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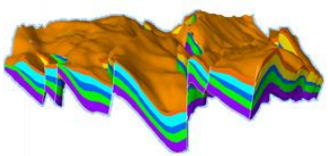
Petrel 2017 Property Modeling
Module 6: Facies modeling data analysis

Petrel 2017 Property modeling

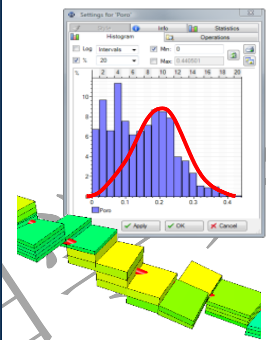


Intro

Petrel Property Modeling objective and workflow

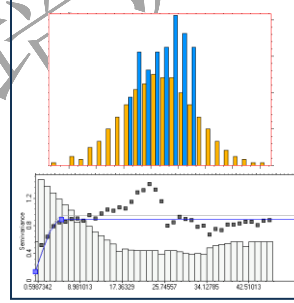
Property modeling data preparation

Scale up well logs

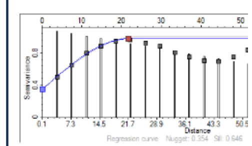


Univariate and bivariate geostatistics

Basic statistics

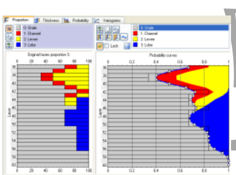


Variogram modeling

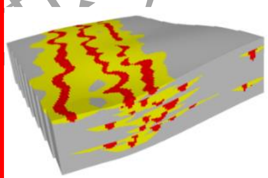


Facies modeling

Discrete data analysis

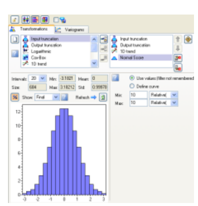


Stochastic facies modeling

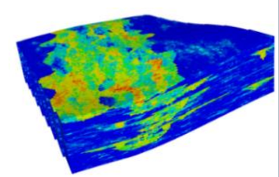


Petrophysical modeling

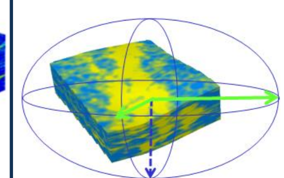
Continuous data analysis



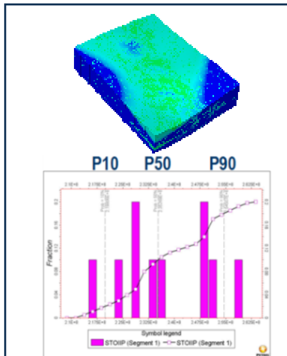
Stochastic and deterministic petrophysical modeling



Use of secondary information for property modeling



Volume calculation and Uncertainty analysis



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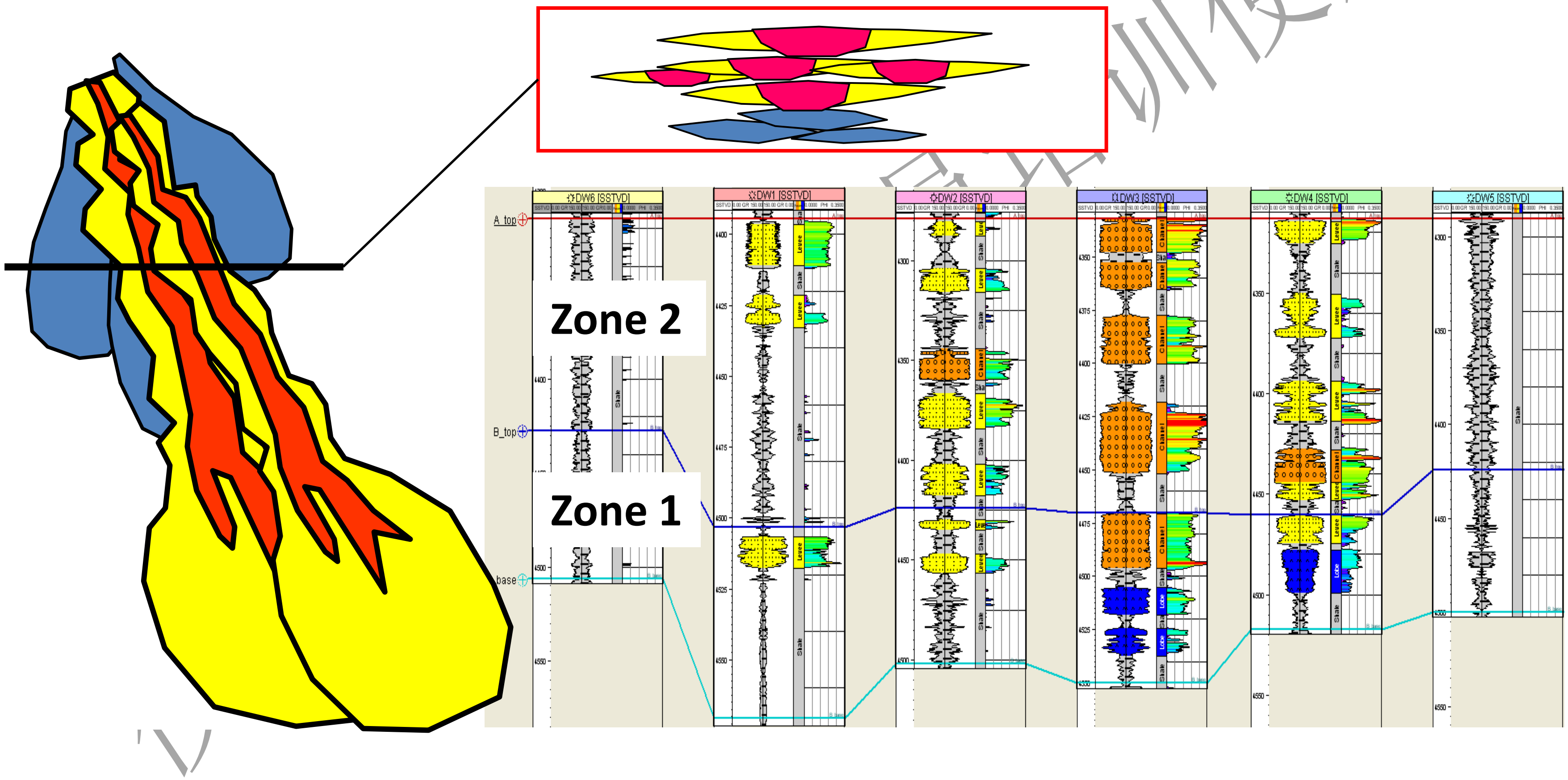
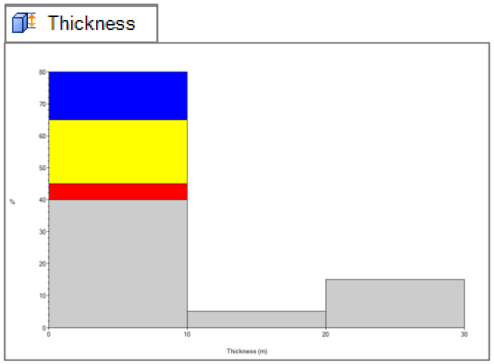
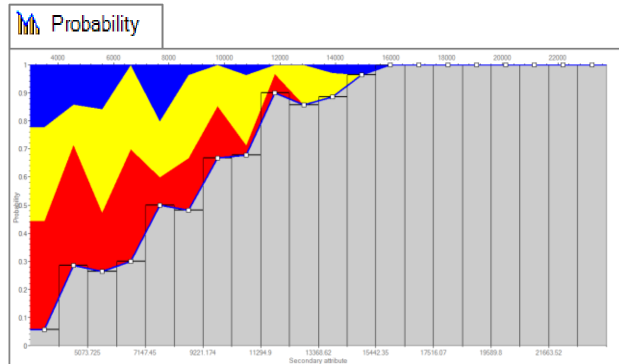
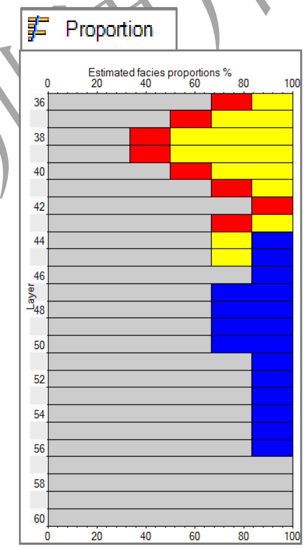
Depositional environment

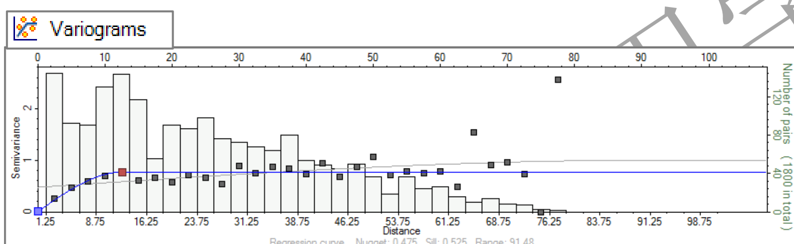


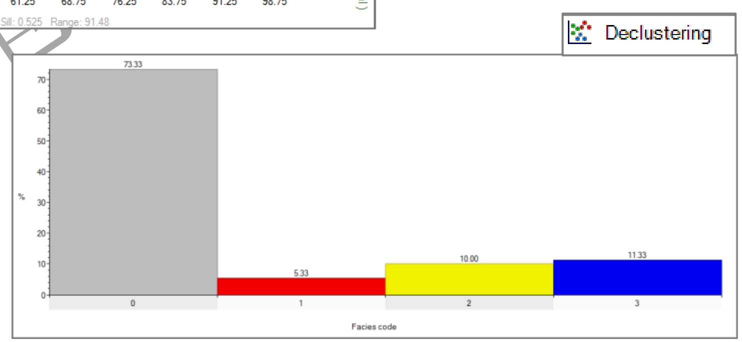
Statistical discrete data analysis











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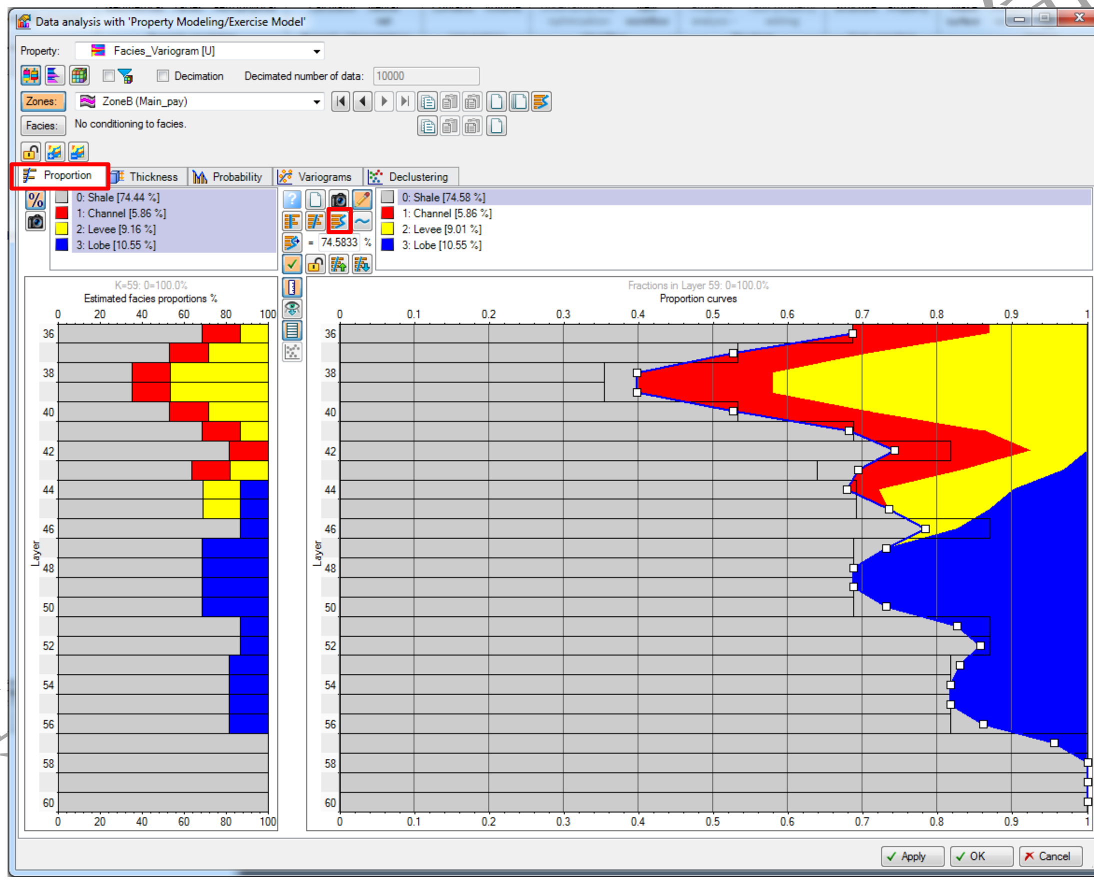
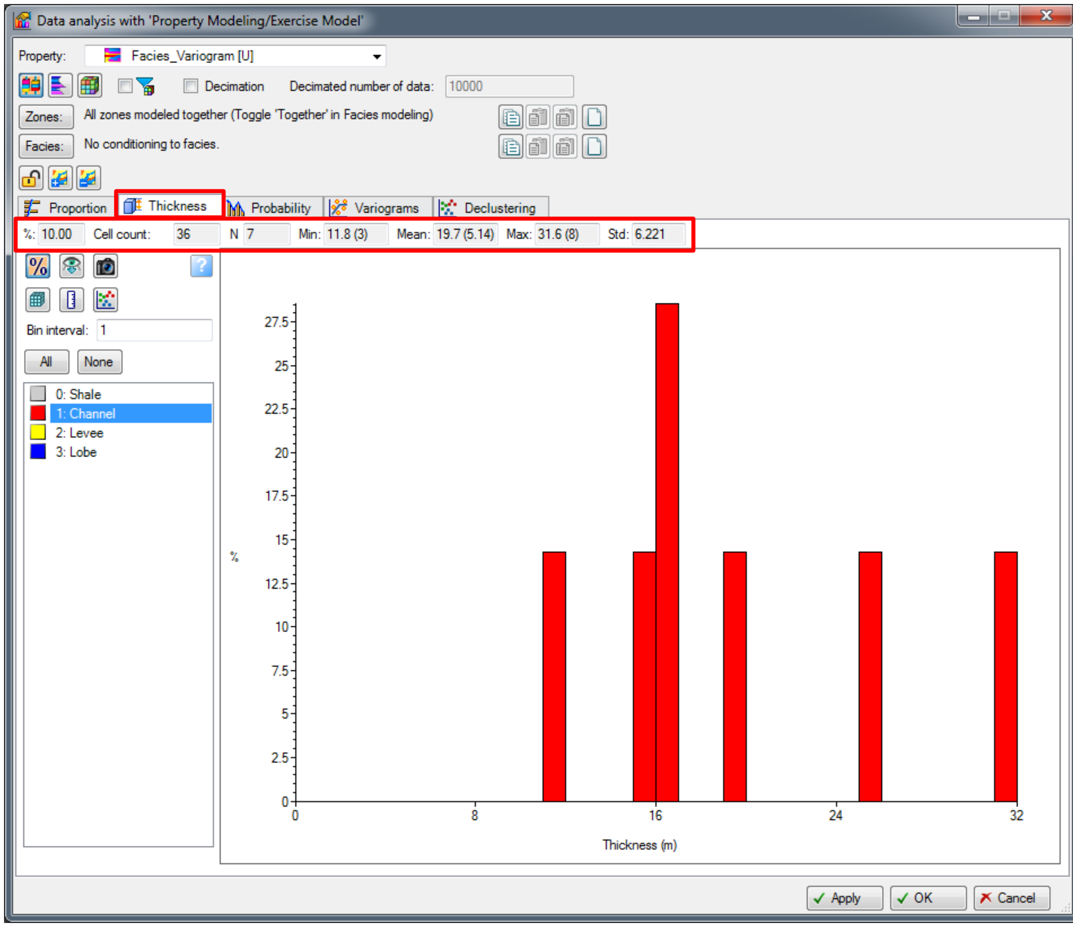
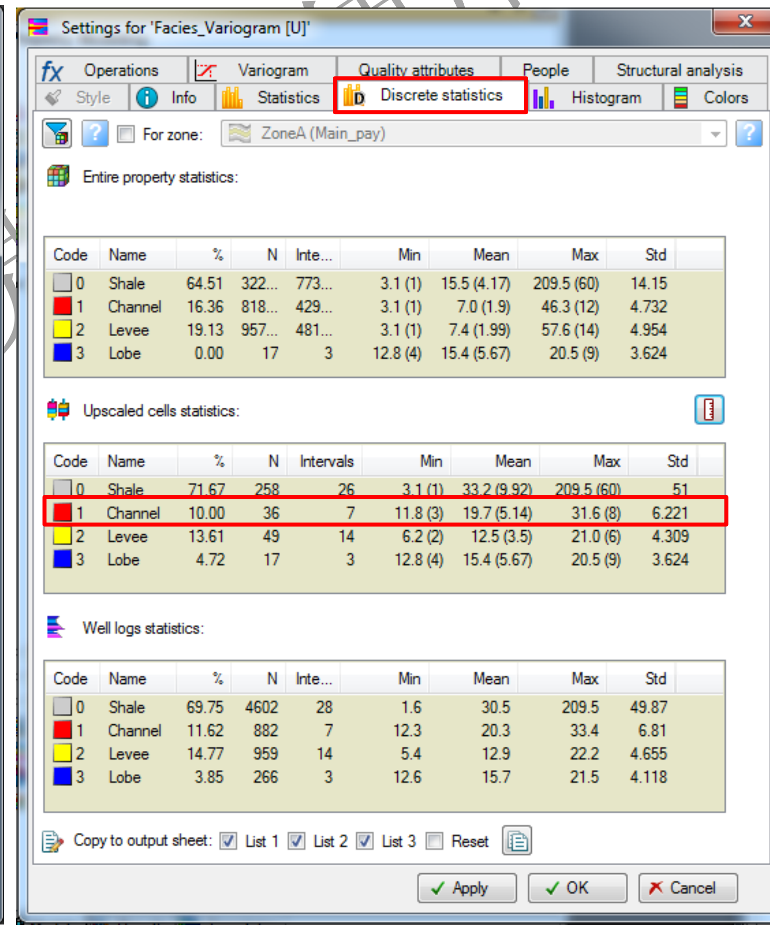
Vertical proportion curves



Thickness of facies





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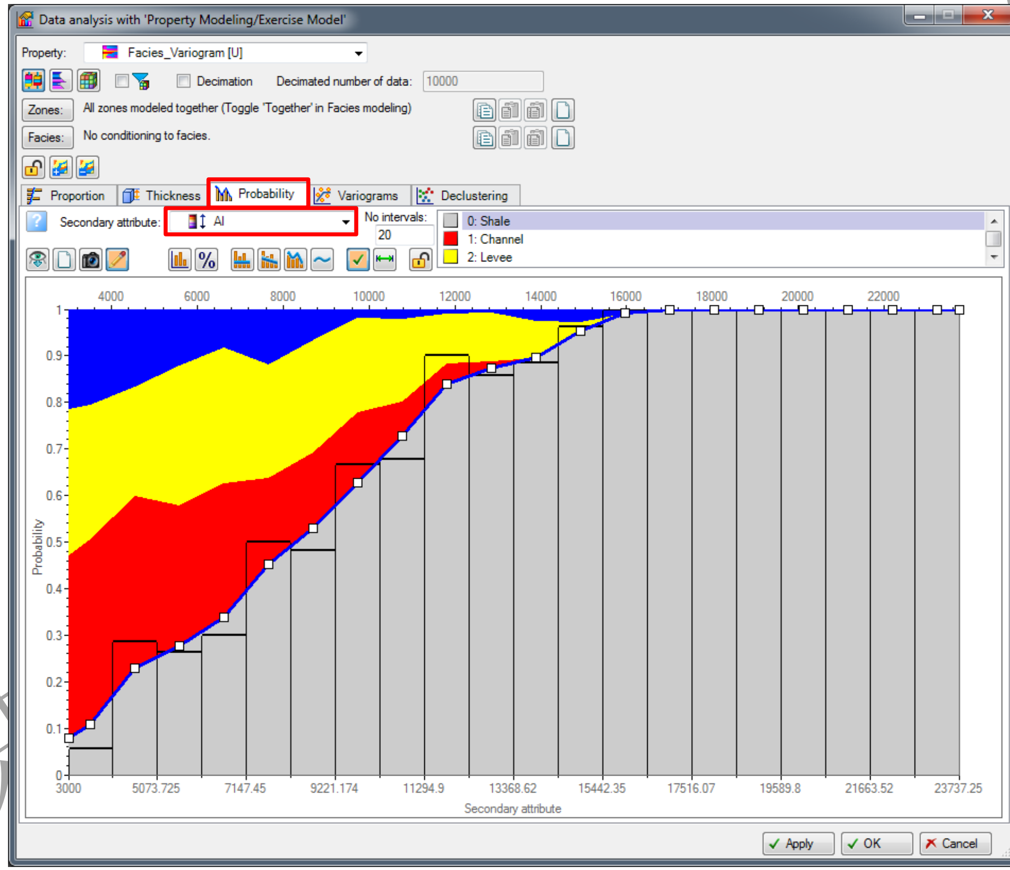
3D probability curve



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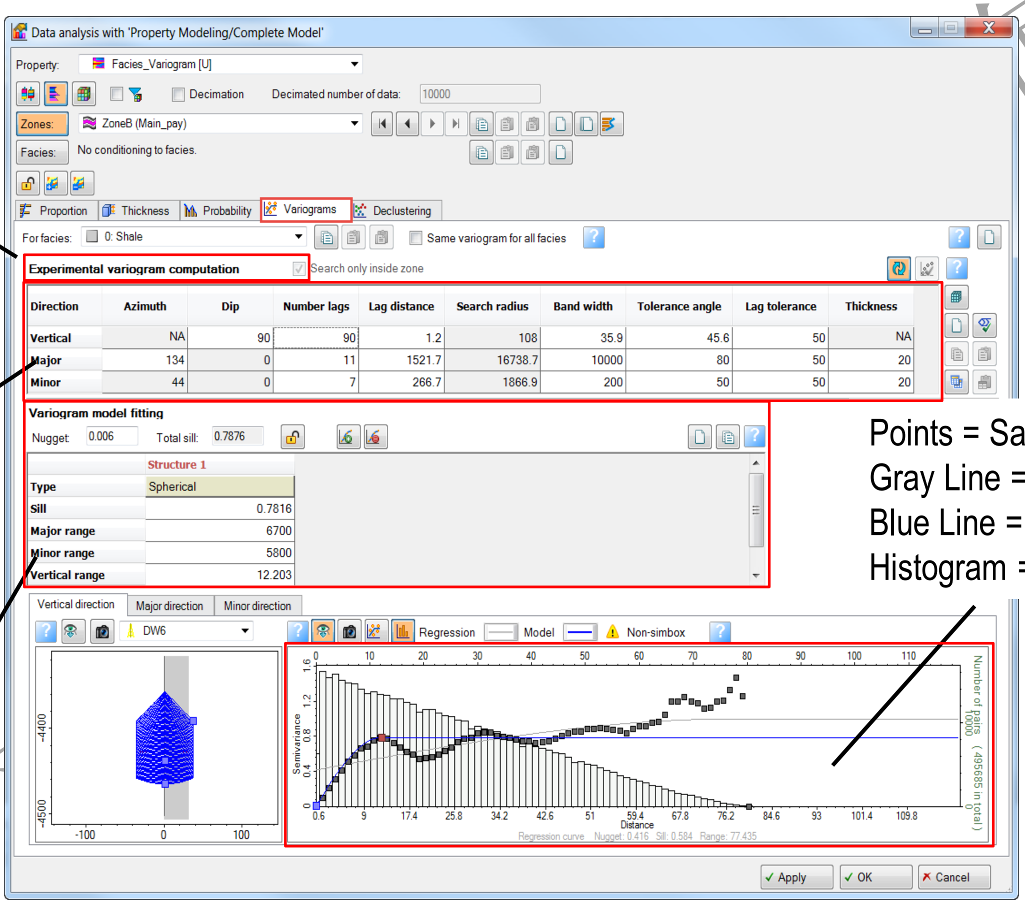
Variogram analysis

Facies type

Search cone setup: Generates the sample variogram

Variogram results: For use in modeling



Points = Sample variogram
Gray Line = Regression line
Blue Line = Model variogram
Histogram = Number of pairs

Indicator variogram calculation process

1. Transform discrete data as binary variables. Convert the facies of interest to 1 and the remaining facies to 0.
2. Calculate the classical semivariogram using the binary codes to create the semivariance for each lag for that discrete value:

$$\gamma_{(h)} = \frac{1}{N_h}\sum_{i=1}^{N_h}\left(\left(facies_{(i+h)}\right)-\left(facies_i\right)\right)^2$$

3. Calculate a prior distribution function (**pdf= F(z)**): $F(z_i) = \sum_{j=1}^{i-1} P(z_j)$

$$Where: P(z_j) = facies \quad proportion$$

4. Calculate the variance for a discrete property according to the distribution (**Var= F(z)*(1-F(z))**).
5. Standardize the classical variogram by **Var= F(z)*(1-F(z))**: $(\gamma_{(h)}) \big/ [F(z)*(1-F(z))]$

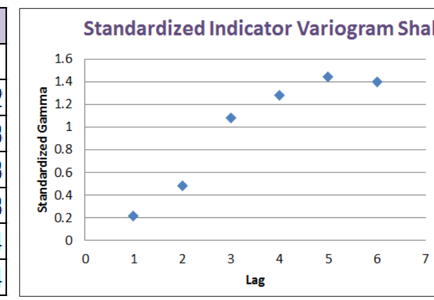
Example:

Code	Facies	Proportion	pdf=F(z)	F(z)*(1-F(z))
0	Shale	0,50	0,50	0,250
1	Sand	0,05	0,55	0,248
2	Silt	0,15	0,70	0,210
3	Fine Silt	0,20	0,90	0,090

Indicator variogram for Shale:

- Shale is recognized as 1 and other facies as 0 to calculate the variogram (semivariance).
- The variogram is standardized by the pdf factor.

	Shale	
Lag	**Semivariance**	**Standardized**
Lag 1	0.055	0.22
Lag 2	0.12	0.48
Lag 3	0.27	1.08
Lag 4	0.32	1.28
Lag 5	0.36	1.44
Lag 6	0.35	1.4



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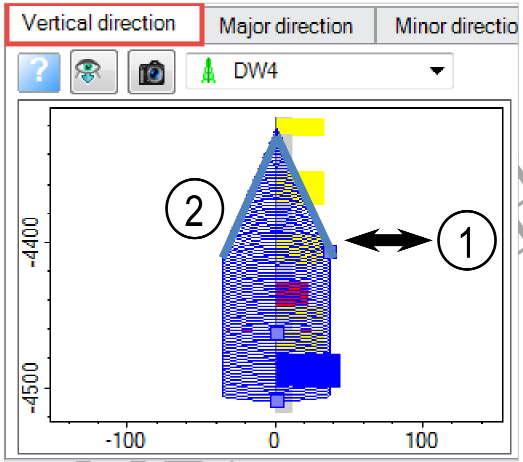
Obtain the best search cone parameters

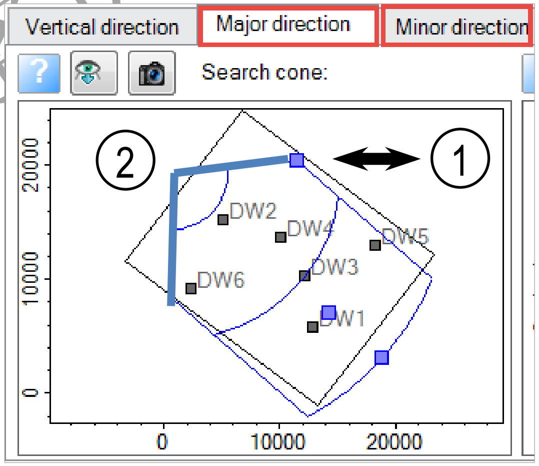
Proportion | Thickness | Probability | Variograms | Declustering

For facies: 0: Shale — Same variogram for all facies

Experimental variogram computation — Search only inside zone

Direction	Azimuth	Dip	Number lags	Lag distance	Search radius	Band width	Tolerance angle	Lag tolerance	Thickness
Vertical	NA	90	90	2.1	189	36.7	23.3	50	NA
Major	131.7	0	3	8140	24420	[illegible]	48	50	0.2
Minor	41.7	0	3	4941.9	14825.7	[illegible]	[illegible]	50	0.2





Suggested Lag Distance Vertical
= Cell thickness/log sampling

Suggested Lag Distance Lateral
= Well spacing

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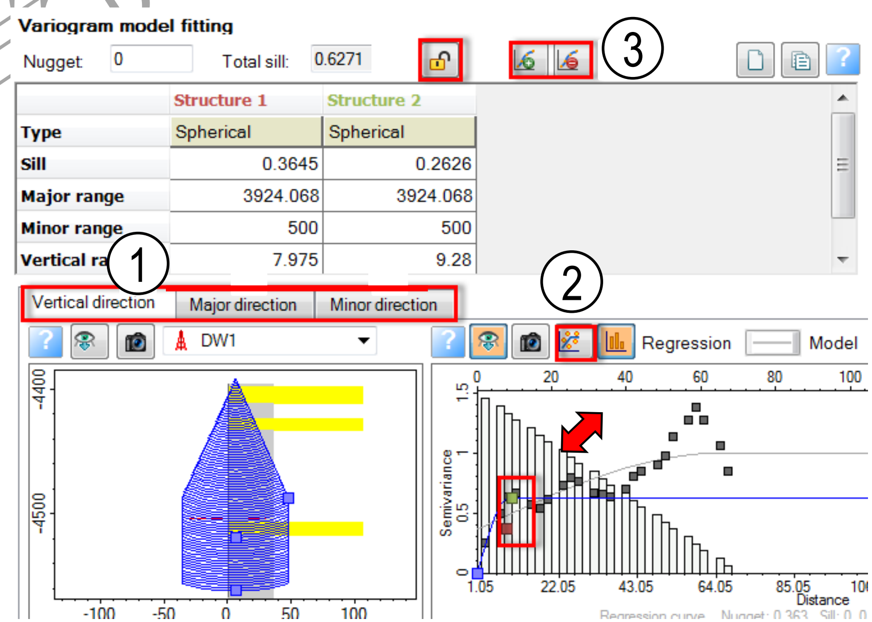
Fit the variogram model (1)

1. Begin with Vertical direction. Use raw logs in non-simbox mode.
2. Click *Fit variogram to regression curve* to fit the model quickly.
3. Add or remove structures as necessary to fit the variogram model more closely to the experimental variogram. Click *Fit variogram to regression curve* after each addition or deletion of a structure.



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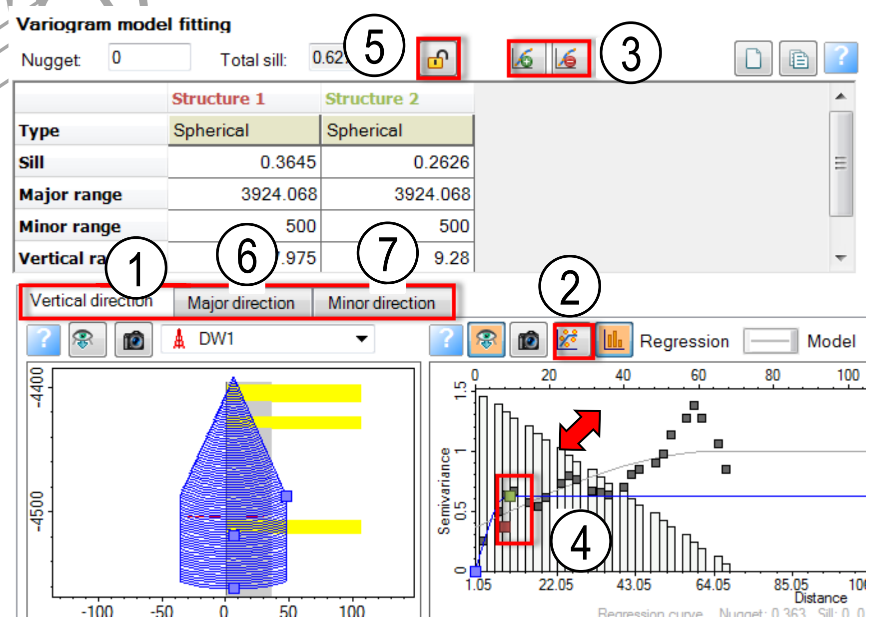
Fit the variogram model (2)

4. Modify variogram parameters as necessary by editing them in the Variogram model fitting table or directly in the variogram graph.
5. Click *Lock nugget and sills* to prevent the nugget and sills from being modified.
6. Repeat the process for the major horizontal direction. Use upscaled data in Simbox mode.
7. Repeat the process for the minor horizontal direction. Use upscaled data in Simbox mode.



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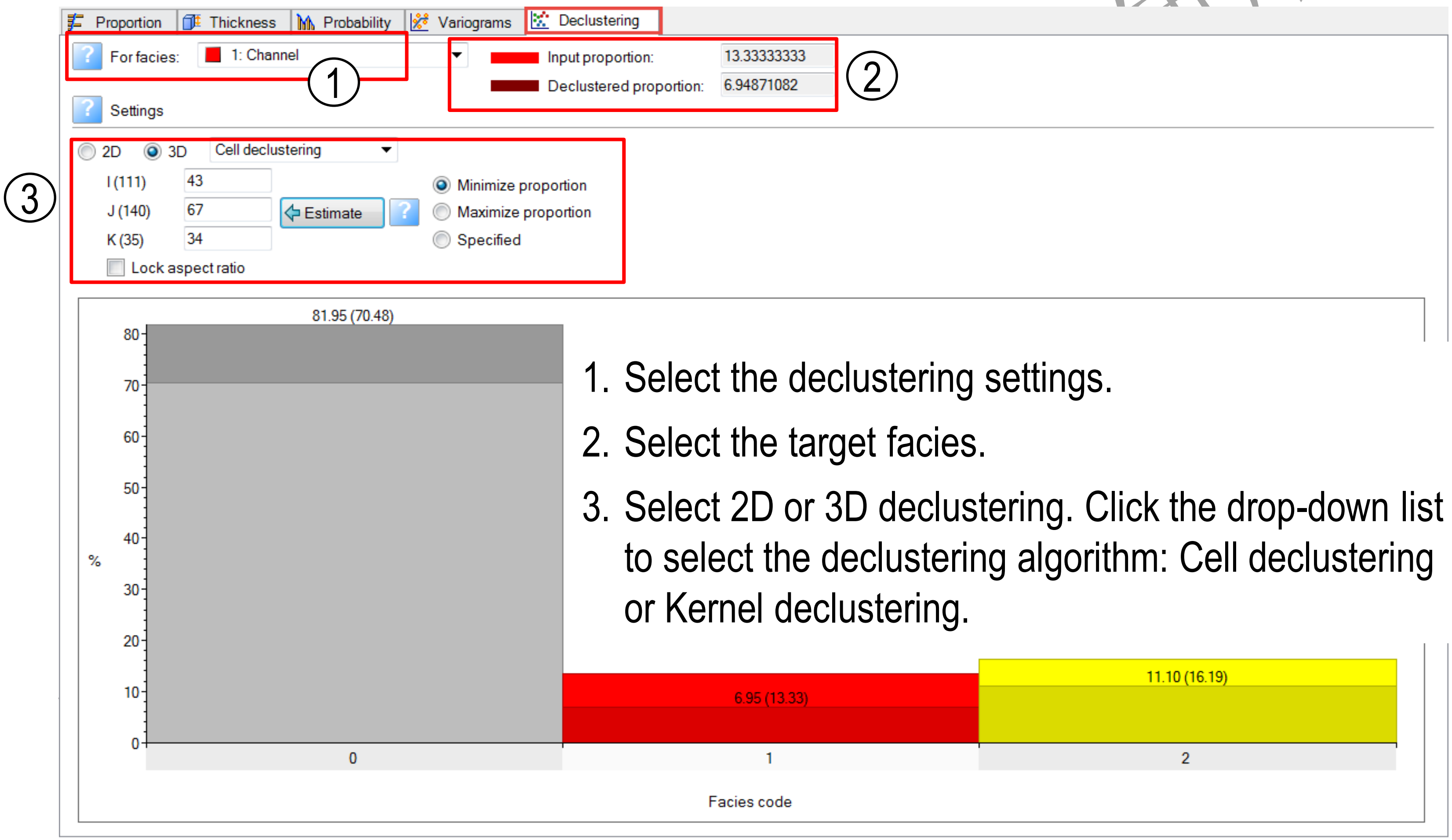
Declustering (1)



1. Select the declustering settings.
2. Select the target facies.
3. Select 2D or 3D declustering. Click the drop-down list to select the declustering algorithm: Cell declustering or Kernel declustering.

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Variogram modeling process summary

- Model vertical variograms:
  - Sufficient amount of data
  - Easy to estimate
- Fit the model variogram to the sample variogram:
  - Spherical, Gaussian, and Exponential
- Model horizontal variograms:
  - Limited data to compute the variogram
  - Can imply data from geology knowledge
  - Can derive data from correlated data source

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Exercises

- Run a vertical facies proportion analysis
- Run a facies thickness analysis
- Run a facies probability analysis
- Run a variogram analysis
- Run facies proportion declustering