Uncertainty Analysis in Geological Surface Modelling
(Duvernay Formation / Muskwa Formation and Leduc Formation Case Studies)

Introduction

In geological surface modelling, uncertainty analysis is used to provide information about the reliability of the three-dimensional (3D) geological model. The uncertainty analysis of geological surfaces can be divided into two main categories: global uncertainty and local uncertainty. These categories are crucial for enhancing the quality of geological models.

Introduction

To solve this problem, a unique workflow for assessing prediction uncertainty was developed using a combination of innovative techniques in software. The methodology involves assessing the uncertainty of predicted surfaces using a combination of different techniques in Petrel and Matlab. The workflow uses the estimation error to calculate the average and variance of uncertainty for different number of realizations and percentages taken from the reference dataset.

Local and Global Uncertainty Implementations

Global Uncertainty

Sensitivity analysis was applied to the Duvernay Formation / Muskwa Formation joint dataset to come up with the optimal parameters for the number of realizations (N) and the percentage of the data taken from the entire pick dataset (P). The optimal parameters: 10 realizations of the reference data taken from the reference pick dataset (P) and 80% of reference data (N).

Local Uncertainty

To determine the area of high and low uncertainty in the modelled surface, the workflow uses a combination of different techniques in Petrel and Matlab. The workflow uses the estimation error to calculate the average and variance of uncertainty for different number of realizations and percentages taken from the reference dataset.

Detect and Manage Uncertainty

There are different sources of uncertainty that affect the surfaces of geological models: geological complexity, subsurface complexity, and data quality. These sources can be managed by applying different techniques in software.

Sensitivities Analysis:

The workflow works as follows:

1. Generate surfaces for each subset realizations, and export them to Matlab.
2. Calculate the average of uncertainty for each combination of P and N values.
3. Calculate the standard deviation maps for each combination of P and N values.
4. Determine the optimal parameters for the number of realizations (N) and the percentage of the data taken from the entire pick dataset (P).

Case Studies: Duvernay Formation / Muskwa Formation and Leduc Formation

Two case studies:

- Duvernay Formation / Muskwa Formation case from 3D PGF model v2 (Figures 6 and 7) and standard deviation uncertainty map. P = 80% and N = 10 (Figure 6).
- Leduc Formation case from 3D PGF model v2 (Figures 8 and 9) and standard deviation uncertainty map. P = 80% and N = 10 (Figure 9).

Conclusions and Future Work

Conclusions:

- Global and local uncertainty workflow shows higher uncertainty on surfaces with low density datasets and more complex geological structures.
- Local uncertainty map represents the more uncertain areas by mapping higher standard deviation values resulting from the presented workflow.
- The case developed for this technology is software independent and can be applied to other referenced surfaces (Duvernay, Leduc, Gray Providence).

Future Work:

- Sensitivity of quality within a pick dataset is not considered as a variable in assessing the uncertainty in this workflow and will be assessed in further studies.
- The sensitivity of P values overrealized and oracles in this case study for other studies with different sources of uncertainty is assessed in future studies.

References