PAPER E

A PROPOSAL FOR INTEGRATED RESERVOIR CHARACTERIZATION

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GOALS

Through crosswell data, provide a calibration and improvement on interpretability of attributes derived from 3D surface seismic.

Through geostatistical approaches, integrate all available geophysical, geological and engineering data and information to provide a more realistic sampling of spatial variability and probabilistic distribution of reservoir properties.

MOTIVATION

Haldorsen and Damsleth, 1993 present one of the best overviews of the state-of-the-art and current trends within reservoir characterization. In spite of all R&D efforts applied in the last 5 years, the province-average recovery factors have not changed significantly and production forecasts are still notoriously in error. The need for seismic resolution improvements is considered the most important aspect to achieve the challenges of building a picture of the internal reservoir anatomy and mapping fluids fronts through time.

Today, there is a general belief that many companies still do not use 3D seismic data to their full extent, beyond field delineation, fluid detection and sometimes fluid contact delineation. For example, a deterministic calibration of such data with fine and intermediate-scales, such as crosswell, could yield to discriminate the effect of actual spatial variations in geological facies, rock type, permo-porosity properties and saturation on seismic attributes maps. Better reservoir descriptions require a way to relate measurements at different scales and the techniques of mapping and geostatistics.

The advantage of stochastic approaches over deterministic ones is to pulverize a unique final solution, always subjective, through the generation of thousand of formalized guesses, the assessment to spatial uncertainties is provided and also can be transferred to the final process, but only after the critical assumptions based on earth spatial stationarity, the modeling of bivariate spatial dependence and a posteriori probabilistic distribution function of the unknown value were performed.

Geostatistical data analysis can be improved with the incorporation of surface seismic data, to reduce lateral paucity of well and core data, and cross-well to generate a more realistic interwell picture of the reservoir heterogeneities than those obtained by geologists through markers correlation (see figure 1). This experiment can provide additional information about heterogeneties which can influence heavily fluid-flow in the reservoir. The way to extend this information to the entire field seems to be obtainable through the several hybrid geostatistical techniques designed to incorporate discrete and continuos information and by calibration with surface seismic.

IDENTIFICATION OF PROBLEM / PROPOSED RESEARCH

Two critical points must be studied in order to improve the contribution of seismic (surface and cross-well) data to reservoir characterization: The first is the need to assess the real potential of crosswell data as a small-medium scale experiment. The second is the upscale of its contribution to 3D seismic interpretation.

In the first case, crosswell can provide undoubtedly, high quality and high resolution interwell image. However, we need to estimate acoustic properties correlated with rock properties as porosity, saturation and also permeability, evaluating if the tremendous richness of different modes of waves, in a such way redundantly, can provide a way to discriminate the effects of those rock properties on seismic attributes.

In this integrated local scale approach, we intend to stress the most apparent application of crosswell data, which is to provide a local picture of the fine-to-medium scale structure of reservoir, using P and S reflection images, velocity and attenuation tomogram (Quan and Harris 1996), both generated by node models in a 2.9 fashion (Harris, 1994, Costa et al, 1996) and AVA gathers (Lazaratos, 1993). The establishment of statistical link between crosswell and all other available data and also the geostatistical spatial analysis will be done guided by lithofacies-based approaches. The 3D-integrated multiwell images will be performed through geostatistical estimators and stochastic simulation.

The second is the calibration of well and surface seismic data using the bridge built by crosswell in order to implement a geostatistical approach to simulate 3D reservoir models. We believe, such down-scale of seismic data may be feasible based on simulations of synthetic data or allowed by deterministic relations. As pointed out by Bashore et al, 1995, it is currently too expensive or impractical to "shoot" across every interwell distance. This cannot be true in a nearby future or at least, it will be affordable as a generation of fence diagrams from multiple cross-well. The McElroy Reservoir Geosciences Project, or something more generous is a candidate for this study.

Geostatistical Integration

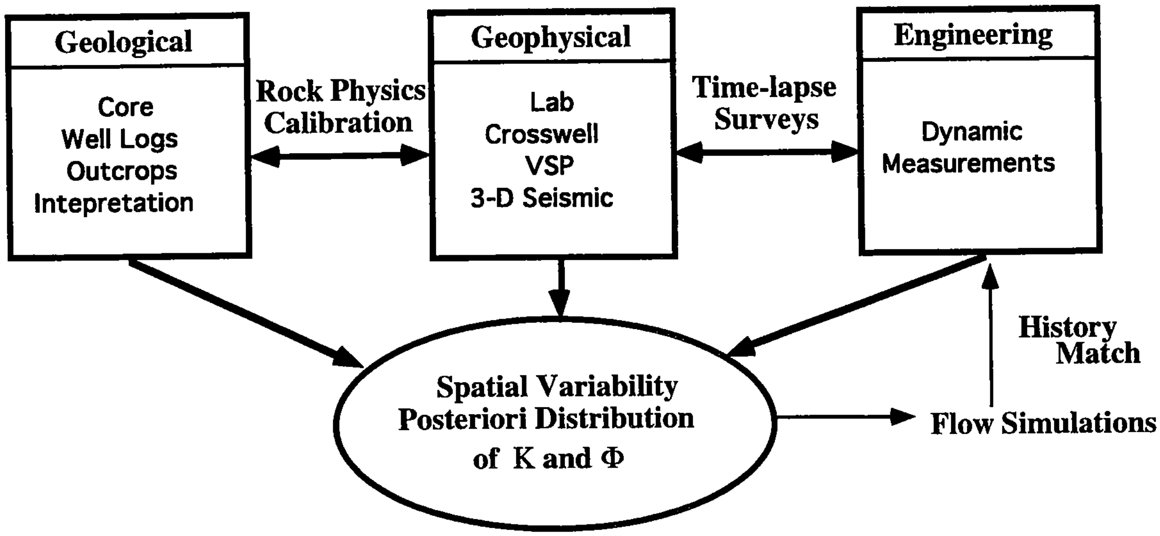

Figure 1. Sketch for the proposed reservoir integration.

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