[PS]Assessing Risk and Volume Relationships in Multiple-Segment Exploration Prospects*

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Abstract

Probabilistic assessment of multiple-target exploration prospects should consider three types of geologic relationships between the targets: risk dependency, parameter correlation, and hydrocarbon communication. Definition of these relationships should be a fundamental activity within the geologic evaluation. Failure to evaluate these relationships will result in incorrect assessments of risk and volume.

Targets are also known as zones, reservoirs, segments, or compartments. Targets within an exploration prospect may represent separate stratigraphic intervals, fault blocks, depositional bodies, facies within a depositional body, or traps. Targets are defined by a unique combination of risk and volumetric parameters. They are assessed individually, then aggregated to create the overall prospect assessment. The aggregation must include definition of the geologic relationships between the targets in order to properly assess a prospect's probability of success and success case volume.

Risk dependency defines relationships in the targets' probabilities of success. Targets that share a risk dependency are more likely to succeed together or fail together. Risk dependency impacts both the prospect's overall probability of success and the prospect's success case volume. It is a critical aspect of the geologic evaluation. Evaluations that do not consider risk dependencies will overestimate the prospect's probability of success and underestimate the success case volume.

Parameter correlations define relationships between the targets' volumetric parameters. Targets within the same reservoir interval may have similar net thicknesses and porosities. Targets within the same trap may have similar structural areas and gas-oil-ratios. Parameter correlation impacts the range of the potential success case volumes within the prospect. Failure to consider parameter correlation may contribute to success case P10/P90 ratios for the prospect that are unreasonably narrow.

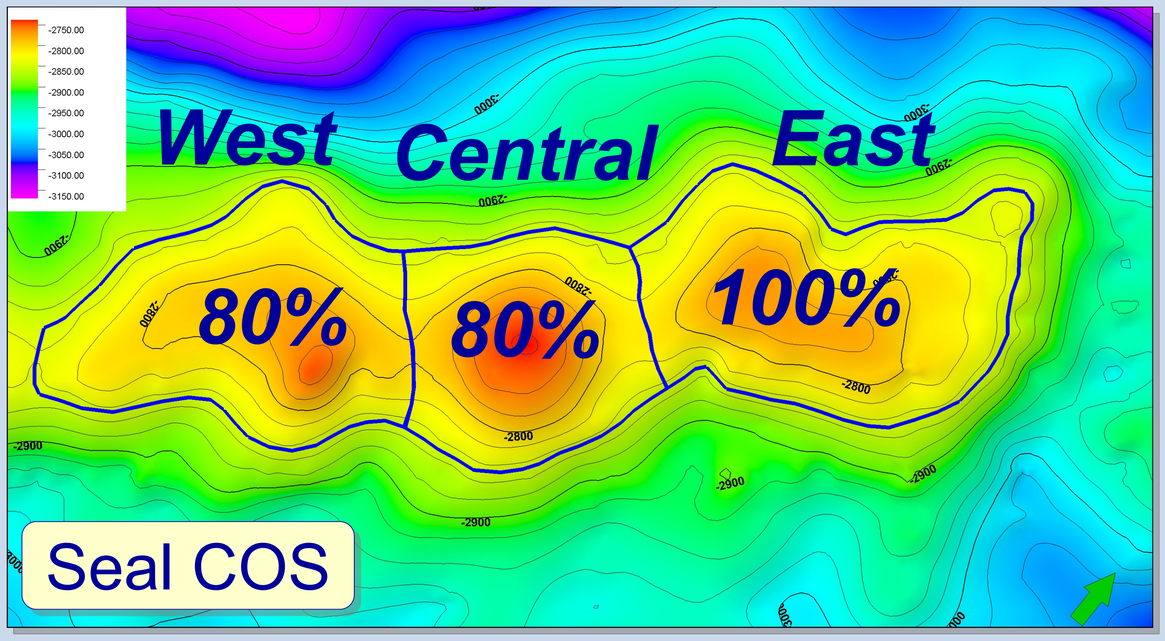
Hydrocarbon communication refers to spilling or leaking of hydrocarbons between targets in geologic time, as opposed to during production. Communication may result in shared hydrocarbon-water contacts, or migration of hydrocarbons between segments. The assumption that each target will fill individually, and will have a unique hydrocarbon-water contact, usually results in overestimation of prospect volumes.

Assessing Risk and Volume Relationships in Multiple-Segment Exploration Prospects

Darrel Norman, GeoKnowledge

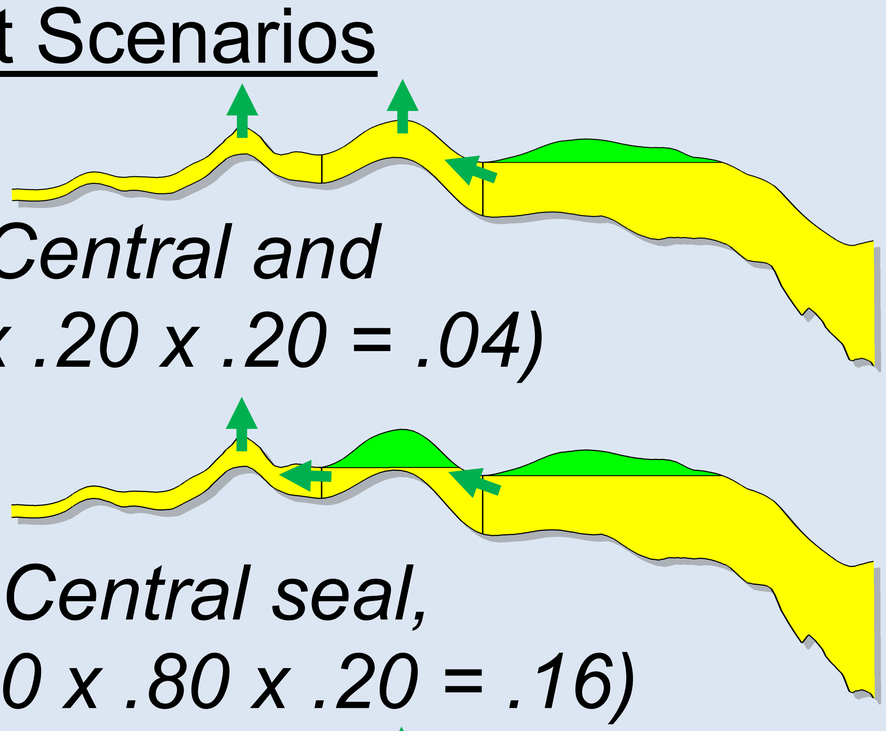
- HC communication (pre-production) between segments
- Dependencies between segment risk factors
- Volume parameter correlations between segments

HC Communication



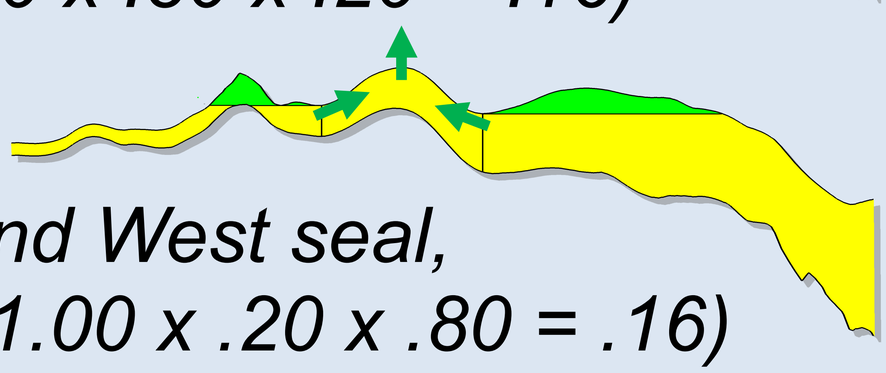
- Contact uncertainty may be a function of seal risks and the depths of communication points
- Connected segments should always be assessed together

Seal and Contact Scenarios

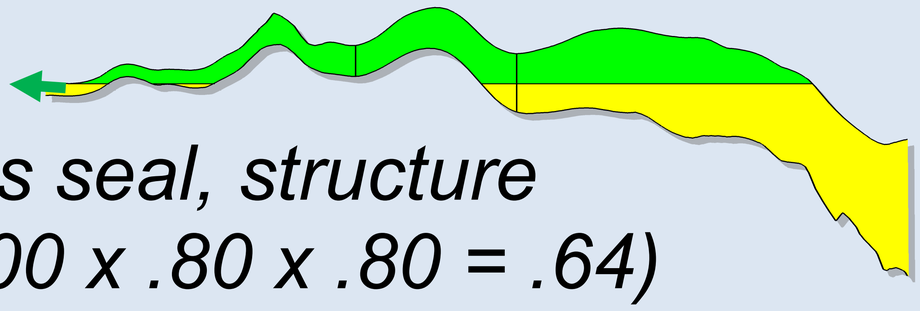


East seals, Central and West leak (1.00 x .20 x .20 = .04)

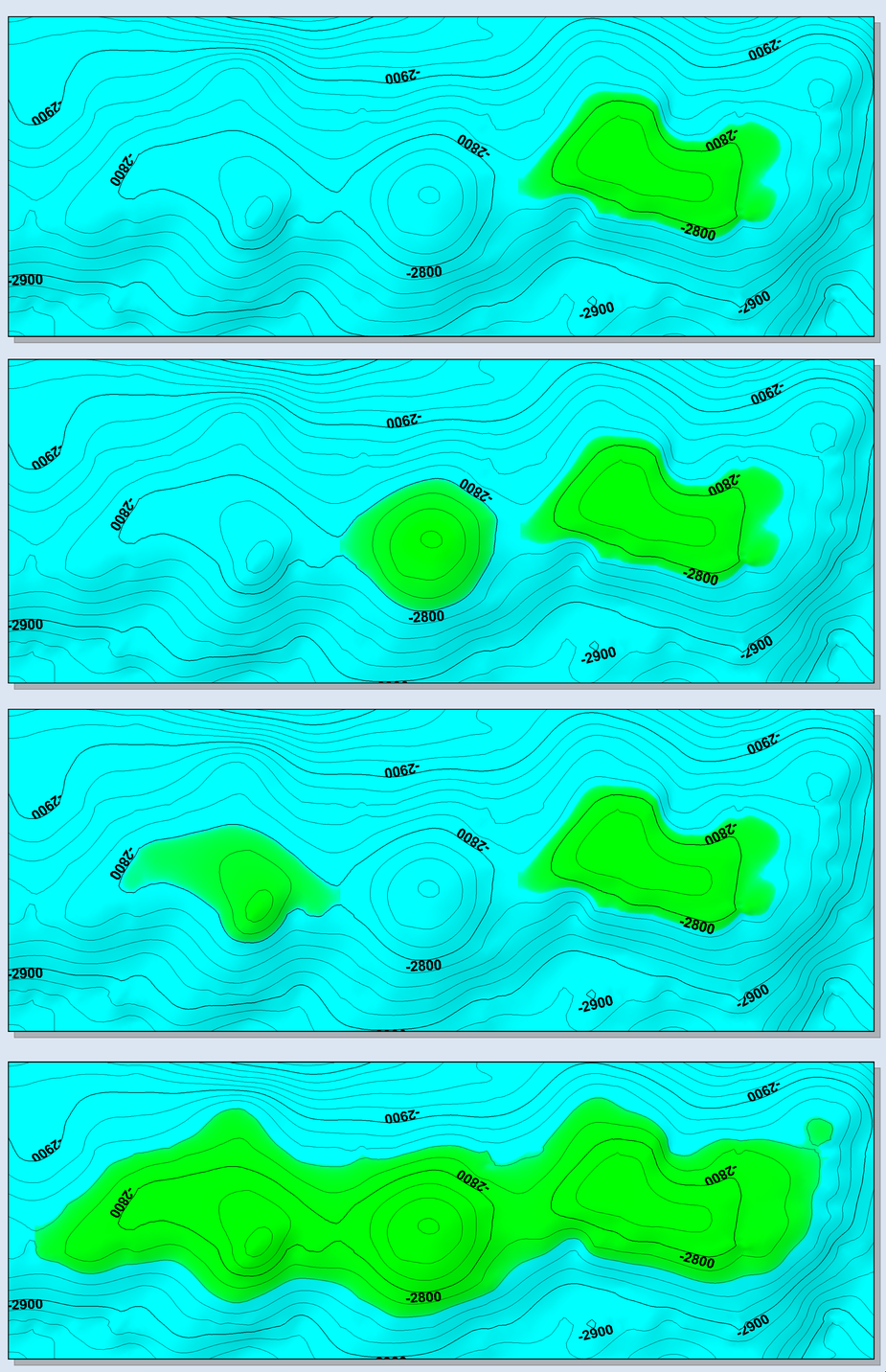
East and Central seal, West leaks (1.00 x .80 x .20 = .16)



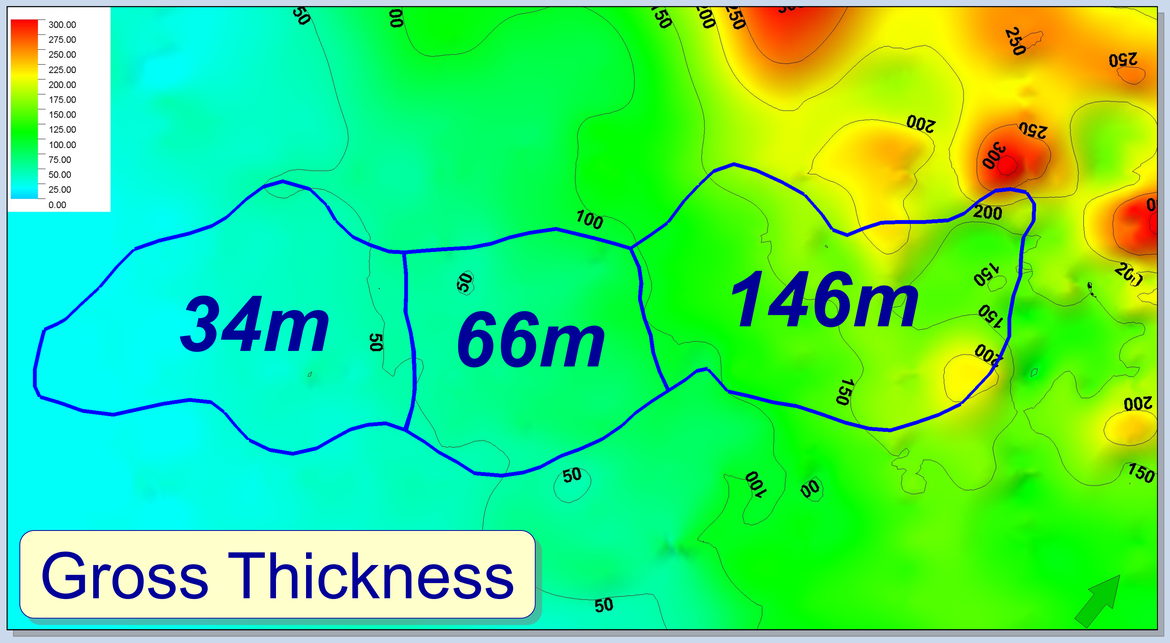
East and West seal, Central leaks (1.00 x .20 x .80 = .16)

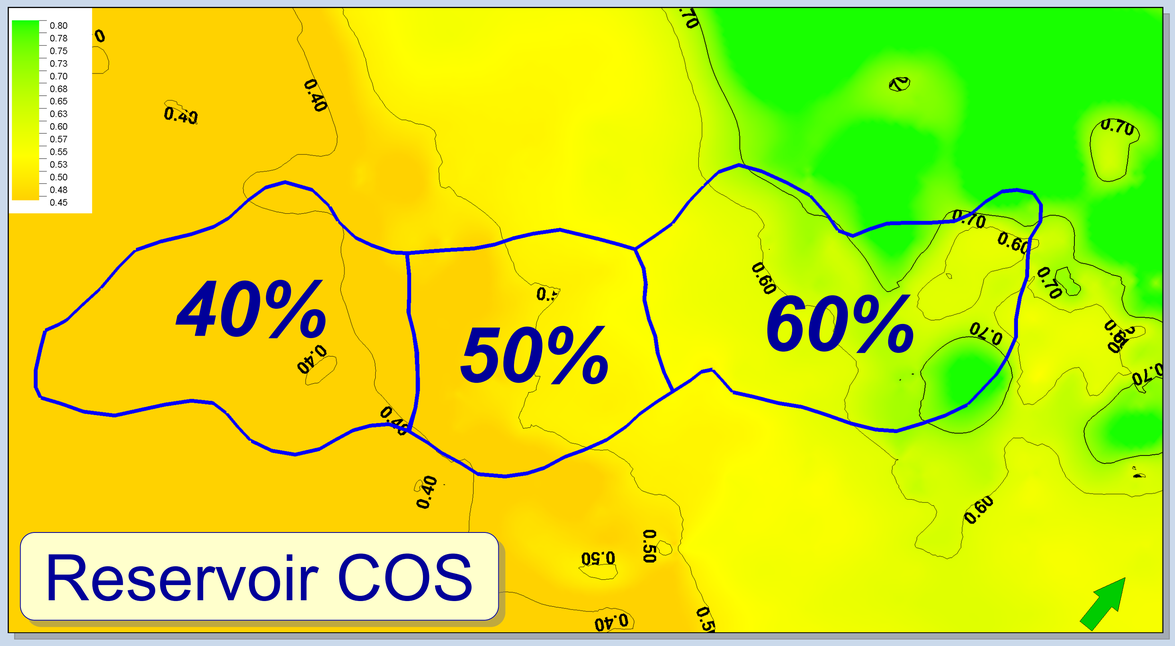


All segments seal, structure filled to spill (1.00 x .80 x .80 = .64)



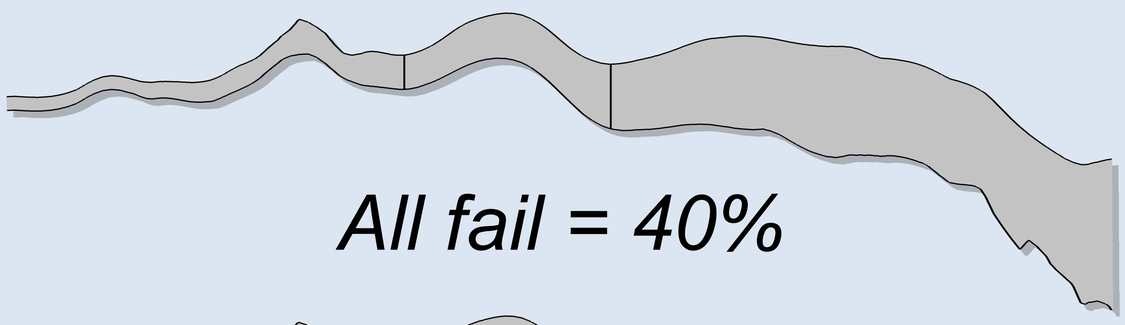
Reservoir Risk Dependency





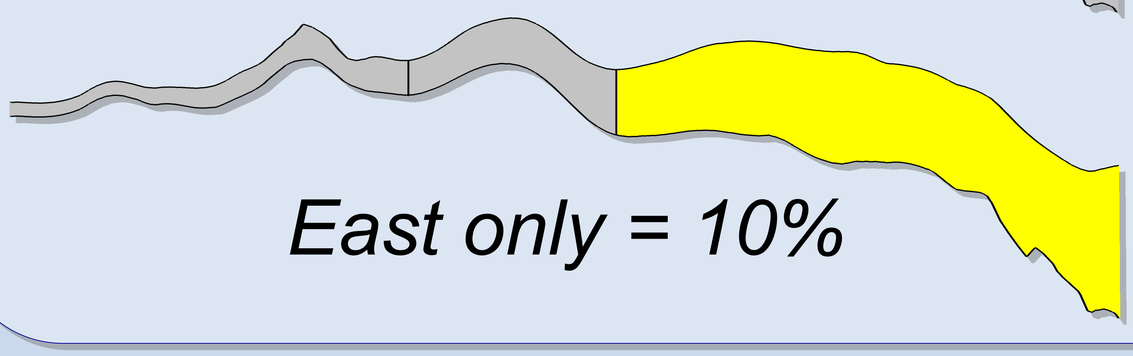
Section thins to the west and chance of adequate reservoir decreases

Reservoir Scenarios

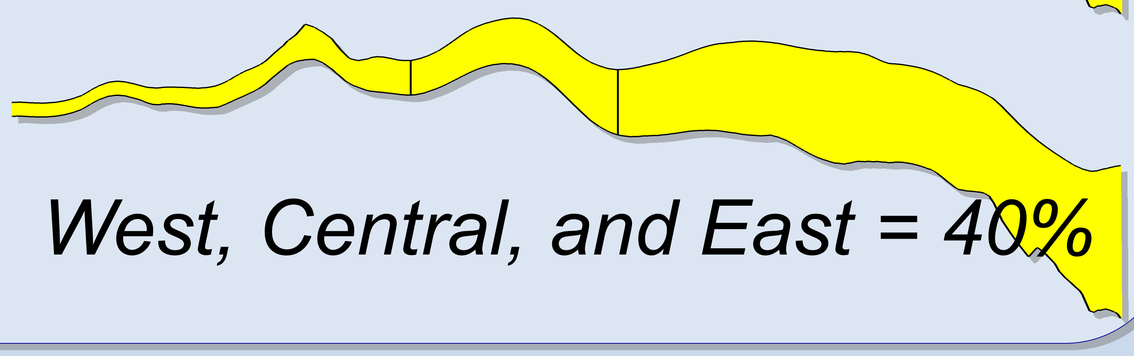


All fail = 40%

Central and East = 10%

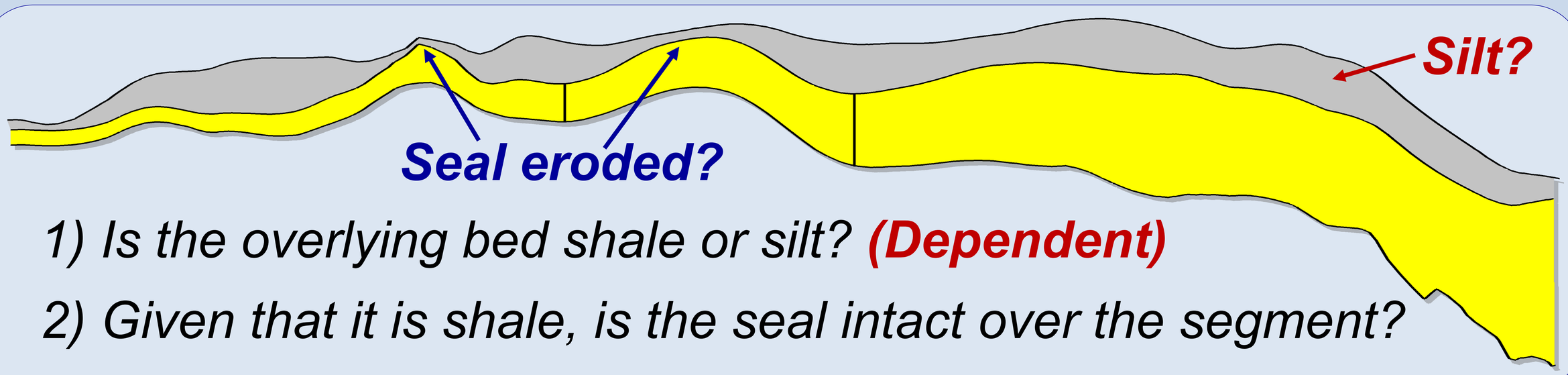


East only = 10%



West, Central, and East = 40%

Seal Risk Dependency



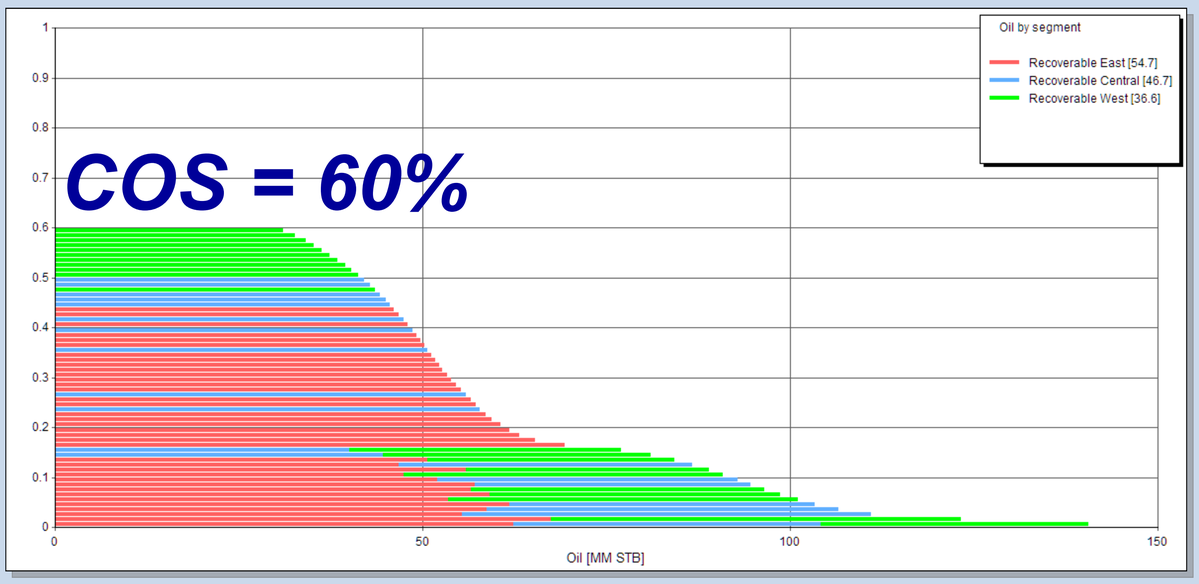
1) Is the overlying bed shale or silt? ***(Dependent)***

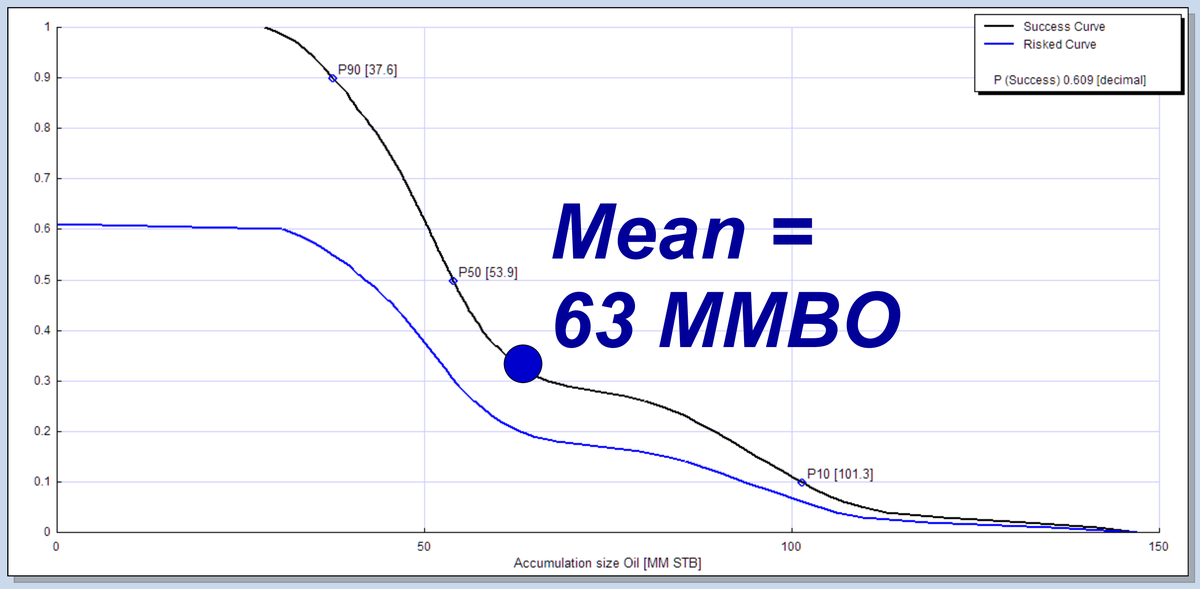
2) Given that it is shale, is the seal intact over the segment?

Segment	P(shale)	P(seal|shale)	P(seal)
East	**.60** *If bed is not shale, all segments fail*	1.00	.60
Central		.80	.48
West		.80	.48

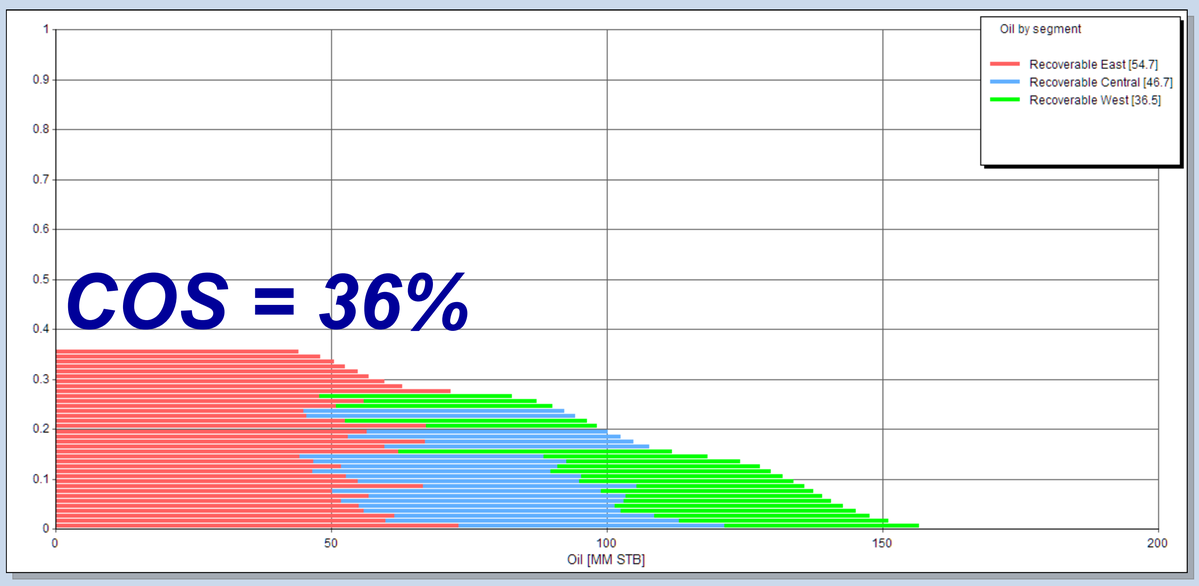
Impact of Risk Dependency

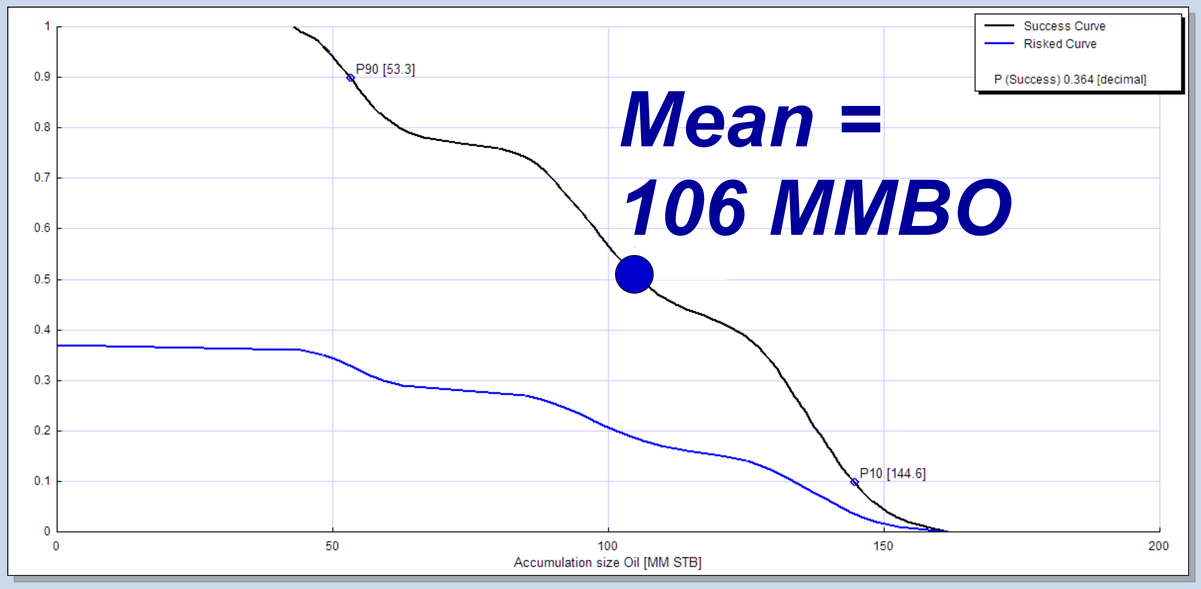
Target	P(reservoir)	P(seal)	COS	Mean
East	.60	.60	.36	55 MMBO
Central	.50	.48	.24	47 MMBO
West	.40	.48	.19	37 MMBO





No risk dependency:
Prospect COS = 60%, Success Mean = 63 MMBO

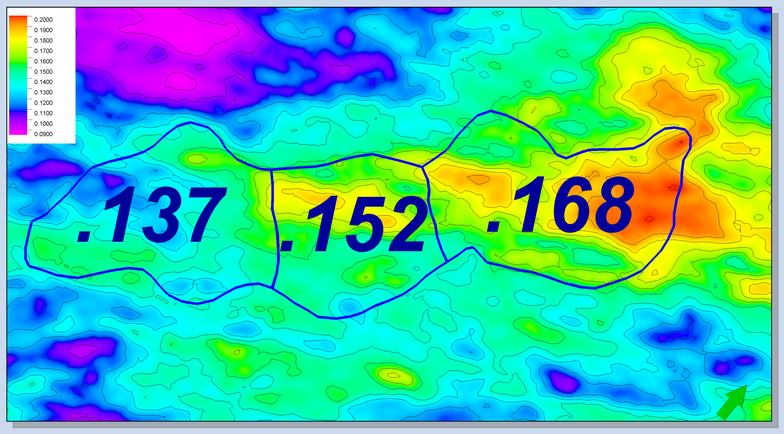




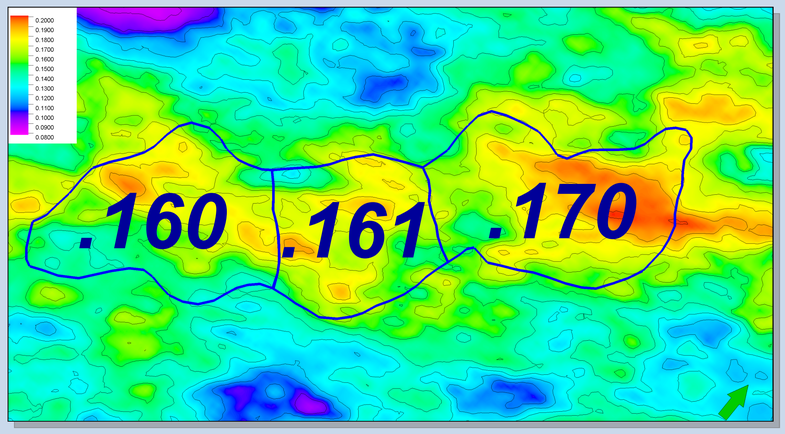
Reservoir and seal risk dependency:
Prospect COS = 36%, Success Mean = 106 MMBO

- Risk dependency decreases the prospect chance of success and increases the prospect success case mean
- Dependency is required to create a probabilistic model that honors the relationships defined by the geologic evaluation
- Dependency may have a major impact on the economic value

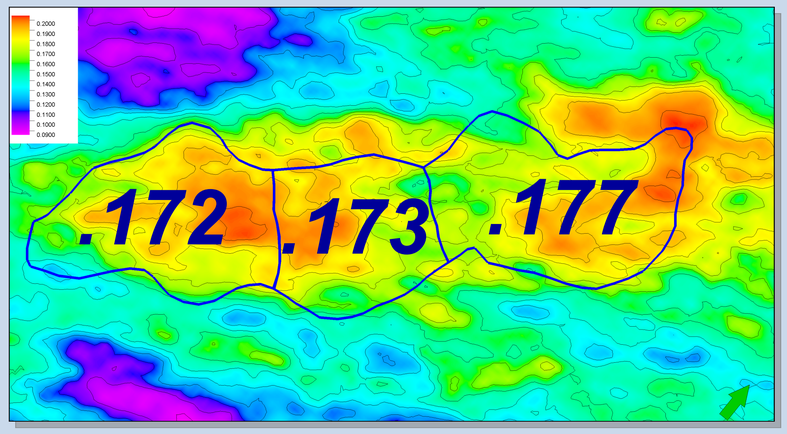
Volume Parameter Correlations



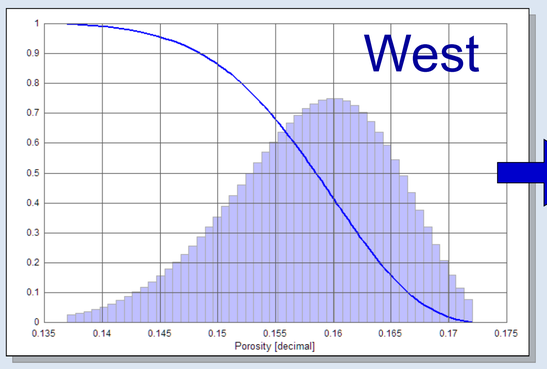
MIN Porosity

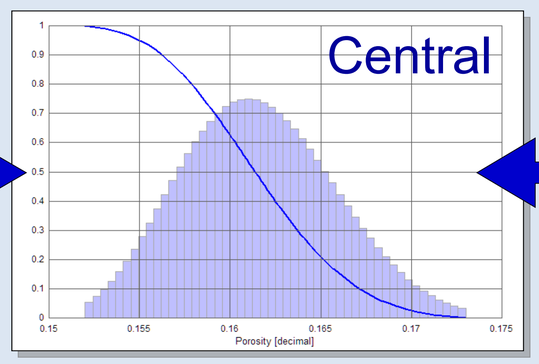


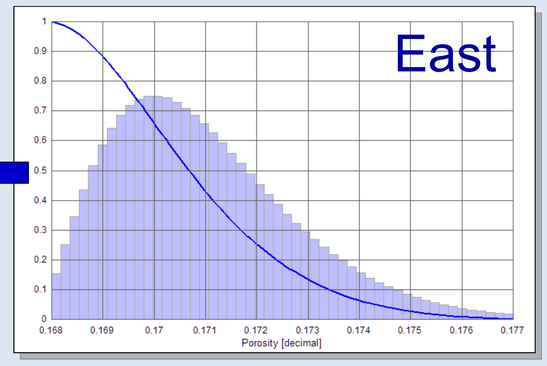
ML Porosity

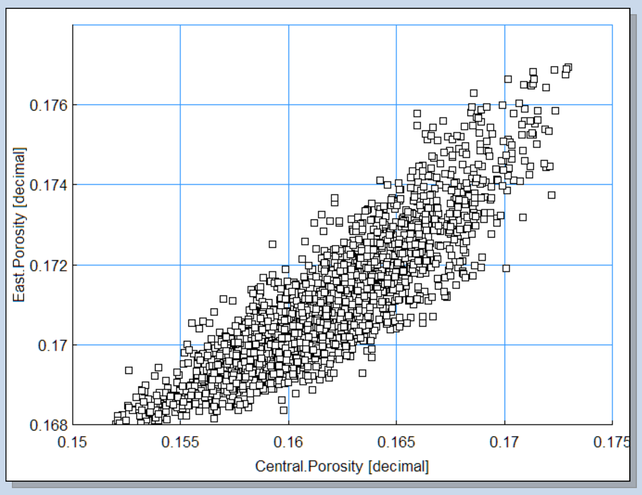


MAX Porosity

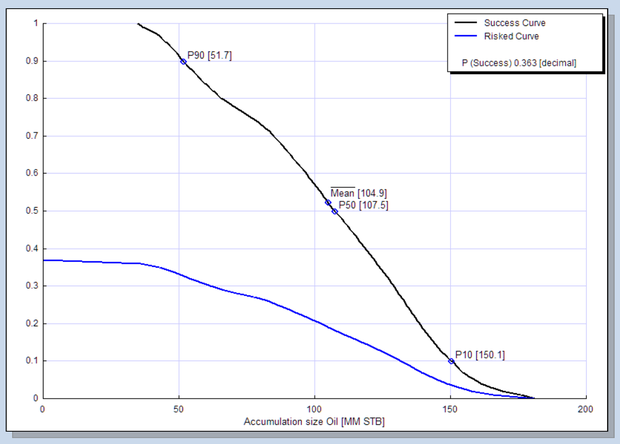


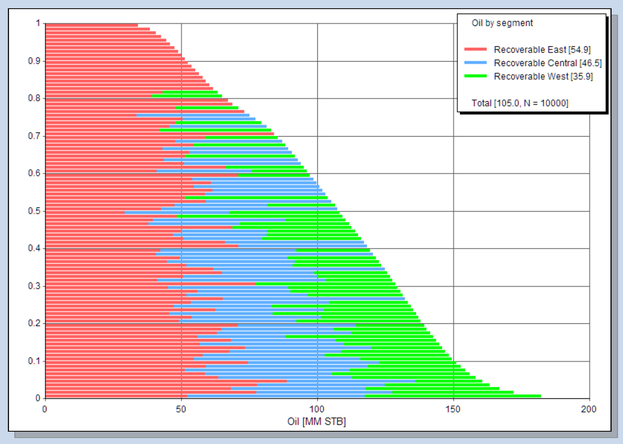


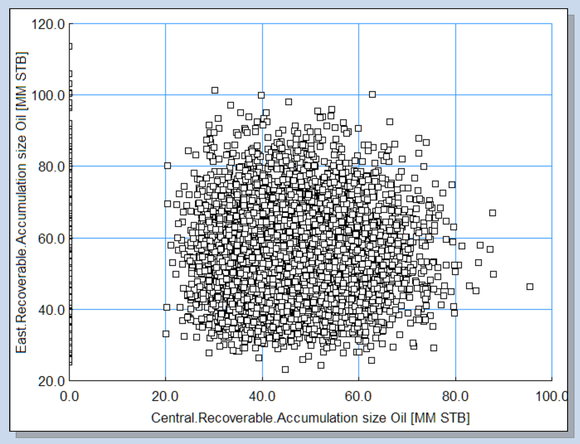


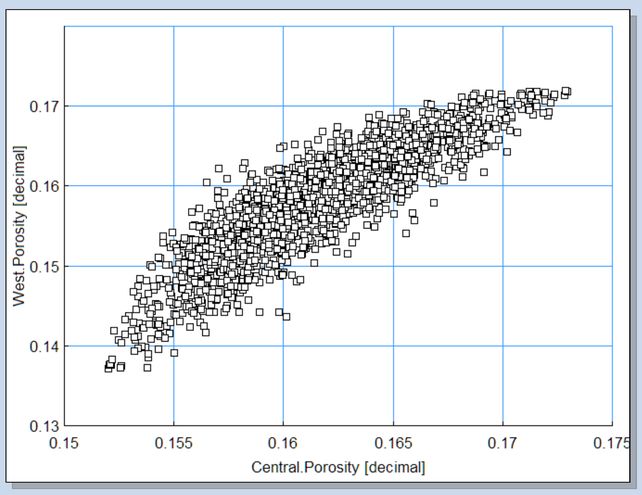


Porosity correlations: West dependent on Central (high), East dependent on Central (high)

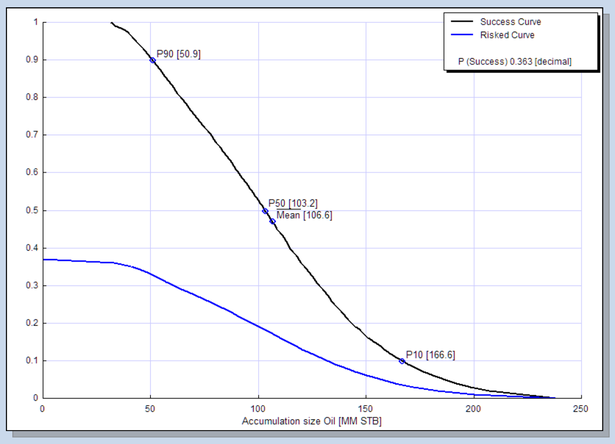


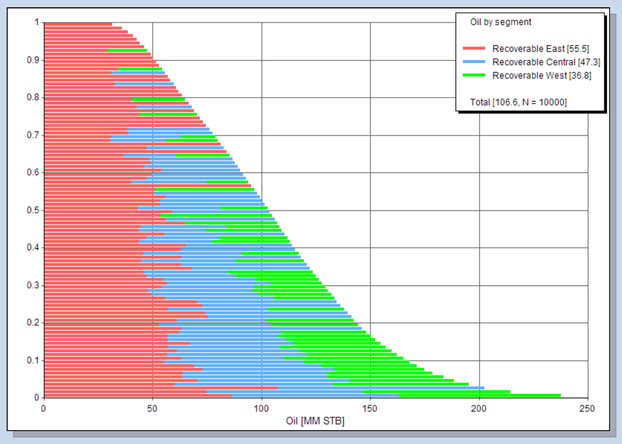


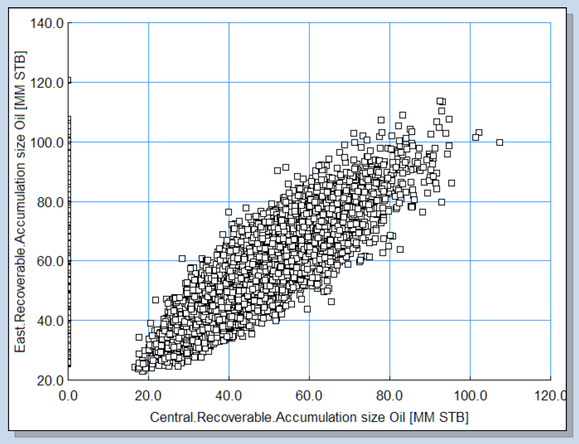


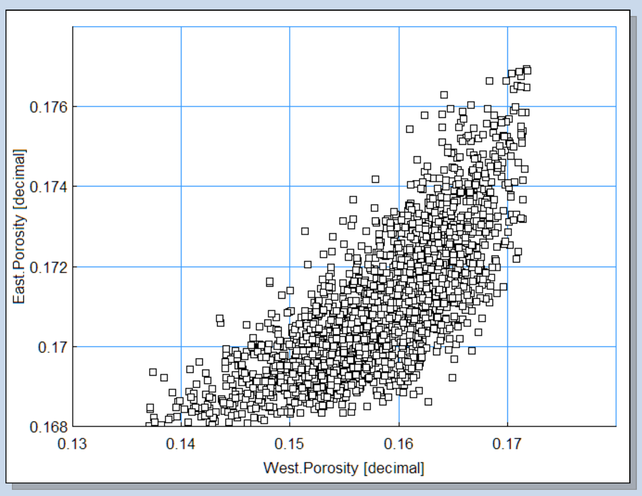


Without correlations









Reservoir and fluids parameters correlated

Implied correlation

- Correlations capture relationships between segment volumes
- Common correlations: thickness, NG, porosity, FVF, RF, S_{hc}
- Correlations increase the P10/P90 ratio, but the difference in the assessment result is often insignificant compared to the impact of segment risk and risk dependency between segments