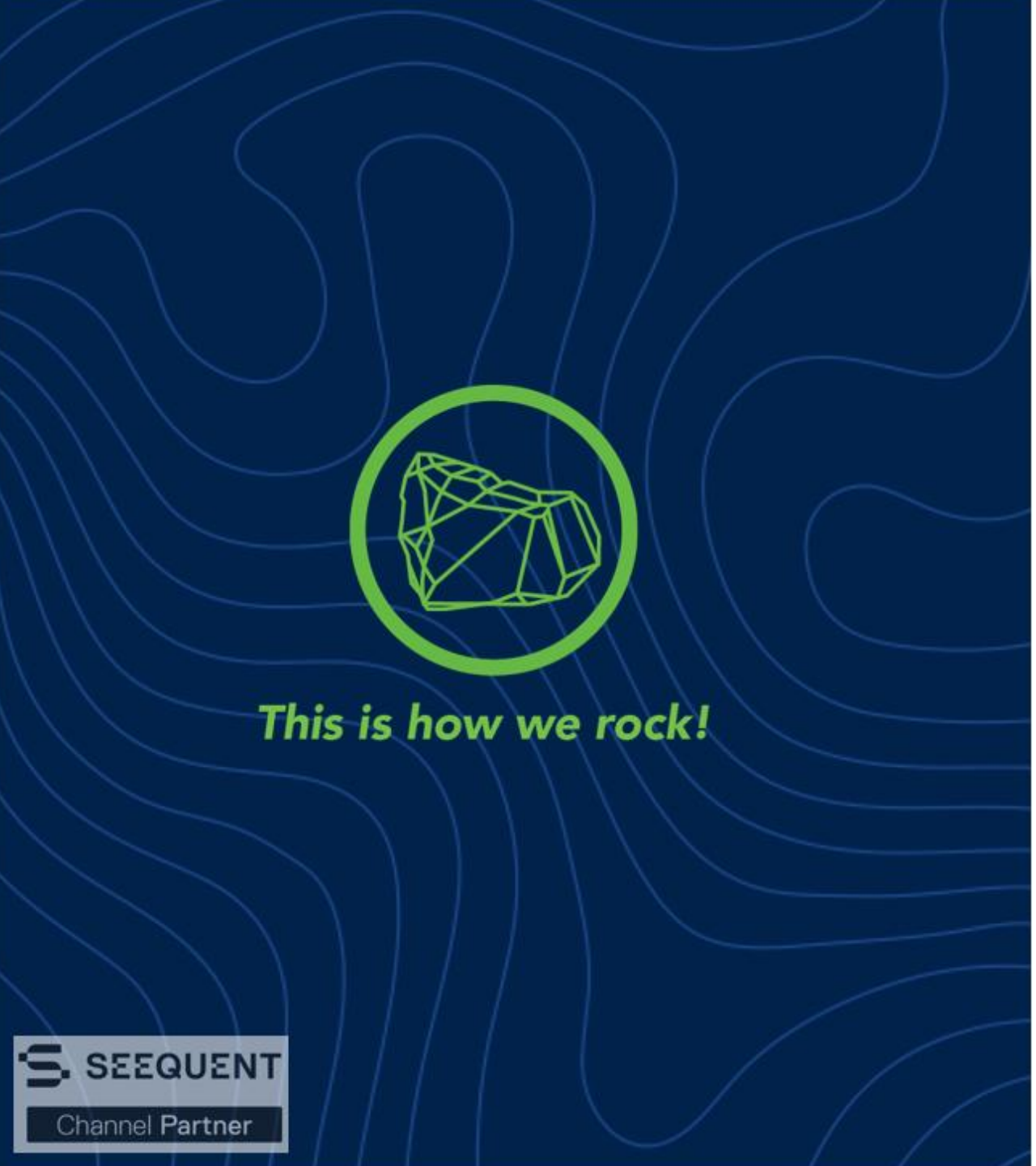


Beyond the Surface: Improving Seam Thickness Modelling in Faulted Geological Settings

Version 1.0

October 2026

GSZ Summer Symposium & Macgregor Memorial Lecture

SEEQUENT

B&S GEOLOGICAL

Agenda

1. Brief company introduction;
2. Geographic location;
3. Regional geological setting;
4. Local geology;
5. Is your seam thickness consistent;
6. Geological Modelling;
7. Thickness Modelling Prototype;
8. Conclusions;
9. References.

ABOUT US



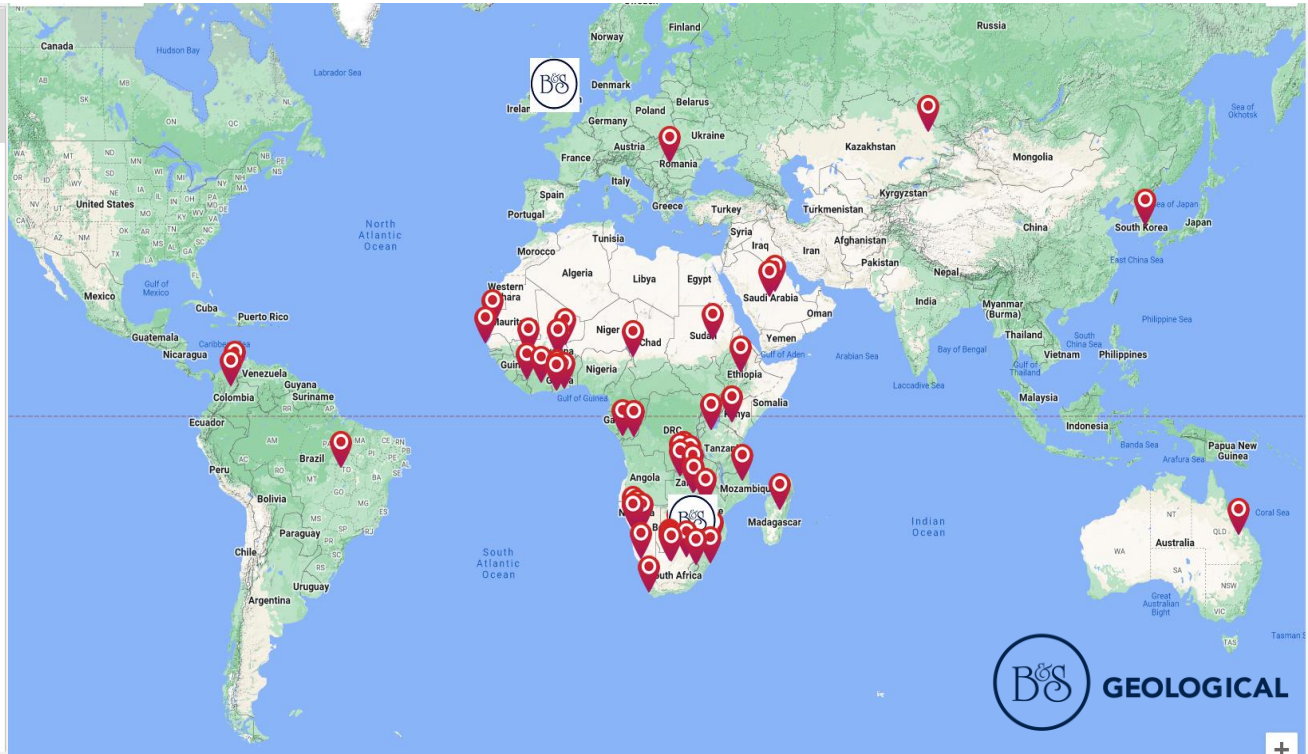
1. Brief company introduction

- B&S Geological is a proudly South African company and 100% black-owned with a Level 1 B-BBEE Accreditation with a 135% Procurement Recognition. B&S Geological is an **official Channel Partner of Seequent.**

- With over 25 years of expertise, we specialise in 3D geological and mineral resource modelling, leveraging industry-leading software like Leapfrog Geo, Leapfrog Edge, Seequent Central, MX Deposit, Imago, and Datamine.

- Our commitment extends beyond technical excellence, emphasising skills development and implementing best-practice geological modelling workflows in diverse workplaces.

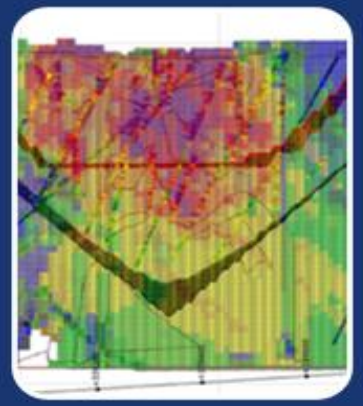
OUR CLIENTS



1. Our service offerings

SEEQUENT Channel Partner

Deeper Questions. Richer Results







leapfrog
DEPOSIT
IMAGO
Oasis montaj

Consulting Services

- 3D Geological modelling – Structure, Strat, Alteration, Mineralisation etc
- Mineral resource modelling
- Leapfrog Geo Audits and Reviews

Implementation/ Mentorship

- Implementation of site specific geological modelling workflows
- Customised Skills Development
- Ongoing Geo modelling Support and Guidance

Training Programs

- Online/In Person public and private training courses
- Basic, Intermediate and Advance levels
- Deposit specific courses – Kimberlite, Lode Gold, Maps to Models, Geostats and Coal

Software

- Seequent Software Sales
- Leapfrog Geo, Edge
- Seequent Central
- MX Deposit
- Imago
- Oasis Montaj

2. Geographic location



Figure 1: Location of the study area (red pin).

- The study area is located in the **Limpopo Province** of South Africa.
- Approximately 22 km northeast of the rural town of Northam.
- Has an extent of 4.3 km x 0.63 km.
- Located within the **Palaeoproterozoic** (2.55-2.60 Ga) **Bushveld Igneous Province** (BIC) in South Africa**.**
  (Kinnaird, 2005)

2. Geographic location



Figure 2: The location of the study area (red cross) within the Western Limb of the BIC.

- The Bushveld Igneous Complex (BIC) is the largest known layered intrusion in the world.
- Extends 450 km east-west and 350 km north-south (~ 66 000 km^2).
- This complex spans across four provinces in South Africa: Limpopo, North-West, Mpumalanga, and Gauteng (Hasch, 2022).
- The vertical thickness of the layered rocks reaches a maximum of 12 km in places, with some individual layers being traced for more than 150 km along strike (Cawthorn et al., 2006).
- Over time, the rim of the intrusion has been exposed by erosion, revealing three major separate segments known as the **Western, Eastern** and **Northern** Limbs.

3. Regional geological setting

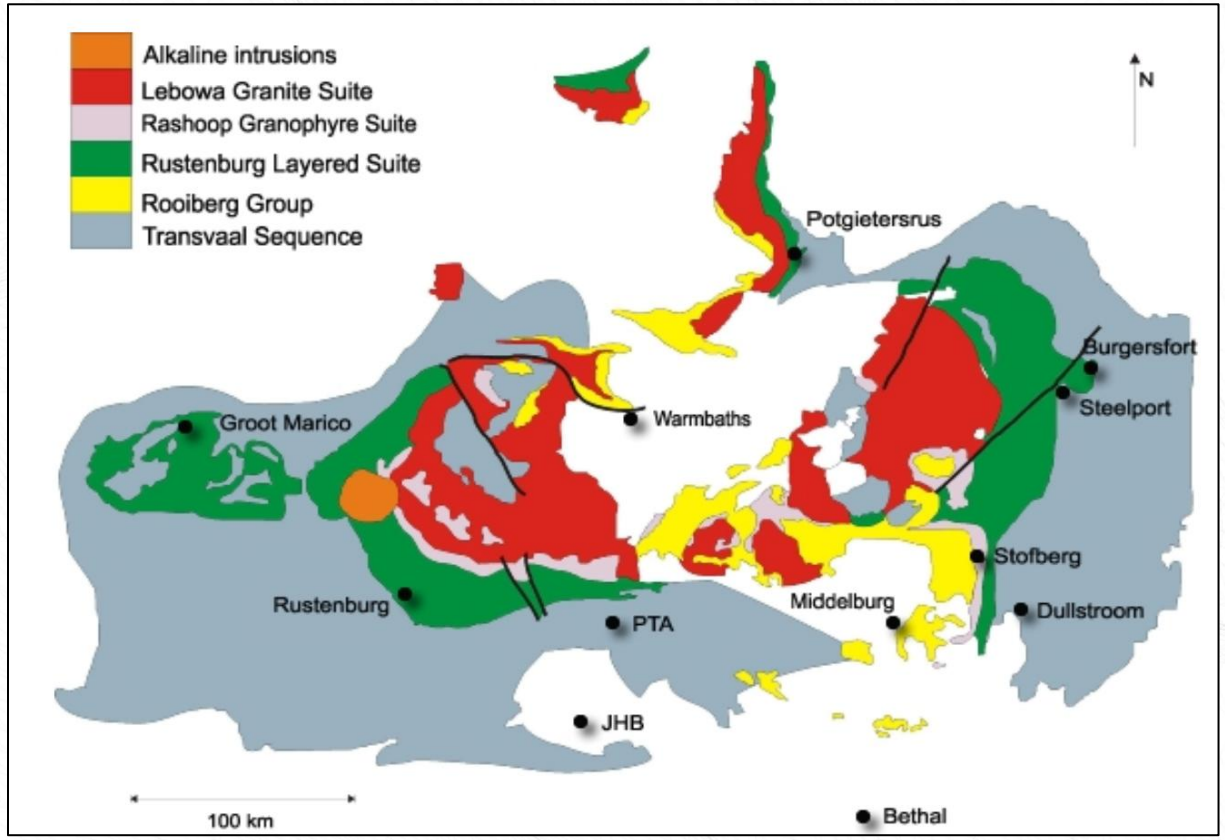


Figure 3: Simplified geological map of the Bushveld Igneous Complex, which shows the major limbs of the mafic layered rocks from the Lebowa Granite Suite, Rashoop Granophyre Suite, Rustenburg Layered Suite, and Rooiberg Group. This map also shows the contact with the Transvaal Sequence. Sourced from Kinnaird (2005).

The BIC is composed of gently steepening sheets of mafic and ultramafic rocks of four main suites (oldest to youngest):

- Rooiberg Group**
- Rustenburg Layered Suite (RLS) (2.054 Ga)
- Rashoop Granophyre Suite
- Lebowa Granite Suite

(Cawthorn et al., 2006)

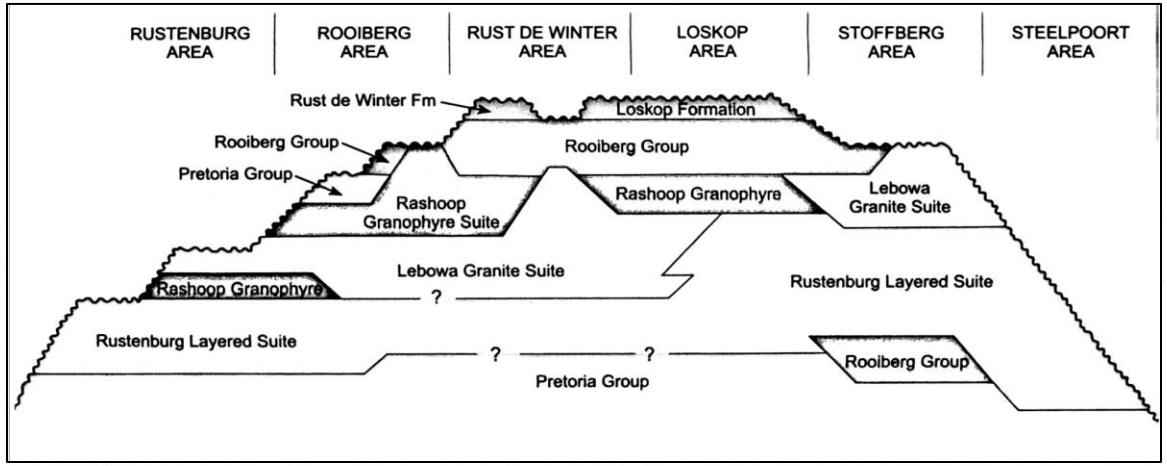


Figure 4: Schematic west-east cross-section of the geology of the Bushveld Igneous Complex. Modified after Cawthorn et al (2006).

3. Regional geological setting

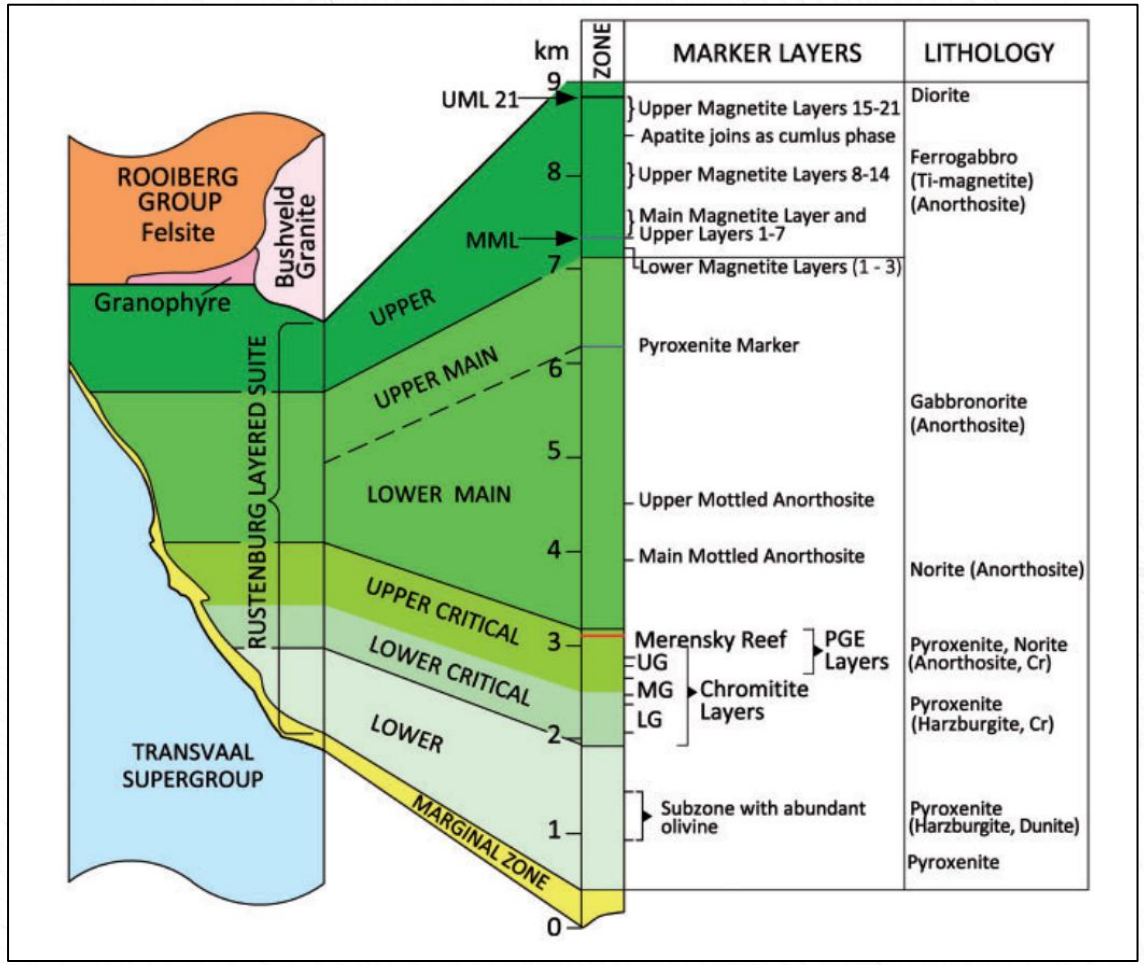


Figure 5: Schematic depiction of the Rustenburg Layered Suite subdivided into zones of distinct lithologies and marker layers. Chromitite layers are restricted to the Upper Critical Zone (UCZ) and Lower Critical Zone (LCZ). Sourced from Scoon and Costin (2018).

- The main part of the BIC is represented by mafic volcanic rocks of the Rustenburg Layered Suite (RLS), which is characterised by a fully differentiated sequence of ultramafic, mafic, and felsic rocks.
- The Rustenburg Layered Suite comprises five major subdivisions:
  - Upper Zone (UZ)
  - Main Zone (MZ)
  - Critical Zone (CZ)
  - Lower Zone (LZ)
  - Marginal Zone

  (Cawthorn et al., 2006)
- The Critical Zone is subdivided into the **Upper Critical Zone** (UCZ) and **Lower Critical Zone** (LCZ).
- A distinct feature of the RLS is the occurrence of relatively thick layers of **chromitite** (Scoon and Costin, 2018).

3. Regional geological setting

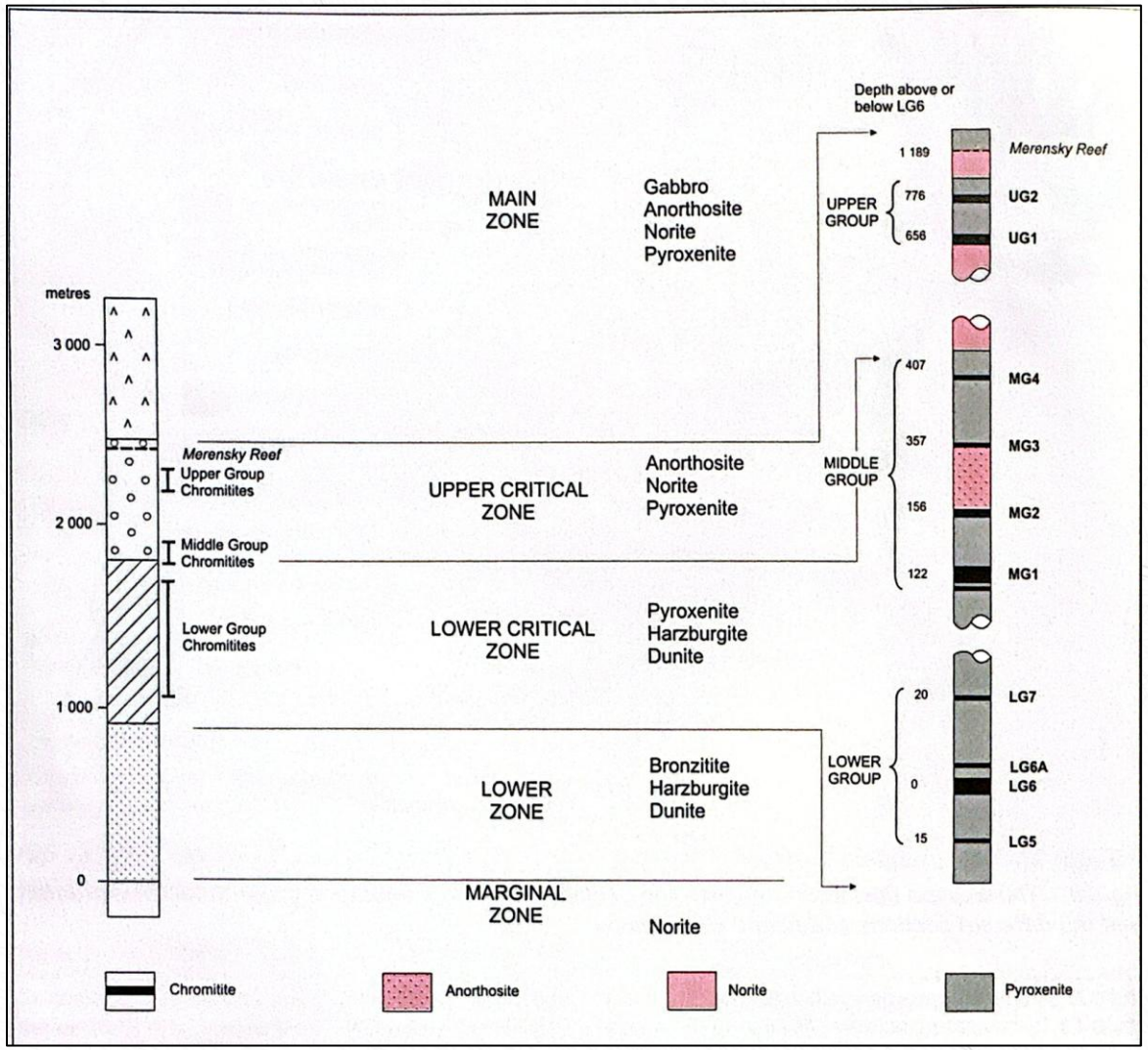


Figure 6: Illustration of the different zones and chromitite groups in the Rustenburg Layered Suite. Sourced from Schurmann et al. (1998).

- The Critical Zone (CZ) contains massive, distinguishable chromitite layers classified as the **Lower Group** (LG), **Middle Group** (MG), and **Upper Group** (UG).
- **Lower Critical Zone:** LG 1 – 7
- **Upper Critical Zone:** MG 1 – 5, UG 1 – 3, Merensky Reef, Bastard Reef, Platreef (Northern Limb)

(Scoon and Costin, 2018)

4. Local geology and project overview

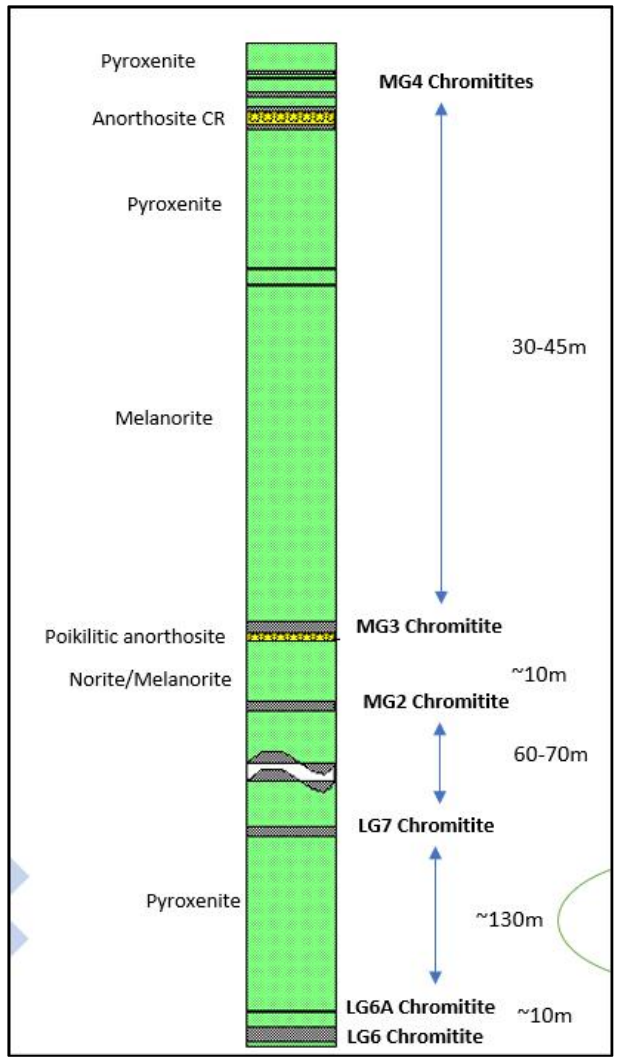


Figure 7: Local geology of the study area. The MG1 is not well developed in this area.

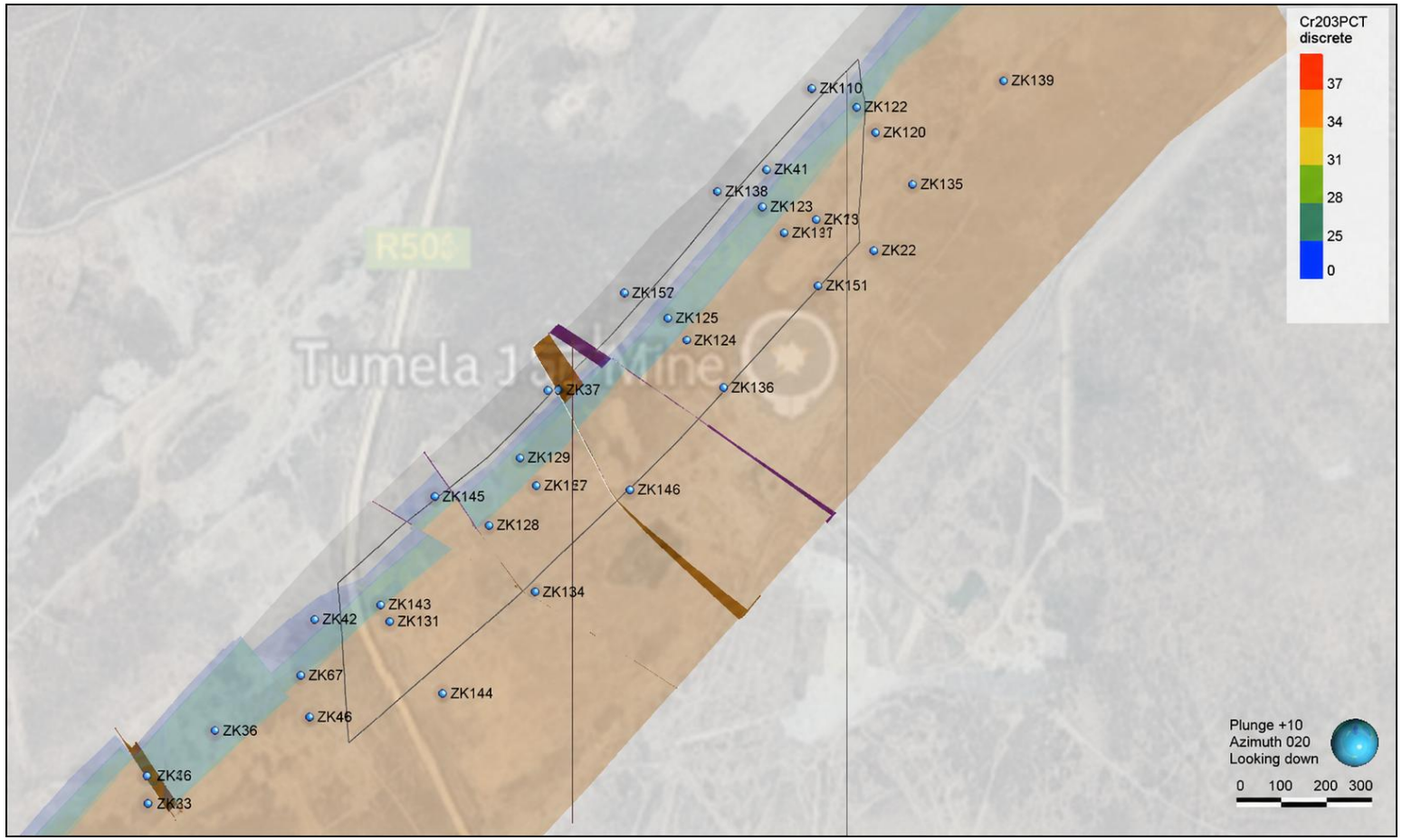


Figure 8: Plan view of the study area showing the drill spacing and faults.

5. Is your seam thickness consistent?

- Accurate seam thickness modelling is critical for developing reliable geological models and resource estimates, particularly where tabular geological units are disrupted by faulting.
- In faulted settings, apparent variations in seam thickness between adjacent fault blocks can arise, especially where **data coverage is limited**.
- If not appropriately addressed, these variations may introduce geological artefacts and contribute to the over- or under-estimation of seam volumes and tonnage.
- Where faults exhibit limited lateral displacement, the true thickness of a geological unit would generally be expected to remain relatively consistent across adjacent fault blocks.
- However, modelling based solely on 3D surface elevation can result in artificial thickness variations as the model attempts to honour structural geometry.

6. Geological modelling

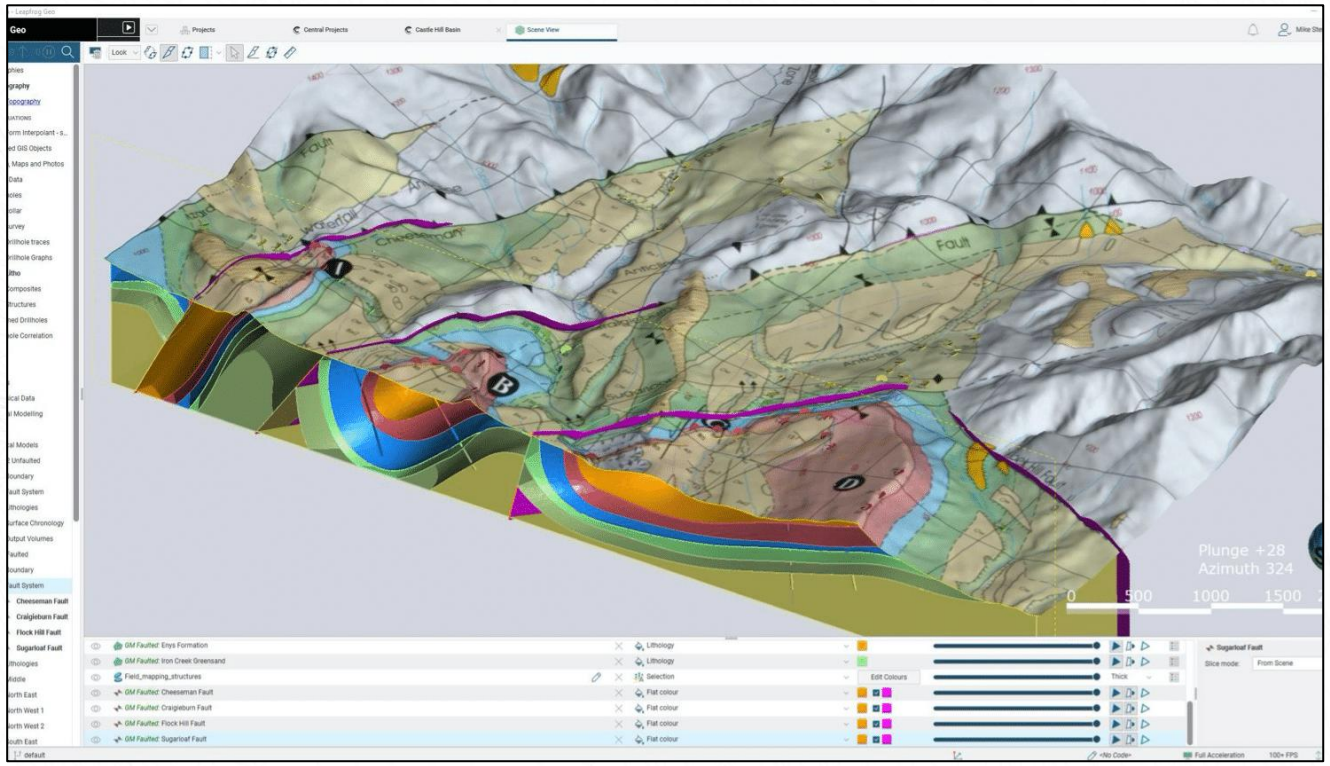
- The geological models (seams) were created using the 3D geological modelling software Leapfrog Geo.

What is Leapfrog Geo?

Leapfrog Geo is a workflow-based, 3D implicit geological modelling tool which allows you to quickly construct models directly from various sources including drillholes, points and surfaces.

Leapfrog uses a **volumetric algorithm** called the **FastRBF™** to construct first-pass surfaces quickly; these surfaces can then be modified as needed to fit your geological interpretations.

Due to its implicit nature, your models can be dynamically updated to honour new input data at any time.



7. Thickness Modelling - Prototype

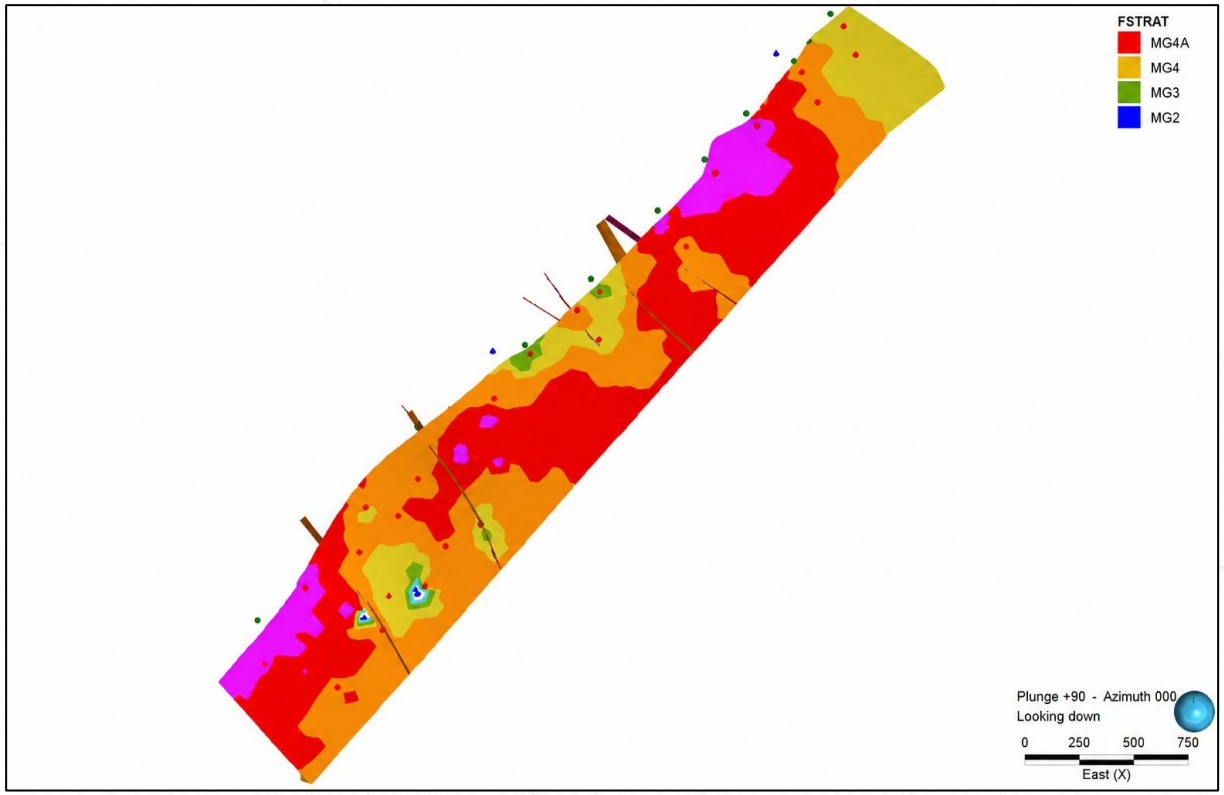


Figure 9: Thickness plot of the unfaulted MG4 seam. Note the consistent thickness across the fault blocks. Thickness plots calculated using Leapfrog's RBF Interpolant.

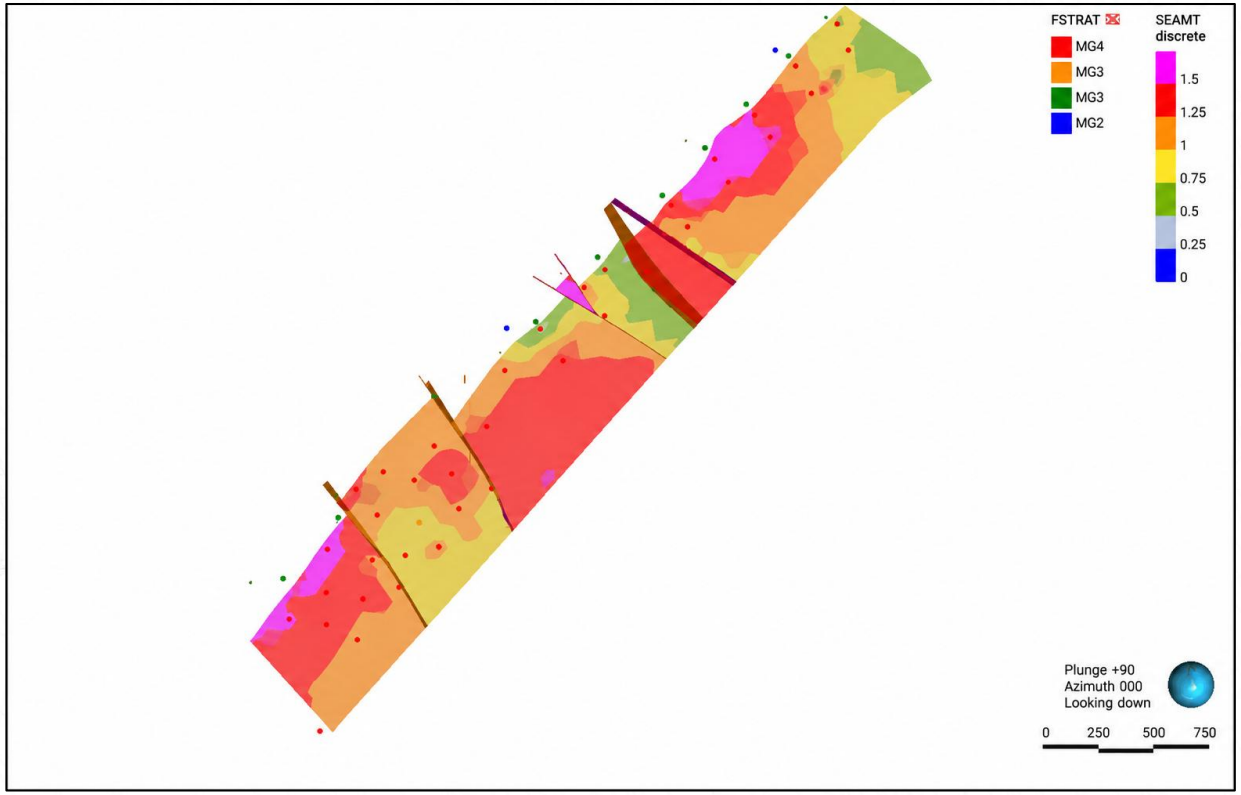


Figure 10: Inconsistent seam thickness in the MG4 seam across fault blocks.

This prototype explores an **integrated approach** that combines **3D surface elevation** with a **thickness interpolant** to better constrain the geometry and continuity of tabular units across faulted domains. By incorporating thickness as an additional modelling control, the approach aims to preserve geological continuity while maintaining the structural relationships defined by the fault framework.

7. Thickness Modelling - Prototype

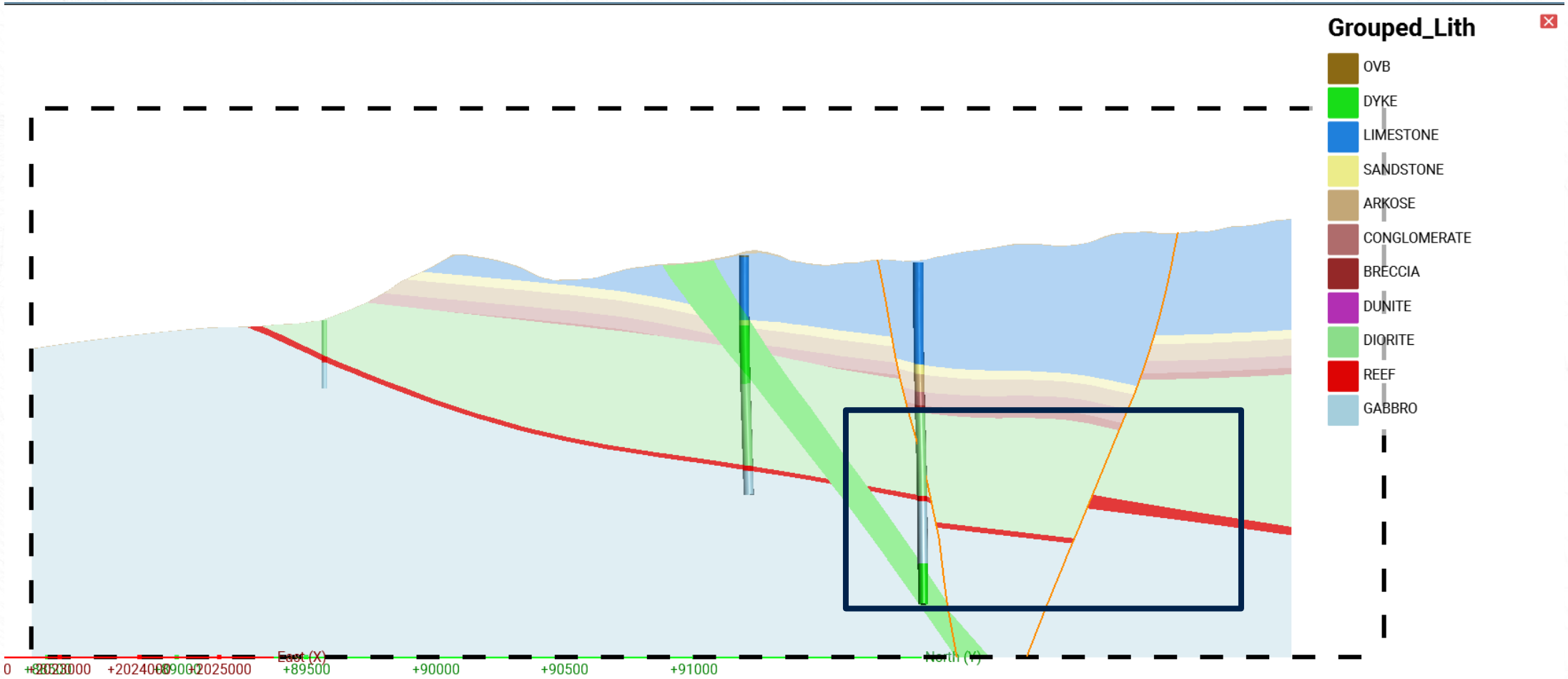
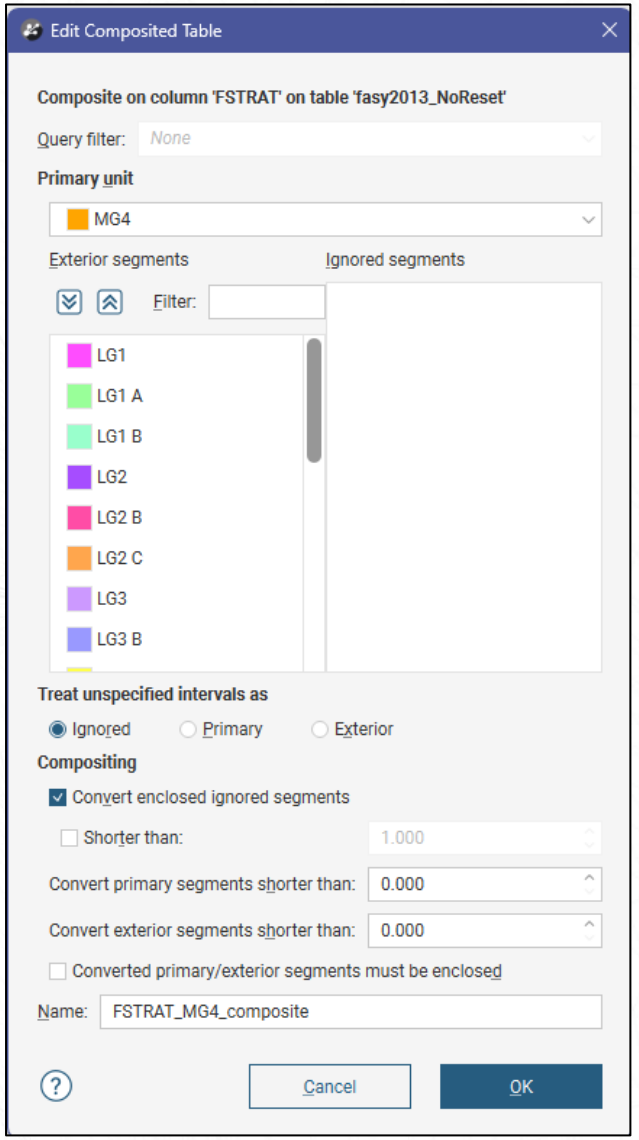


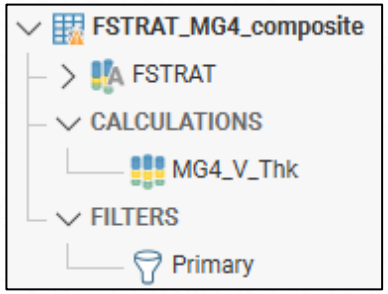
Figure 11: An example of inconsistent seam thickness across faults in a3D geological model.

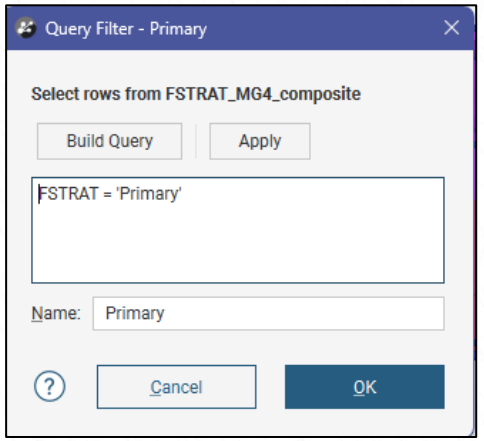
7. Thickness Modelling - Prototype

Steps:

- Create a seam using Leapfrog Geo's veining tool.
- Copy the faulted model and remove faulting to create faulted and unfaulted models. Use the unfaulted model for validation.
- Determine which surface is to remain fixed (HW or FW). In this case, it is the FW.
- Composite Intervals in drill holes to a single continuous interval, in this case, MG4.
- Check that the composite has worked, then create the Calculated Column (V_Thk = to-from). Note, we are working with vertical thickness. Set up the query filter for primary intervals only.



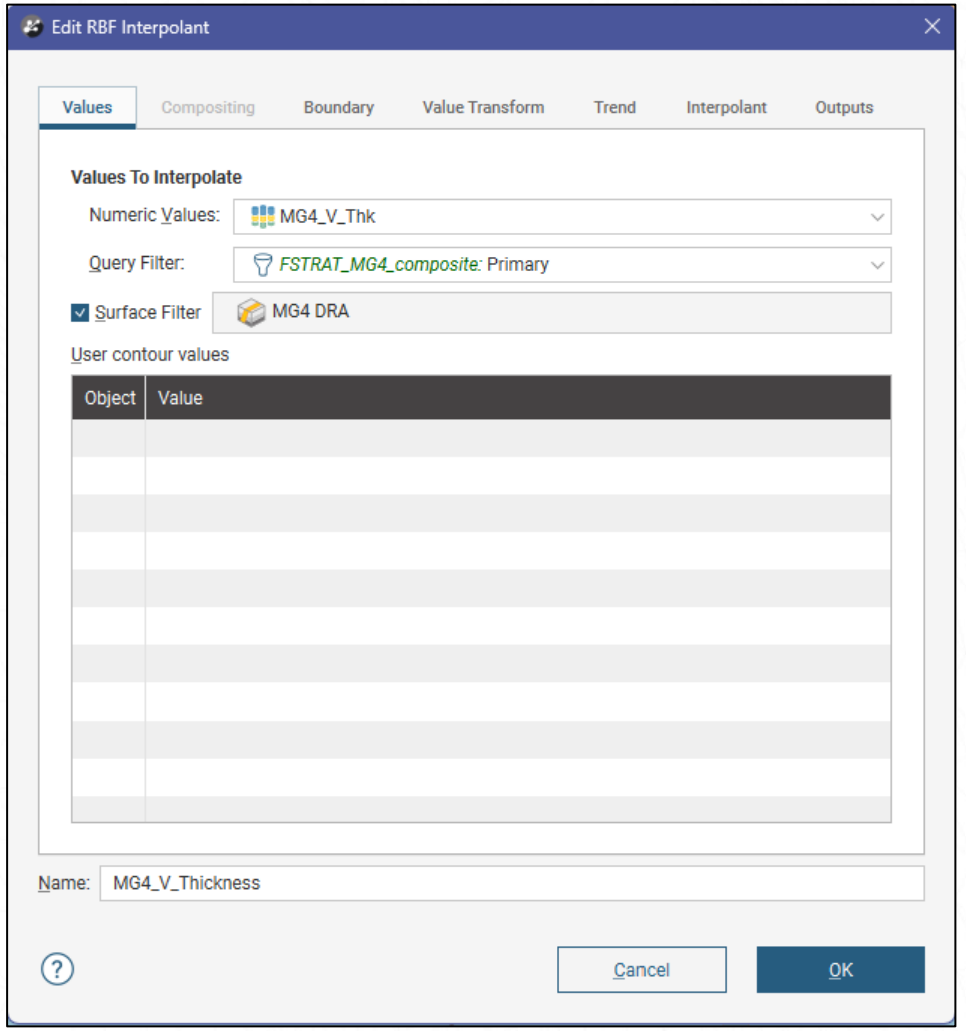




7. Thickness Modelling - Prototype

Steps:

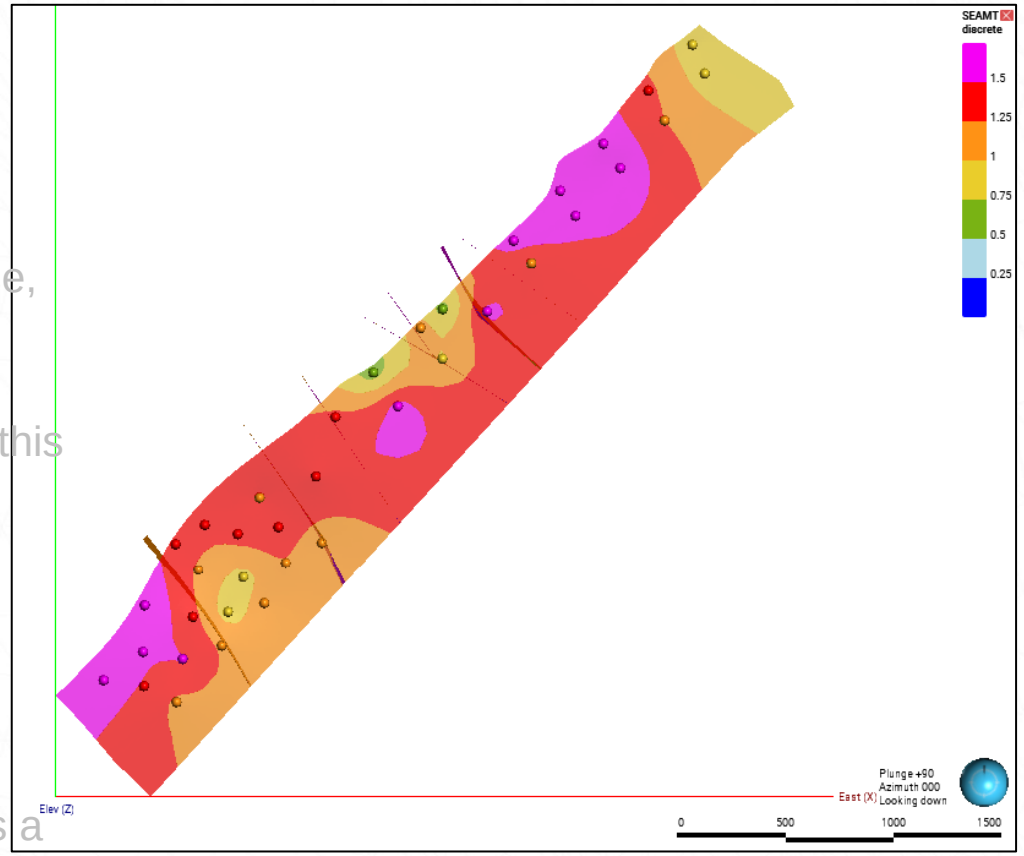
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- Setup V_Thickness Interpolant. Use unfaulted Geological Model as a boundary and use the filter to interpolated MG 4 Thickness.



7. Thickness Modelling - Prototype

Steps:

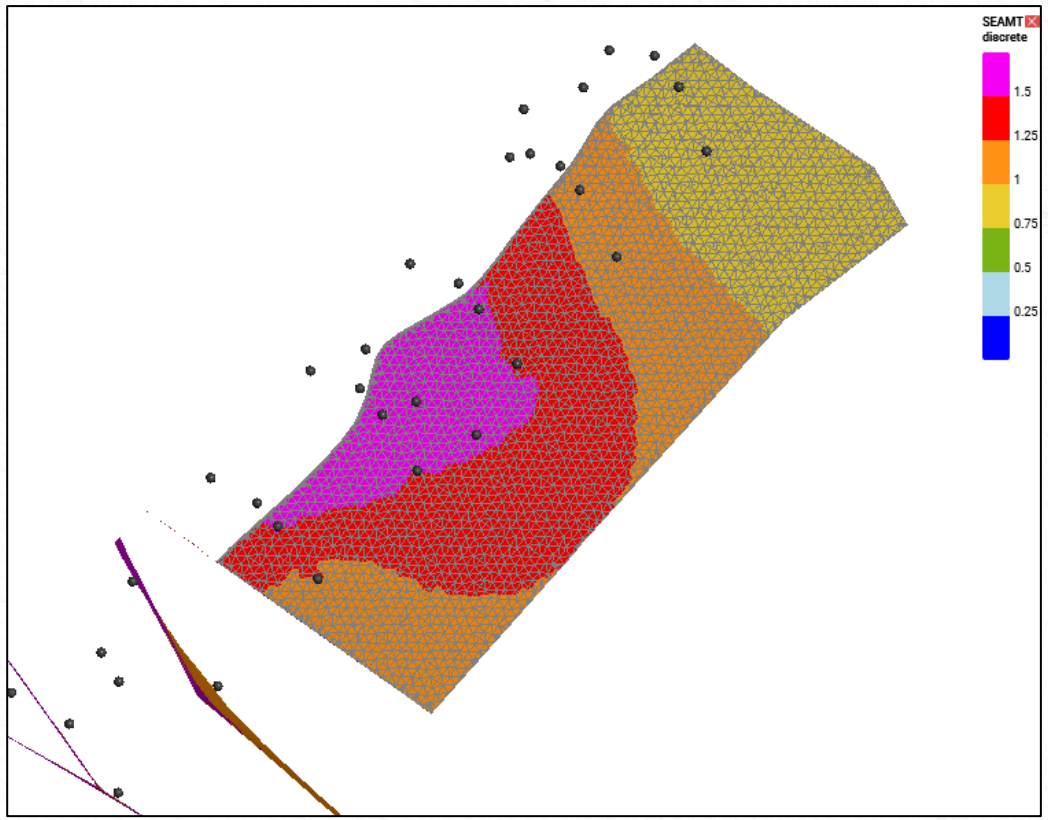
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- Check that the composite has worked, then create the Calculated Column (V_Thk = to-from). Note, we are working with vertical thickness. Set up the query filter for primary intervals only.
- Setup V_Thickness Interpolant. Use unfaulted Geological Model as a boundary and use the filter to interpolated MG 4 Thickness.
- Check and Validate. Adjust Interpolant settings until happy.



7. Thickness Modelling - Prototype

Steps:

- Apply **Evaluation against the FW of the Faulted model.**
- Extract Vertices of the FW Surface, include evaluations and exact clipped vertices. Rename points file for FB
- Export points and calculated new Z for HW elevations
- The Import adjusted points file.



Ignored	id	x	y	z	MG4_V_Thickness
	1	33969.1...	-273979...	930.009...	1.10091959501
	2	34032.7...	-273971...	932.784...	0.955448254048
	3	33761.8...	-274021...	870.415...	1.67453893279
	4	33651.7...	-274022...	908.256...	1.82164661393
	5	33698.2...	-274014...	921.015...	1.65302635748
	6	33818.5...	-274013...	875.686...	1.51999280082
	7	3369			
	8	3377			
	9	3383			
	10	3356			
	11	3349			
	12	3358			
	13	3363			
	14	3333			
	15	3338			
	16	3343			
	17	3407			
	18	3397			
	19	3403			

	A	B	C	D	E
1	x	y	z_old	MG4_V_Thickness	z_adjusted
2	33969.143	-2739800	930.00988	1.100919595	931.1108
3	34032.758	-2739713	932.78473	0.955448254	933.74018
4	33761.88	-2740211	870.41587	1.674538933	872.09041
5	33651.772	-2740229	908.2567	1.821646614	910.07834
6	33698.207	-2740145	921.01556	1.653026357	922.66859
7	33818.578	-2740135	875.68648	1.519992801	877.20647
8	33693.097	-2740302	864.04302	1.776353972	865.81938
9	33777.746	-2740317	821.47159	1.642443378	823.11403
10	33838.131	-2740238	827.05358	1.556988555	828.61057
11	33565.52	-2740211	949.07865	1.951865557	951.03052
12	33498.92	-2740296	939.67788	2.195445995	941.87333
13	33584.681	-2740317	901.6791	1.965168802	903.64427
14	33631.056	-2740125	955.79425	1.712925561	957.50717
15	33339.2				
16	33387.7				
17	33434.6				
18	34078.8				
19	33970.				
20	34034.0				
21	34012.4				
22	34142.				

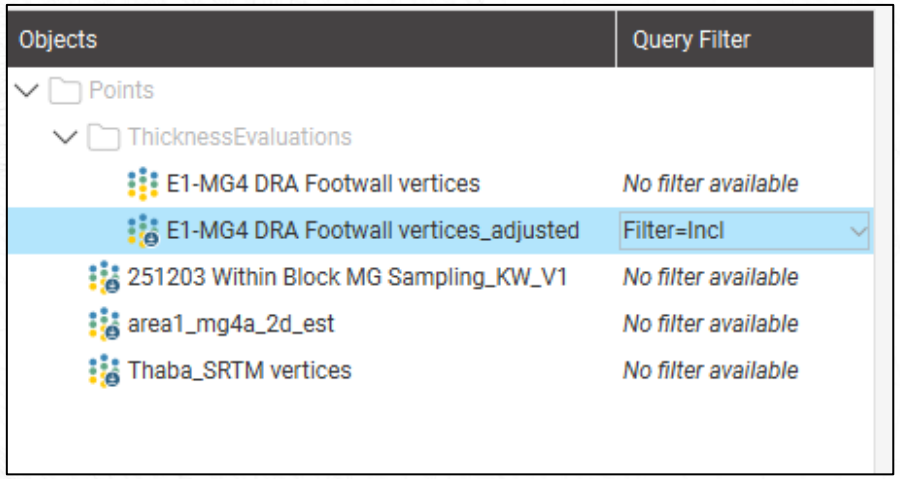
File Data

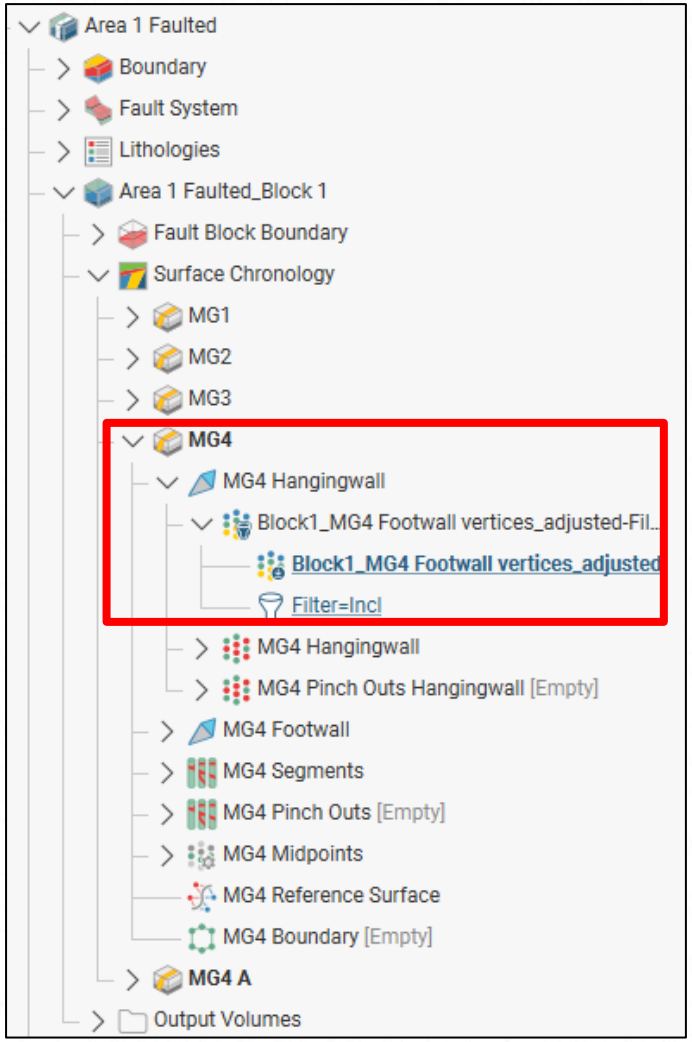
	East (X)	North (Y)	Not Imported	Not Imported	Elev (Z)
1	x	y	z_old	MG4_V_Thickness	z_adjusted
2	33969.14343	-2739799.795	930.0098788	1.100919595	931.1107984
3	34032.75751	-2739712.676	932.7847277	0.955448254	933.7401759
4	33761.87959	-2740210.686	870.4158677	1.674538933	872.0904066
5	33651.7723	-2740228.632	908.2566979	1.821646614	910.0783445
6	33698.20686	-2740144.693	921.0155618	1.653026357	922.6685881
7	33818.5781	-2740135.308	875.68648	1.519992801	877.2064728
8	33693.09739	-2740302.356	864.0430219	1.776353972	865.8193759
9	33777.74574	-2740317.427	821.471585	1.642443378	823.1140284
10	33838.13149	-2740238.441	827.0535814	1.556988555	828.61057
11	33565.5201	-2740211.466	949.0786507	1.951865557	951.0305162
12	33498.92047	-2740296.41	939.6778843	2.195445995	941.8733303
13	33584.68136	-2740317.004	901.679098	1.965168802	903.6442668
14	33631.05632	-2740125.492	955.7942452	1.712925561	957.5071708
15	33339.29743	-2740512.809	930.4690078	1.747124251	932.2161321
16	33387.71843	-2740447.907	934.0274892	1.93578464	935.9632738

7. Thickness Modelling - Prototype

Steps:

- Create a new category column to filter out any points.
- Create a filter and add points to the FB HW surface.



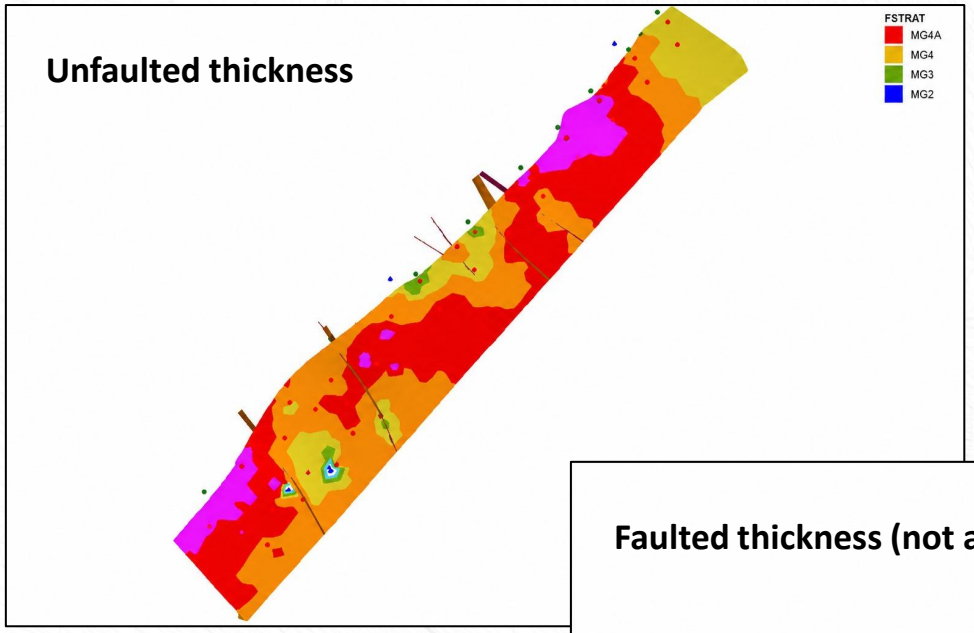


7. Thickness Modelling - Prototype

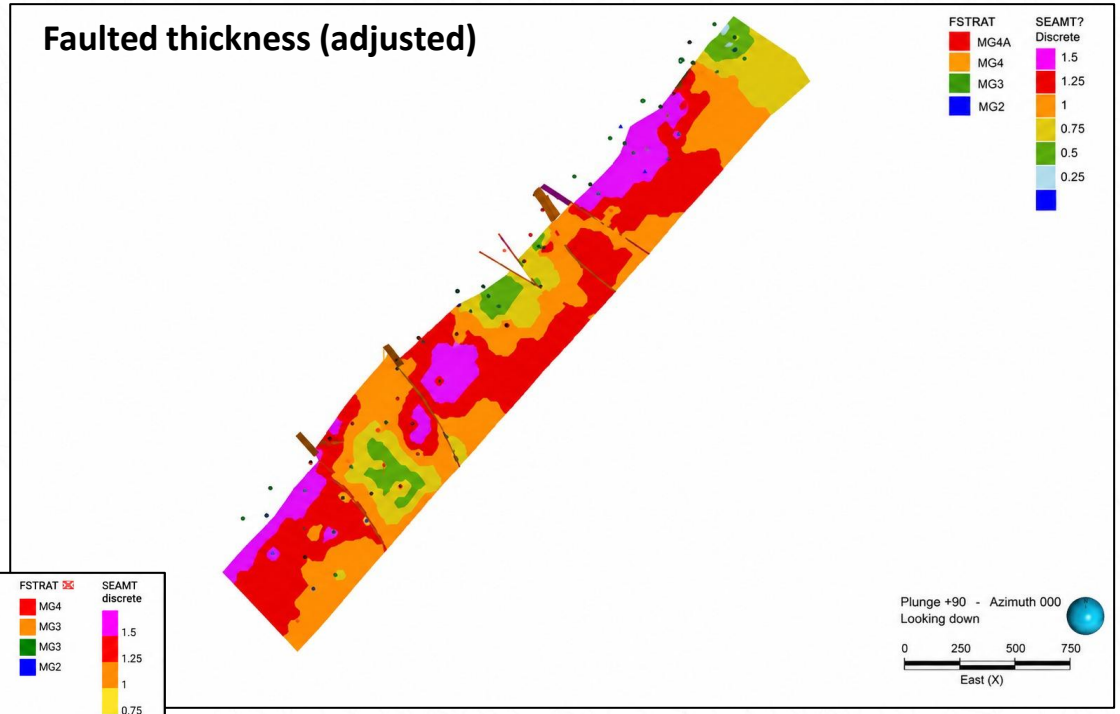
Steps:

- Repeat for all other fault blocks.

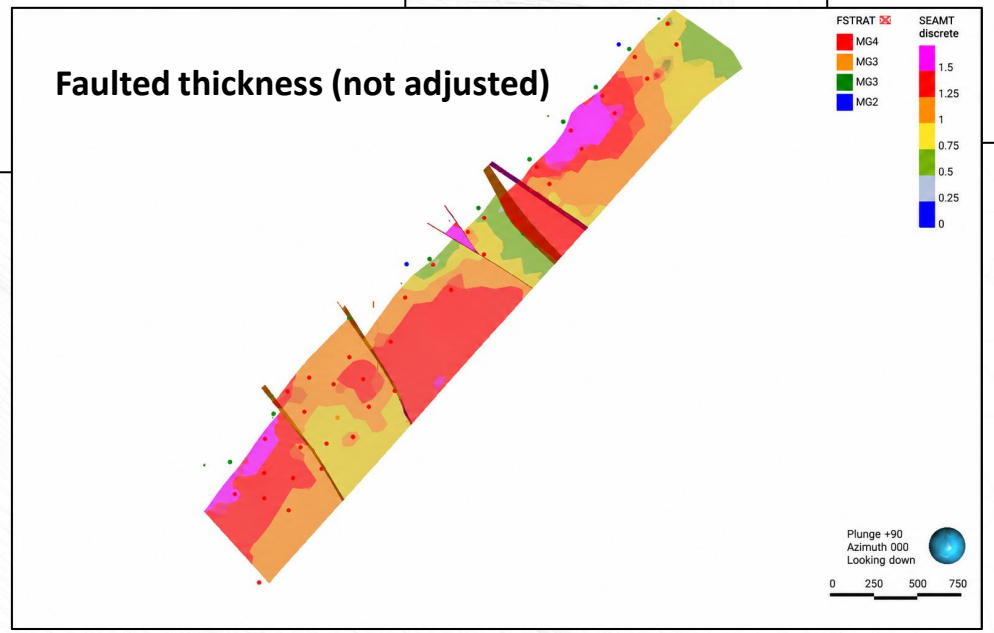
Unfaulted thickness



Faulted thickness (adjusted)



Faulted thickness (not adjusted)



8. Conclusions

- Accurate seam thickness modelling is critical for developing reliable geological models and resource estimates, particularly **where tabular geological units are disrupted by faulting.**

- In faulted settings, apparent **variations in seam thickness between adjacent fault blocks** can arise, especially where data coverage is limited. If not appropriately addressed, these variations may introduce geological artefacts and contribute to the over- or under-estimation of seam volumes and tonnage.

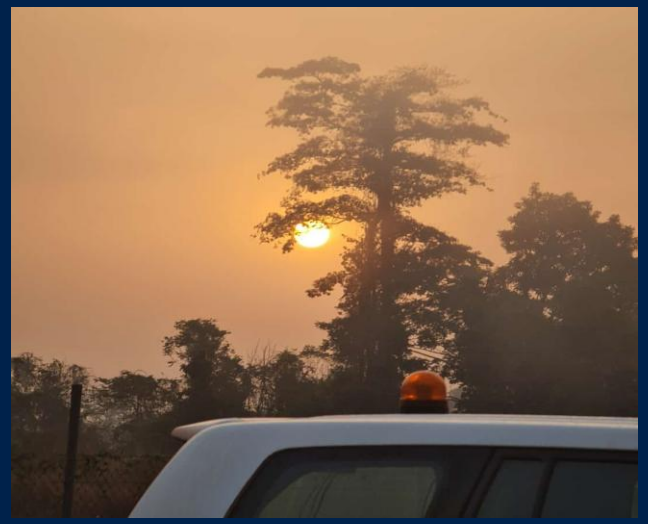
- Where faults exhibit limited lateral displacement, the true thickness of a geological unit would generally be expected to remain relatively consistent across adjacent fault blocks. However, modelling based solely on 3D surface elevation can result in **artificial thickness variations as the model attempts to honour structural geometry**.

- An integrated approach that combines 3D surface elevation with a thickness interpolant should be considered. This approach will better constrain the geometry and continuity of tabular units across faulted domains. By incorporating thickness as an additional modelling control, **the approach aims to preserve geological continuity while maintaining the structural relationships defined by the fault framework.**

- Additionally, the presentation highlights practical considerations for applying thickness constraints in 3D geological modelling workflows and demonstrates how **integrating geological understanding with modelling techniques can improve the consistency and robustness of resource models**.









Thank you, questions?

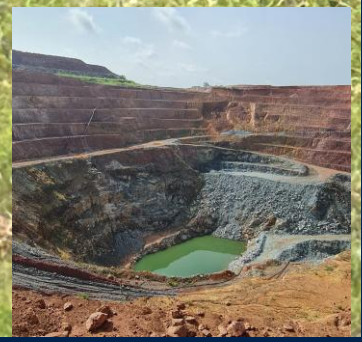












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