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# Quantified Uncertainty Estimation In Depth Conversion

I. Meisingset* (ModelGeo), J. Hubred (First Geo), D. Krasova (First Geo)

## Summary

Depth conversion with quantified base case and uncertainty estimates of depth and gross rock volume is carried out in an exploration area with five structural closeres, using a demo dataset. The study shows how this innovative method is used stand alone in an exploration context. Use in field development studies is very similar. The study investigates some of the common assumptions made in uncertainty estimation, namely the assumption of normal duistribution, and of symmetrical uncertainties in gross rock wolume around a depth base case. These do not hold up well, indicating that there is potential for improving the quality of uncertainty estimation. The solution is to stop guessing, and to start calculating these things.

## Introduction

Depth conversion is a central element in many important investment decisions, in exploration, field development and field operation. Field development studies leading up to a Plan for Development and Operation (PDO) is a typical example. A PDO study consists of three main parts; reserves, drilling and facilities. The reservoir model affects them all. In this study we are concentrating on reserves, and specifically, on how depth conversion can be carried out to give a more objective base case model with quantified uncertainty estimates, expressed as $P_{90}$ (low) $P_{50}$ (median) and $P_{90}$ (high). A method where this is achieved using seismic processing velocities is presented.

The presented method estimates uncertainties objectively from the data. In a PDO study this will be used as *input* to Monte Carly simulation of the total reserve uncertainties. Few good methods exist for estimation of this type of input. The traditional approach is to run a few depth conversion cases and make an experienced based guess at the uncertainty.

Many years of experience shows that extreme depth conversion cases sometimes end up as base cases, leading to incorrect PDO investment decisions and/or drilling plans for production wells. Mistakes of this type can have great economic consequences and should not be allowed to happen. This was the motivation for development of the method.

## Method

Horizon keyed depth conversion with seismic processing velocities is carried out in stochastic mode. Within constrains set by the user, all possible depth conversions allowed by the data are explored, and stored as realisations. These are then used to calculate statistics. It is not necessary to assume normal distribution. Figure 1 shows depth statistics at a position on the structure.

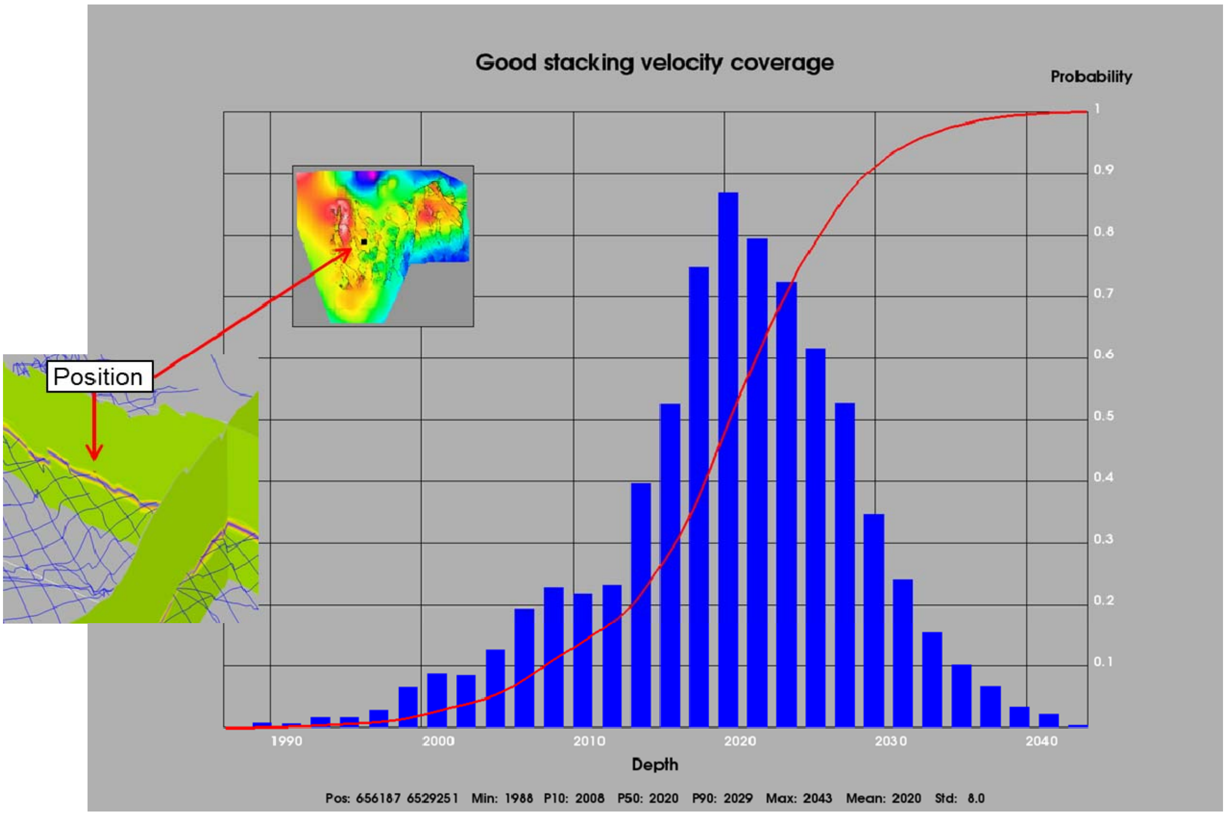


***Figure 1*** *Depth statistics at a selected position on the structure, expressed as percentiles $P_{10}$, $P_{50}$, $P_{90}$, mean, standard deviation, min and max.*

Figure 1 shows velocity uncertainty in depth conversion. When used as input to Monte Carlo simulation of reserve uncertainty, this is normally a separate entry. The output comes as a set of grids, which support grid based reserve uncertainty methods, or as point uncertainties as shown, which support depth uncertainty prognoses such as needed in well planning. It is possible to calculate combined velocity and time interpretation uncertainty when that is asked for

In prospect evaluations or early phase PDO studies gross rock volume uncertainties are often required. These are calculated with a scripted volume calculation routine. Figure 2 shows an exploration scenario with 5 structural segments where the routine has been asked to detect spill point depth and calculate the gross rock volume. The map is from a dummy dataset.

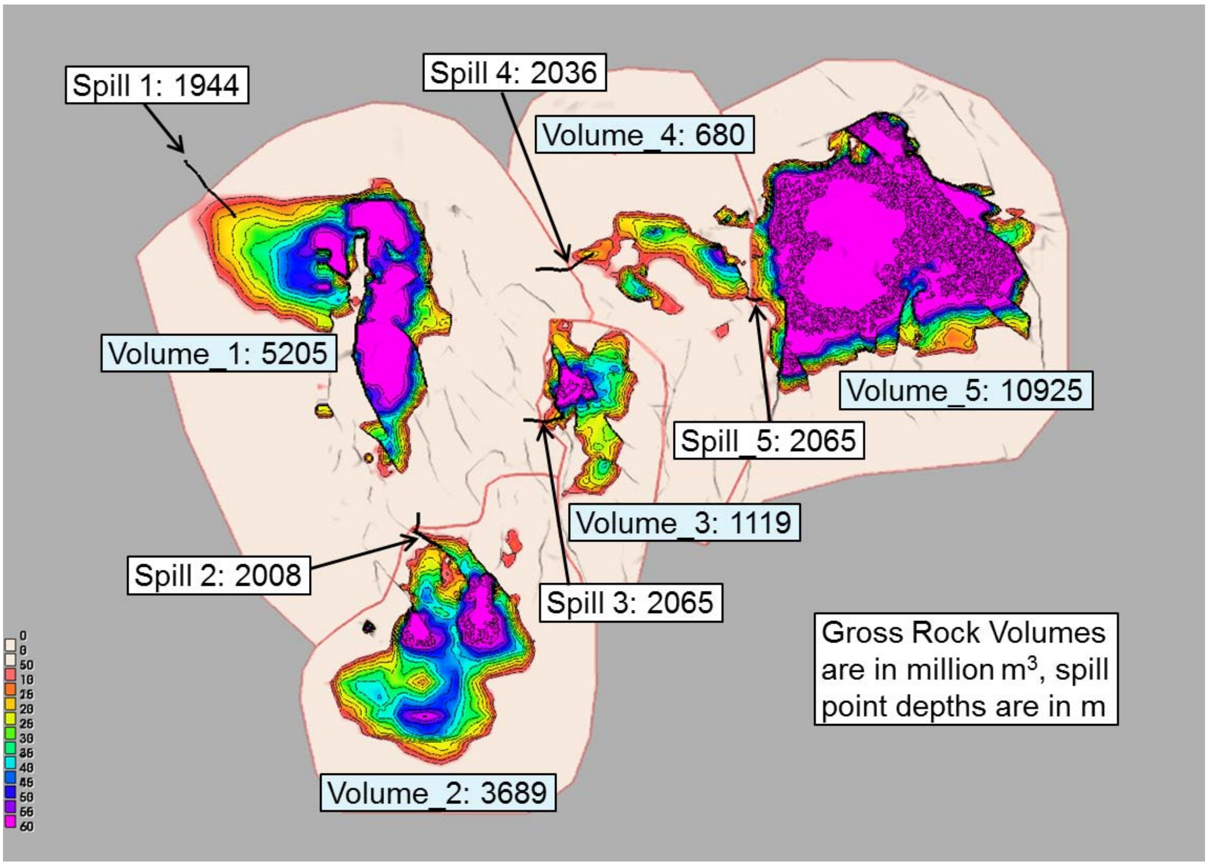


***Figure 2*** *Gross rock volume and spill point depth in five segments of a structure map. The base case is shown.*

The velocities allow a considerable depth uncertainty across the area, which for segment 1 leads to the gross rock volume uncertainty shown in Figure 3. The base case volume, labelled Volume_1 in Figure 2, is marked on the histogram with a red cross. Notice that the base case, which in this case is the one that ties the wells best, does not coincide with the middle of the GRV uncertainty distribution. This is typical, and illustrates one of the largest pitfalls in reserve uncertainty estimations. It is only in the most extreme symmetrical cases that a depth base case and medium GRV cases correspond. These relationships deserve being calculated, not guessed on.

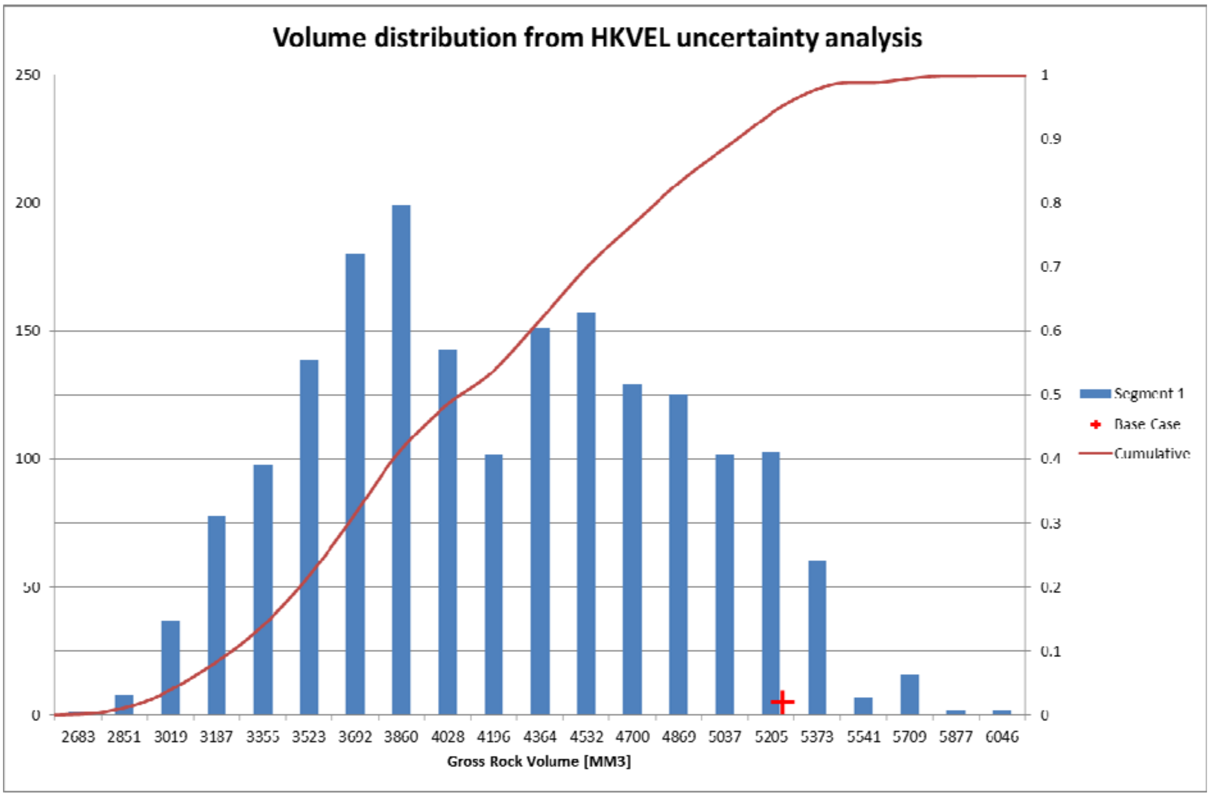


***Figure 3*** *Gross rock volume uncertainty for segment 1.*