir characterization need to be quantified as part of the decision of whether or not to proceed with the analysis.

Now that we have determined the benefits (the value of the information) and the costs to acquire it, we need to weight these against each other. As we have not done the work yet, the outcomes on both the benefit and cost sides of the equation need to be assessed for the probability of occurrence. The integrated reservoir characterization will not change the amount of resource that is actually available to be found or developed. The integrated reservoir characterization needs to show us something that we would not otherwise see. It needs to change our interpretation of what resource is there. What is the probability that it will change our understanding of the reservoir to the point that it would change our way forward? The application of probability to the outcomes is our last step in determining the economic value of an integrated reservoir characterization.

### **Integrated Reservoir Study: Can we do it?**

Integration is the coordination and combination of different kinds of data. The data is coming from different sources, are acquired by means of tools which access different portions of the reservoir with different resolutions, and are analyzed by various experts.

Four main challenges face an integrated study:

1. Quality data
2. Time commitment
3. Human challenges
4. Technical challenges

While poor data quality may hinder the completion of an integrated reservoir study, non existing data will bring it to a stop. For a fully integrated study well test data or production data are required. Frequently this data is not available.

An integrated reservoir study requires a multi-disciplinary team. These experts have to communicate effectively. This communication is frequently hindered by different software platforms. While integrated packages would be the logical choice in terms of ease of use, the frequently preferred tools are the best-in-class software from different vendors.

This paper focuses on the technical challenges of integration. The simplified workflow in figure 1 illustrates the integration process. In general, the goal is not to derive one optimized deterministic solution but rather to describe a range of solutions. The stochastic approach appears to be the most appropriate way. Geostatistics allows honoring the uncertainties of each input parameter. However, the interpreter has to be aware that the global space of uncertainty can be much bigger than the sampled space of uncertainty.

### **Integrated Reservoir Study: Are WE doing it?**

The Panuke case history demonstrates how EnCana is proceeding in this specific case with an integrated reservoir study. In the late 1990's EnCana discovered the Deep Panuke Field some 250 km offshore Nova Scotia, Canada. Within the last few years a total of nine wells were drilled to explore the field. The Deep Panuke natural gas field occurs in the carbonate platform (Abenaki Formation) which formed along the East Coast of North America during the opening of the Atlantic Ocean in the Middle to Late Jurassic, approximately 170 to 128 million years ago. The reservoir is made up of limestone and dolomite. The natural gas pool is contained in a combined structural/stratigraphic trap.

A detailed geological model furnished the base for the seismic structure interpretation.

Supervised neural networks were trained at well locations to predict porosity and facies from the 3D seismic volume. For this purpose, PSDM data, AVO processing results, and coherency cubes all served as inputs. The structure model combined with the facies and porosities were integrated into a static model.

The dynamic response of these models were simulated and compared to well production data to test their validity. The process is iterative and has led to marked improvements of the characterization of the reservoir.

The final product is a range of history matched models which served as the basis for the economic evaluation and production scenarios.

Figures 2 and 3 show some of the integrated study results.

## Conclusions

“Integrated reservoir study: are we doing it”, cannot be answered without considering the specific case. It will always be a question of the economics of the project. Technical feasibility is a secondary concern. Even though technical challenges might be significant if there is economics value to be captured by the study, it can be and will be done.

## Suggested Reading:

L. Cosentin, 2001, Integrated Reservoir Studies, Institut Francais du Petrole Publications, Editions Technip

## Acknowledgments:

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Figure 1: Simplified workflow example: Integrated reservoir study

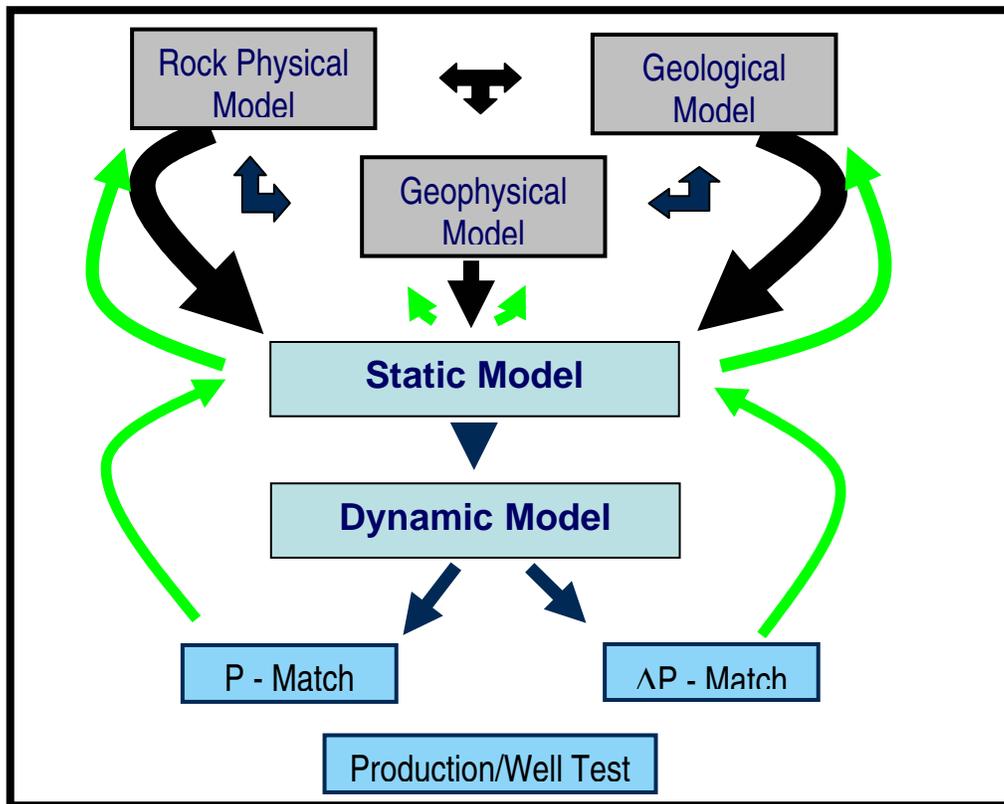


Figure 2: High permeable reef front volume

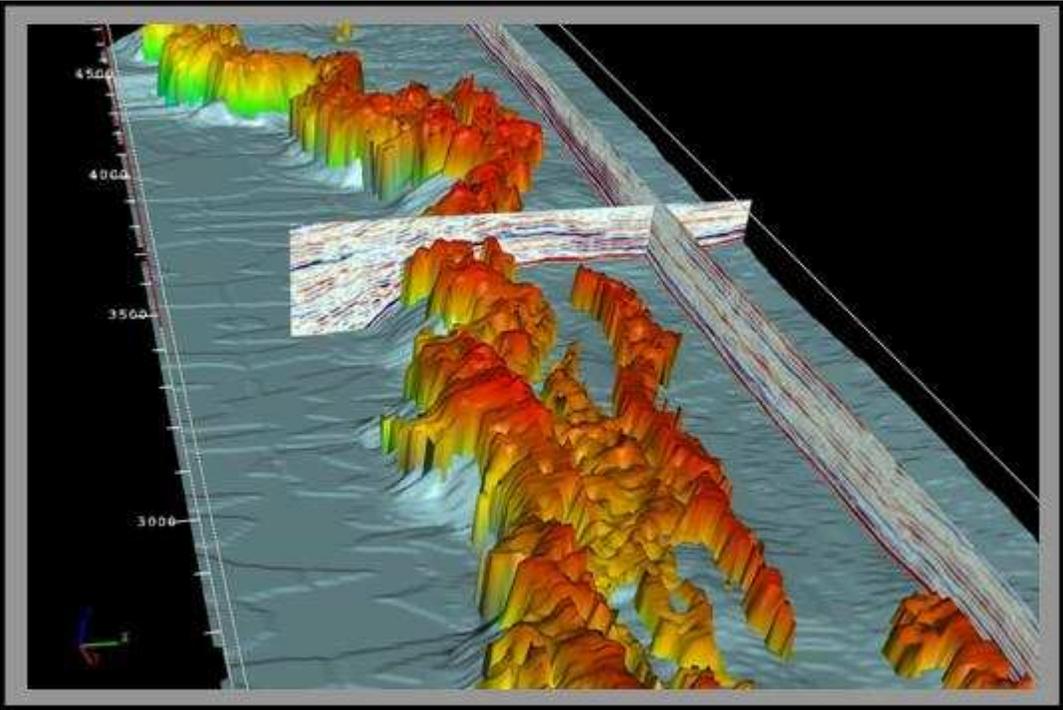


Figure 3: Porosity volume

