Stochastic Velocity Modelling For Depth Conversion In 3D Modelling

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Introduction

Stochastic velocity modelling is used to make a number of equi-probable versions of the structure of the reservoir. This technique generates multiple realisations of the velocity model. These velocity models are then used to make multiple depth conversions of the horizons and faults.

It is quite common practice in 3D modelling to make multiple stochastic realisations of facies distributions and petrophysical parameters conditioned to facies. However, the main uncertainty commonly lies in the structural mapping and depth conversion rather than the property distribution. Such uncertainty is often not modelled.

By carrying out a geostatistical approach for velocity modelling, depth conversion uncertainties are modelled and can be quantified. Consequently, the following questions can be answered:

- What is the volumetric uncertainty based on depth conversion?
- How many closures could there be, and how could they be connected?
- Where should we drill next to minimize the risk or learn the most about the field?
- How big is the uncertainty related to depth conversion compared to other uncertainties, such as facies distribution, fault sealing, oil saturation, etc?

Method

1. Find locations where the velocity profile can be estimated with high accuracy, such as check shots or vertical wells.

2. Check for spatial trends and standard deviation through data analysis. Figure 2 (top right) illustrates an observed trend with depth, and the standard deviation is around 85 m/s when the trend is removed (approximately 3%).

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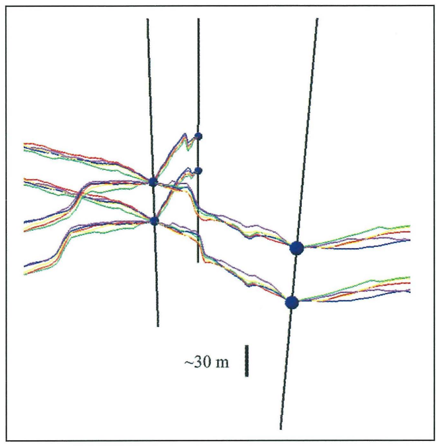

Fig. 1. Intersection through some wells showing different depth horizons resulting from different 3D velocity models.

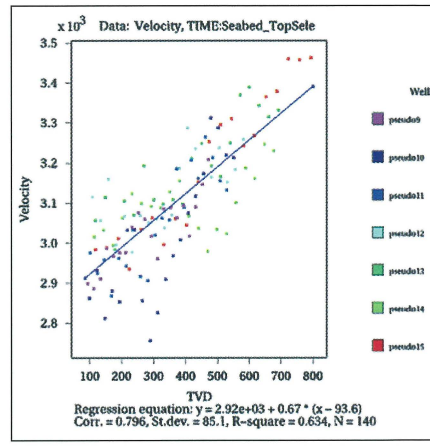

Fig. 2. Iillustrates an observed trend with depth.

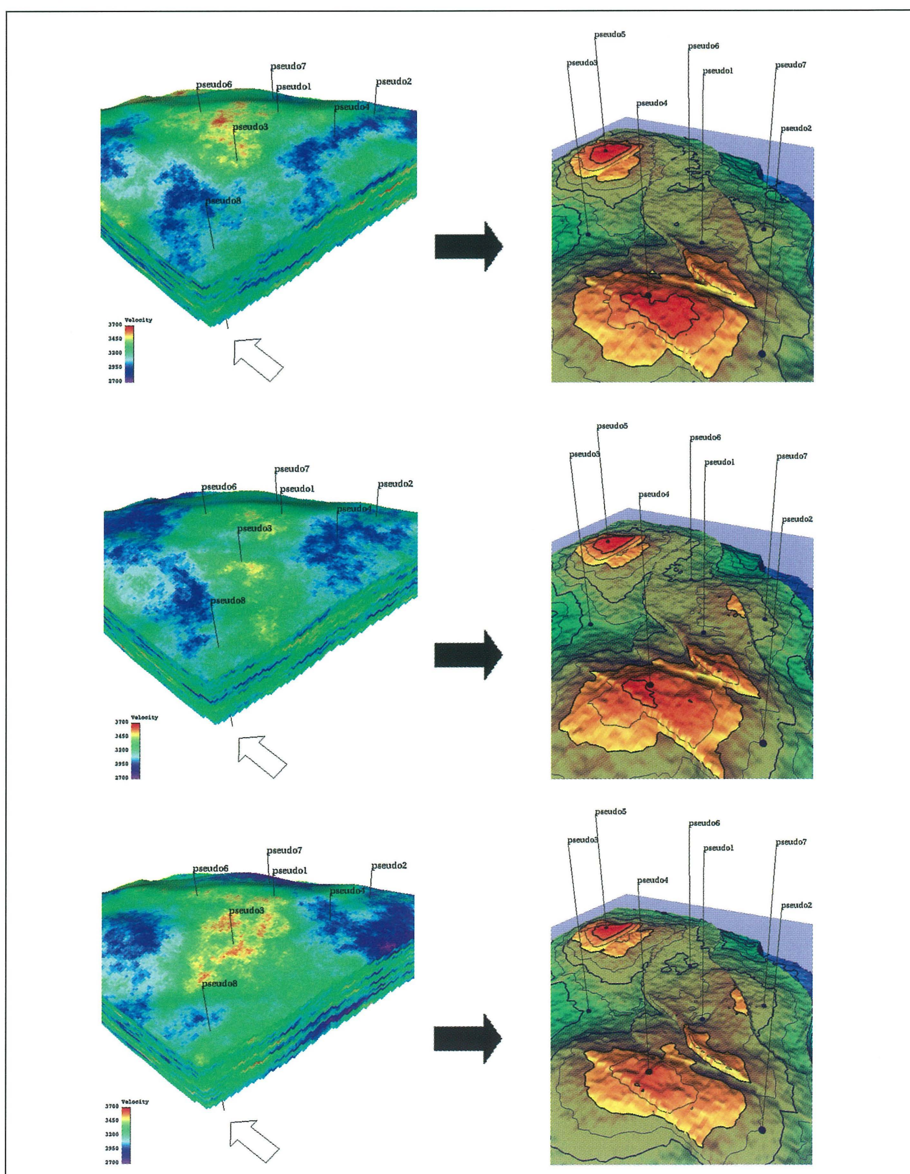

Fig. 3. (Right) Intersections of three equi-probable 3D velocity fields between time-horizons and the resulting equi-probable Top Reservoir depth horizons. A semi-transparent OWC is shown to better illustrate the effect of uncertainty. Note that the number of closures varies from two (at top) to four (at bottom).

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3. Use this information in stochastic modelling to generate 3D velocity fields.

4. Depth convert the fault model and the horizons.

5. Generate a 3D grid using the depth converted faults and horizons.

6. Perform volumetrics within this 3D grid.

7. Repeat steps 3–6 through a loop to generate different stochastic realisations (see resulting 3D velocity fields and resulting depth maps in figure 3).

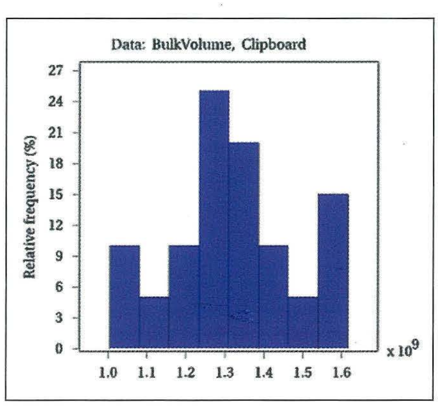

Fig. 4.

Impact

There are several advantages with a sound geostatistical approach to reservoir modelling:

- Production and injection wells can be planned at locations with lowest risk.
- Appraisal wells can be planned where there is a big uncertainty that needs to be eliminated.
- An uncertainty study will tell you where the development should be flexible.
- The predicted reserve uncertainty span is based on a sound geostatistical study (Figure 4).

The method described above provides the modeller with a quick and proper way to quantify structural uncertainty in the reservoir. Such information is very useful when planning wells and development facilities.