3D Model Uncertainty

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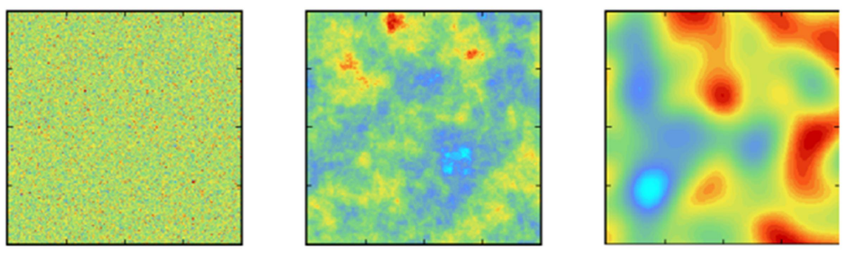
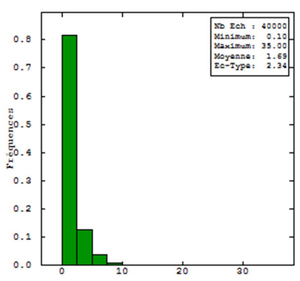
Geomodel & uncertainty

- A 3D geomodel is a numerical representation of the reality. It is used to compute global (reservoir volumes, production forecast) uncertainty and local statistics cell by cell.
- In geomodeling workflow, uncertainty is present at each step. There are several solutions matching the data that we have. Therefore, we can not predict with exactitude the reality.
- Global uncertainties may be the same given identical global statistics whereas local uncertainties can have substantial variations:

The 3 maps are different:



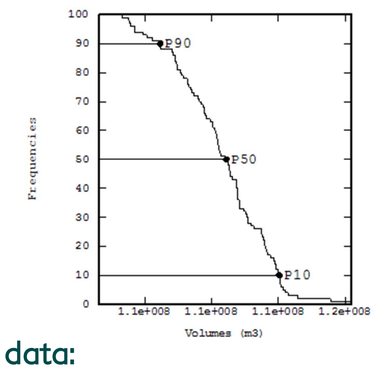
- But the global statistics are the same:



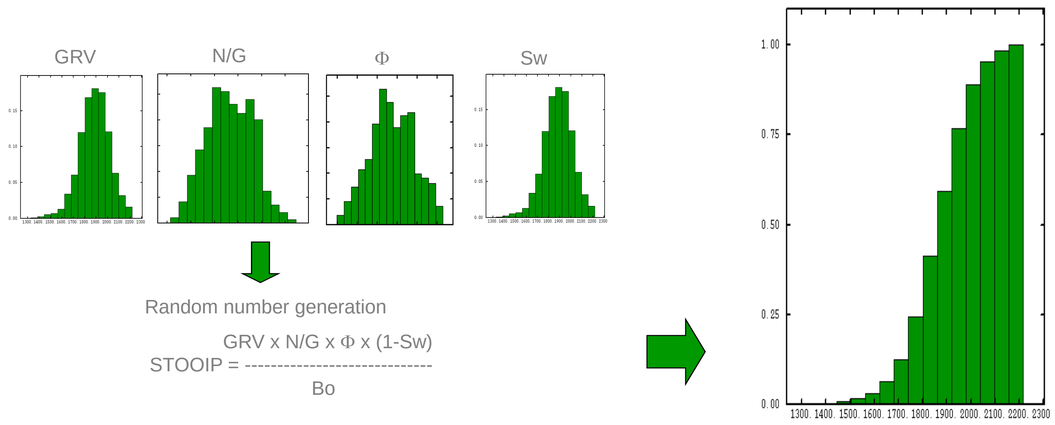
Uncertainties assessment

- Uncertainties can be assessed from stochastic simulations.
- For global uncertainty, Uncertainties from different parameters (ex reservoir volume computation) are cumulated.

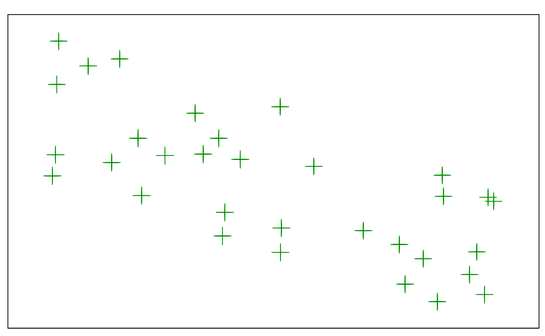
e.g. <OOIP>=<GRV>*<NtG>*<φ>*(1-<Sw>)/Bo



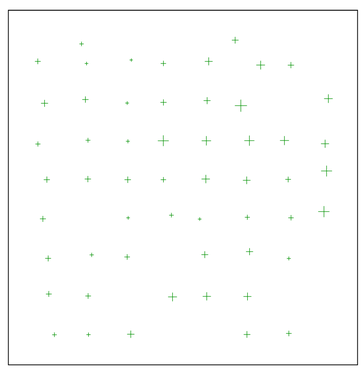
- This approach can be generalized to production data:
  - By simulating flow in the model with varying dynamic parameters
  - If too long, an approximation by experimental design can be used
- Knowing the histograms or PDF, global uncertainty quantification can be done by a Monte-Carlo approach



- The uncertainty level depends on the degree of heterogeneity of the variable. We need to find a minimal uncertainty on variable parameters
- It is link to the data sampling:
  - Number of observations (should increase with the heterogeneity)
  - Position in space (better when uniformly sampled)
- Example assuming the same variable and field (ie same heterogeneity):



+ uncertainty



- uncertainty

Heterogeneities examples

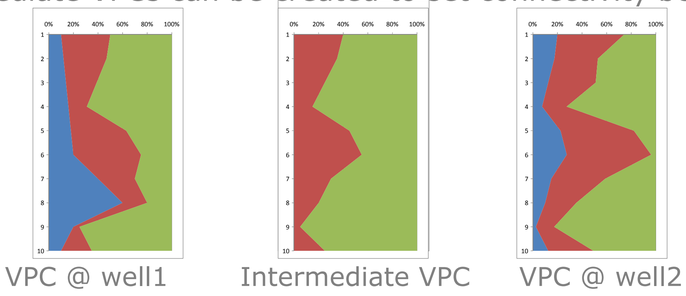
- More heterogeneous our system is less we can predict at the local scale.
- But the global scale prediction still holds as long as the statistics (i.e. PDF) are accurate.
- For example, Sylvinite beds in potash mines can be continuous over long distances. But Shoal in carbonate environment can be very heterogeneous (less than the typical reservoir cell size).

Carbonate shoal

Sylvinite beds

Limits & consequences

- The Incertitudes are computed on a mathematical model. However it is possible to get radical errors occurring if the model is not realist (impacting the capacity of prediction of the model).
  - e.g. Presence of a sub-seismic fault
  - seal problem
  - structural problem +- 10m below or above target
- This type of error is not captured by uncertainty quantification. This could have a minimum impact on reserves but a strong one on local parameters (e.g. reservoir top, connection between blocks).
- A model is not a measure of the reality.
  - It is our numerical approximation of the reality
- To minimize the error we need to integrate data of different natures and of different scales
  - Well logs, cores
  - Seismic, Gravimetric, EM…
  - Dynamic synthesis (basic reservoir engineering)
  - Generally not taken into account in static model building
- The geomodel quality depends on the amount of information (knowledge) that it incorporates.
- Integrating inputs (knowledge) from various disciplines helps reducing the risk of radical errors.
- There should be a consistency between geomodel and dynamic synthesis. Geomodels are expected to reproduce these connections, but there is no geostatistical algorithm honoring connections. One way is to use local VPC.
  - Intermediate VPCs can be created to set connectivity between wells



VPC @ well1 Intermediate VPC VPC @ well2

Conclusions

- Geomodels are representations of the reality not the reality itself.
- Uncertainty is due to lack of precise data (e.g. well control), imprecise data (e.g. seismic), impossibility to conceive with certainty a conceptual model.
- Model uncertainty can be accessed by stochastically varying the model parameters and generating equiprobable outcomes.
- Even if uncertainty on a global parameter is low, the prediction capability at local scale may be poor.

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