Introduction

Static geological models are made of horizons and faults which define their geometry. Both faults and horizons (in depth) are uncertain objects, which result from a time-to-depth conversion procedure involving variables such as time maps, velocity maps, markers at wells that in turn might all be affected by a given level of uncertainty. Even faults location may be uncertain and impact Gross Rock Volumes (GRV) calculated in the geological model (Correia et al., 2019). This paper details methods which allow simultaneous calculation of depth maps and the associated uncertainty. Focus is put on how to quantify the impact on the global uncertainty on GRV of each Time-Depth conversion input parameter uncertainty. The relative impact of each individual source of uncertainty is calculated on a real case study and the quantitative effect of combining the different sources is estimated and analyzed.

Methodology

Geostatistics provide several techniques that can be combined for calculating accurate depth maps, with or without auxiliary data, and quantifying rigorously the uncertainty associated with each point of the map. In doing so, Geostatistics provide a better estimation of the range of variation on Volumetrics.
Stochastic Conditional simulations are a method for dealing with the uncertainty of various input data sources. They are a set of n realizations of a given variable, calculated on 2D or 3D grids. Each realization is a possible representation of the Depth-converted horizon, which honours the true variability of experimental data, the experimental variogram and the data points value. To account for uncertain input data, a specific set of samples is defined for each realization. Then, the different realizations are conditioned by different data sets. When making statistics on the full set of realizations, the uncertainty on input data is automatically accounted for.
Conditioning data can be made by Kriging with external drift, which allows integrating auxiliary data in the calculation process.

Application to a real dataset

A Time-Depth conversion has been done on a dataset made of well data and Time and Velocity maps. The uncertainty on final reservoir volumes has been evaluated by mean of geostatistical conditional simulations, conditioned by different datasets at each realization. Specific datasets were prepared to test the impact of uncertainty on markers depth, Time or Velocity maps, and on fault location. All these uncertainties were combined in the end to quantify the impact of using simultaneously several uncertain data. These tests show that the uncertainty on each source of data affects the final results, and their combined use significantly widens the range of variation of final volumes.

Conclusion

The combined use of advanced geostatistical techniques offers a solution for quantifying and visualizing uncertainty on reservoir geometry and volumes. Conditional simulations allow integrating the uncertainty on many input data sources and quantifying the global uncertainty resulting from all the associated uncertainties. If all the uncertainties of the different data sources are taken into account in Time-Depth conversion, then the range of variation on the results (reservoir GRV, Closure Depth) will be more realistic and avoid biaises. If all the intermediate uncertainties are included in the calculations, it is obvious that the provided ranges of variation on results may be quite wide, but more realistic than a narrow range resulting from an underestimation of the intermediate uncertainties. This allows decision makers to take the most appropriate decisions concerning the field development based on more solid grounds.

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References

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