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Simplifying Complex Coal Modeling

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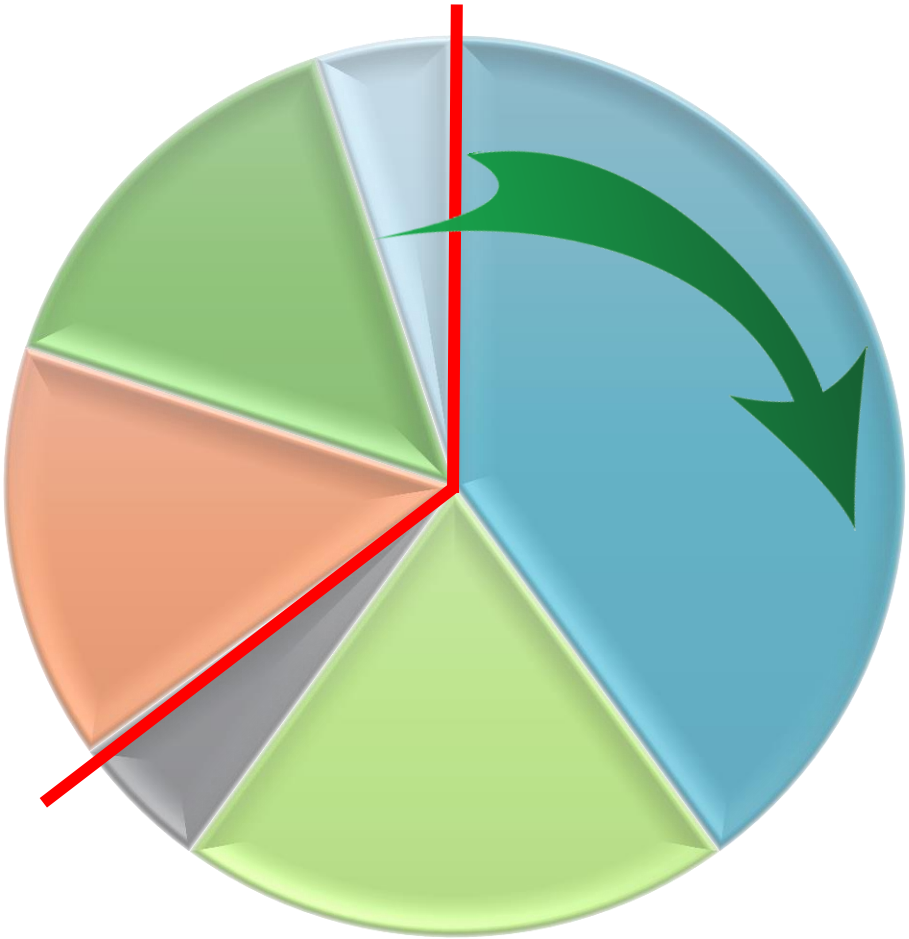
AGENDA

1) A model timeframe
2) One model fits all?
3) Get your ducks in a row!

   Special note: Quality & True Thickness
4) Embracing new technologies
5) Coal modeling: a game plan
6) Hexagon Mining

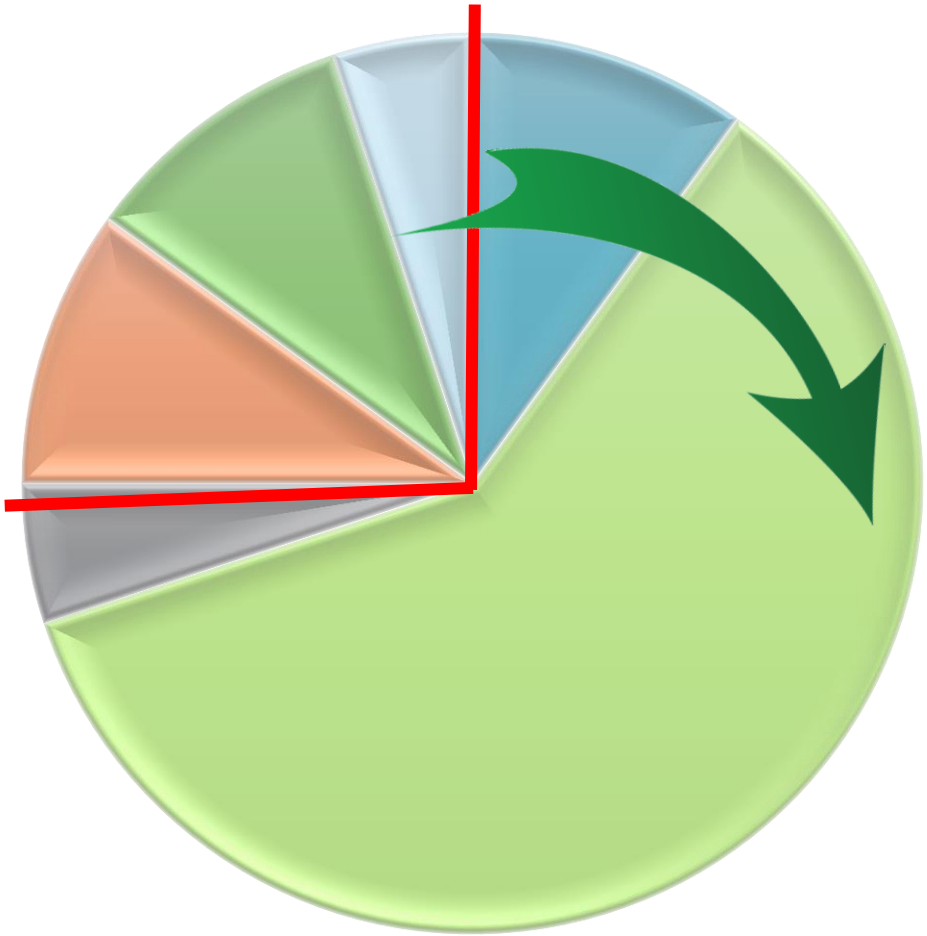
A model timeframe

How long does it takes to **create** a model?



- Drillhole Management and Validation
- Interpretation
- Seam FW Validation
- True Thickness Calculations
- Model Build
- Model Check
- Resources/Reserves Reporting

How long does it takes to **update** a model?



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One model fits all?

Geologic Model versus a Block Model

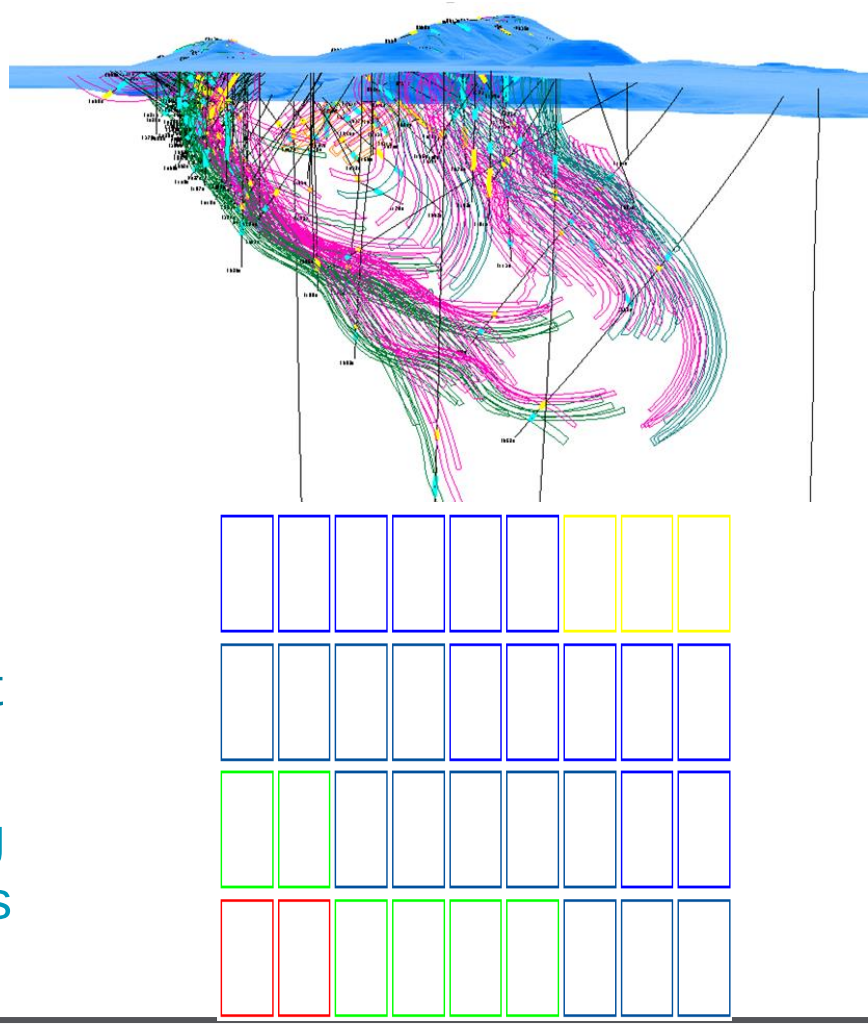
Geologic Model

Numerical equivalent of a three-dimensional geological map

Block Model

Organized numerical representation of physical quantities of a domain of interest

aka: your best guess of what's happening in the ground, between known data points



Why are you building a model?

- Exploration
- Pre-Feasibility
- Feasibility

Why are you building a model?

- Exploration
- Pre-Feasibility
- Feasibility

- Writing a 43-101
- Infill drilling campaign
- Life of Mine Planning
- Short Term Planning
- Producing Mine
- Extend the life of your mine

Why are you building a model?

	Pre-Feas/Feas	LTP	STP
Coal Pit Volume/Tonnes	✓	✓	
Seam location		✓	✓
Quality	✓	✓	✓
Block Classification	✓	✓	
Waste Tracking	✓	✓	✓

Get your ducks in a row

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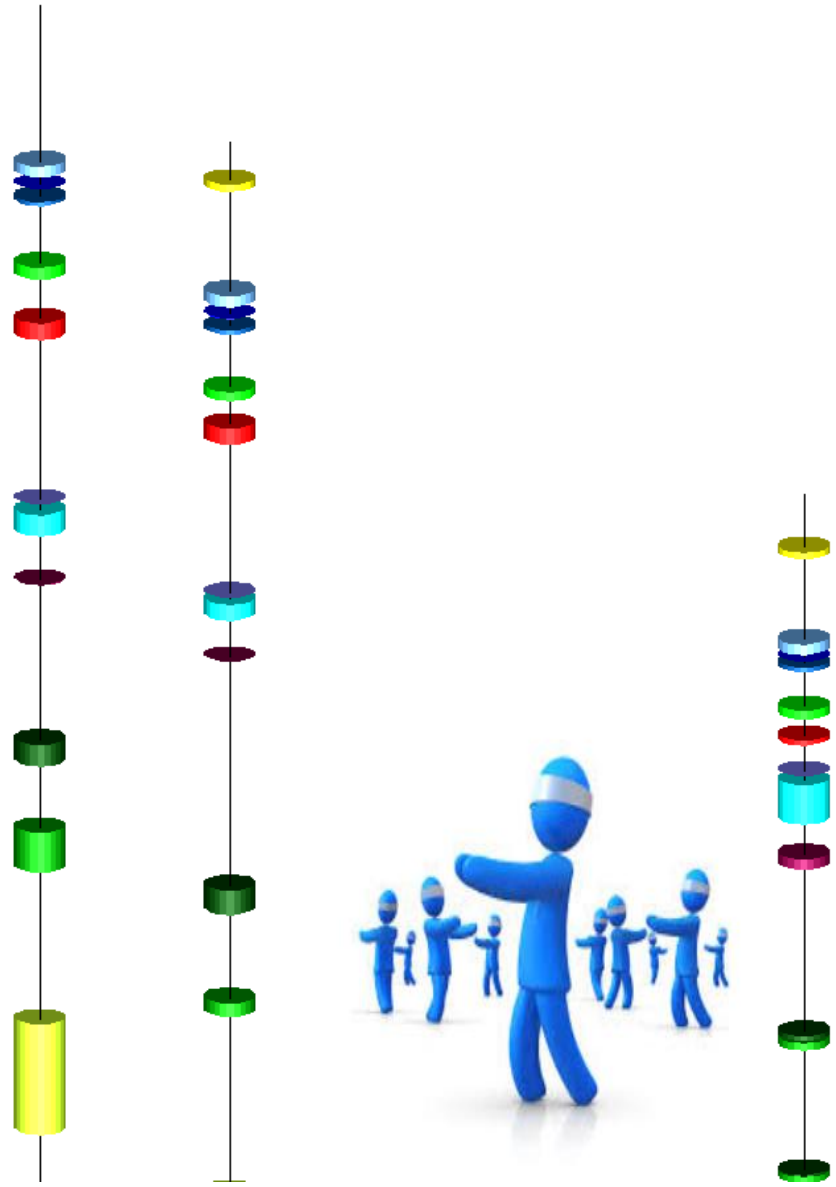
Essentials

3

Collar Survey
Downhole Survey
Seam Picks

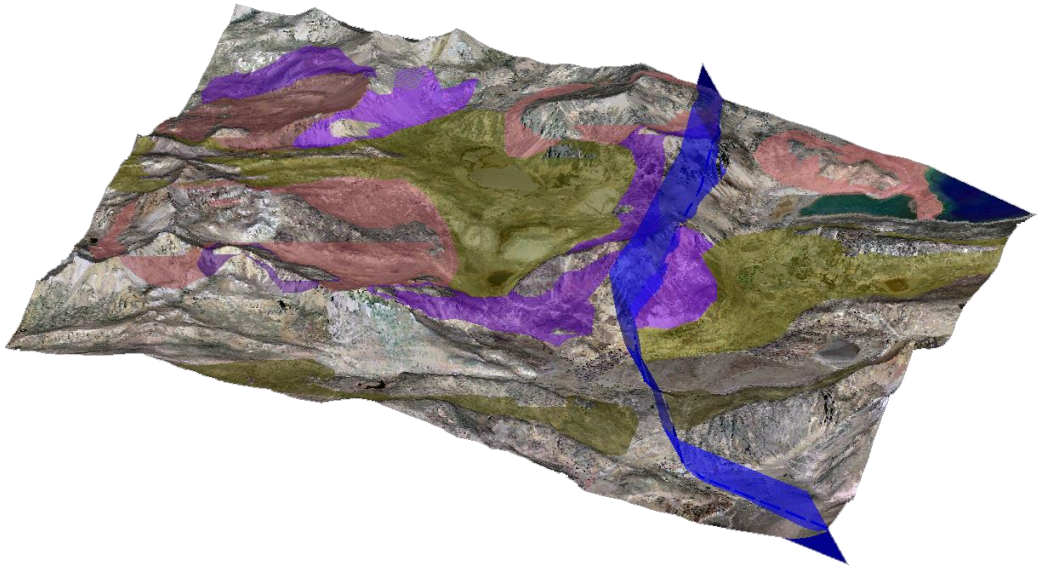
Lithology (Coal, Waste & Overburden)

Topographic Surface



Consider these

Surface maps
Aerial photos
Lease boundaries
Pit Mapping
Mined Out Surface



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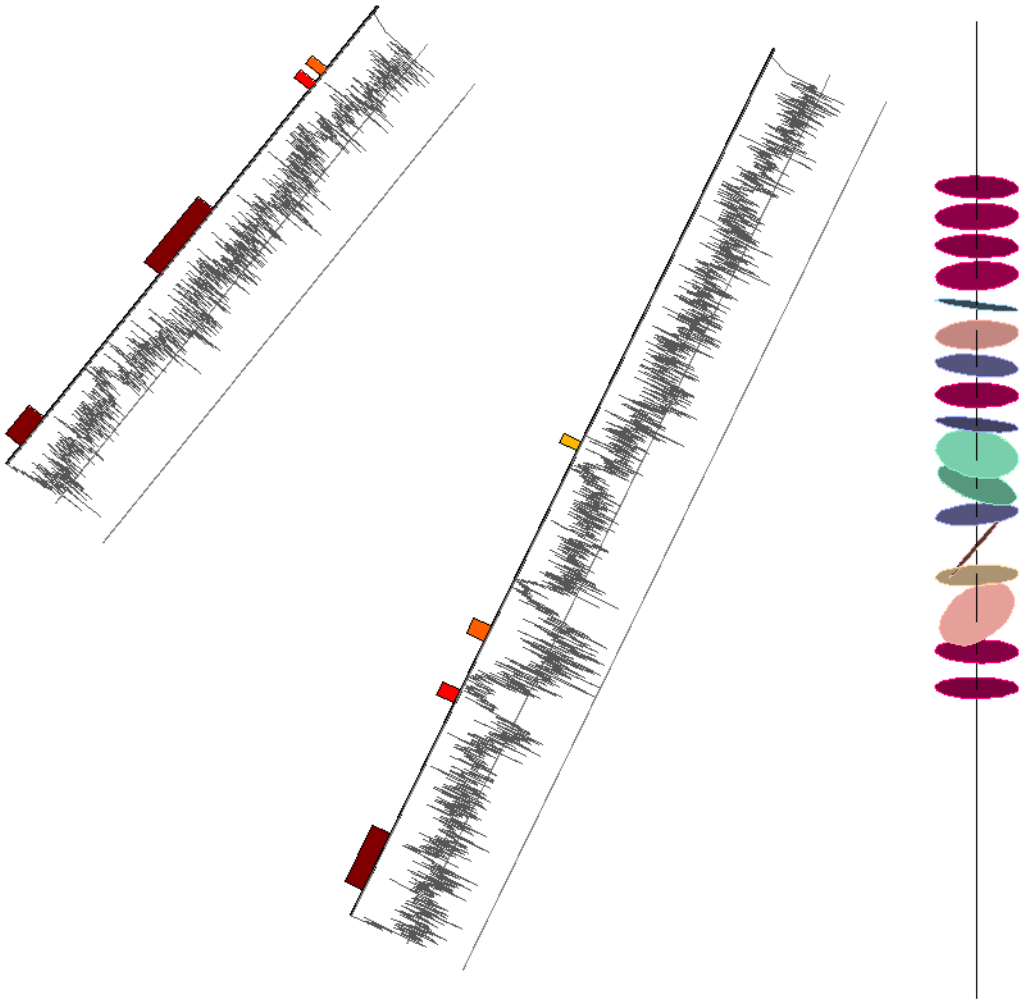
Gamma Logs

Dip Meters

Marker Horizon

Qualities



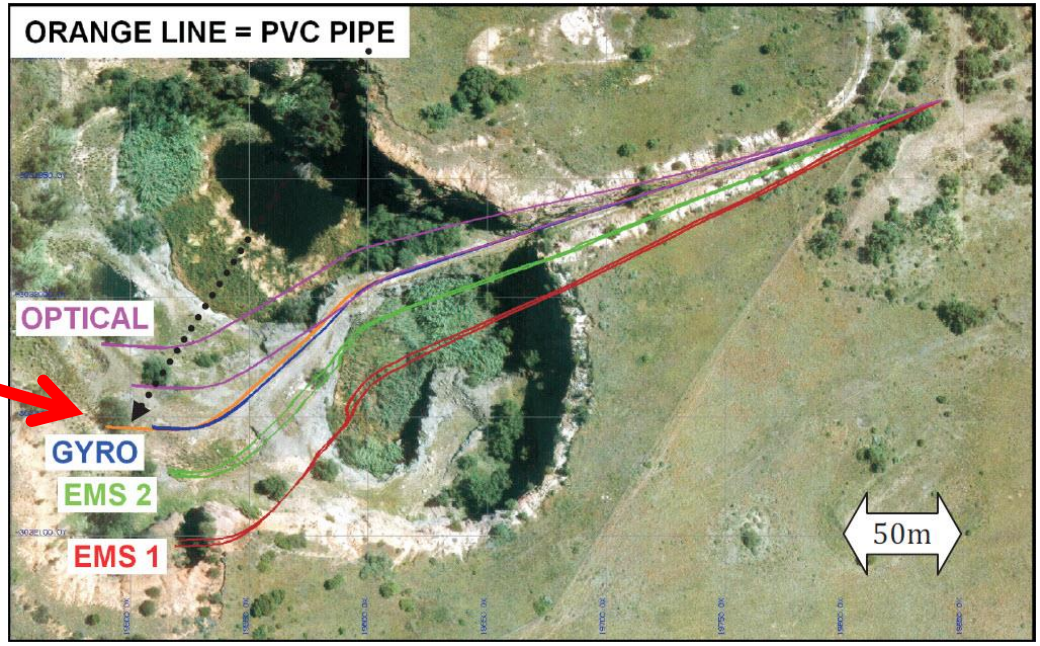
Consider these

Surface Maps
Aerial Photos
Lease Boundaries
Pit Mapping
Mined Out Surface
Gamma Logs
Dip Meters
Marker Horizon
Qualities
History of the project
Field Geologist input

Drill holes Validation

1. Downhole surveys
2. Spreadsheets
3. Missing Seams
4. True Thicknesses
5. Qualities

Drill holes Validation - survey



- THE EFFECT OF DOWNHOLE SURVEY UNCERTAINTY ON MODELLED VOLUME - **W Nordin1**
  - Seventh International Mining Geology Conference Perth, WA, 17 - 19 August 2009

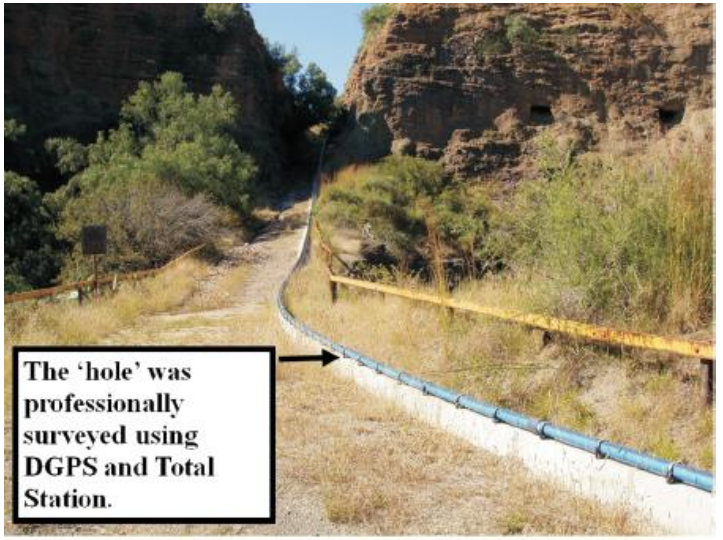
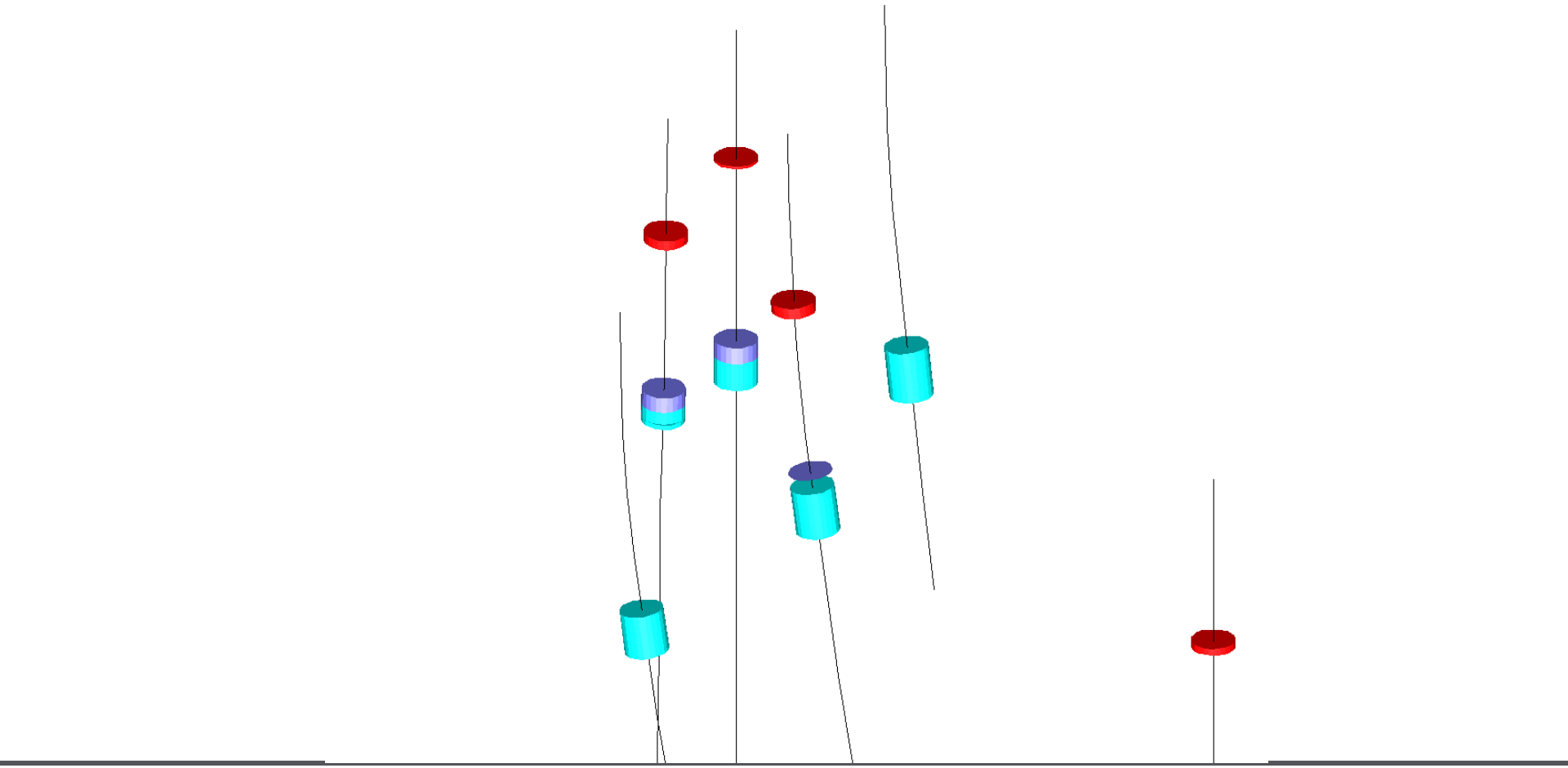


FIG 1 - Artificial 'borehole' clamped onto concrete blocks.

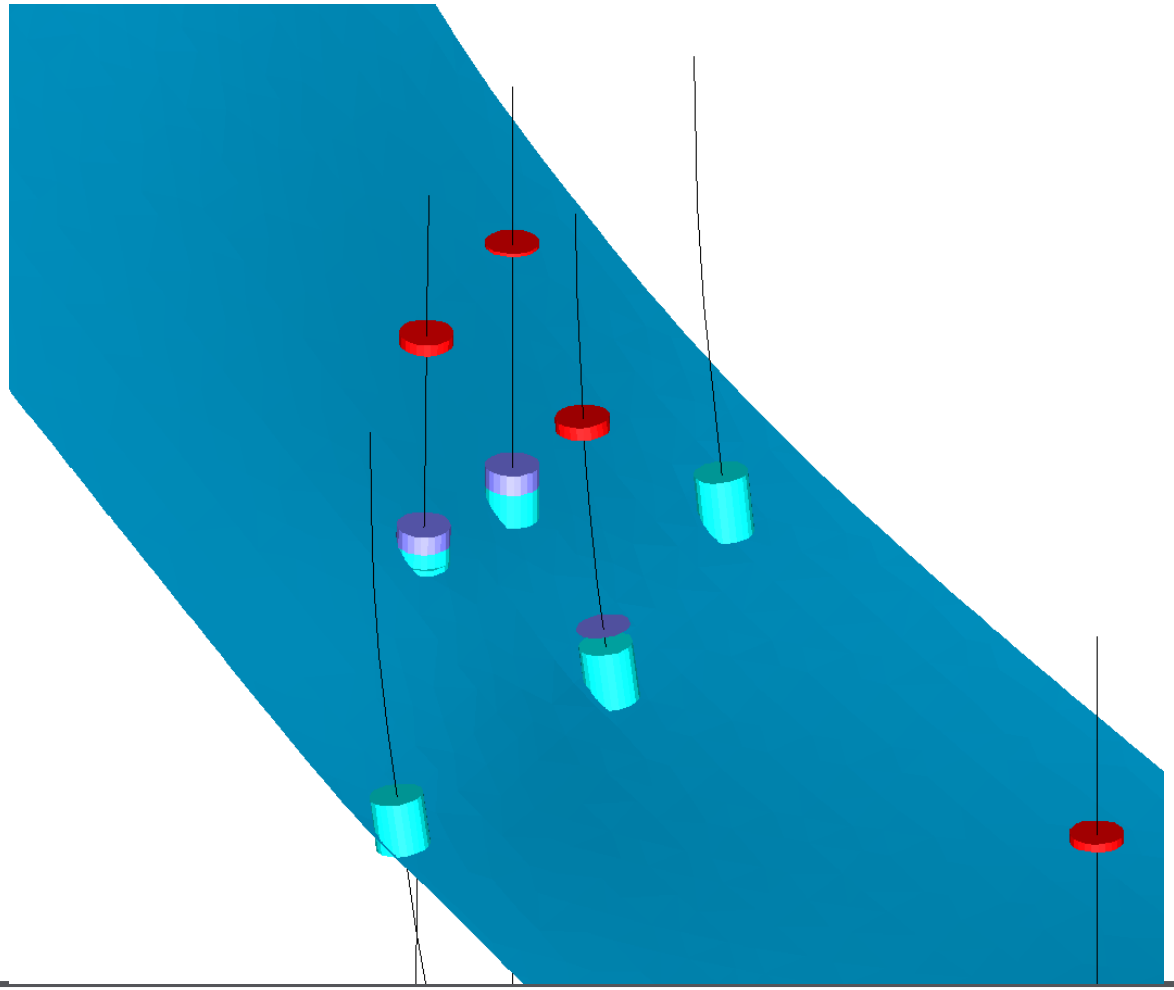
Drill holes Validation – 88% of spreadsheets have errors!

[Alpha SEAM]== "A" :	7	[Alpha SEAM]== "4" :	33	[Alpha SEAM]== "2UP" :	11
[Alpha SEAM]== "A1" :	7	[Alpha SEAM]== "4R" :	33	[Alpha SEAM]== "2P" :	13
[Alpha SEAM]== "A2" :	7	[Alpha SEAM]== "4R2" :	33	[Alpha SEAM]== "2LP" :	15
[Alpha SEAM]== "1U" :	8	[Alpha SEAM]== "4R1" :	33	[Alpha SEAM]== "3UP" :	21
[Alpha SEAM]== "1L" :	9	[Alpha SEAM]== "4L" :	37	[Alpha SEAM]== "3UBP" :	21
[Alpha SEAM]== "1" :	9	[Alpha SEAM]== "4L2" :	37	[Alpha SEAM]== "3P" :	21
[Alpha SEAM]== "2U" :	11	[Alpha SEAM]== "4L1" :	37	[Alpha SEAM]== "3B1P" :	21
[Alpha SEAM]== "2" :	13	[Alpha SEAM]== "5" :	39	[Alpha SEAM]== "3UAP" :	23
[Alpha SEAM]== "2L" :	15	[Alpha SEAM]== "R5" :	39	[Alpha SEAM]== "3A1P" :	23
[Alpha SEAM]== "2L1" :	15	[Alpha SEAM]== "5M" :	39	[Alpha SEAM]== "3AP" :	23
[Alpha SEAM]== "2L2" :	15	[Alpha SEAM]== "6" :	43	[Alpha SEAM]== "3P" :	23
[Alpha SEAM]== "3UB" :	21	[Alpha SEAM]== "7L" :	59	[Alpha SEAM]== "3L1P" :	27
[Alpha SEAM]== "3B2" :	21	[Alpha SEAM]== "8M" :	61	[Alpha SEAM]== "3LAP" :	29
[Alpha SEAM]== "3B1" :	21	[Alpha SEAM]== "8" :	65	[Alpha SEAM]== "4UP" :	31
[Alpha SEAM]== "3UA" :	23	[Alpha SEAM]== "9" :	73	[Alpha SEAM]== "4P" :	33
[Alpha SEAM]== "3A1" :	23	[Alpha SEAM]== "10B" :	81	[Alpha SEAM]== "4RP" :	33
[Alpha SEAM]== "3A2" :	23	[Alpha SEAM]== "10R" :	83	[Alpha SEAM]== "4LP" :	37
[Alpha SEAM]== "3L2" :	25	[Alpha SEAM]== "10A" :	85	[Alpha SEAM]== "5P" :	39
[Alpha SEAM]== "3L1" :	27	[Alpha SEAM]== "AP" :	7	[Alpha SEAM]== "8P" :	65
[Alpha SEAM]== "3LA" :	29	[Alpha SEAM]== "A1P" :	7	[Alpha SEAM]== "10RP" :	83
[Alpha SEAM]== "4U" :	31	[Alpha SEAM]== "1LP" :	9	[Alpha SEAM]== "4U1" :	31
[Alpha SEAM]== "4U2" :	31	[Alpha SEAM]== "1P" :	9	[Alpha SEAM]== "4LP1" :	37

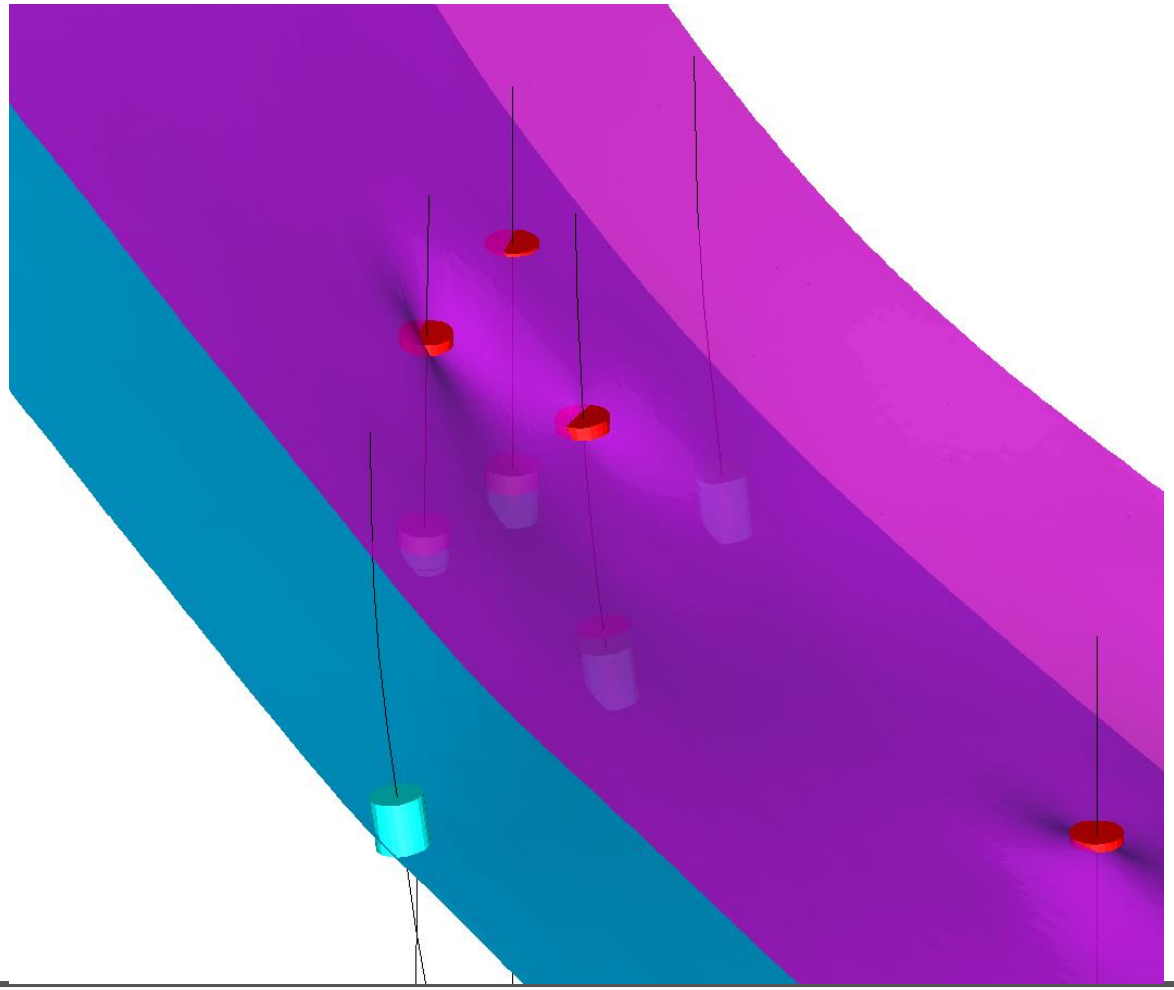
Drill holes Validation – Missing Seams



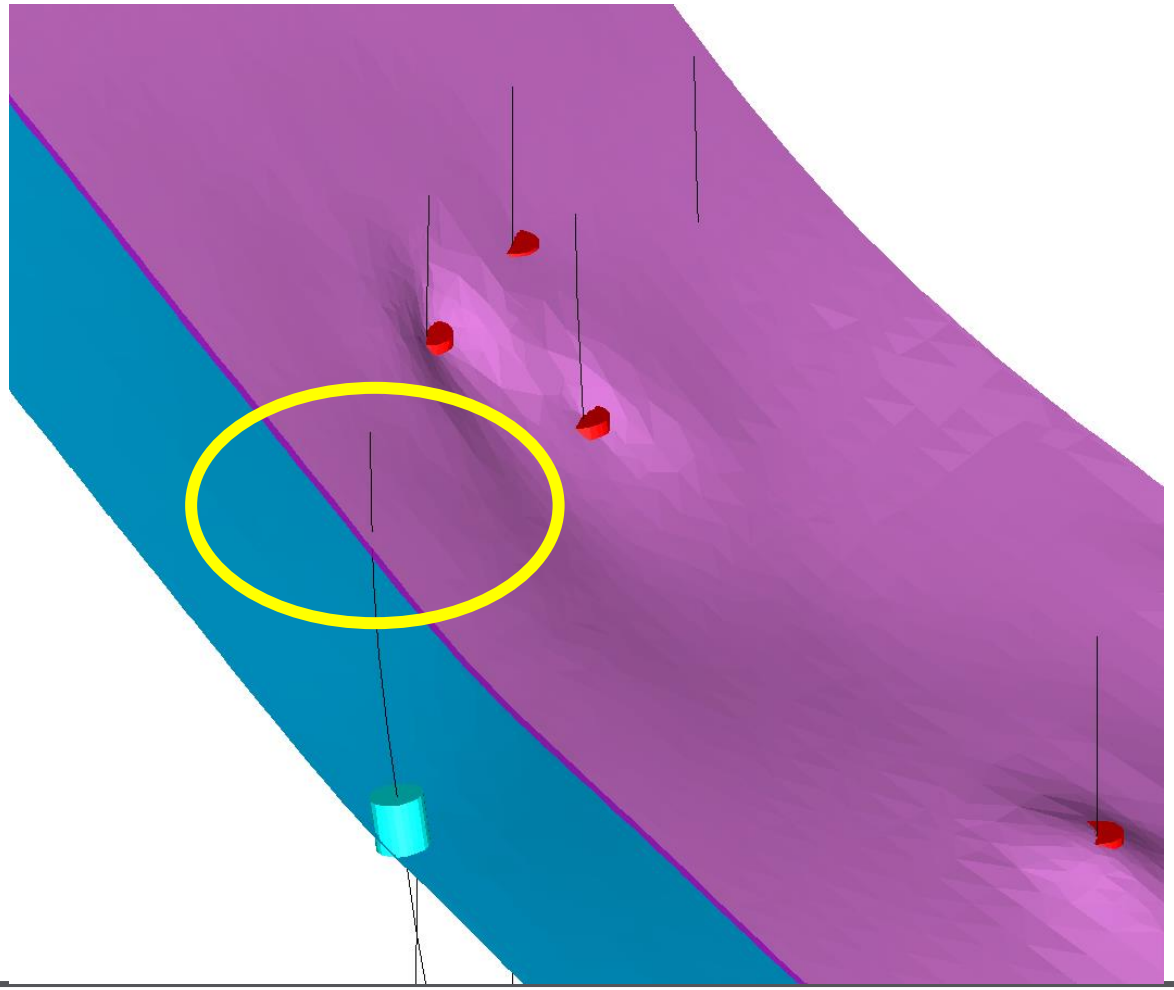
Drill holes Validation – Missing Seams



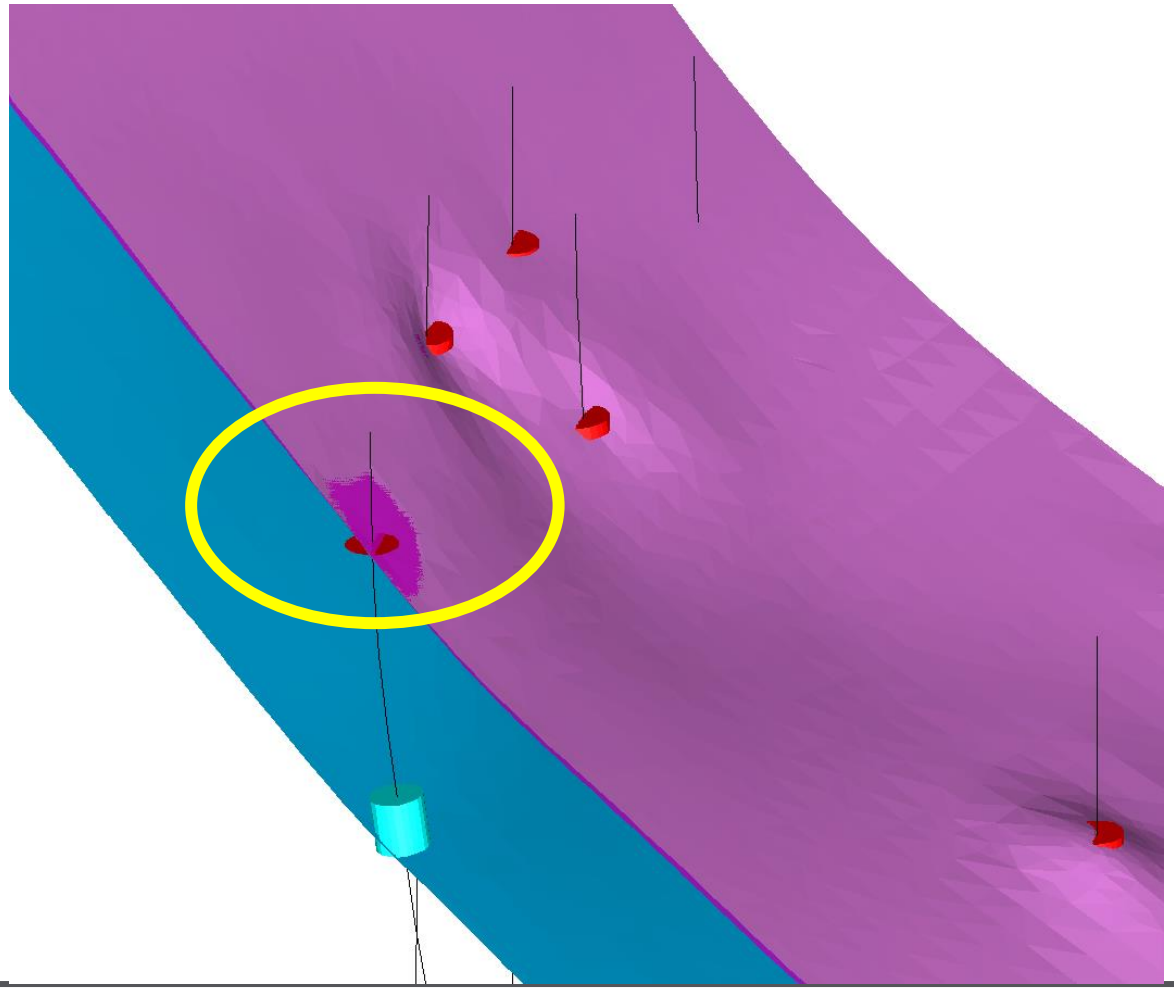
Drill holes Validation – Missing Seams



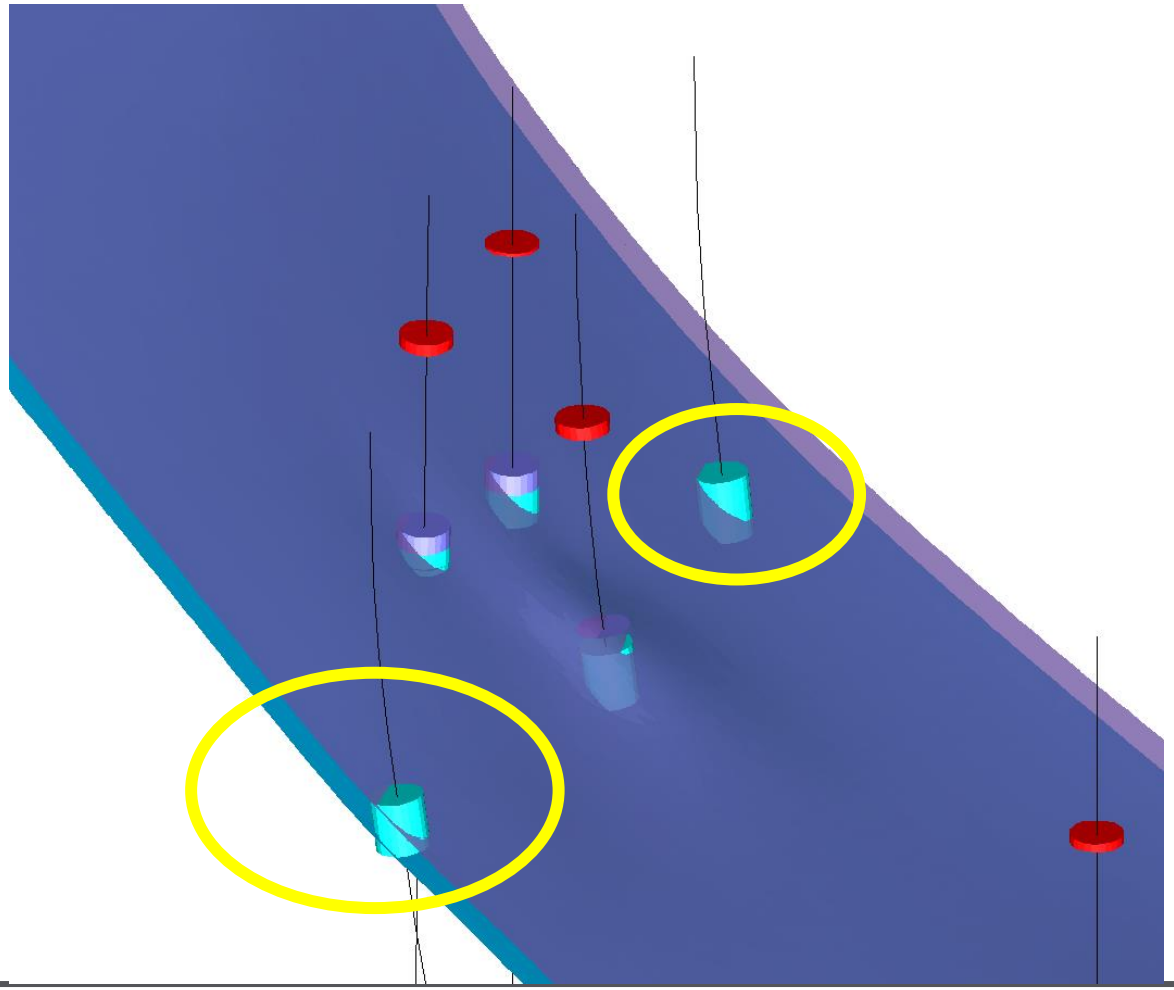
Drill holes Validation – Missing Seams



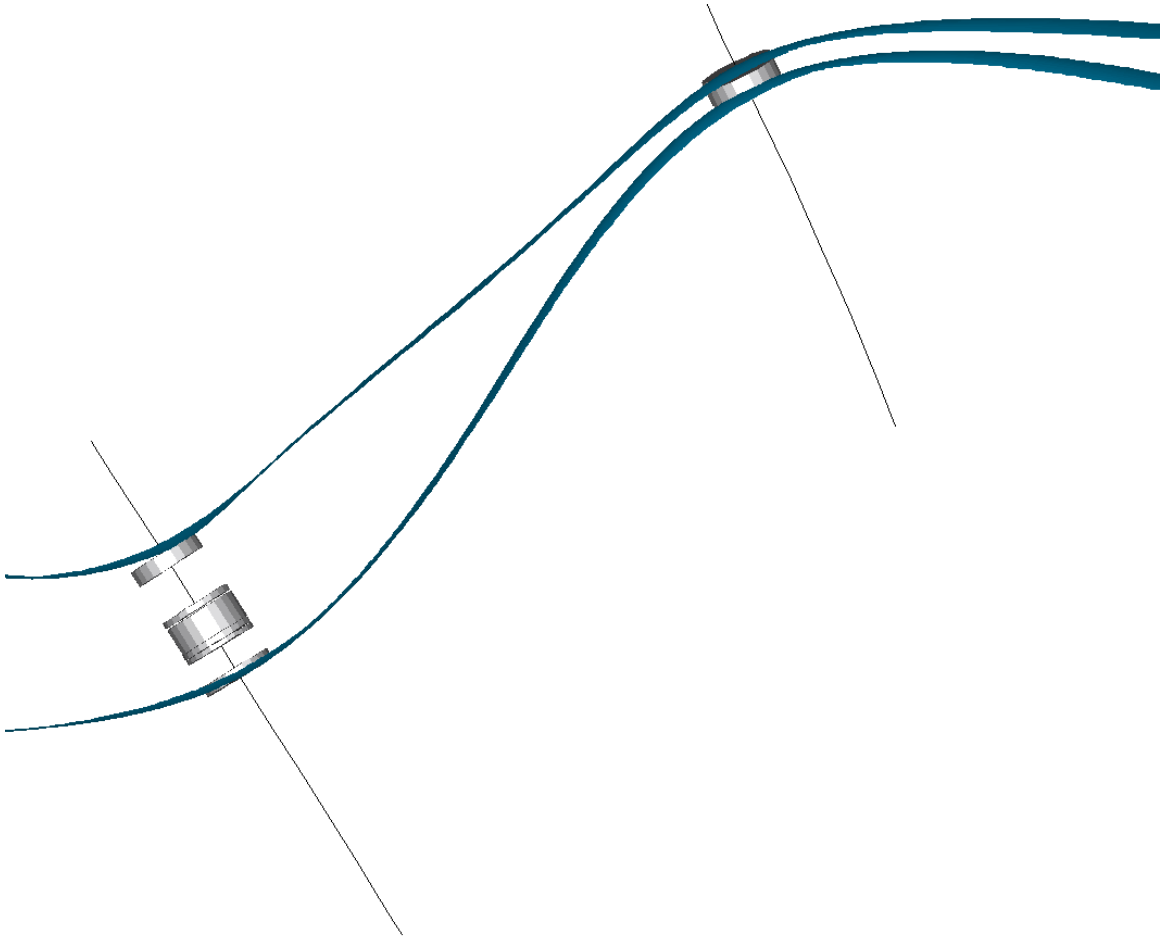
Drill holes Validation – Missing Seams



Drill holes Validation – Missing Seams



Drill holes Validation – True Thicknesses



Drill holes Validation – True Thicknesses

Original Code	LITHO	TTHK	Model Seam	Mineable Flag
Upper Seam (31)	coal	0.31	30	1
Upper Seam (31)	parting	0.29	30	1
Upper Seam (31)	coal	0.31	30	1
Upper Seam (31)	coal	0.31	30	1
	waste	2.1	30	0
Lower Seam (32)	coal	0.21	30	0
Lower Seam (32)	parting	0.41	30	0
Lower Seam (32)	coal	0.21	30	0
Lower Seam (32)	parting	0.32	30	0
Lower Seam (32)	coal	0.61	30	1

**example based on 0.6m minimum mineable and 0.3m minimum seperable

COMPOSITE				
	TTHK	Model Seam	Mineable Fraction	Mineable TTHK
	5.08	30	0.36	1.83

Drill holes Validation – Quality

SEAM PICKS						QUALITY INFORMATION			
Sample Site Name	From	To	Length	Seam Code	LITHO	Sample Site Name	From	To	ASH
DH-1	43.36	45.86	2.50	20	coal	DH-1	43.36	44.20	2.75
DH-1	45.86	48.36	2.50	20	coal	DH-1	44.20	46.72	2.12
						DH-1	46.72	48.26	4.08
						DH-1	48.26	48.48	62.98

Dilution?

Drill holes Validation – Quality

SEAM PICKS							QUALITY INFORMATION			
Sample Site Name	From	To	Length	Seam Code	LITHO	Mineable Flag	Sample Site Name	From	To	ASH
DH-2	60.80	61.80	1.00	10	coal	yes	DH-2	60.80	63.64	59.9
DH-2	61.80	62.98	1.18	10	parting	no				
DH-2	62.98	63.64	0.66	10	coal	yes				

Too high?

SEAM PICKS							QUALITY INFORMATION			
Sample Site Name	From	To	Length	Seam Code	LITHO	Mineable Flag	Sample Site Name	From	To	ASH
DH-3	131.20	132.10	0.90	20	coal	yes	DH-3	131.20	145.80	14.6
DH-3	132.10	132.60	0.50	20	parting	yes				
DH-3	132.60	134.40	1.80	20	coal	yes				
DH-3	143.30	143.90	0.60	20	parting	yes				
DH-3	143.90	145.80	1.90	20	coal	yes				

Too low?

Embracing New Technologies

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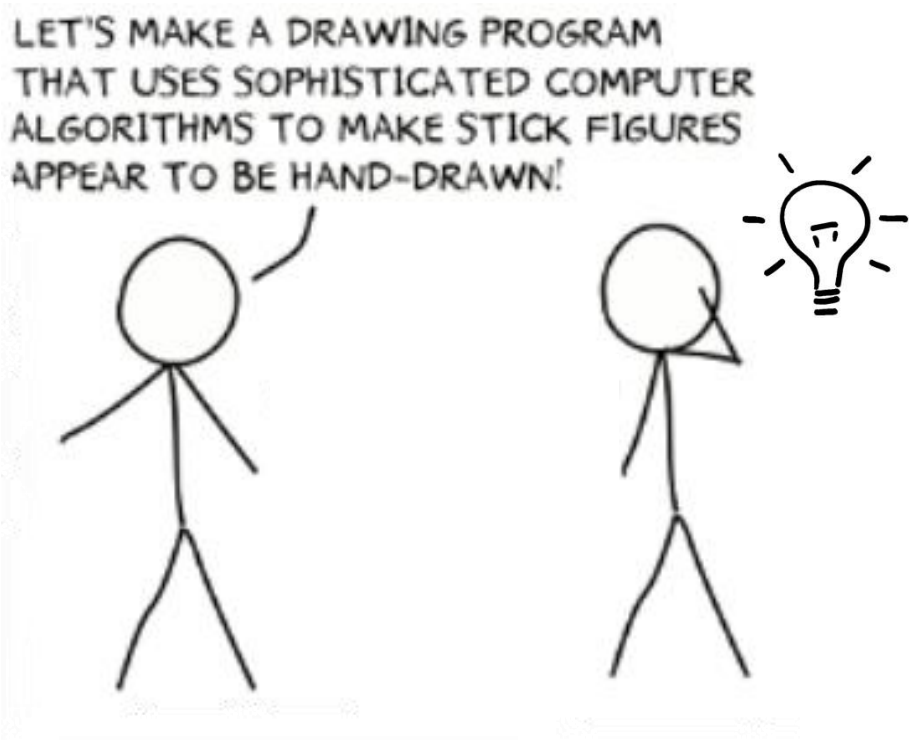
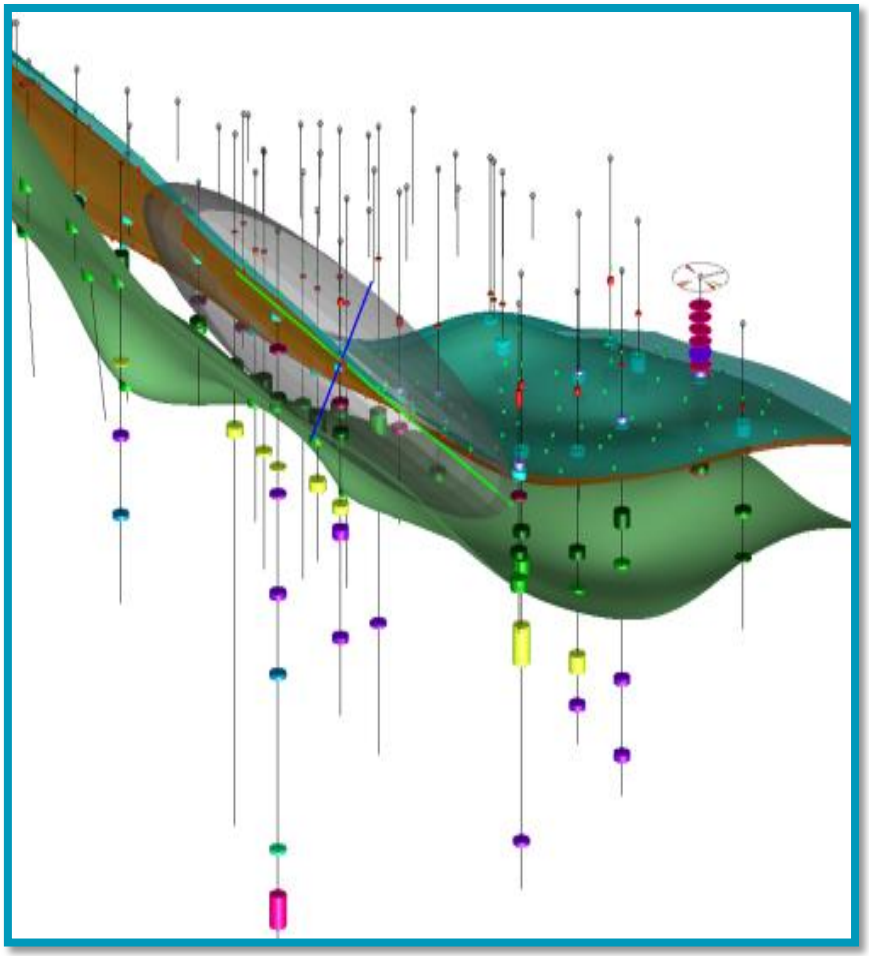
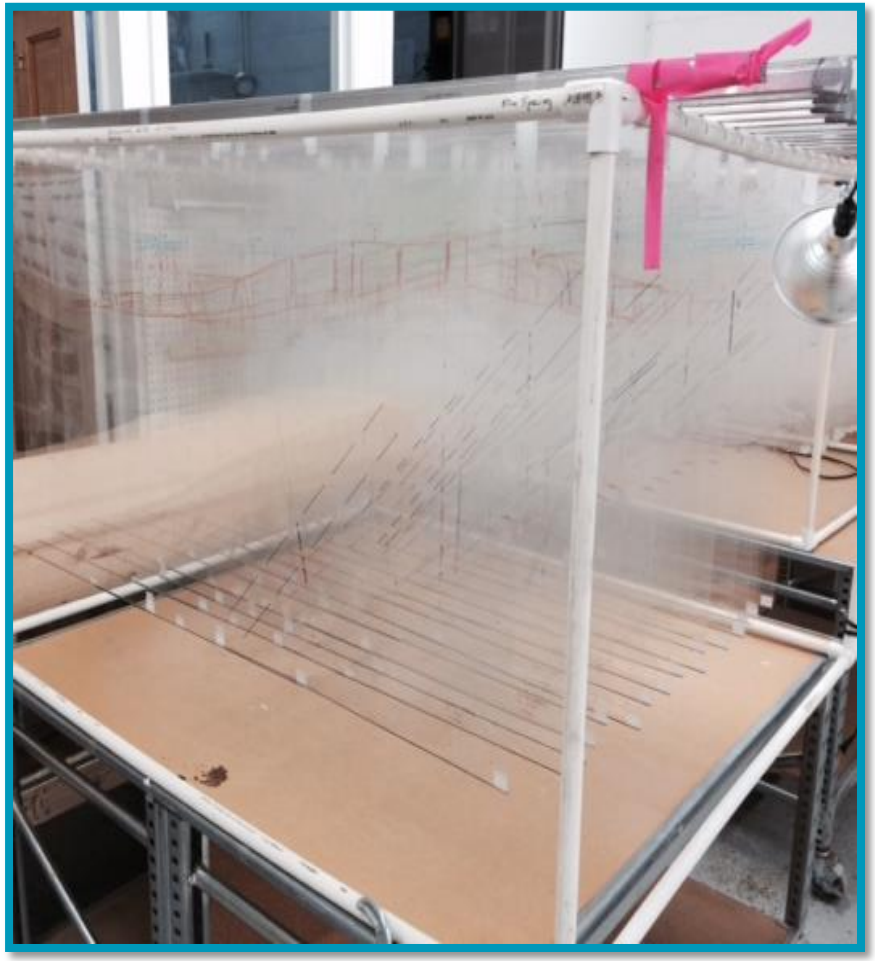
Implicit Modeling

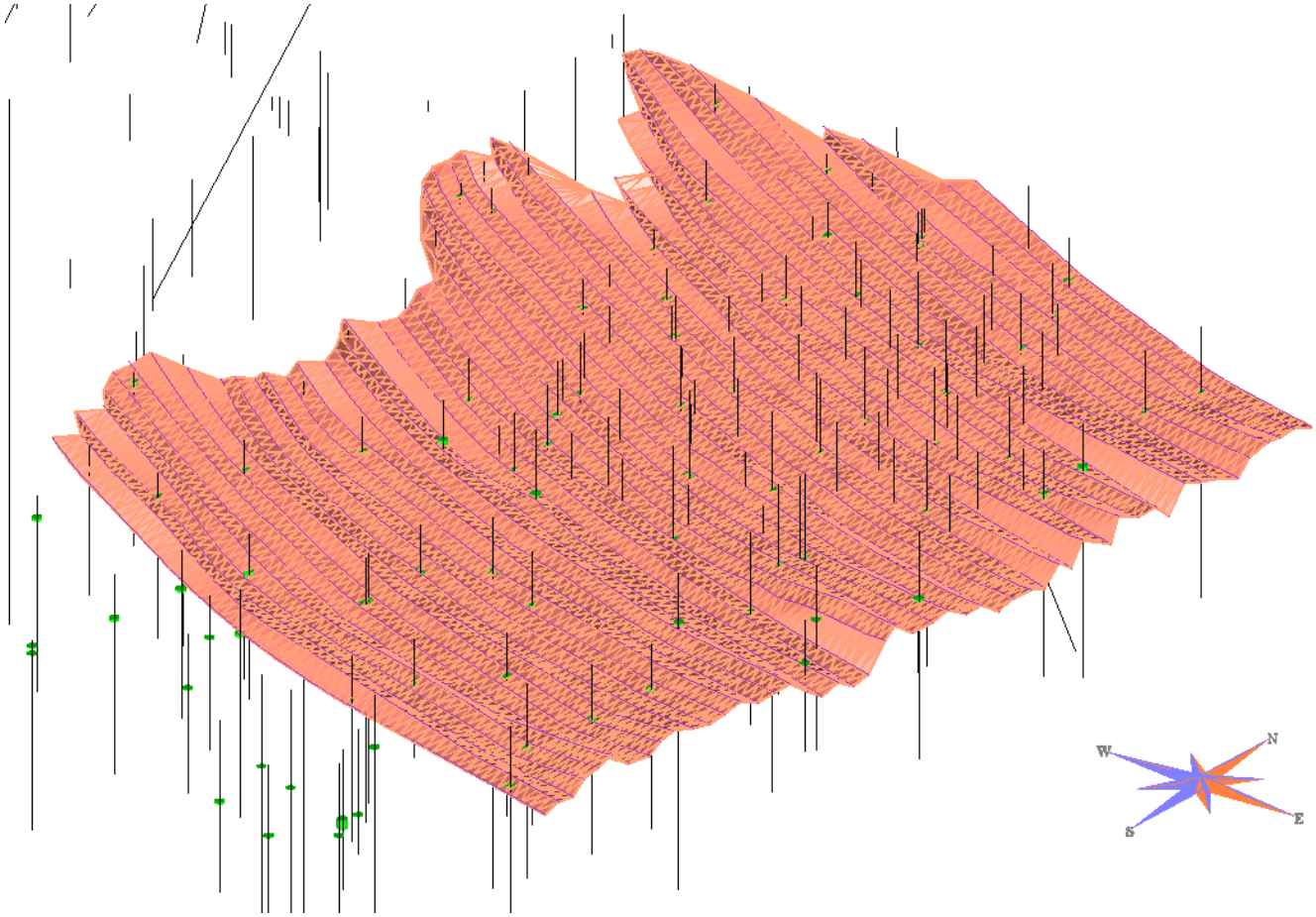


Implicit Modeling versus Explicit Modeling

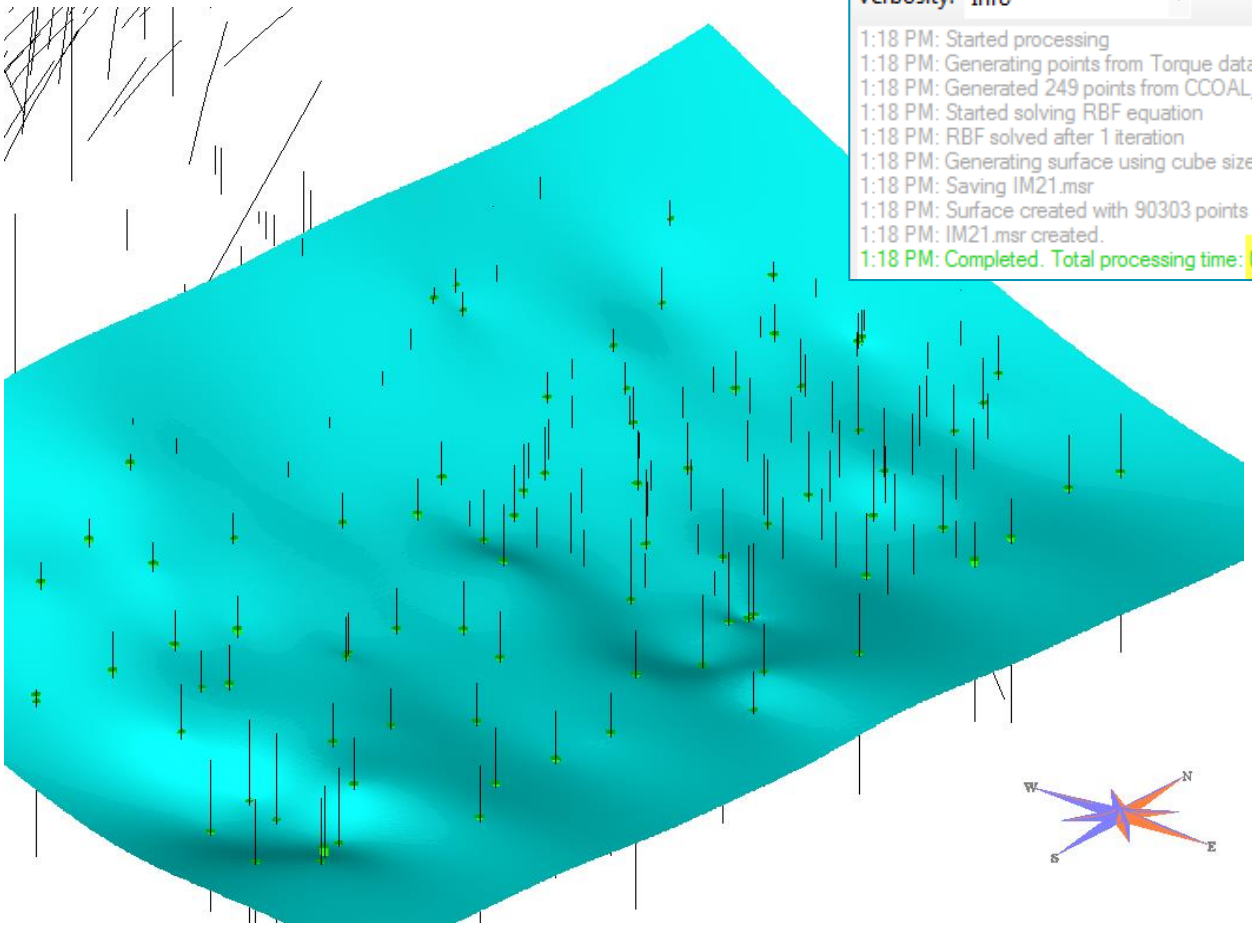




Explicit Modeling

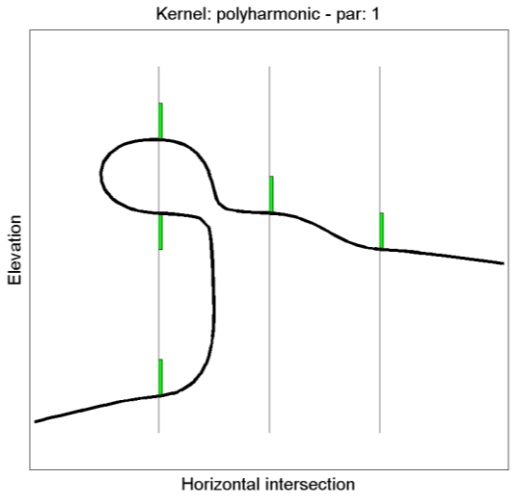


Implicit Modeling

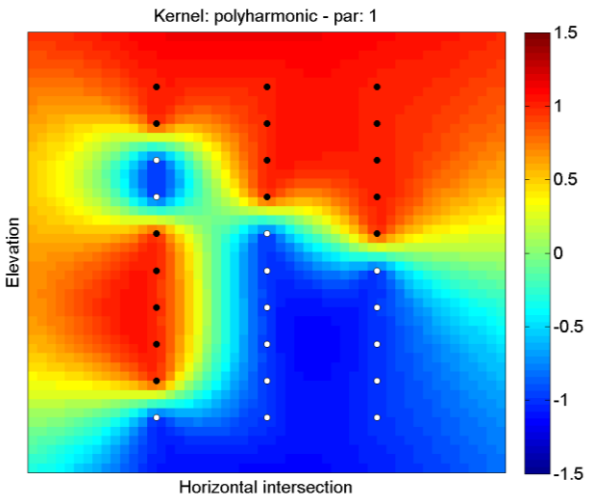


Implicit Modeling

mathematical surface fitting method (RBF) that interpolates point data to generate a smoother surface than traditional triangulation methods



on-surface points



off-surface points

Implicit Modeling – Fault

Implicit Modeling – True Thickness Stacking

Implicit Modeling

	Implicit Modeling	Explicit Modeling
User controlled?	✓	✓
Honors Seam Picks?	✓	✓
Auditable?	✓	✓
Fast?	✓	
True 3D?	✓	
Reproducible?	✓	
3D True Thickness and Seam Dip?	✓	

Less digitizing time = more time to be a geologist!

Coal Modeling: a game plan

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Game Plan

1. Pinpoint the purpose of the model
2. Validate your data
3. Identify seam packages
4. Establish a seam naming convention
5. Model Faults
6. Model Marker Seam
7. Manage Missing Seams
8. Stack with True Thickness Methodology
9. Keep an Audit Trail
10. Review
11. Ask someone else to review
12. Define Block Size
13. Build Block Model

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Best-in-class Solutions

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Mine planning software platform for exploration, modeling, design, scheduling and production	Management, optimization, and automation of underground mining workflows	Fleet and production optimization, high precision machine guidance and autonomous control	Traffic safety and collision avoidance technologies for open pits

Thank You

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