CUBE CONSULTING

Tabular Deposits:
A Volume Comparison of Deterministic and Leapfrog Volumes

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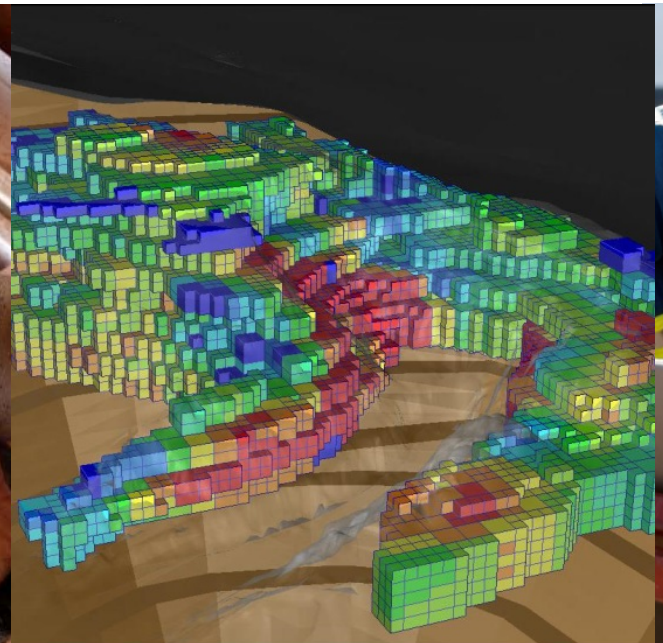



Volume Analysis: Introduction

Questions

- How can we evaluate the interpreted volumes of tabular orebodies built from traditional cross-sectional and implicit modelling methods?
- Should we be concerned with the risk associated with our interpretation?
- Should the interpretation risk be considered when reporting a MRE?

Objective

- To investigate a simple solution to critically interrogate the interpreted volumes of tabular orebodies

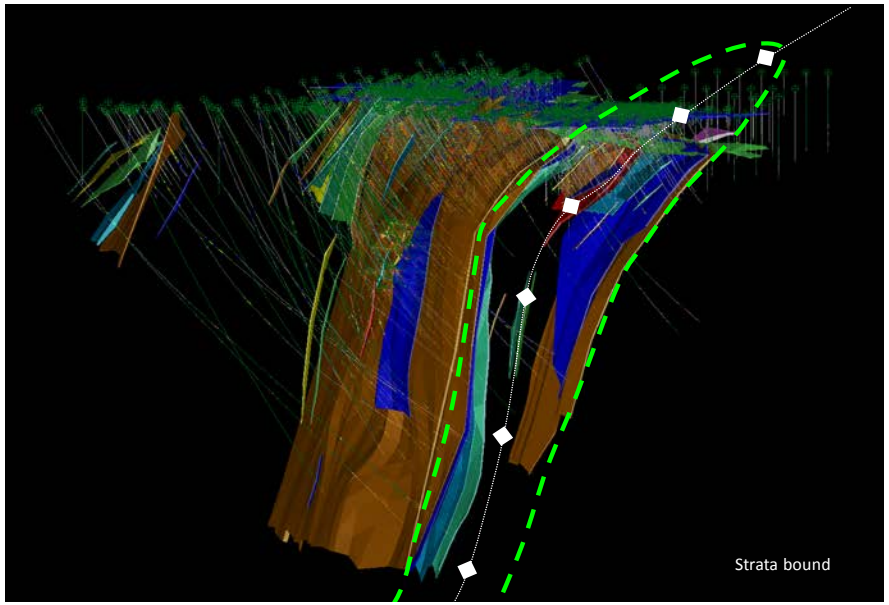
Volume Analysis: Background

The risk associated with the interpreted volumes of tabular orebodies increases as:

- The true width decreases with respect to the strike and down-dip dimensions (i.e. narrower orebodies have a greater risk)
- The variability and nugget effect of the economic variable increases
- The structural complexity increases (i.e. pre, syn and post)

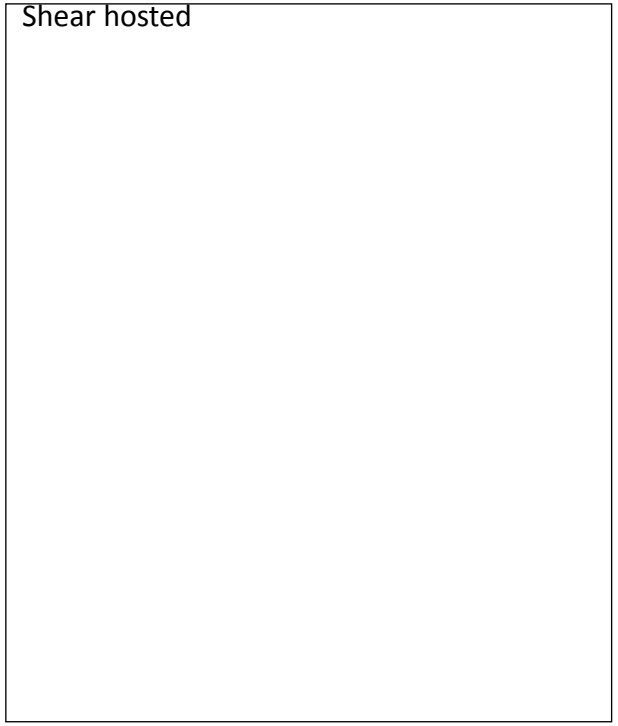
Examples:

- Shear hosted
- Strata bound
- Massive nickel sulphides



Volume Analysis: Validation Approach

- Performed using the same approach used to validate variables such as gold, copper, etc
- On average the interpreted thickness should reproduce the sampled thickness:
  - Global comparison of interpreted volumes
  - Global comparison of interpreted thickness and the sampled thickness
  - Semi-local comparison or Swath Plot Analysis of the interpreted and sampled thickness



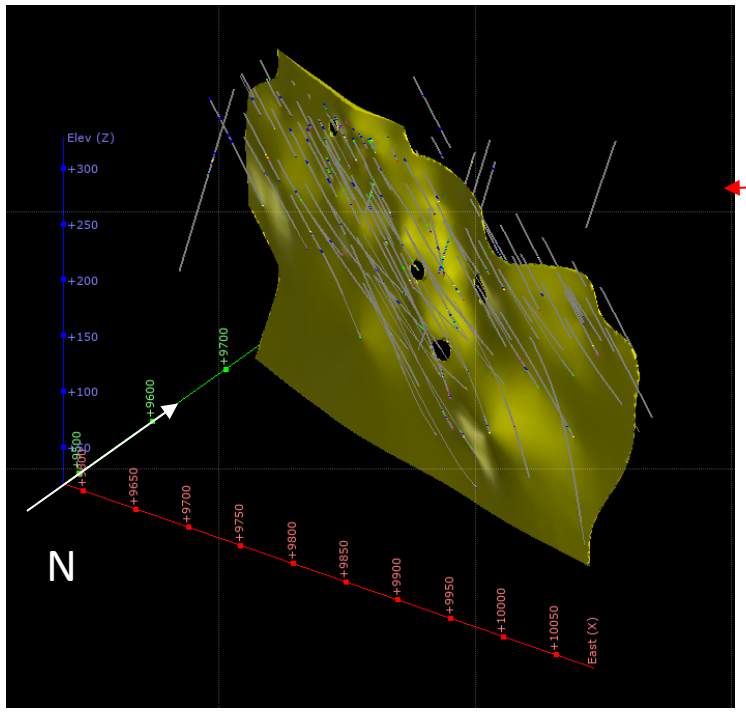
Volume Analysis: Validation Method

Methodology assumes that the interpreted volumes have been generated:

1. Determine the horizontal or vertical width of the drill hole intercepts (i.e. sampled thickness)
   - Trigonometry methods using the down hole intercept length, dip and dip direction of the drill hole and the dip and dip direction of the interpreted orebody
   - “New Distance” function within Leapfrog
2. Determine the width of the interpreted volumes at a nominal spacing (i.e. estimated thickness at 5m x 5m spaced long section intervals)
   - Block model manipulation
   - Draping point over the hanging and footwall surfaces
   - “New Distance” function within Leapfrog
3. Conduct the comparison between the estimated thickness and sampled thickness

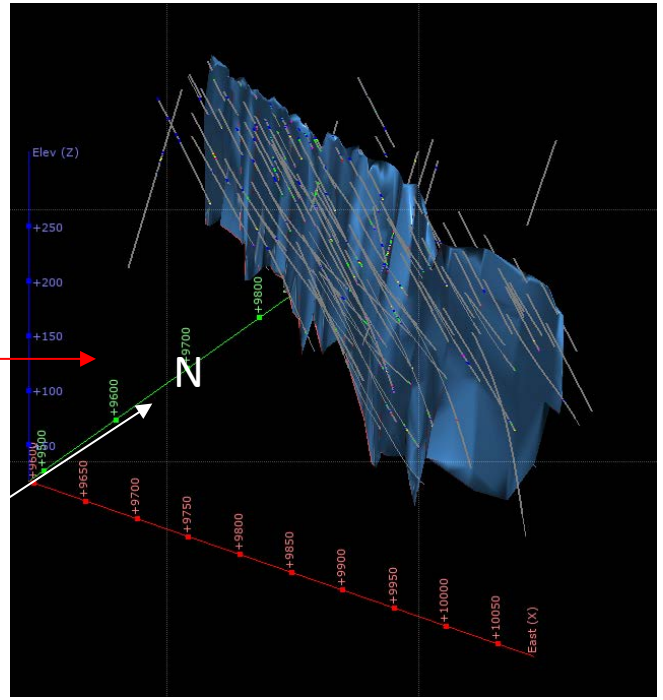
Example 1: Narrow Lode Gold Deposit

- Shear hosted gold deposit - the higher grades are associated with quartz veining
- Drilling is based on RC and diamond drilling methods
- Sectional interpretation based on 25 m spaced sections and the interpretation supplied by the client
- Leapfrog shapes based on “vein modelling” tool and “pinch outs” were applied



Leapfrog Interpretation

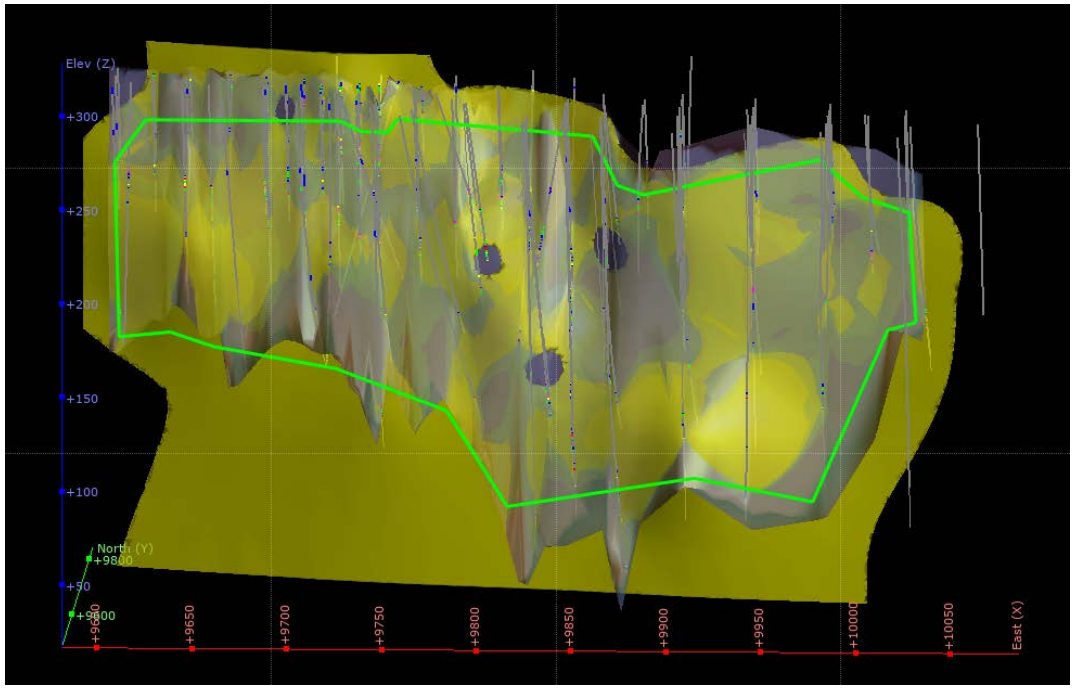
Sectional Interpretation



Example 1: Narrow Lode Gold Deposit

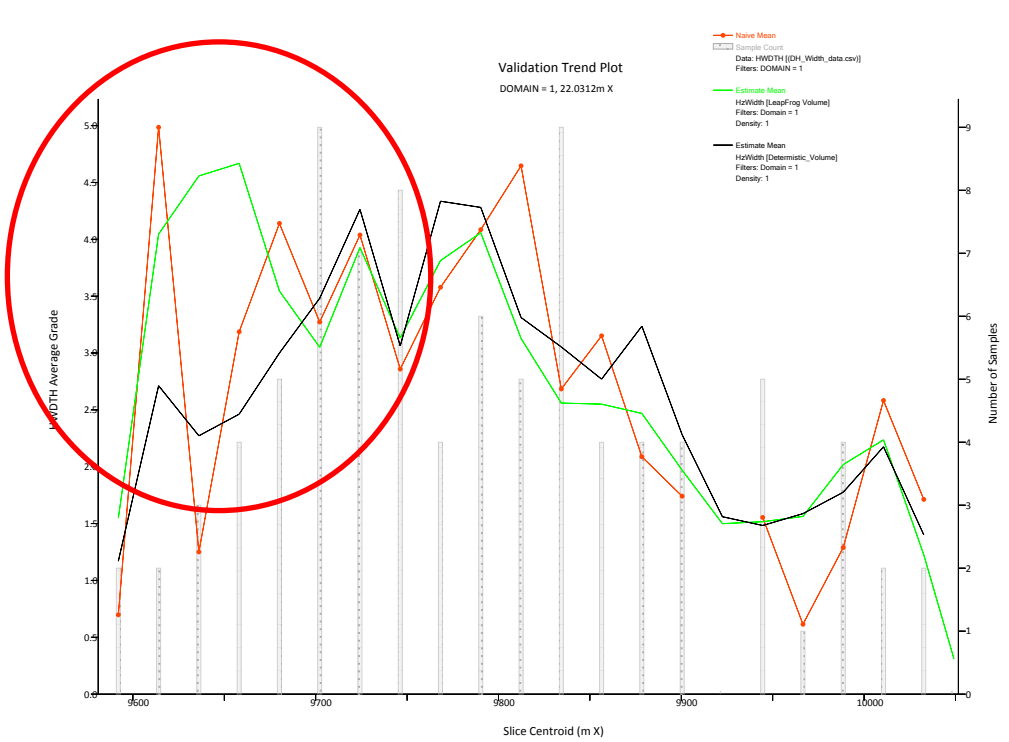
Global comparison conducted within the same long section area projection

- Interpretation Volume Comparison
  - Leapfrog – 146,126m^3
  - Sectional – 143,703m^3
  - 2% difference in volume
- Horizontal Width Global Comparison
  - Drill holes Average - 2.95m
  - Leapfrog Average - 3.21m (+9% diff)
  - Sectional Interpretation - 3.10m (+5% diff)

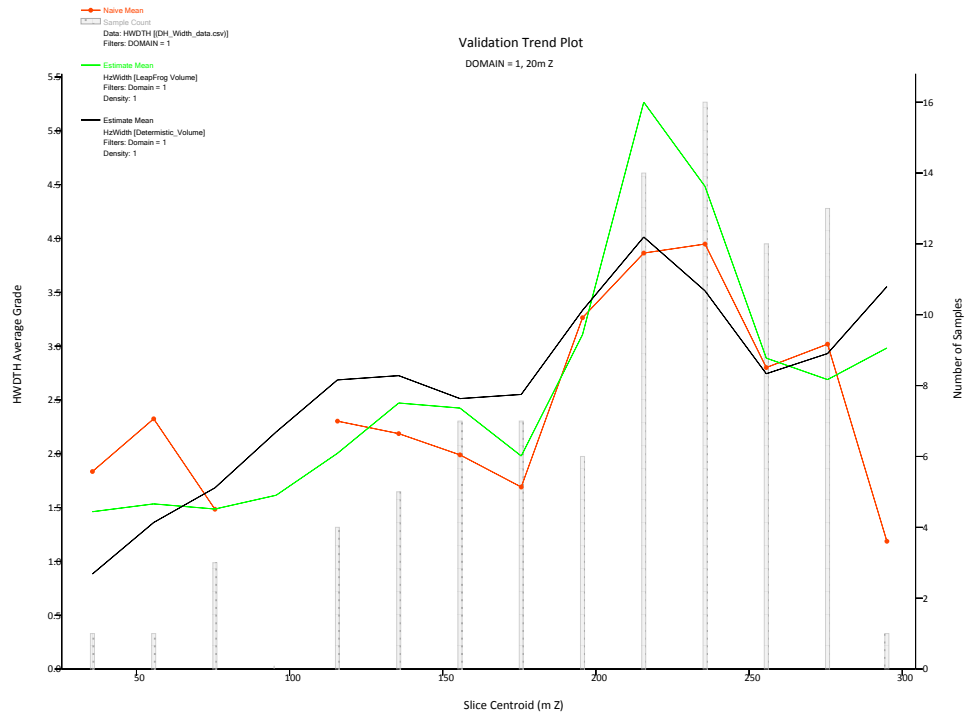


Example 1: Swath Plot Comparison

Leapfrog Interpreted Volumes – Green
Sectional Interpreted Volumes – Black
Sampled thickness - Red



Easting Swath

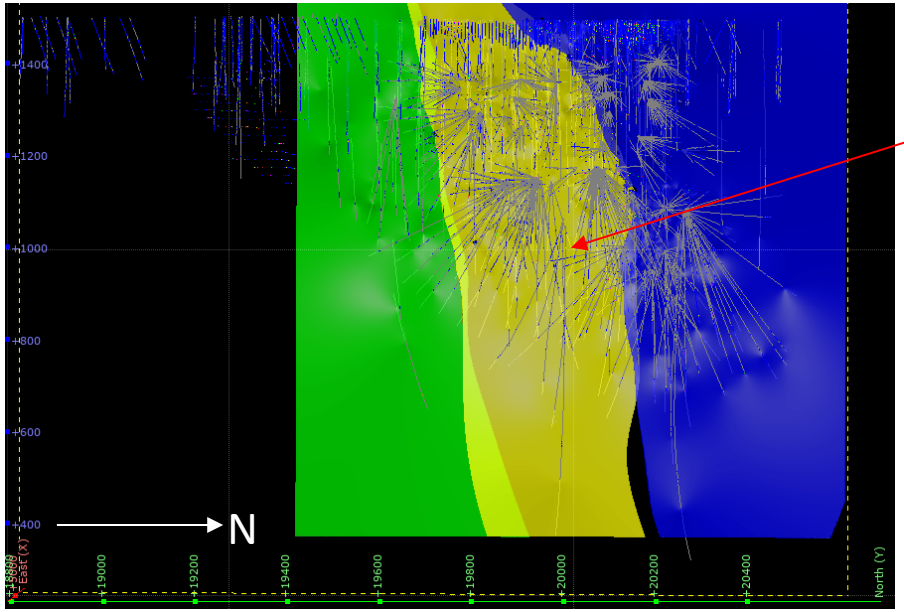


Elevation Swath

- Note the difference between the interpreted volumes in the poorly informed regions.

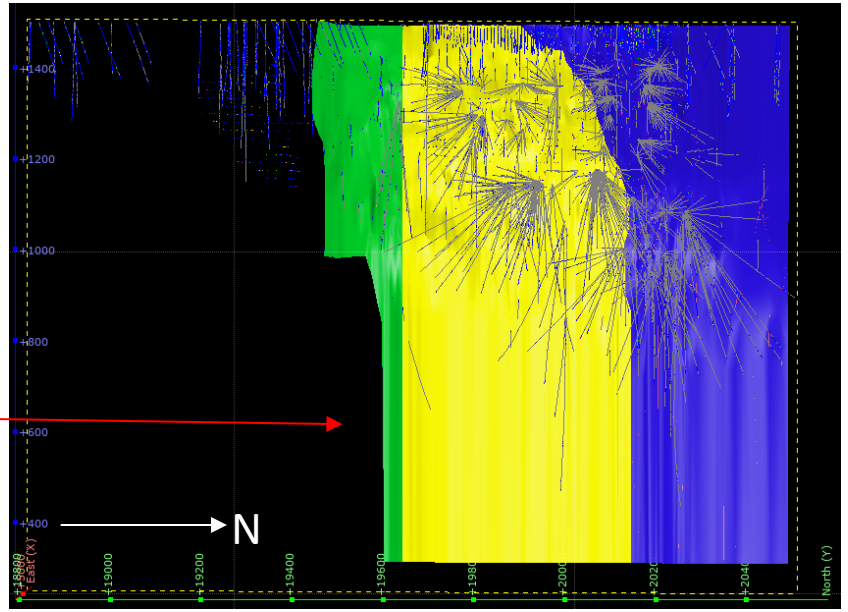
Example 2: Narrow Lode Gold Deposit

- Shear hosted deposit with quartz veining and higher grades associated with S-fabrics within the vein
- Interpretation based on diamond and underground grade control sampling
- Sectional interpretation based on 5 m spaced sections
- Leapfrog shapes created using the “vein modelling” function



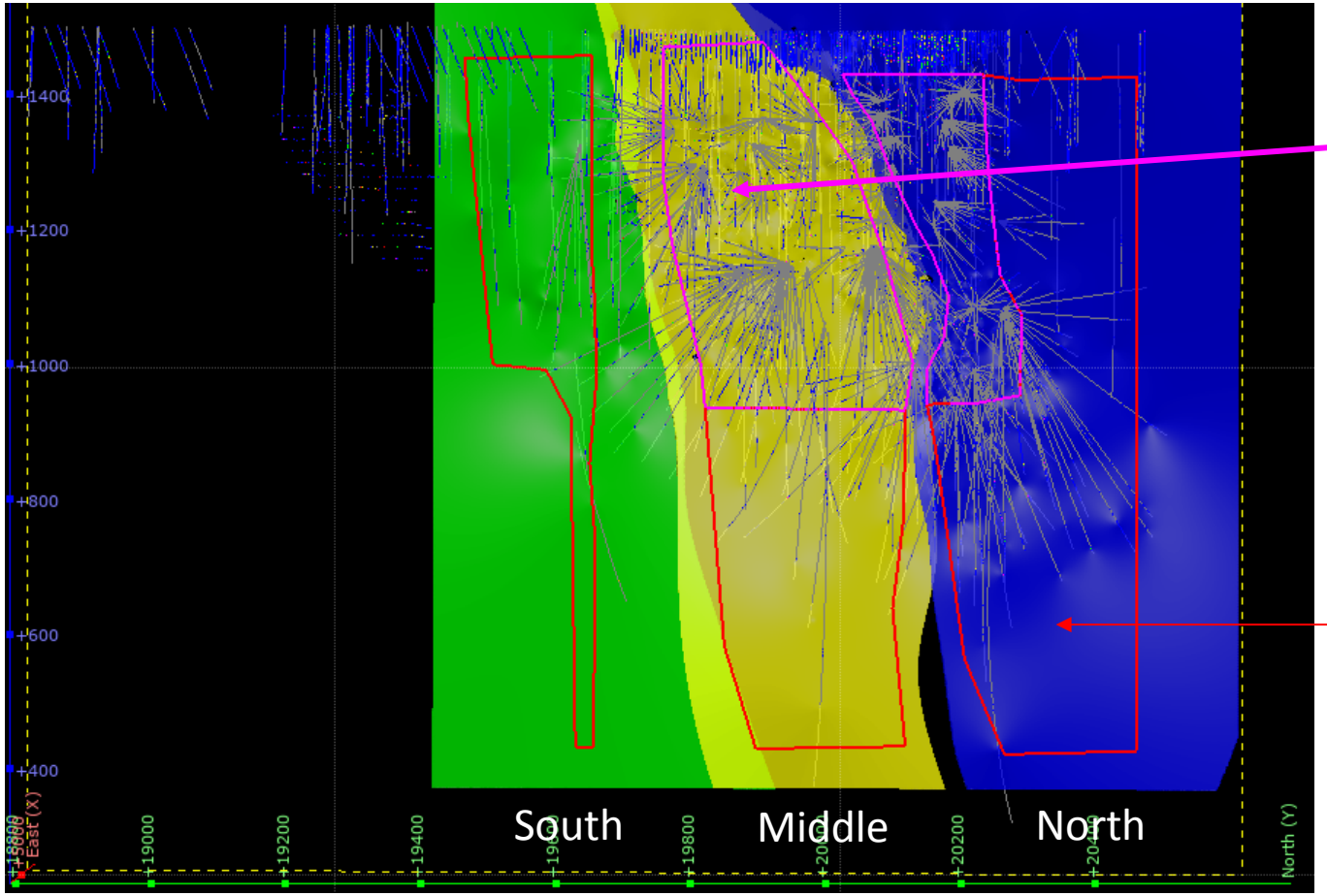
Leapfrog Interpretation

Sectional Interpretation
(5m spacing)



Example 2: Narrow Lode Gold Deposit

- Comparison conducted within like areas and further separated into grade control and resource definition regions



UG

Resource Definition

Example 2: Narrow Lode Gold Deposit

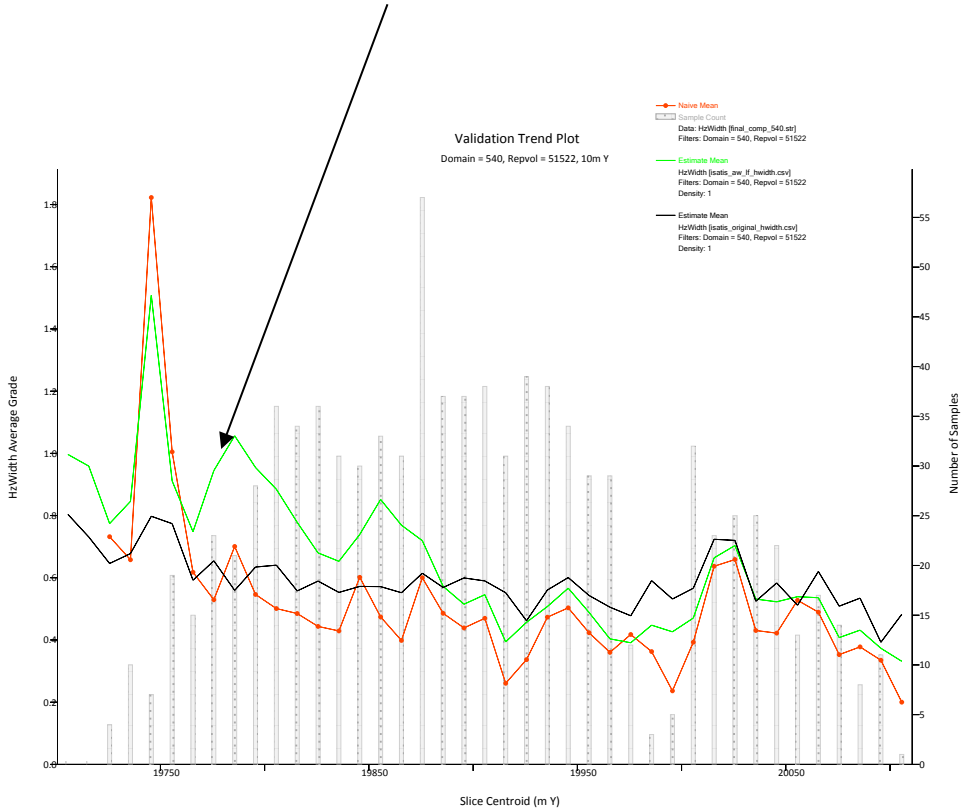
- Interpreted Volume Comparison
- Horizontal Width Global Comparison

Volume Comparison				
Domain	Location	Original WF	LF WF	% Diff
South	Face	-	-	-
South	Res Def	62,474	53,493	-14%
Central	Face	73,857	70,662	-4%
Central	Res Def	101,183	46,560	-54%
North	Face	45,909	46,282	1%
North	Res Def	118,793	197,600	66%
	Total	**402,216**	**414,597**	**3%**

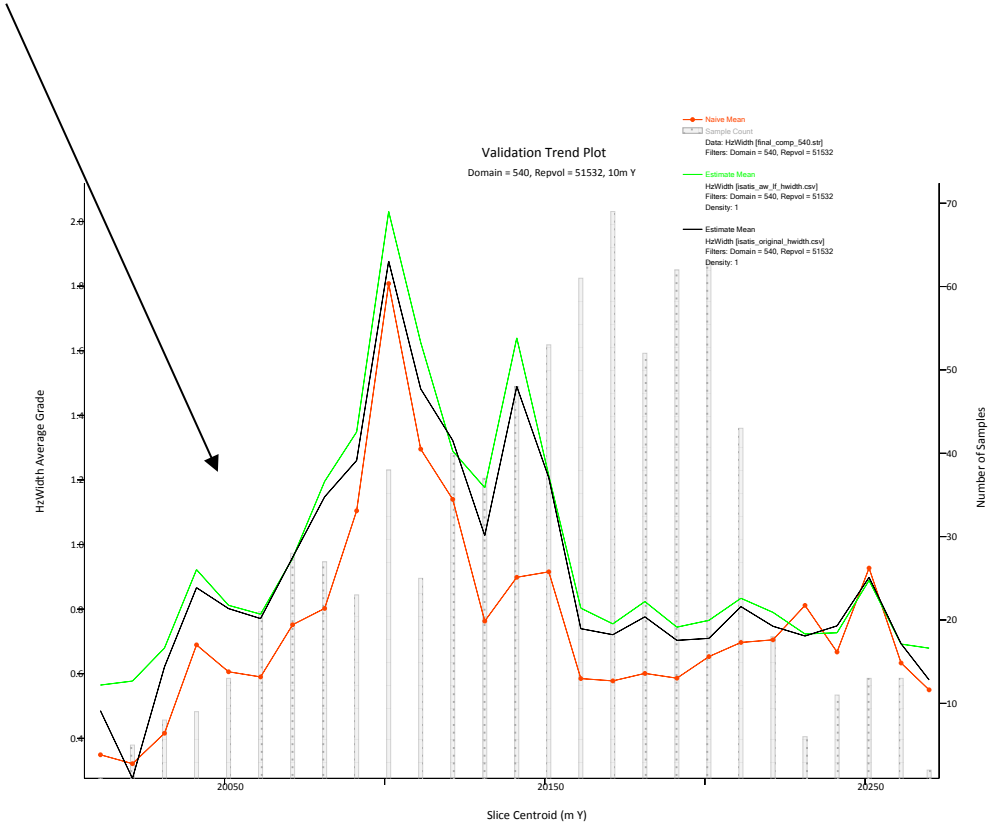
Horizontal Width Comparison						
Domain	Area	DH Mean (m)	Original WF Mean (m)	% Diff	LF WF Mean (m)	% Diff
South	-	-	-	-	-	-
South	ResDef	0.571	0.771	35%	0.676	18%
Central	Face	0.497	0.592	19%	0.7	41%
Central	ResDef	0.368	0.846	130%	0.452	23%
North	Face	0.795	1.029	29%	1.095	38%
North	ResDef	0.64	0.556	-13%	1.133	77%
	Total	**0.765**	**0.866**	**13%**	**0.921**	**20%**

Example 2: Swath Plot Comparison UG Area

Is there bias in the calculation of the drill hole horizontal width?



Central Area



Northern Area

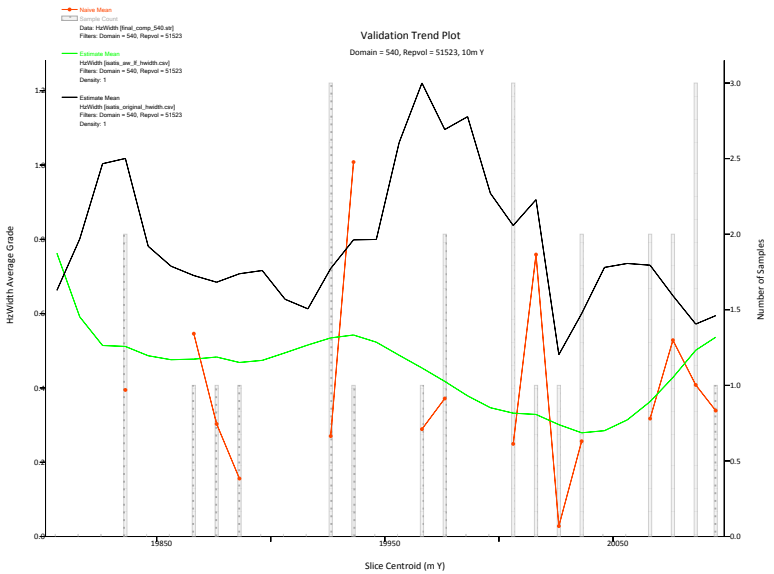
Leapfrog Interpreted Volumes – Green
Sectional Interpreted Volumes – Black
Sampled thickness - Red

Example 2: Swath Plot Comparison ResDef Area

LF: Extrapolation of lower thicknesses
Sect: Consistent

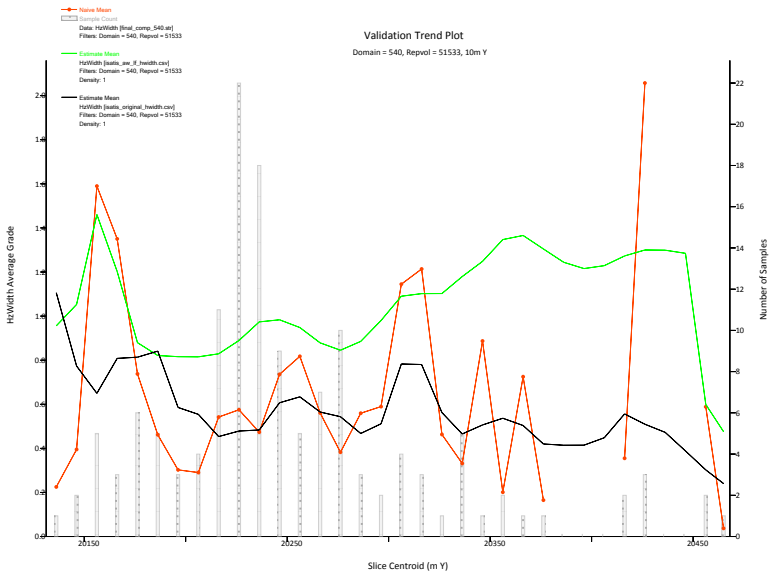
Southern Area

LF: Consistent
Sect: Optimistic Interpretation



Central Area

LF: Extrapolation of higher thicknesses
Sect: Consistent



Northern Area

Leapfrog Interpreted Volumes – Green
Sectional Interpreted Volumes – Black
Sampled thickness - Red

Volume Analysis: Conclusions

- Both interpretation methods can reproduce the global statistics within acceptable limits if constructed with due care
- The confidence in the interpreted volume increases as the sampling increases – as expected
- Poorly informed areas
  - Sectional volume is dependent of the pessimistic or optimistic nature of the person conducting the interpretation
  - Leapfrog volumes are influenced of outliers (positive and negative) which may increase or decrease the interpreted volumes
    - Easily overcome by introducing control points

Volume Analysis: What Next?

- Analysis can be extended by:
  - Assessing the variance of the estimation error (i.e. nearest neighbour analysis)
  - Validation against Ordinary Kriged estimate of the thickness variable
  - Risk analysis can be extended through use of conditional simulations

- Interpreted volumes should be critically reviewed to increase confidence in our modelling process
- Areas of higher risk should be reflected in the classification of the MRE