Why One Dimension is Not Enough – A Comparative Study of Lignite Resources Estimation Using Drillhole Mineable Lignite Compositing of Uncorrelated Seams and Mineable Lignite Compositing of Correlated Lignite Seams

ISCSM 2018

Ioannis Kapageridis, Andreas Iordanidis

Laboratory of Mining Information Technology

Technological Educational Institute of Western Macedonia

A 1-Dimensional Approach to a 3D Resource Estimation Problem

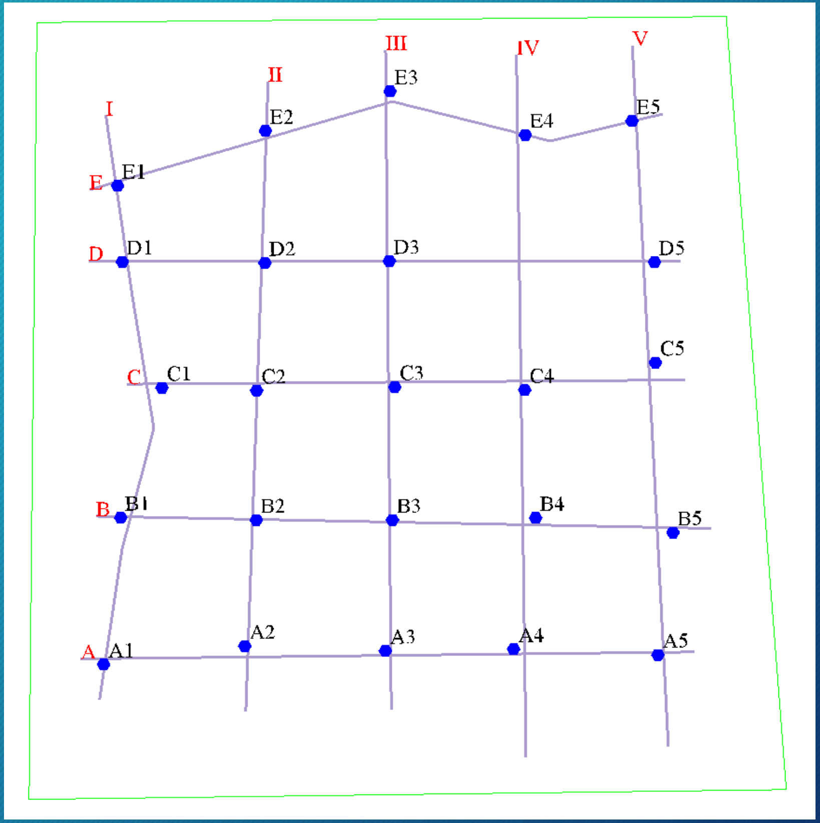
- Lignite deposits in Greece consisting of multiple thin lignite layers are traditionally estimated using a 1D compositing approach.
- Each drillhole is evaluated using mining and processing criteria leading to a number of mineable lignite "packages", the sum of which is reported as the total mineable lignite at the drillhole horizontal location.
- The total minable lignite values from the various drillholes are interpolated horizontally leading to a two-dimensional model of the mineable lignite parameter.

The Issues of Applying a 1-Dimensional Approach to a 3D Resource Estimation Problem

- This approach is capable of calculating global lignite resources with acceptable accuracy provided a high sample density.
- However, it is particularly prone to errors in calculating local lignite resources which are necessary for effectively planning and scheduling a continuous mining process.
- The approach suffers from large error margins particularly in the presence of medium to large tectonism and uneven vertical distribution of lignite seams.
- Another issue with this approach is the sensitivity of the results to potentially incomplete or incorrectly interpreted drillholes that due to the one-dimensional nature of the modelling process can lead to significant errors in the local resource estimates.

A Simple Case Study

- Data used to compare lignite resource modelling approaches in this study come from an exhausted lignite mine in NW Greece.
- A small area of the mine was selected and a total of 24 drillholes on a random grid of 5x5.
- Maptek Vulcan was used for all compositing and modelling purposes.



Methods Compared

In this study we compared the following methods:

1. 1D Compositing of Mineable Lignite (a single total value per drillhole)
2. 1D Compositing Mineable Lignite per bench (a total value per bench for each drillhole)
3. 3D Mineable Lignite Compositing of Correlated Lignite Seams (complete 3D model of mineable lignite seams)

1D Drillhole Compositing of Mineable Lignite

- **Pass 1:** Samples down the hole are classified as lignite or waste based on the ash cutoff value specified.
- **Pass 2:** Adjacent samples of lignite and waste are combined to produce runs of pure lignite and pure waste.
- **Pass 3:** waste intervals between lignite are checked as to their length and composited with adjacent lignite intervals if their length is shorter than a specified limit and the composited ash value is lower than a specified cutoff.
- **Pass 4:** upper and lower waste dilution is added to lignite runs. It should be noted that this step will not disqualify any lignite runs. Roof and floor losses area applied to lignite intervals and respective gains to waste intervals.
- **Pass 5:** The final pass checks all resulting lignite runs to see if they are longer than the minimum lignite run length. Lignite runs that are shorter than this limit, are reclassified as waste and absorbed into the surrounding waste runs. All quality calculations are length weighted.

1D Compositing Parameters and Results

- Applying this method to the 24 drillholes of the example dataset led to the generation of 1,016 composited mineable intervals of lignite and waste from the 2,950 raw intervals.
- A 0.5m minimum mineable lignite thickness and 0.3m waste thickness was applied.
- The maximum ash content for lignite was set to 36% and the roof and floor losses for lignite were 0.1m.

Original

Litho	Length	Ash
AL	3.70	100.00
CO	0.50	46.50
MR	0.60	100.00
AL	2.40	100.00
AL	0.60	100.00
CO	0.60	38.50
MR	0.80	100.00
CO	0.60	45.10
AL	1.00	100.00
MR	0.90	100.00
CO	0.40	36.20
MR	0.50	100.00
CO	1.20	30.90
MR	2.60	100.00
CO	0.40	35.80
CO	1.70	25.20
MR	0.70	100.00
CO	0.60	23.00
CO	0.60	22.70
MR	0.50	100.00
CO	1.40	36.00
MR	0.50	100.00
CO	1.60	40.90
MR	1.00	100.00
CO	0.40	40.60
AL	0.90	100.00
CO	1.30	34.40
MR	0.30	100.00
CO	0.50	35.90
CO	1.00	25.30
MR	1.30	100.00
MR	6.10	100.00
CO	0.60	23.30
MR	0.50	100.00
CO	0.50	28.60
CO	0.80	27.60
CO	1.20	39.60
CO	1.20	33.50
MR	0.40	100.00
CO	1.40	22.70
CO	0.20	17.80
MR	0.20	100.00
CO	0.25	18.00
MR	0.75	100.00
CO	0.80	21.20
CO	0.80	32.90
CO	0.40	25.80
MR	0.20	100.00

Pass 1

Litho	Length	Ash
WASTE	3.70	100.00
WASTE	0.50	46.50
WASTE	0.60	100.00
WASTE	2.40	100.00
WASTE	0.60	100.00
WASTE	0.60	38.50
WASTE	0.80	100.00
WASTE	0.60	45.10
WASTE	1.00	100.00
WASTE	0.90	100.00
WASTE	0.40	36.20
WASTE	0.50	100.00
CO	1.20	30.90
WASTE	2.60	100.00
CO	0.40	35.80
CO	1.70	25.20
WASTE	0.70	100.00
CO	0.60	23.00
CO	0.60	22.70
WASTE	0.50	100.00
WASTE	1.40	36.00
WASTE	0.50	100.00
WASTE	1.60	40.90
WASTE	1.00	100.00
WASTE	0.40	40.60
WASTE	0.90	100.00
CO	1.30	34.40
WASTE	0.30	100.00
CO	0.50	35.90
CO	1.00	25.30
WASTE	1.30	100.00
WASTE	6.10	100.00
CO	0.60	23.30
WASTE	0.50	100.00
CO	0.50	28.60
CO	0.80	27.60
WASTE	1.20	39.60
CO	1.20	33.50
WASTE	0.40	100.00
CO	1.40	22.70
CO	0.20	17.80
WASTE	0.20	100.00
CO	0.25	18.00
WASTE	0.75	100.00
CO	0.80	21.20
CO	0.80	32.90
CO	0.40	25.80
WASTE	0.20	100.00

Pass 2

Litho	Length	Ash
WASTE	12.60	100.00
CO	1.20	30.90
WASTE	2.60	100.00
CO	2.10	27.22
WASTE	0.70	100.00
CO	1.20	9.90
WASTE	6.30	100.00
CO	1.30	34.40
WASTE	0.30	100.00
CO	1.50	28.83
WASTE	7.40	100.00
CO	0.60	23.30
WASTE	0.50	100.00
CO	1.30	27.98
WASTE	1.20	39.60
CO	1.20	33.50
WASTE	0.40	100.00
CO	1.60	22.09
WASTE	0.20	100.00
CO	0.25	18.00
WASTE	0.75	100.00
CO	2.00	26.80
WASTE	0.20	100.00

Pass 3

Litho	Length	Ash
WASTE	12.60	100.00
CO	1.20	30.90
WASTE	2.60	100.00
CO	2.10	27.22
WASTE	0.70	100.00
CO	1.20	9.90
WASTE	6.30	100.00
CO	1.30	34.40
WASTE	0.30	100.00
CO	1.50	28.83
WASTE	7.40	100.00
CO	0.60	23.30
WASTE	0.50	100.00
CO	1.30	27.98
WASTE	1.20	39.60
CO	1.20	33.50
WASTE	0.40	100.00
CO	2.05	29.19024
WASTE	0.75	100.00
CO	2.20	26.80
WASTE	0.2	100

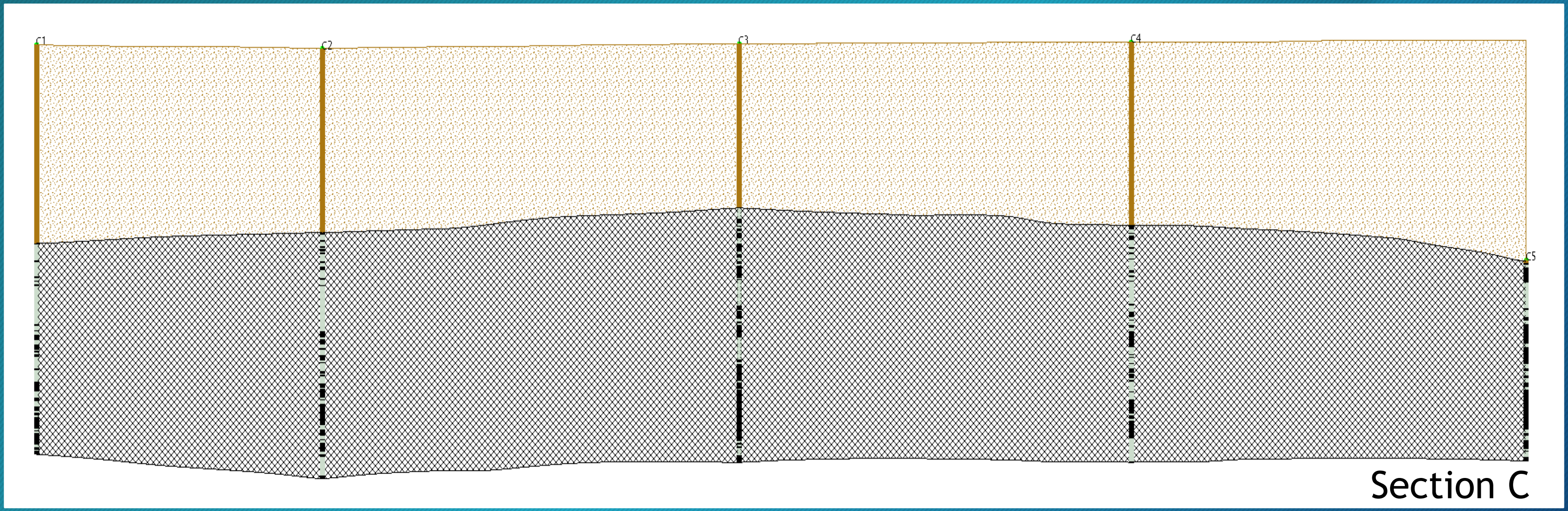
Pass 4

Litho	Length	Ash
WASTE	12.70	100.00
CO	1.00	30.90
WASTE	2.80	100.00
CO	1.90	27.22
WASTE	0.90	100.00
CO	1.00	9.90
WASTE	6.50	100.00
CO	1.10	34.40
WASTE	0.50	100.00
CO	1.30	28.83
WASTE	7.60	100.00
CO	0.40	23.30
WASTE	0.70	100.00
CO	1.10	27.98
WASTE	1.40	39.60
CO	1.00	33.50
WASTE	0.60	100.00
CO	1.85	29.19
WASTE	0.95	100.00
CO	2.00	26.80
WASTE	0.30	100.00

Pass 5

Litho	Length	Ash
WASTE	12.70	100.00
CO	1.00	30.90
WASTE	2.80	100.00
CO	1.90	27.22
WASTE	0.90	100.00
CO	1.00	9.90
WASTE	6.50	100.00
CO	1.10	34.40
WASTE	0.50	100.00
CO	1.30	28.83
WASTE	8.70	100.00
CO	1.10	27.98
WASTE	1.40	39.60
CO	1.00	33.50
WASTE	0.60	100.00
CO	1.85	29.19
WASTE	0.95	100.00
CO	2.00	26.80
WASTE	0.30	100.00

Resource Modelling Based on 1D Compositing of Mineable Lignite



- Using the information produced by the compositing process for the thickness, roof and floor of the mineable lignite and the corresponding values for overburden and midburden, grid models were generated using the inverse distance weighting method.
- The power of 1 for inverse distance was used for the roof and floor models, while the power of 2 was used to model thicknesses.

Resource Modelling Based on 1D Compositing of Mineable Lignite

- As lignite seams are not correlated, we rely on the total mineable lignite thickness model for resource estimation. Stripping ratio is also calculated using the total overburden and midburden thickness models.
- Calculating lignite resources per bench is based on the total mineable midburden/lignite ratio and the thickness of their sum (lignite plus midburden) inside each bench.
- The same midburden/lignite ratio is effectively applied to all benches, with the only possibly varying parameter being the thickness of the mineable lignite plus midburden.
- For benches being totally enclosed in the area between the roof and floor of mineable lignite, this parameter is constant, leading to equal resources being reported in these benches.

1D Drillhole Compositing per Bench of Mineable Lignite

- The second approach considered is based on the previous compositing method but adds an extra pass where the produced lignite and waste composite intervals are split and coded based on surfaces corresponding to mining benches.
- The height of the benches can be constant or different between benches, and essentially controls the vertical resolution of the calculation.
- As the interval splitting takes place after any quality and thickness-based classification to lignite or waste, the added sixth pass does not reduce the total mineable lignite of a drillhole produced by the previous method.

1D Compositing per Bench Parameters and Results

- The 1,016 mineable lignite and waste composite intervals from the previous method were intersected with bench surfaces every 10m vertically (pass 6).
- This led to the generation of 1,404 new composites that were stored in a separate table of the database.

Original

Litho	Length	Ash
AL	3.70	100.00
CO	0.50	46.50
MR	0.60	100.00
AL	2.40	100.00
AL	0.60	100.00
CO	0.60	38.50
MR	0.80	100.00
CO	0.60	45.10
AL	1.00	100.00
MR	0.90	100.00
CO	0.40	36.20
MR	0.50	100.00
CO	1.20	30.90
MR	2.60	100.00
CO	0.40	35.80
CO	1.70	25.20
MR	0.70	100.00
CO	0.60	23.00
CO	0.60	22.70
MR	0.50	100.00
CO	1.40	36.00
MR	0.50	100.00
CO	1.60	40.90
MR	1.00	100.00
CO	0.40	40.60
AL	0.90	100.00
CO	1.30	34.40
MR	0.30	100.00
CO	0.50	35.90
CO	1.00	25.30
MR	1.30	100.00
MR	6.10	100.00
CO	0.60	23.30
MR	0.50	100.00
CO	0.50	28.60
CO	0.80	27.60
CO	1.20	39.60
CO	1.20	33.50
MR	0.40	100.00
CO	1.40	22.70
CO	0.20	17.80
MR	0.20	100.00
CO	0.25	18.00
MR	0.75	100.00
CO	0.80	21.20
CO	0.80	32.90
CO	0.40	25.80
MR	0.20	100.00

Pass 5

Litho	Length	Ash
WASTE	12.70	100.00
CO	1.00	30.90
WASTE	2.80	100.00
CO	1.90	27.22
WASTE	0.90	100.00
CO	1.00	9.90
WASTE	6.50	100.00
CO	1.10	34.40
WASTE	0.50	100.00
CO	1.30	28.83
WASTE	8.70	100.00
CO	1.10	27.98
WASTE	1.40	39.60
CO	1.00	33.50
WASTE	0.60	100.00
CO	1.85	29.19
WASTE	0.95	100.00
CO	2.00	26.80
WASTE	0.30	100.00

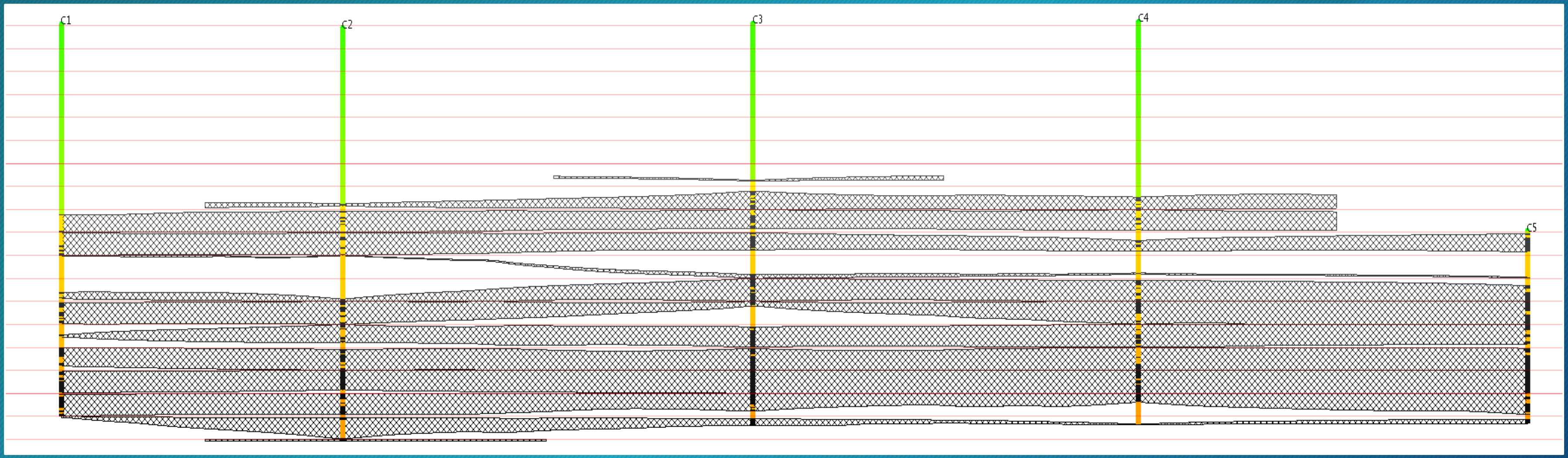
Pass 6

	Litho	Length	Ash
BENCH 570	WASTE 570	10.00	100.00
BENCH 560	WASTE 560	2.70	100.00
	CO 560	1.00	30.90
	WASTE 560	2.80	100.00
	CO 560	1.90	27.22
	WASTE 560	0.90	100.00
	CO 560	0.70	9.90
BENCH 550	CO 550	0.30	9.90
	WASTE 550	6.50	100.00
	CO 550	1.10	34.40
	WASTE 550	0.50	100.00
	CO 550	1.30	28.83
	WASTE 550	0.30	100.00
BENCH 540	WASTE 540	8.40	100.00
	CO 540	1.10	27.98
	WASTE 540	0.50	39.60
BENCH 530	WASTE 530	0.90	39.60
	CO 530	1.00	33.50
	WASTE 530	0.60	100.00
	CO 530	1.85	29.19
	WASTE 530	0.95	100.00
	CO 530	2.00	26.80
	WASTE 530	0.30	100.00

Resource Modelling Based on 1D Compositing per Bench of Mineable Lignite

- The same process followed in the previous method, was applied in the case of mineable lignite composites per bench.
- This time, there were several models corresponding to the different benches, and resources were calculated per bench using the composited mineable thicknesses per bench.
- There was no need to use the waste to lignite ratio to calculate resources per bench, as the mineable overburden, midburden and lignite thicknesses were calculated directly for each bench using values related to each bench.

Resource Modelling Based on 1D Compositing per Bench of Mineable Lignite



- The horizontal extents of mineable lignite in each bench had to be considered during modelling. Vertical variations in lignite density meant that not all drillholes contained mineable lignite in each bench.
- This was addressed by applying polygonal masks to the grid models, limiting their horizontal extents.

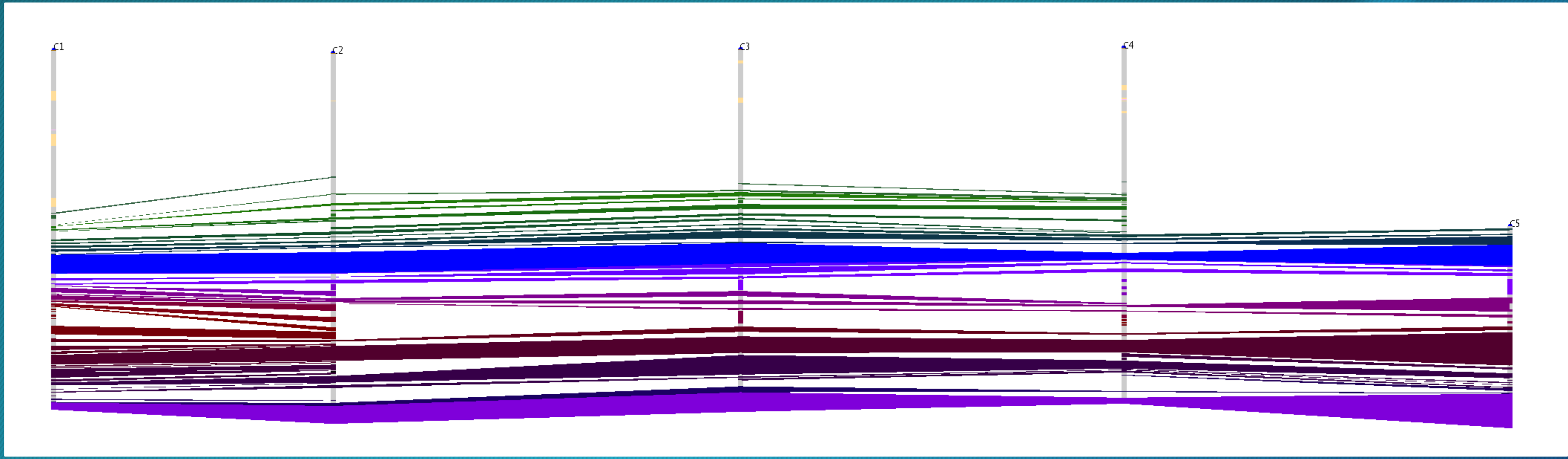
3D Mineable Lignite Compositing of Correlated Lignite Seams

- The last method considered in our study was based on the geological analysis, correlation and modelling of the original (raw) lignite seams.
- The lignite seams were examined in cross sections and were manually correlated by selecting the drillhole intervals considered to belong to a particular seam and coding an appropriate seam field in the database.
- This was a fairly difficult and time-consuming process, the results of which were based to some degree on the geologist’s interpretation.

Modelling Steps

- Lignite seam correlation
- Validation and fixing of seam correlation
- Structural modelling
- Compositing and quality modelling
- Resource model development
- Generation of Run-Of-Mine (ROM) model

Lignite Seam Correlation



- Two characteristic marl horizons were used to group the lignite layers in upper and lower horizons.
- Upper horizons were numbered upwards (lowest one being U1) and lower horizons were named downwards (top one being L1).
- There was no particular reason for this convention other than the need to have a standard convention between drillholes.
- Horizon splits were named after the merging horizon, e.g. splits U8A, U8B and U8C merge to U8

Lignite Horizon Table

- All lignite seam codes and related splits were stored in a special database table and field to be used for structural modelling of the seams.
- A horizon list (table) was also stored for reference by other functions of the software.
- The horizon list should only contain stratigraphy that will be modelled.

	Child	Merge Level 1	Merge Level 2
Upper Horizons	U14		
	U13		
	U12		
	U11		
	U10		
	U9C	U9	
	U9B	U9AB	U9
	U9A		
	U8C	U8	
	U8B		
	U8A		
	U7		
	U6		
	U5H2	U5H	
	U5H1		
	U5		
	U4		
	U3		
	U2		
	U1		

	Child	Merge Level 1
Lower Horizons	L1	
	L2	
	L3	
	L4A	L4
	L4B	
	L4C	
	L5	
	L6	
	L7	
	L8A	L8
	L8B	
	L8C	
	L9	
	L10A	L10
	L10B	
	L11A	L11
	L11B	
	L11C	
	L12A	L12
	L12B	
	L12C	
	L13A	L13
	L13B	
	L13C	
	L14	
	L15	
	L16	

Validation and Fixing of Seam Correlation

Our dataset, even though being limited to a small area of a much larger deposit and consisting of only 24 drillholes, presented the following data collection issues that need to be addressed:

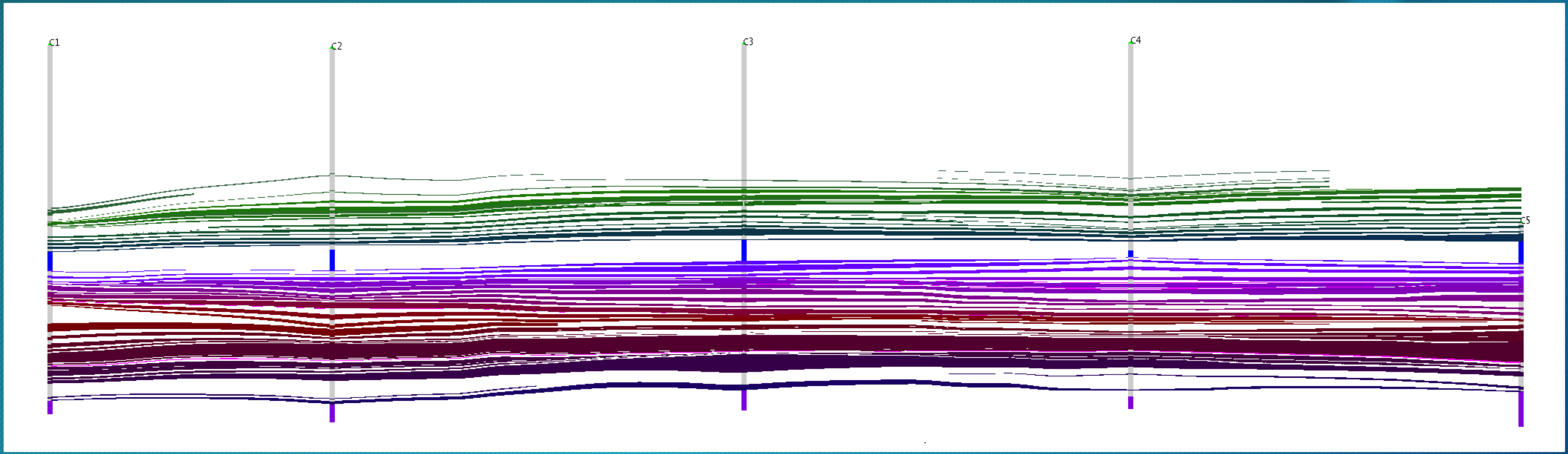
- *Short holes, which are not deep enough to include all horizons of interest or have a collar lower than the original topography surface.*
- *Difficulty determining the position of missing horizons that have thinned to zero thickness.*
- *Issues determining the position of daughter horizon boundaries within their merged parent horizon.*

Validation and Fixing Example for Drillhole C5

- A special function of Maptek Vulcan called FixDHD applies statistical modelling techniques to restore missing or unavailable data from the stored stratigraphy and manipulates the available data to meet required criteria for modelling.
- If the data is not enough to apply these techniques, less rigorous stacking methods are used.

Horizon	Merge	From	FF	To	TF	Thickness	TKF	Sthickness	Flag
CO_U14	CO_U14	-28.812	F	-28.444	F	0.368	F	0.368	FF
CO_U13	CO_U13	-25.098	F	-24.712	F	0.386	F	0.386	FF
CO_U12	CO_U12	-23.462	F	-22.913	F	0.548	F	0.548	FF
CO_U11	CO_U11	-21.004	F	-20.104	F	0.901	F	0.901	FF
CO_U10	CO_U10	-18.983	F	-18.61	F	0.372	F	0.372	FF
CO_U9C	CO_U9	-18.61	F	-18.489	F	0.121	F	0.121	FF
CO_U9B	CO_U9	-18.197	F	-17.676	F	0.521	F	0.521	FF
CO_U9A	CO_U9	-17.204	F	-16.629	F	0.575	F	0.575	FF
CO_U8C	CO_U8	-15.355	F	-14.961	F	0.393	F	0.393	FF
CO_U8B	CO_U8	-14.961	F	-14.765	F	0.197	F	0.197	FF
CO_U8A	CO_U8	-14.765	F	-13.388	F	1.376	F	1.376	FF
CO_U7	CO_U7	-12.563	F	-11.367	F	1.196	F	1.196	FF
CO_U6	CO_U6	-8.944	F	-7.807	F	1.137	F	1.137	FF
CO_U5H2	CO_U5H	-6.112	F	-4.753	F	1.358	F	1.358	FF
CO_U5H1	CO_U5H	-3.258	F	-2.392	F	0.866	F	0.866	FF
CO_U5	CO_U5	-1.86	F	-1.86	F	0	F	0	FF
CO_U4	CO_U4	-1.347	F	-0.523	F	0.823	F	0.823	FF
CO_U3	CO_U3	1	DB	2	DB	1	DB	1	DBDB
CO_U2	CO_U2	3.8	DB	4.4	DB	0.6	DB	0.6	DBDB
CO_U1	CO_U1	5	DB	9.3	DB	4.3	DB	4.3	DBDB
CO_L1	CO_L1	20.1	DB	20.8	DB	0.7	DB	0.7	DBDB
CO_L2	CO_L2	22.1	DB	23	DB	0.9	DB	0.9	DBDB
CO_L3	CO_L3	23.8	DB	25.4	DB	1.6	DB	1.6	DBDB
CO_L4A	CO_L4	26.8	DB	29.518	F	2.718	F	2.718	DBF
CO_L4B	CO_L4	29.518	F	30.963	F	1.445	F	1.445	FF
CO_L4C	CO_L4	30.963	F	35	DB	4.037	F	4.037	FDB
CO_L5	CO_L5	36.25	DB	39.5	DB	3.25	DB	3.25	DBDB
CO_L6	CO_L6	42.6	DB	43.5	DB	0.9	DB	0.9	DBDB
CO_L7	CO_L7	45	DB	46.5	DB	1.5	DB	1.5	DBDB
CO_L8A	CO_L8	48.4	DB	48.659	F	0.259	F	0.259	DBF
CO_L8B	CO_L8	48.659	F	49.351	F	0.692	F	0.692	FF
CO_L8C	CO_L8	49.351	F	49.5	DB	0.149	F	0.149	FDB
CO_L9	CO_L9	49.786	F	49.786	F	0	DB	0	FF
CO_L10A	CO_L10	51	DB	51	F	0	F	0	DBF
CO_L10B	CO_L10	51	F	53	DB	2	F	2	FDB
CO_L11A	CO_L11	54	DB	56.8	DB	2.8	DB	2.8	DBDB
CO_L11B	CO_L11	56.8	DB	59.6	DB	2.8	DB	2.8	DBDB
CO_L11C	CO_L11	59.6	F	59.6	F	0	DB	0	FF
CO_L12A	CO_L12	59.6	DB	67.909	F	8.309	F	8.309	DBF
CO_L12B	CO_L12	67.909	F	70.284	F	2.375	F	2.375	FF
CO_L12C	CO_L12	70.284	F	71	DB	0.716	F	0.716	FDB
CO_L13A	CO_L13	72	DB	73	DB	1	DB	1	DBDB
CO_L13B	CO_L13	73.76	F	73.76	F	0	DB	0	FF
CO_L13C	CO_L13	73.76	F	73.76	F	0	DB	0	FF
CO_L14	CO_L14	75	DB	77.5	DB	2.5	DB	2.5	DBDB
CO_L15	CO_L15	82.7	DB	84	DB	1.3	DB	1.3	DBDB
CO_L16	CO_L16	85	DB	85.4	DB	0.4	DB	0.4	DBDB

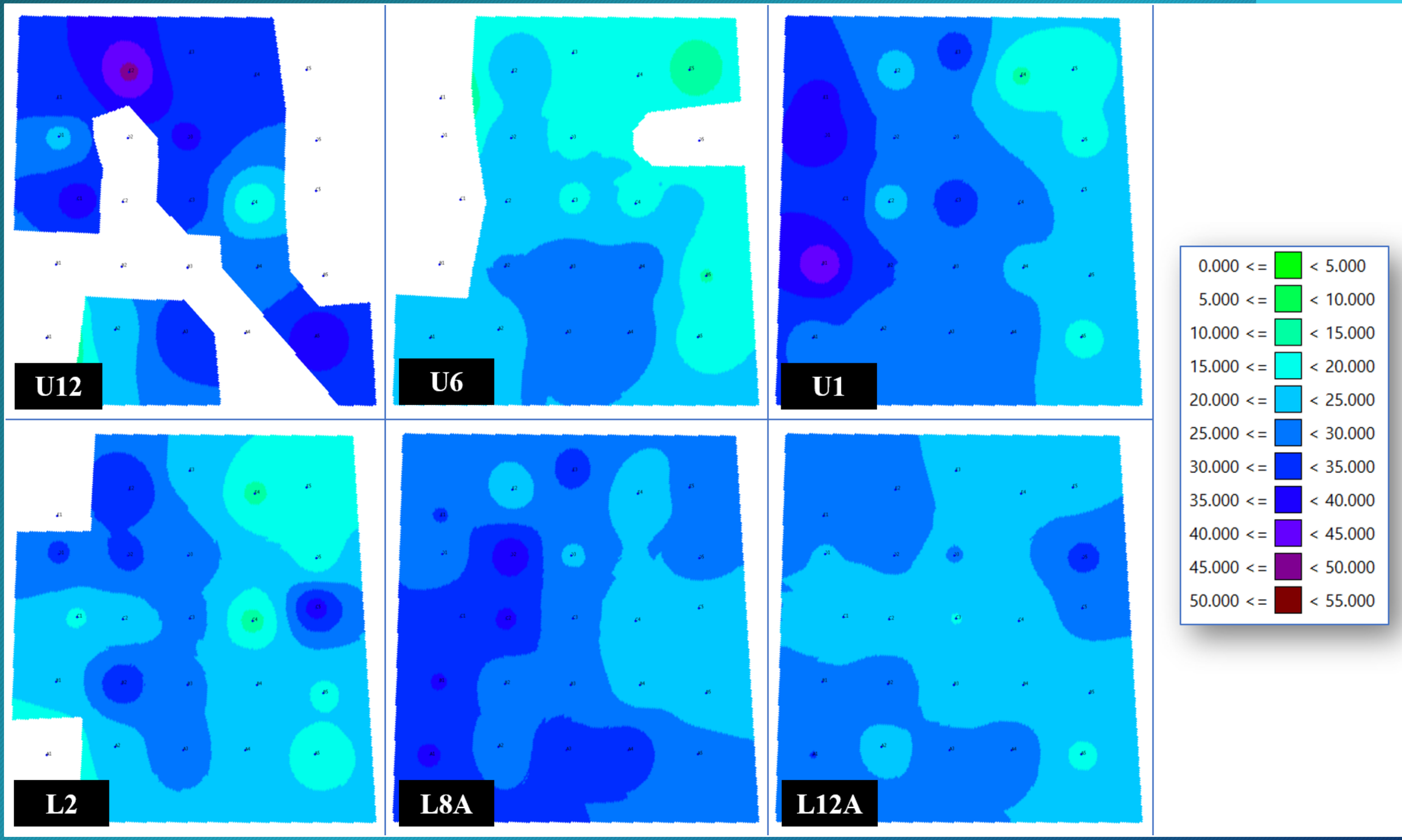
Structural Modelling



- Once the fixed lignite stratigraphic table was produced, structural modelling of the lignite seams could be performed.
- Seam existence limits were generated to control the horizontal area of the seams of the fixed lignite intervals.
- The same interpolation method was used (inverse distance weighting to a power of one) as in the previous methods for consistency.
- Grid models for the roof, floor and thickness of each seam were generated and masked with the corresponding seam limits.

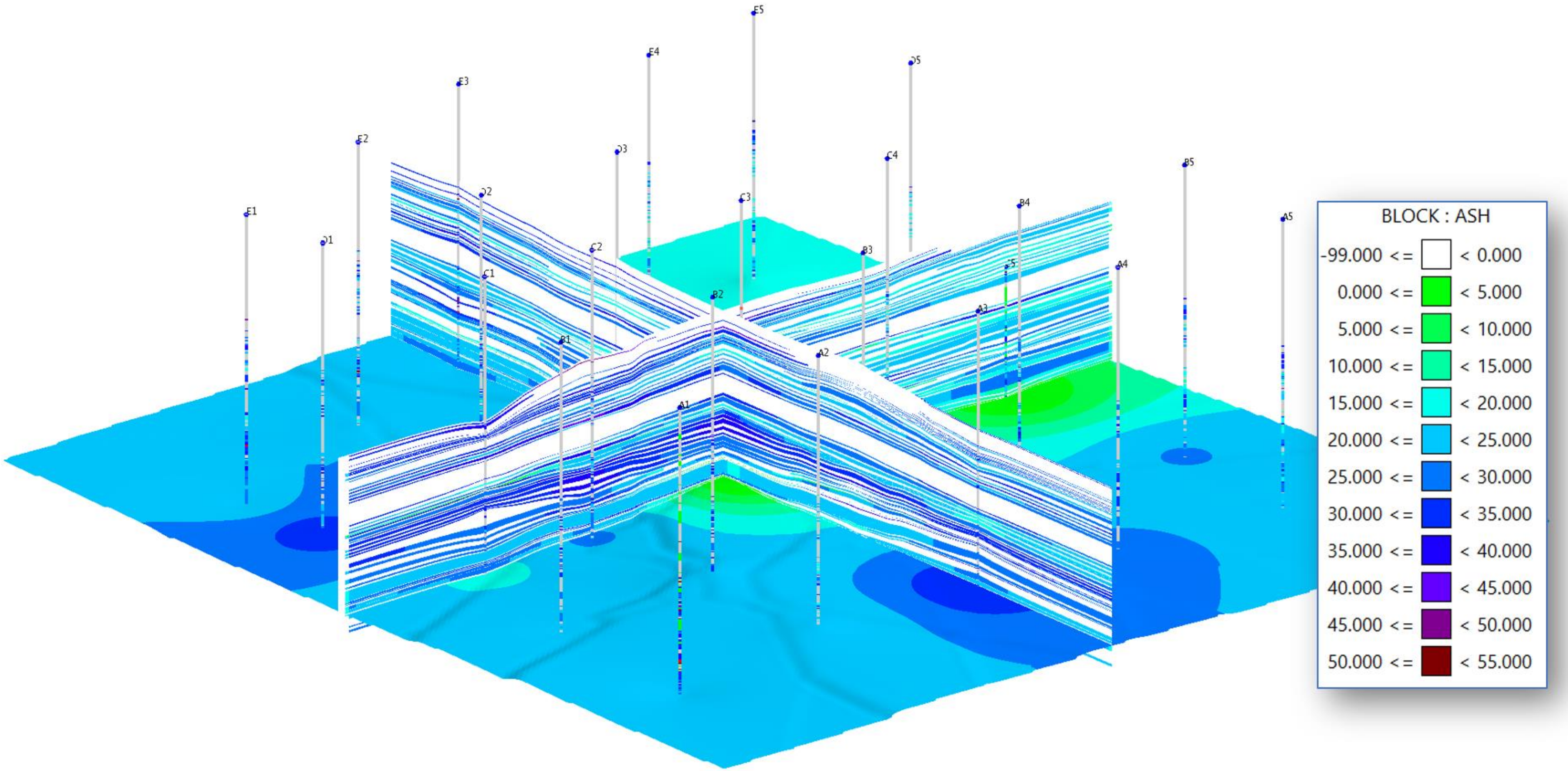
Compositing and Quality Modelling

- For each of the modelled seams, it was necessary to generate corresponding quality grids, one for each of the quality parameters (ash, moisture, calorific value).
- Inverse distance weighting to the power of two was used to interpolate composited quality values (single value per seam and drillhole) to the respective grid models.
- Estimating quality parameters separately for each seam leads to a much more detailed quality model than the previous two methods and allows the application of quality mineability criteria in three dimensions instead of one.


U12
U6
U1
L2
L8A
L12A
0.000 <= < 5.000
5.000 <= < 10.000
10.000 <= < 15.000
15.000 <= < 20.000
20.000 <= < 25.000
25.000 <= < 30.000
30.000 <= < 35.000
35.000 <= < 40.000
40.000 <= < 45.000
45.000 <= < 50.000
50.000 <= < 55.000

Resource Model Development

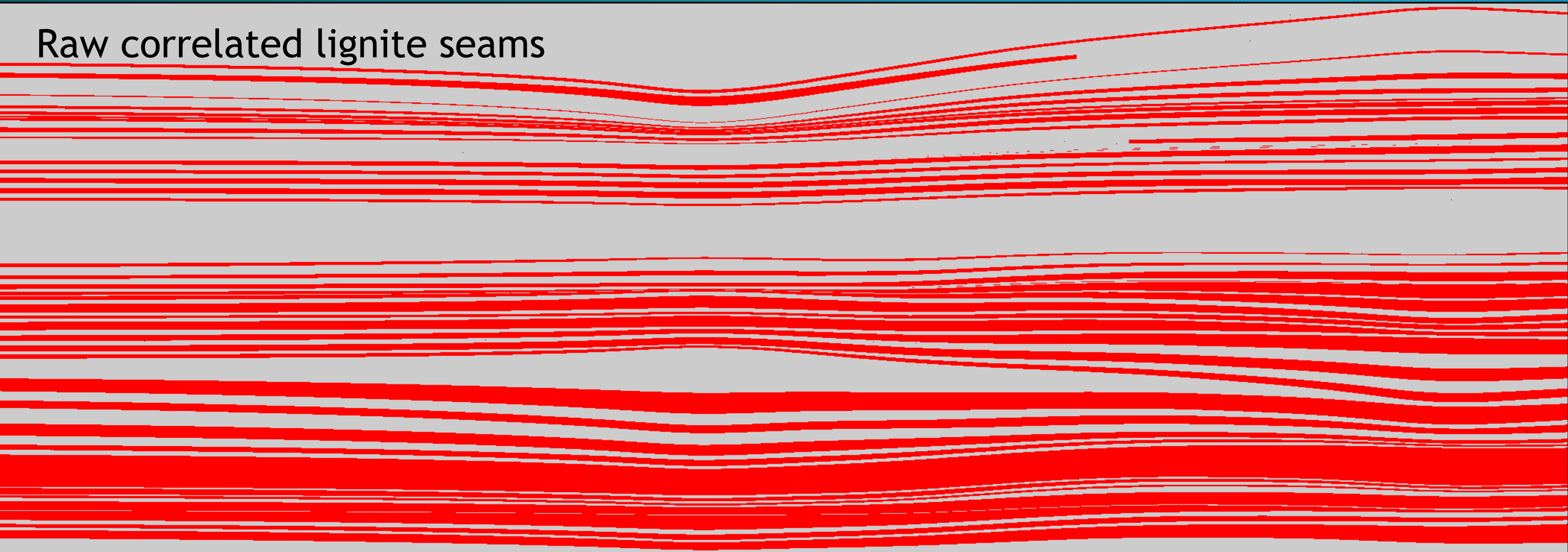
- The resource model was based on the HARP (Horizon Adaptive Rectangular Prism) structure – a type of block model that represents an entire Integrated Stratigraphic Model.
- All structural and quality grids generated for the modelled lignite seams of our study were used to construct a HARP model using the horizontal extents of the considered area.
- Each HARP block was initially coded as lignite or waste and received a seam code based on the formulated horizon list. Waste block seam codes had a prefix added to distinguish them from lignite.

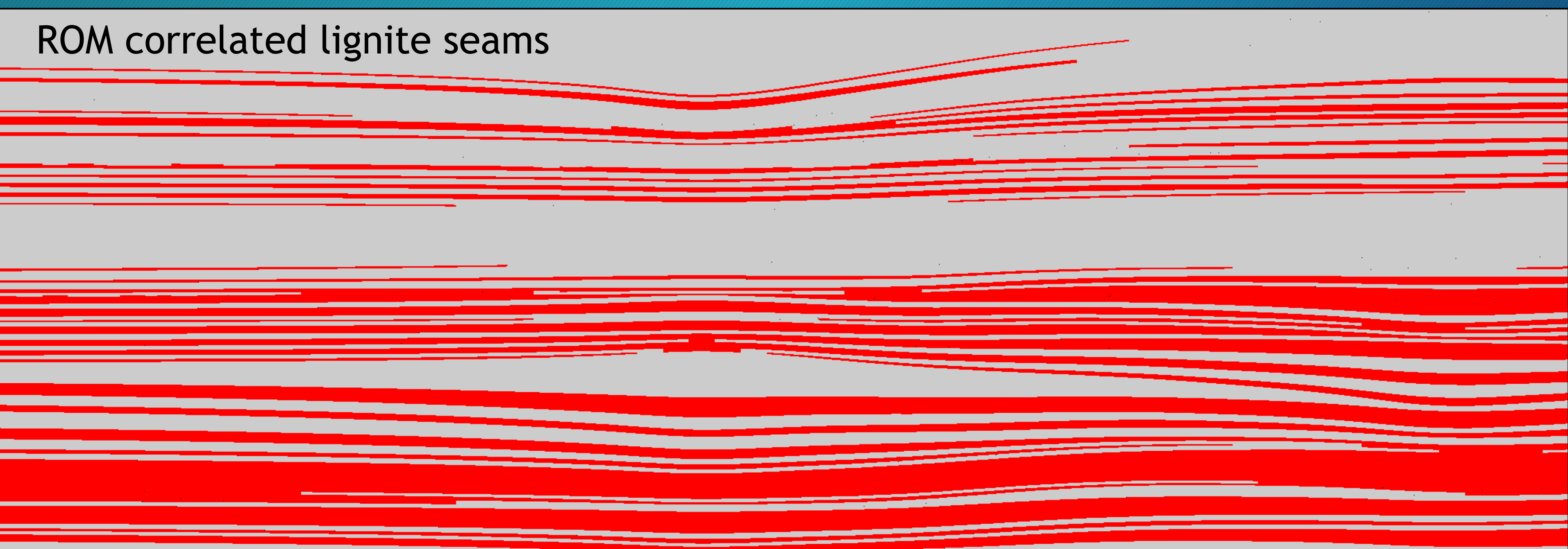

E5
E4
D5
E3
E2
D3
C4
E1
D2
C3
D1
B5
B4
A5
C2
B3
C1
A4
B2
A3
B1
A2
A1
BLOCK : ASH
-99.000 <= < 0.000
0.000 <= < 5.000
5.000 <= < 10.000
10.000 <= < 15.000
15.000 <= < 20.000
20.000 <= < 25.000
25.000 <= < 30.000
30.000 <= < 35.000
35.000 <= < 40.000
40.000 <= < 45.000
45.000 <= < 50.000
50.000 <= < 55.000

Run-Of-Mine Model

The ROM HARP model is constructed from the geologic HARP model using three rules, applied to the mine modelling process in the following order:

- **Minimum mining thickness:** Any horizon less than this thickness is not mined by itself.
- **Minimum parting thickness:** Any waste material between seams less than this thickness is mined with the next seam, resulting in composited seams. Waste material becomes a parting in the composited seam. The assumption when using this option is that burden material less than this thickness cannot be separated in the pit, so it is mined with the product. However, compositing only takes place if the Minimum product to waste ratio is met.
- **Minimum product to waste ratio:** The total product to total waste ratio in a working section must be greater than or equal to this ratio. Total waste is defined as all in-seam partings plus all between-seam parting.


Raw correlated lignite seams


ROM correlated lignite seams

Comparison of Results

	1. Total Mineable Thickness Compositing			2. Mineable Thickness Compositing per Bench			3. Compositing of Correlated Lignite Seams		
Bench	**OB**	**CO**	**MB**	**OB**	**CO**	**MB**	**OB**	**CO**	**MB**
650	14,577,846	-	-	14,577,846	-	-	14,577,846	-	-
640	13,185,074	-	-	13,185,074	-	-	13,185,074	-	-
630	13,185,074	-	-	13,185,074	-	-	13,185,074	-	-
620	13,185,074	-	-	13,185,074	-	-	13,185,074	-	-
610	13,185,074	-	-	13,185,074	-	-	13,185,074	-	-
600	13,175,050	5,675	5,295	13,055,385	61,243	78,653	13,102,556	31,679	56,119
590	11,289,779	1,073,032	1,001,102	9,812,684	708,640	2,781,857	9,668,205	764,268	2,879,979
580	5,184,748	4,529,428	4,225,803	5,001,697	4,646,698	4,311,129	5,129,774	4,260,537	4,504,853
570	1,325,006	6,714,642	6,264,533	1,592,875	4,864,147	7,538,743	1,508,645	5,063,741	7,456,645
560	69,358	7,425,533	6,927,771	504,643	4,623,182	8,827,779	498,204	4,839,959	8,653,571
550	-	7,464,801	6,964,407	-	2,092,204	11,441,571	-	2,162,843	11,382,705
540	-	7,464,801	6,964,407	-	7,802,640	6,682,874	-	7,884,321	6,614,807
530	-	7,464,801	6,964,407	-	8,664,512	5,964,648	-	9,472,897	5,290,994
520	-	7,464,801	6,964,407	-	7,465,063	6,964,188	-	7,836,396	6,654,744
510	-	7,464,801	6,964,407	-	9,209,149	5,510,783	-	9,691,051	5,109,199
500	-	7,464,801	6,964,407	-	12,940,138	2,401,625	-	12,230,637	2,221,503
490	-	6,726,605	6,275,695	-	6,531,122	2,979,474	-	4,900,503	2,928,823
480	-	1,425,875	1,330,293	-	1,393,525	1,013,852	-	731,332	993,575
470	-	161	150	-	106,621	29,975	-	53	11
Total	***98,362,083***	***72,689,757***	***67,817,083***	***97,285,426***	***71,108,884***	***66,527,152***	***97,225,526***	***69,870,216***	***64,747,527***

Conclusions

- Clearly the higher the sophistication of the calculation (going from method 1 to 3) the lower the reported total lignite.
- Overall, it became quite clear during this exercise that the time spent in building a complete stratigraphic model based on lignite seam correlation is **time well spent** as it provides all the necessary quantity and quality information in three dimensions and to the highest resolution possible based on the available data.
- Any efforts to replace seam correlation and compositing with one-dimensional compositing of each drillhole separately, lead to over-simplification of geology and significant reduction of the effectiveness of mine planning.

Thank you for your attention!