Quantifying the Value of Data Before the Measurements are Done; as Applied to Oil Exploration and Production

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1. Introduction

The standard approach in the industry, when deciding between different projects, is to evaluate and rank them according to monetary criteria such as net present value (NPV), profitability index (PI) or internal rate of return (IRR). Only projects with a return on investment above a certain threshold might be accepted and among these one selects from the top of the list.

In hydrocarbon exploration this approach is difficult because conclusive information about the reservoir is usually not available at decision time. Almost every reserve-related decision is therefore made under uncertainty. Acquiring more data should reduce uncertainty. Information does have a cost and it might or might not have a value (Wills, 2004). Costs are generally known beforehand, from contract prices, price lists or direct negotiations. Acquiring additional information is one alternative choice among several.

Seismic data is possible the most important tool for gathering reservoir information in the exploration and production phase. In this presentation we focus on two aspects of seismic, its ability to detect hydrocarbons directly (DHI) and its ability to help in producing a field (4D). Using specific examples we shall generate estimates of the value of surveys (Expected Monetary Value = EMV) before acquiring the data. For other examples the relevant parameters will of course have to be changed accordingly. Doing this, seismic surveys can be compared on equal footing to any other projects in the Oil Companies portfolio that are competing for available funds. Also different seismic parameter settings can be compared according to their monetary value. This has not been standard practice hitherto because it has been considered too difficult to put a value on the seismic information

2. Key Features

In any industry the decision on whether or not to embark on a project depends on the economic expectations of the project. In this study we use Bayesian theory to demonstrate how the Expected Monetary Value (EMV) of seismic data can be calculated before a seismic survey is initiated. The procedure is illustrated on a hydrocarbon detection problem (DHI) and on using so called time lapse seismic for production monitoring (4D).

We first consider that we can purchase Direct Hydrocarbon Information (DHI) for a given field before drilling, i.e. we can get a Yes/No to oil present/not present before drilling. Following the formalism of our reference books we have that the Expected Value of Perfect Information (EVPI) =

EMV (with perfect information)

EMV (without information, i.e. decision under uncertainty)

Although the seismic data might be of high quality, it is not perfect. We thus have to include the possibility that even after having acquired a survey for the sole purpose of determining whether there is oil or not we might make a wrong decision. The Expected Value of Imperfect Information (EVII) =

EMV (with Imperfect information)

EMV (without information)

To estimate EVII we need to introduce two parameters that define the quality of the DHI algorithm. These are the Detection Level and the False Alarm Level. The Detection Level is the probability that the indicator will say "yes there are hydrocarbons" when that in fact is the true state of nature. This number can be made as large as we want it to be, the price being that the False Alarm level goes up. The False Alarm level is the probability that the indicator will say there are hydrocarbons when in fact the structure is dry. A graph of detection probability versus false alarm probability is called the Receiving Operating

Characteristics (ROC) of the system. When evaluating the quality of different detection systems one often does that by comparing the systems ROC curves.

3. Conclusions

In this study we have used several examples to demonstrate how to make estimates of the monetary values of seismic information before acquiring the data. This makes it possible to compare a seismic project with any other project on an equal footing. We believe this would be to the advantage of seismic projects because the values will generally be quite large and compare favorably with alternative methods or projects. Obviously the parameters applied will be field dependent. However, making sensitivity plots helps with the problem of not knowing the a priori probabilities exactly.

The approach can also be used to evaluate seismic tenders. Typically they are separated into two groups, technically acceptable and unacceptable and the job is given to the lowest bidder in the technically acceptable group. Calculating the EMV for each alternative one will be able to assign a value to a survey depending on the parameters applied, say give a value to resolution power, to time and spatial sampling rates or proven processing algorithm performance etc. This should end up with selecting the survey acquisition or processing alternative that in fact is best for the problem at hand and in the end give the decision power back to the experts, the geoscientists. Finally, before a survey is initiated, 4D or ordinary survey, this methodology might be used to help estimate how much an oil company actually could pay for such a survey, which should be useful information both for the receiver and producer of a tender.

4. References and Bibliography

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Dr. Philos. Karl-Andreas Berteussen, is Professor of Geophysics at The Petroleum Institute since 2003. Previous work experience and education:

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