4D Feasibility Studies: Essential Component in Successful 4D Projects

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Abstract

In this work I will discuss the essentials of 4D feasibility studies and illustrate with examples how they can be used in the planning and execution of 4D projects and in the interpretation of the resulting data.

Introduction

Time-lapse (4D) data analysis is a established reservoir surveillance tool that has demonstrated significant value in several oil fields around the world. Well known by geoscientists, 4D analysis consists of careful interpretation of the differences of seismic surveys acquired at different times during the production of a reservoir. The successes reported in the literature span a wide spectrum of geologic environments (from deep-water clastics to carbonate platforms), offshore and onshore fields and a vast variety of production processes (e.g., water and gas injection, compaction driven, etc.). By providing insight in the movement of reservoir fluids, reservoir compartmentalization and reservoir compaction, 4D interpretation has generated a number of opportunities to minimize the number of dry holes, locate by-passed reserves and optimize reservoir management.

An absolute key component of a successful 4D project takes place in very early stages, in the form of a comprehensive feasibility study. In such a study 4D experts and the asset team engage in relevant discussions that should address at least the following questions:

1. Is the hydrocarbon reservoir under consideration suitable for seismic surveillance?
2. If so when the data need to be acquired to maximize the impact of the investment?
3. How often the acquisition should take place?
4. What is the appropriate, fit-for-purpose, seismic acquisition method? Specifically, is the 4D response robust enough that can be interpreted with surface seismic or OBC methods, in view of their potentially better repeatability, are required?

In my experience the questions above are much better addressed with an appropriate level of modeling where realistic seismic simulations are generated from the current asset flow models. The (3D) seismic simulations can be generated for several times of reservoir production, differenced and interpreted, providing therefore insight on potential uses of the 4D data.

The purpose of this 4D modeling is not, however, limited to the technical justification of a time-lapse project. Once the project is sanctioned, the predicted 4D response can be used in the execution of the project. For instance, 4D seismic in-fills, an expensive item in 4D acquisition can in principle be prioritized based on the modeled results.

Finally, the interpretation of the actual 4D data is invariably done in a model-based approach, in such a way that differences between the actual and modeled 4D data are contrasted and reconciled. Accurate (potentially updated) 4D simulations, resulting from the feasibility studies, are thus essential in the proper interpretation of the time-lapse data.

In the presentation I will discuss basic workflows for 4D feasibility studies and illustrate with examples how these have been used in the planning and execution of 4D projects, as well as in the interpretation of the resulting 4D data.

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