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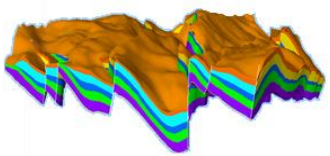
Petrel 2017 Property Modeling Module 17: Petrophysical modeling using secondary data

Petrel 2017 Property modeling

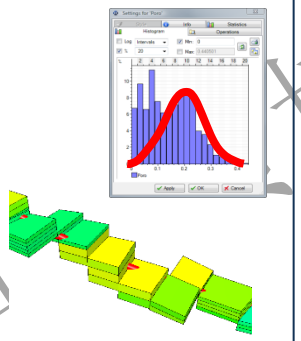


Petrel Property Modeling objective and workflow

Intro

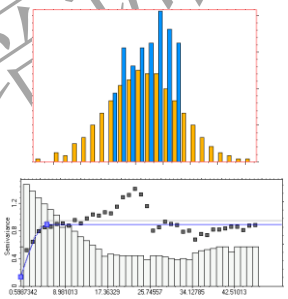
Property modeling data preparation

Scale up well logs

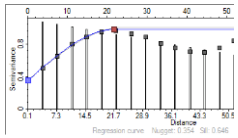


Univariate and bivariate geostatistics

Basic statistics

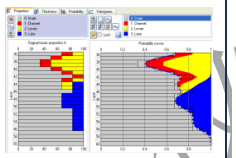


Variogram modeling

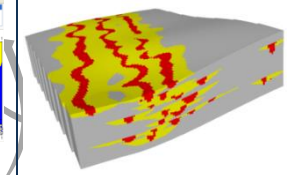


Facies modeling

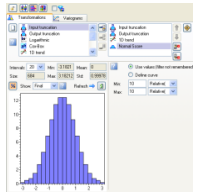
Discrete data analysis



Stochastic facies modeling

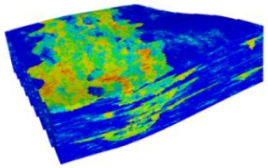


Continuous data analysis

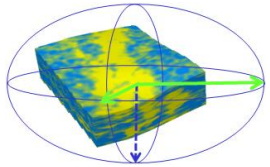


Petrophysical modeling

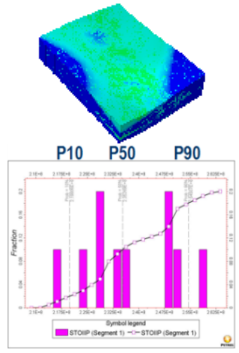
Stochastic and deterministic petrophysical modeling: Gaussian simulation



Use of secondary information for property modeling



Volume calculation and Uncertainty analysis



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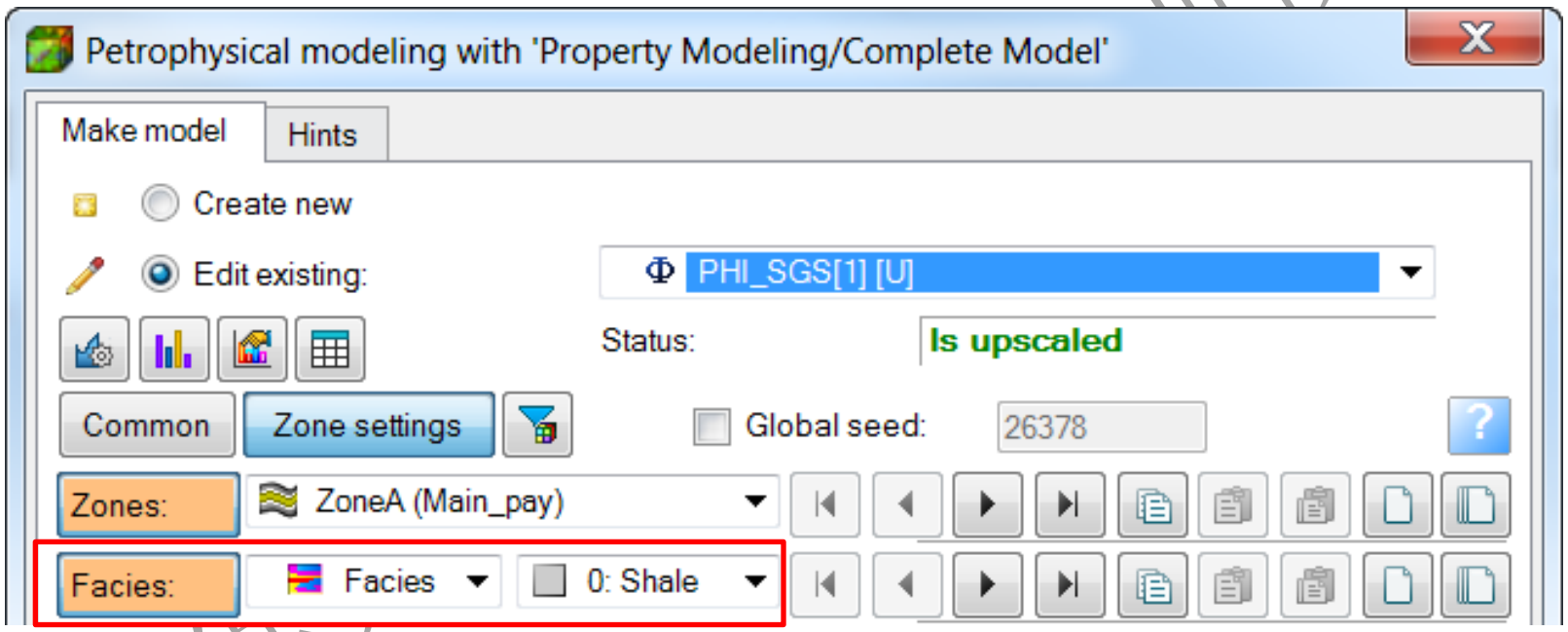
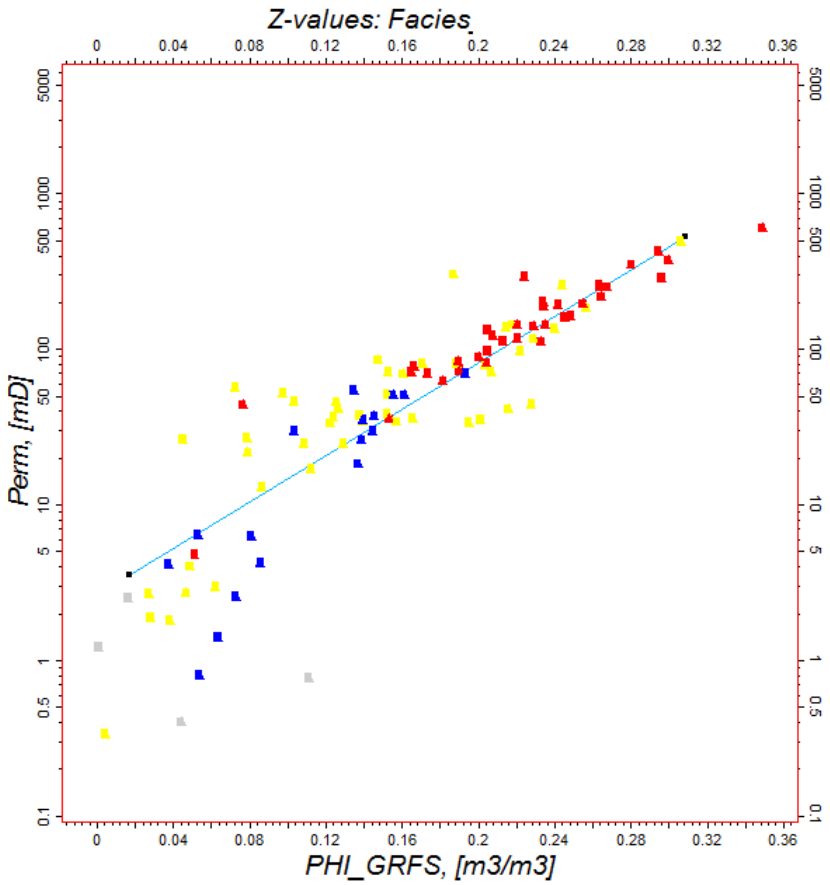
Conditioning to a facies realization



Correlation with secondary data



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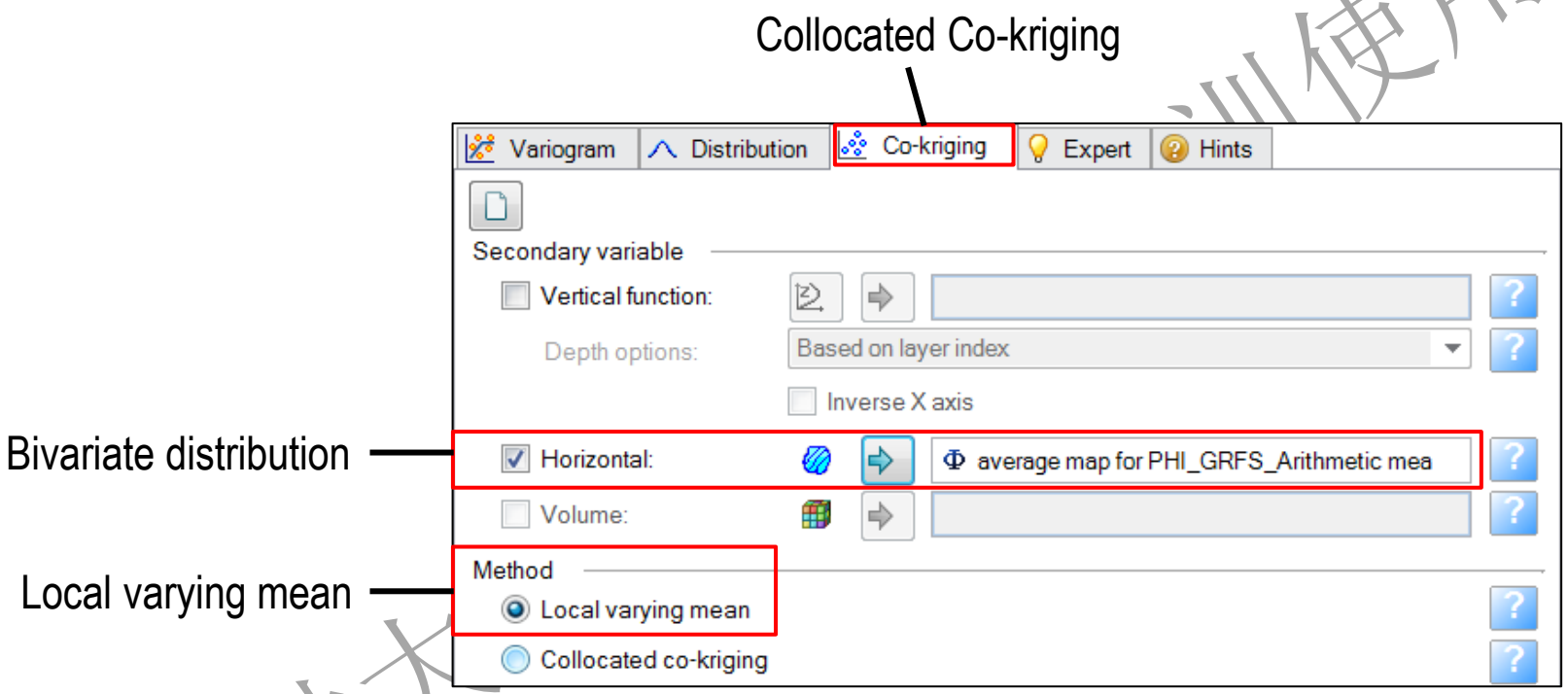
Local varying mean (LVM): Theory

$$z(x_0) = \sum_i^n \lambda_i z(x_i) + [1 - \sum_i^n \lambda_i] m(x_0)$$

- $Z(x_i)$: Data points (for example, porosity).
- $m(x_0)$: Secondary input such as a 2D map (porosity) or a property with a strongly correlated positive value.
- The sum of the weights λ_i can be less than one.
- The smaller the weights the bigger the influence of the Local varying mean $m(x_0)$ on the calculated value $Z(x_0)$.
- Local varying mean gains influence with increasing distance of location x_0 from data points (decreasing weights λ_i).

IMPORTANT: Secondary input should be smooth and available for all locations x_0 and Positively correlated to the primary data.

Local varying mean



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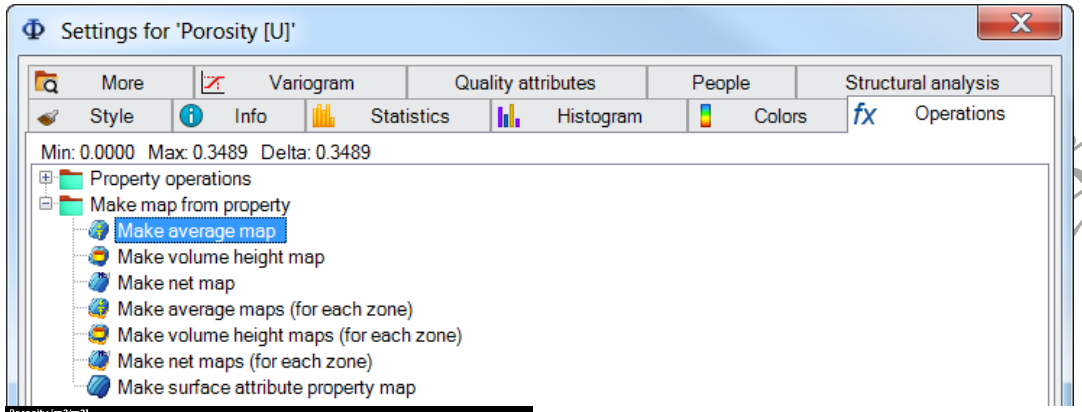
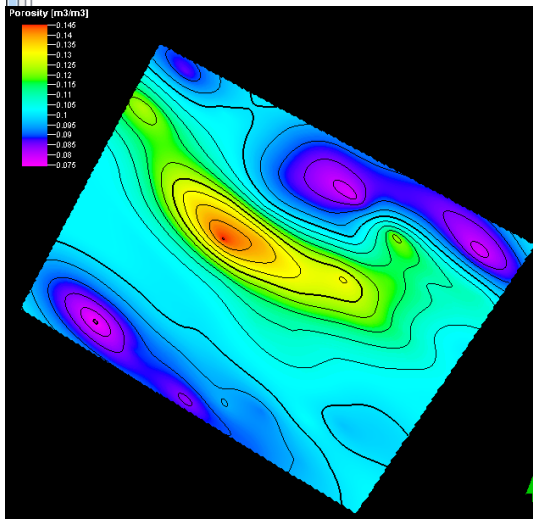
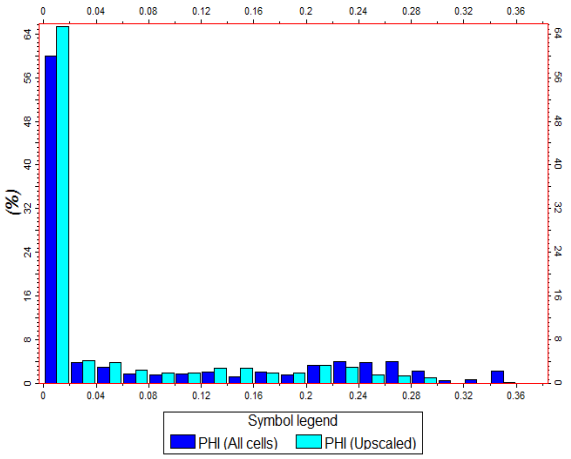
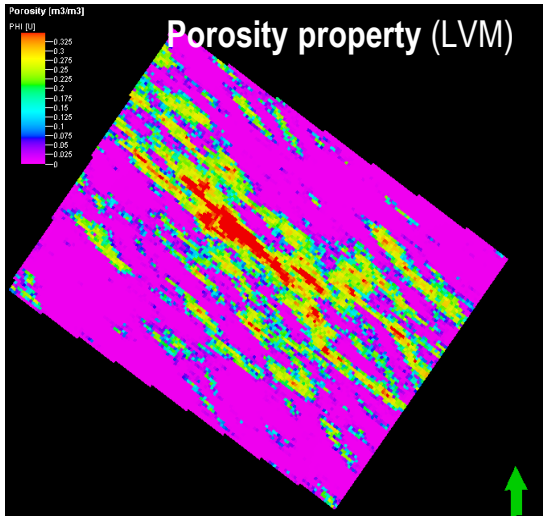
Average porosity map









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Co-kriging: Theory

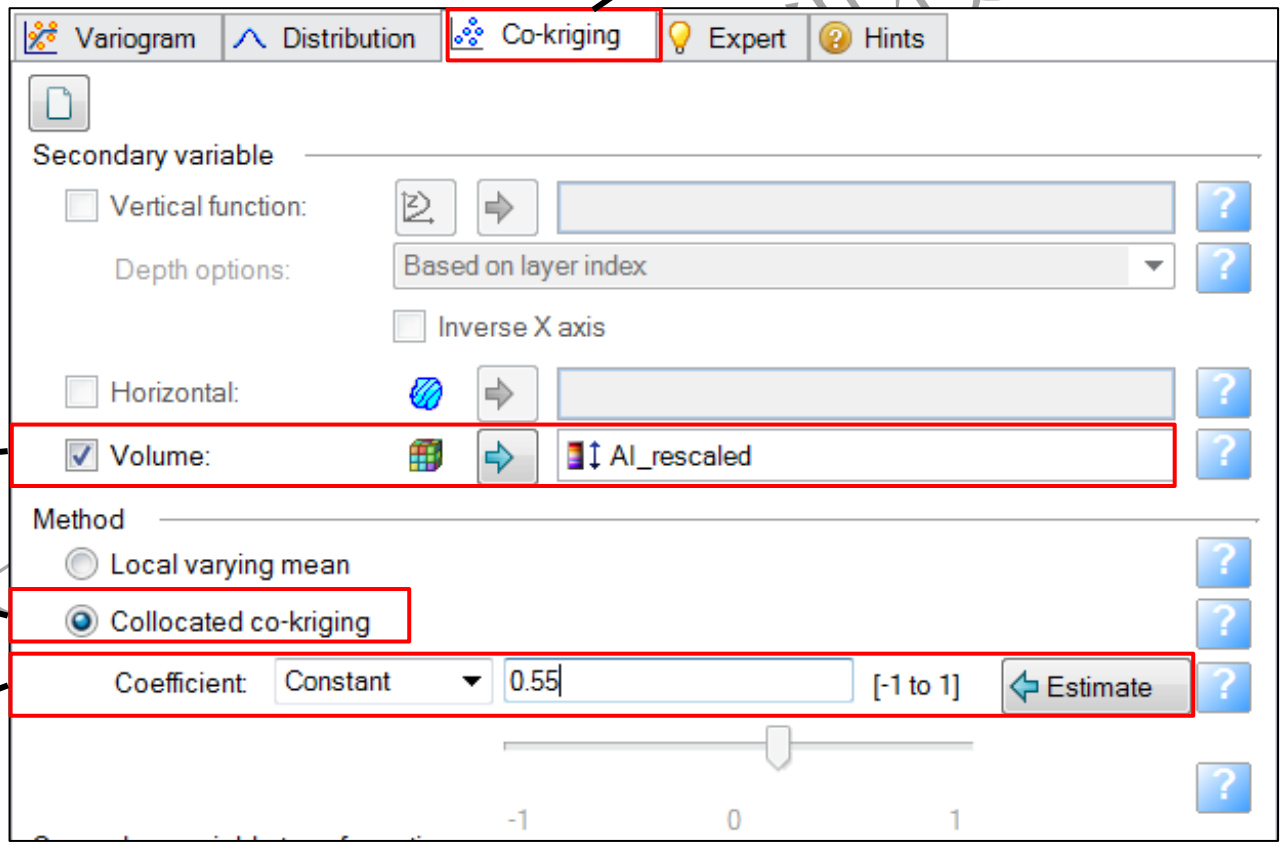
Traditional Co-kriging equation: $$Z_{COK}(x_0) = \sum_i \lambda_i Z(x_i) + \sum_j \mu_j Y(x_j)$$

- Requires variograms of primary and secondary property and a cross variogram.
- Consequently, a larger equation system is constructed with more constraints.

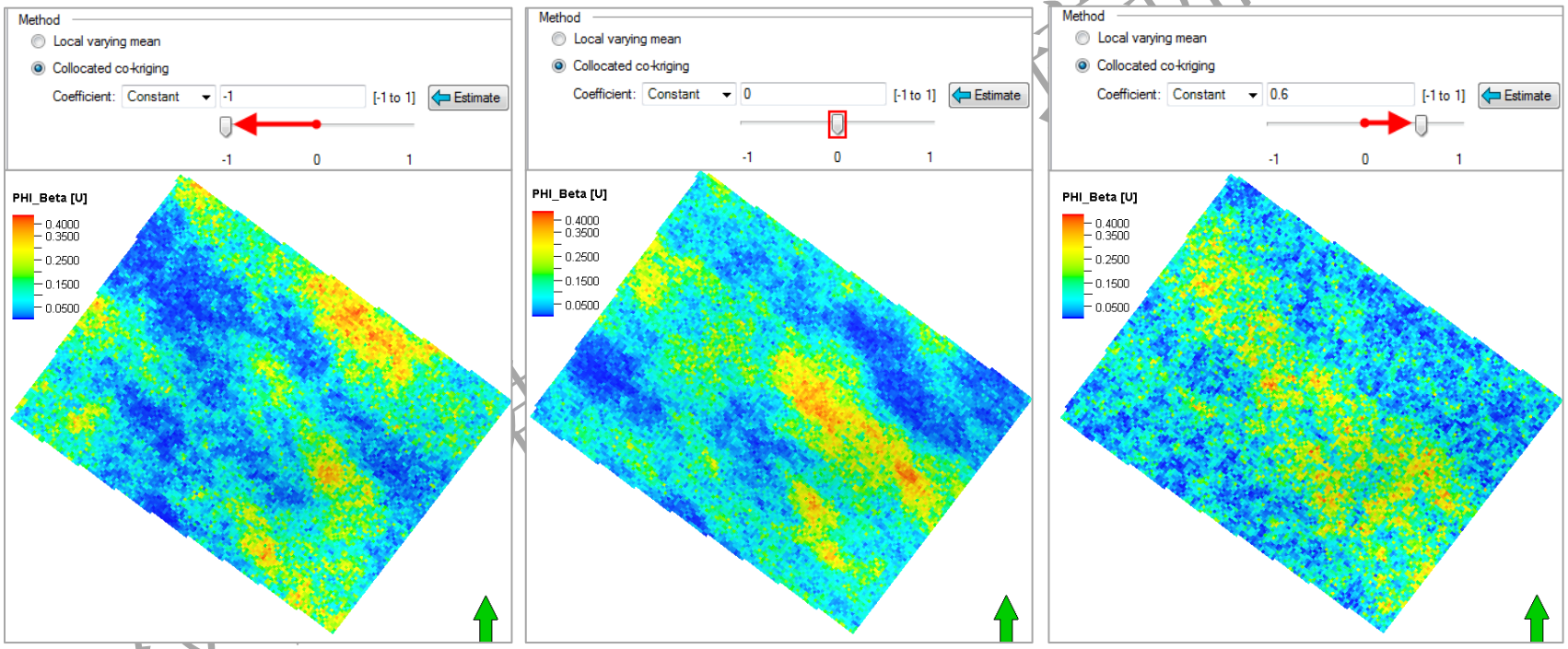
Collocated Co-kriging equation: $$Z_{CCOK}(x_0) = \sum_i \lambda_i Z(x_i) + \mu Y(x_0)$$

- A simplified equation system → faster than traditional Co-kriging.
- Possible solution if there is a more densely sampled secondary variable.
- Requires a variogram only for the primary property, using a correlation coefficient for the secondary property.

Collocated Co-kriging



Correlation coefficient slider bar



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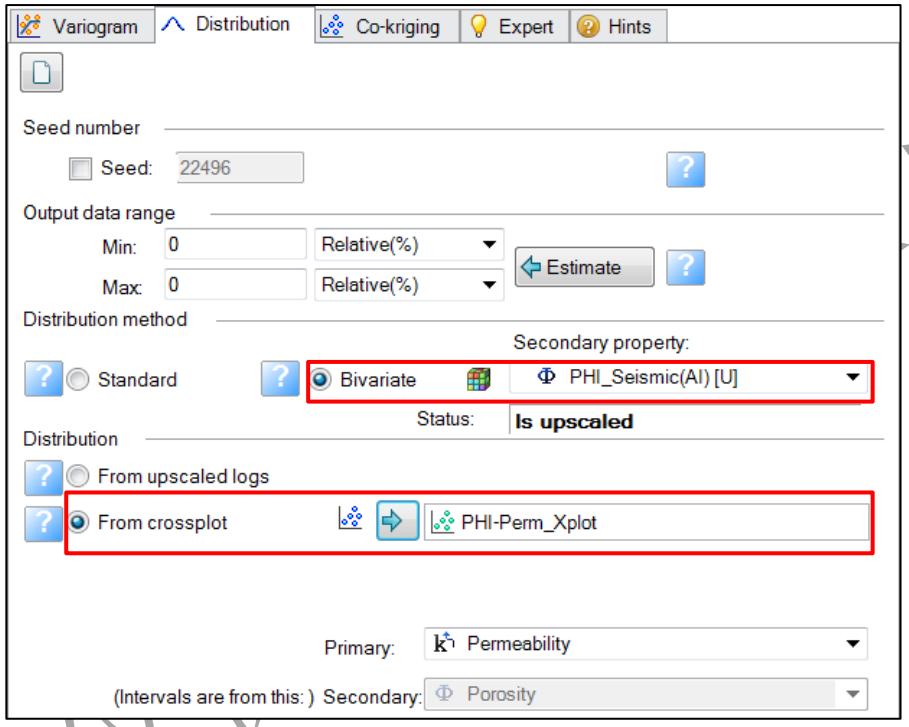
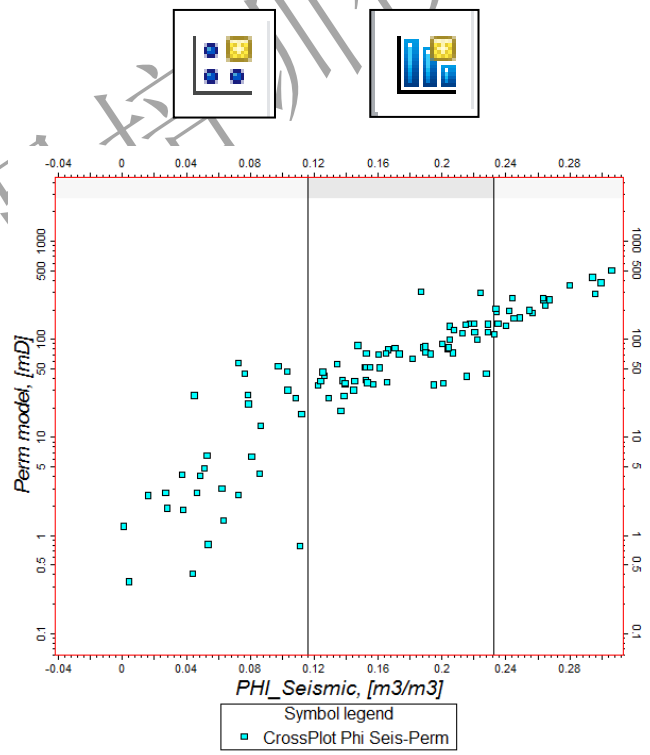
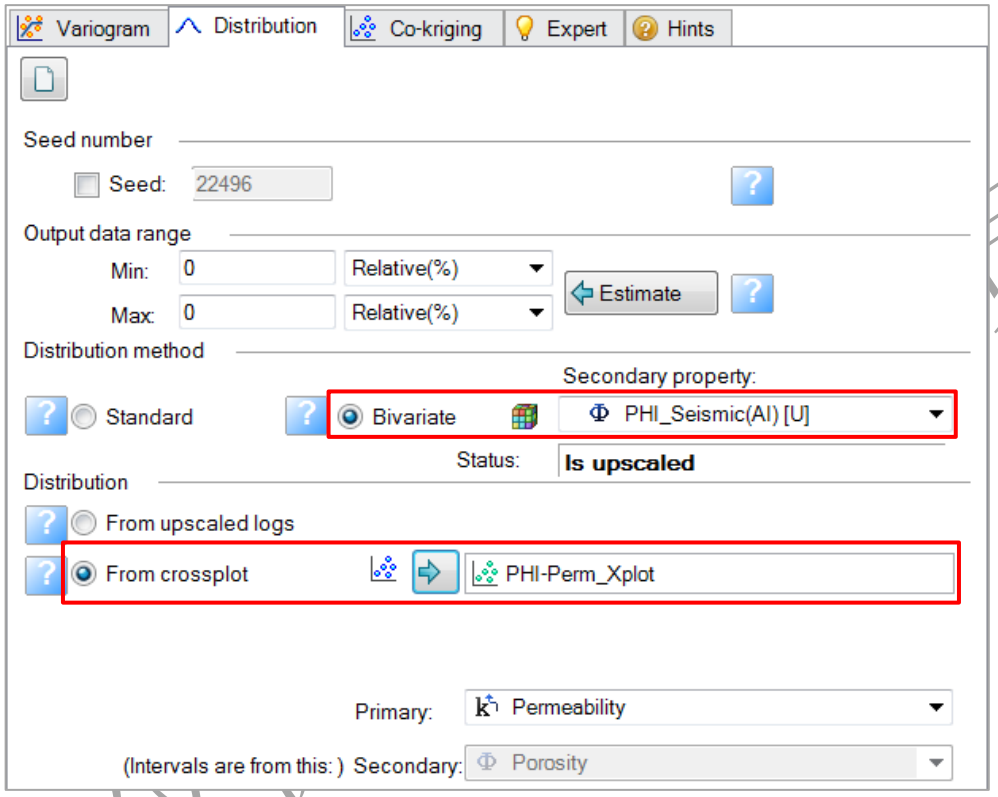
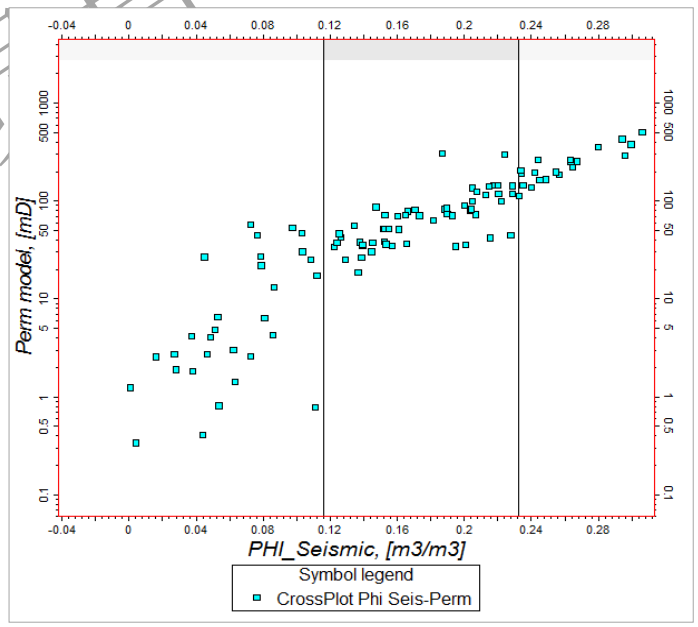
Bivariate distribution

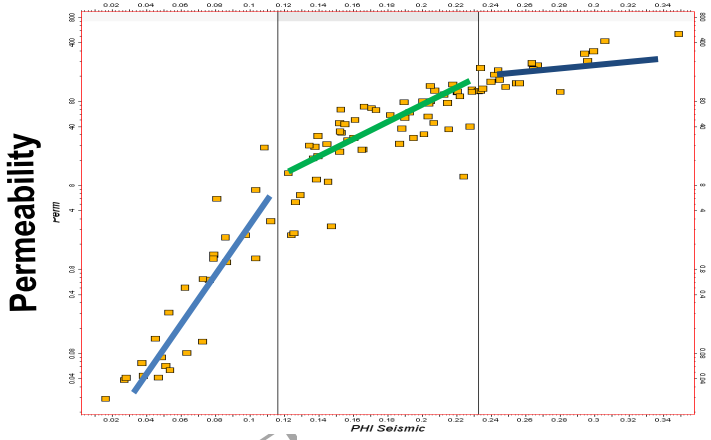




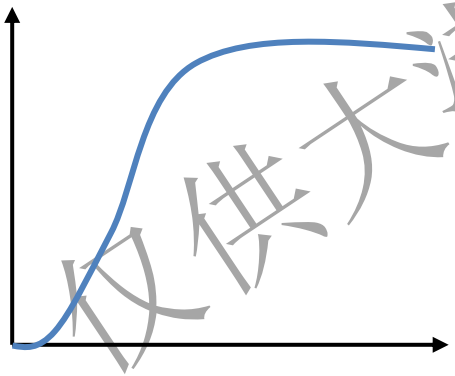




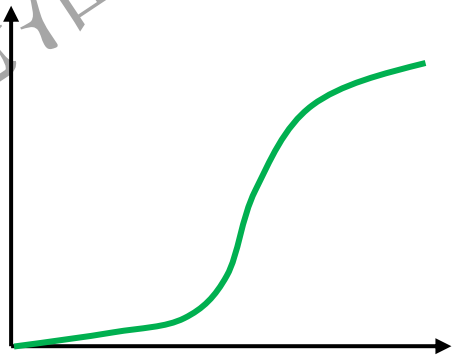
Raw crossplot with bins



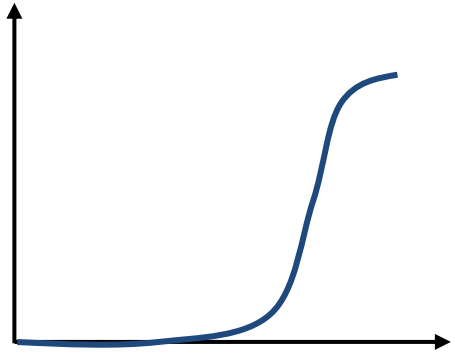
CDF for low porosity



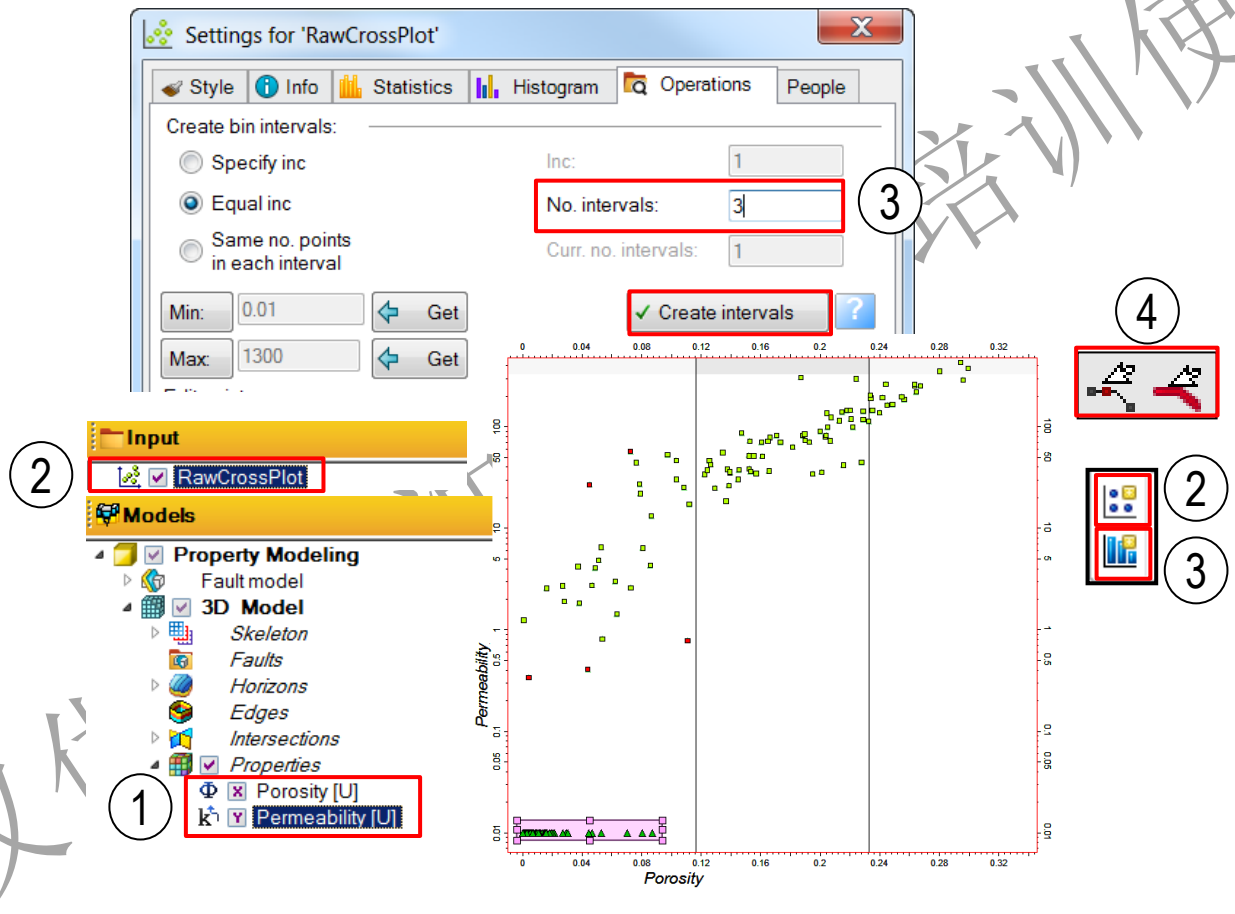
CDF for medium porosity



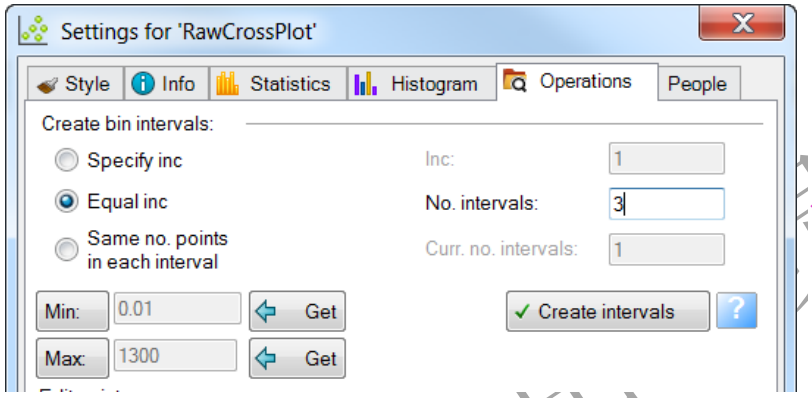
CDF for high porosity

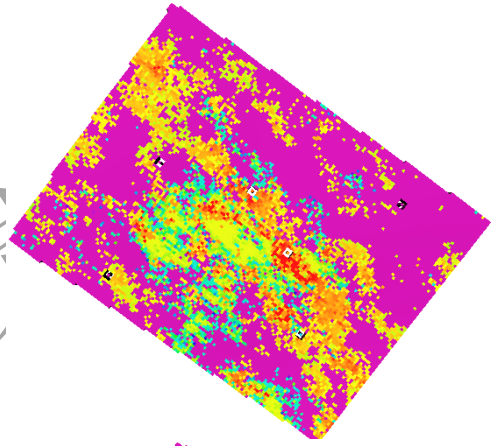


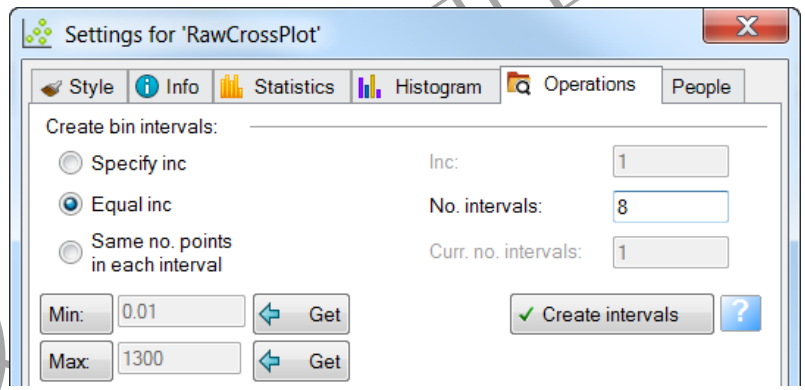
Create crossplot bins

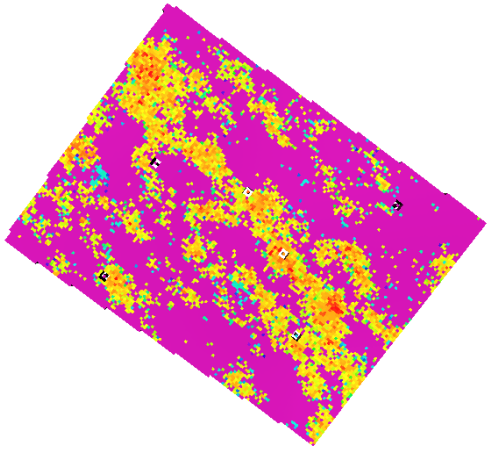


Use different bins









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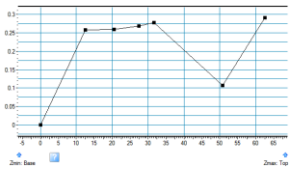
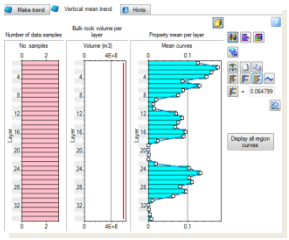
Continuous trend modeling (1)



Vertical function trend

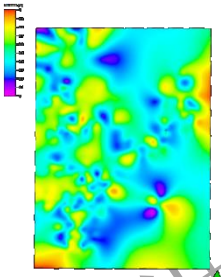


Vertical mean trend from upscaled data

W

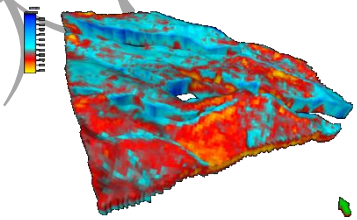
W

2D maps



W

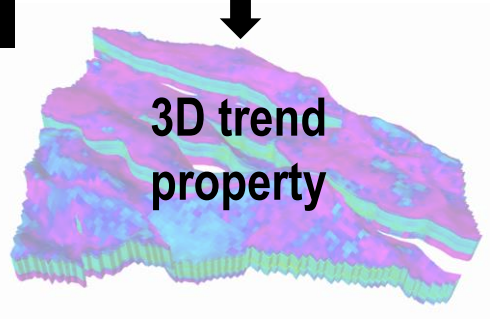
3D grid properties (seismic, AI, …)



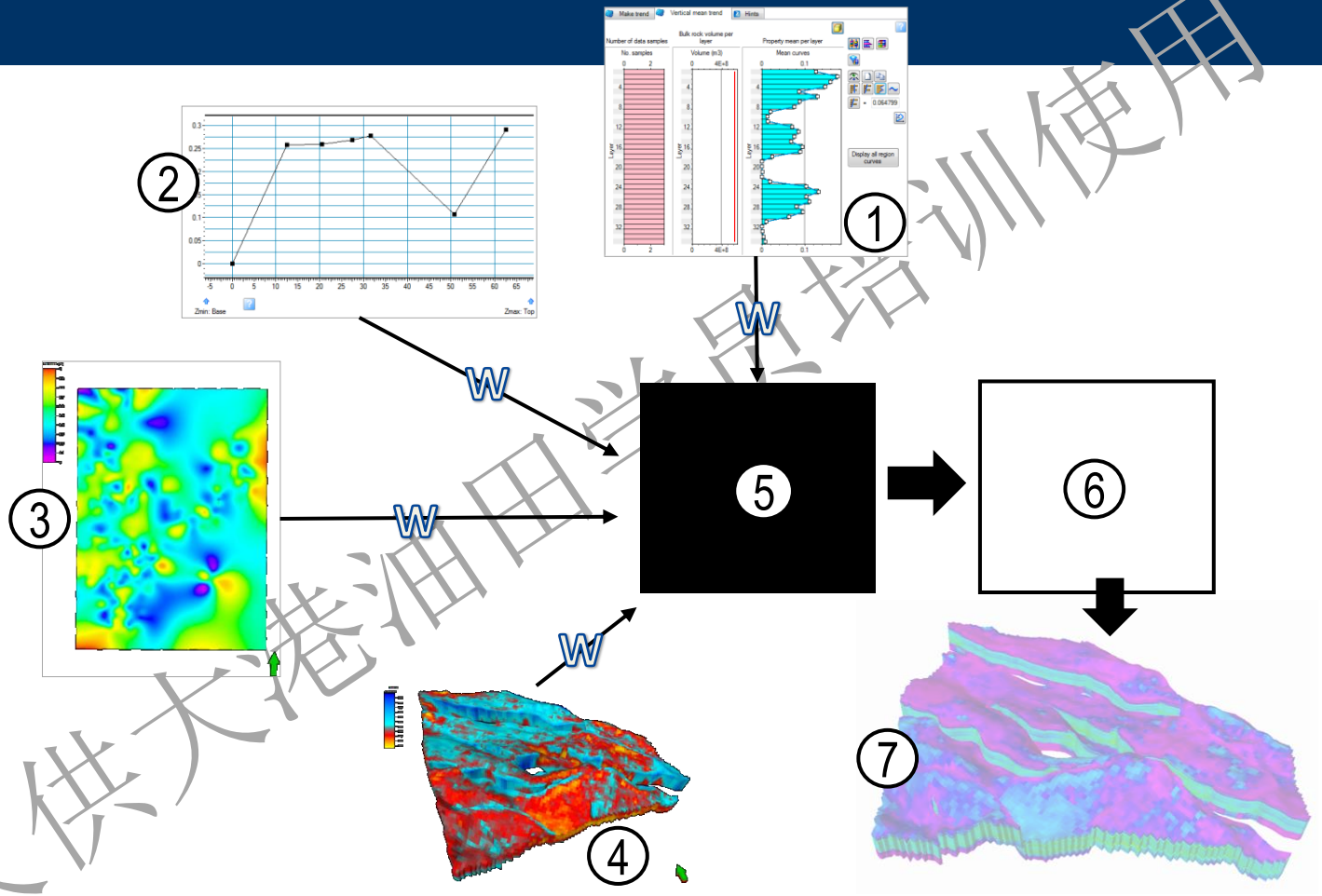
W

Multivariate regression to estimate optimal weights

Linear combination of weighted inputs



3D trend property



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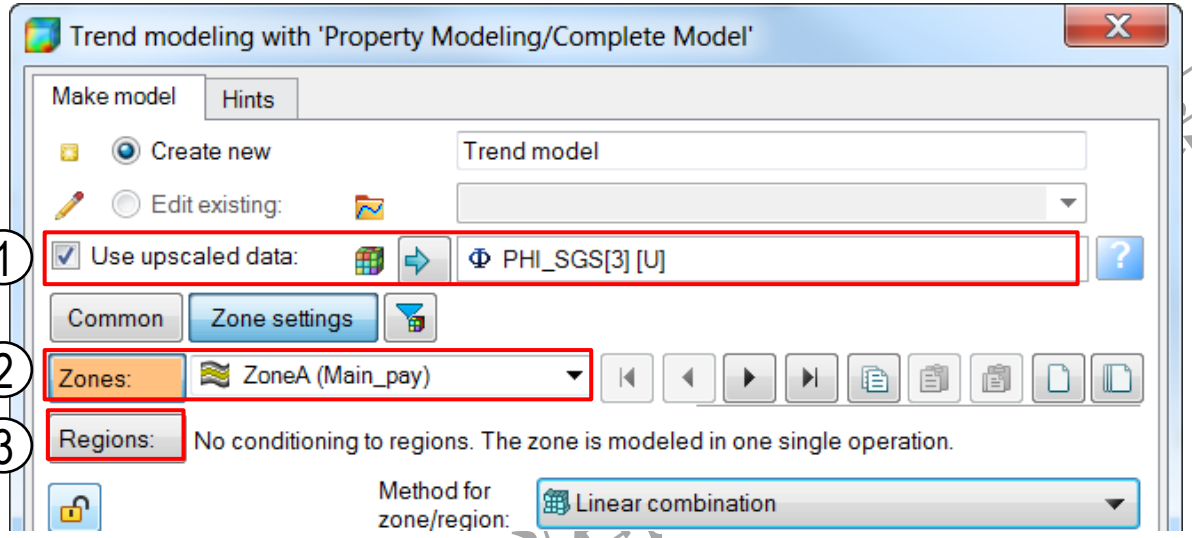
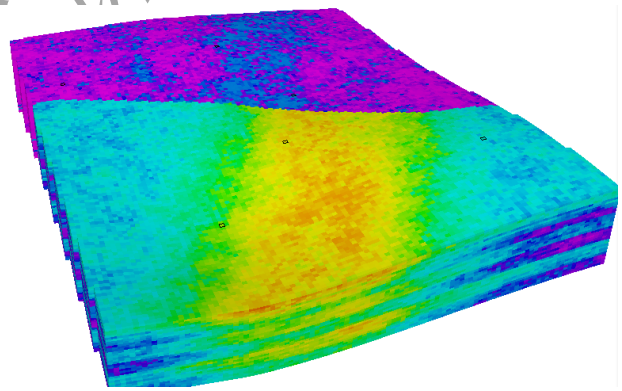
Continuous trend modeling (2)





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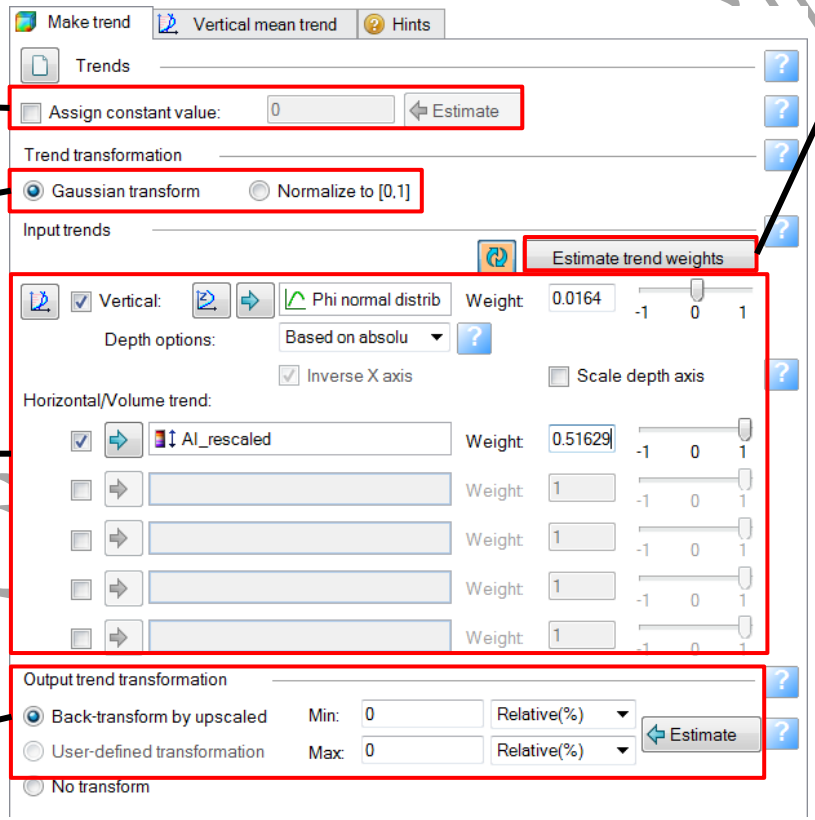
Make trend

Assign constant value section

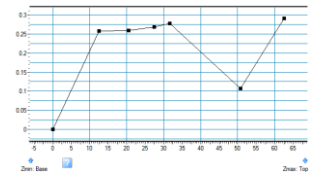
Trend transformation section

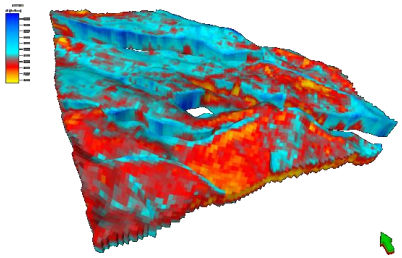
Input trends section

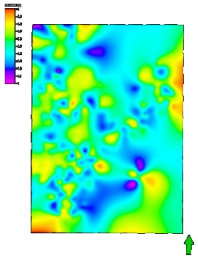
Output trend transformation section



Trend weight







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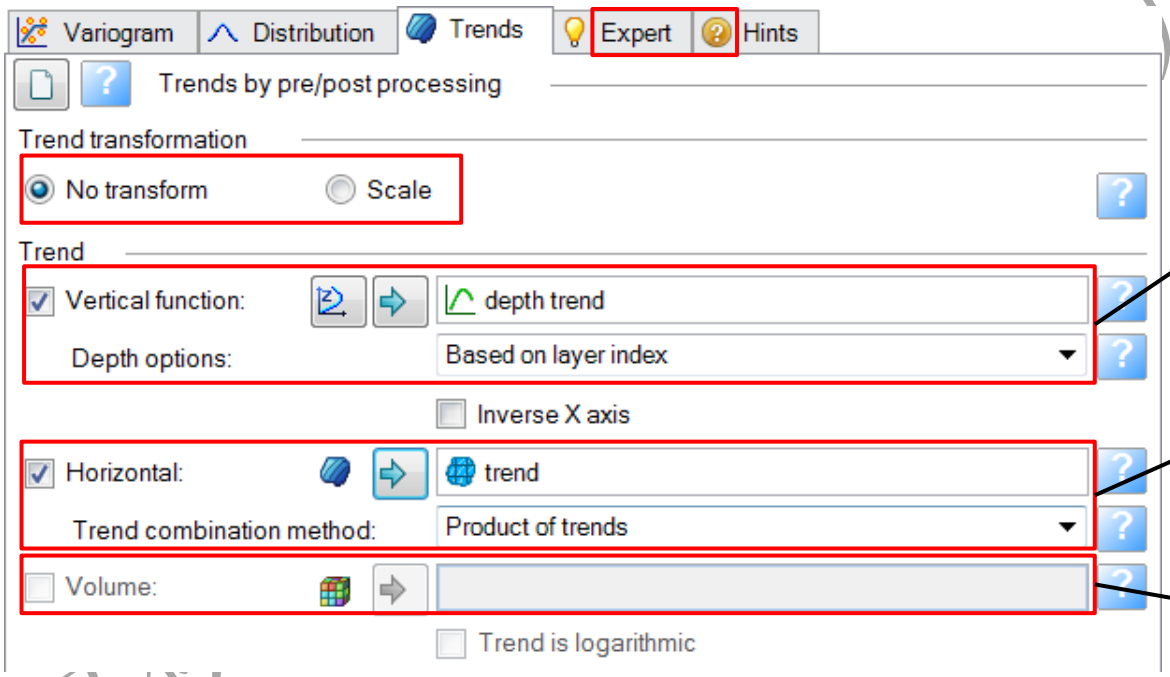
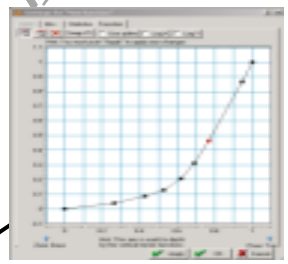
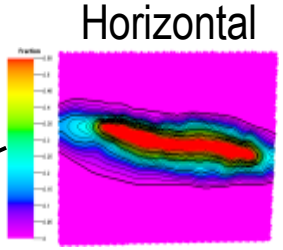
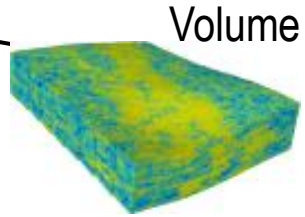
Application of trends









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Exercises

- Create a porosity model with Co-kriging
- Create a permeability model with Co-kriging
- Create a permeability model with trend data
- Create a permeability model with Bivariate distribution