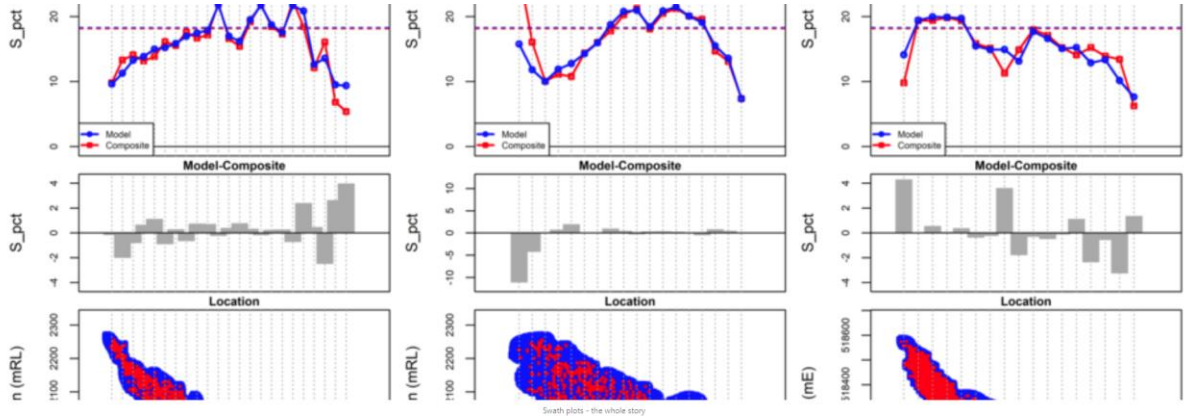

A better swath plot for mineral resource block model validation

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https://www.linkedin.com/pulse/better-swath-plot-mineral-resource-block-model-mark-murphy/

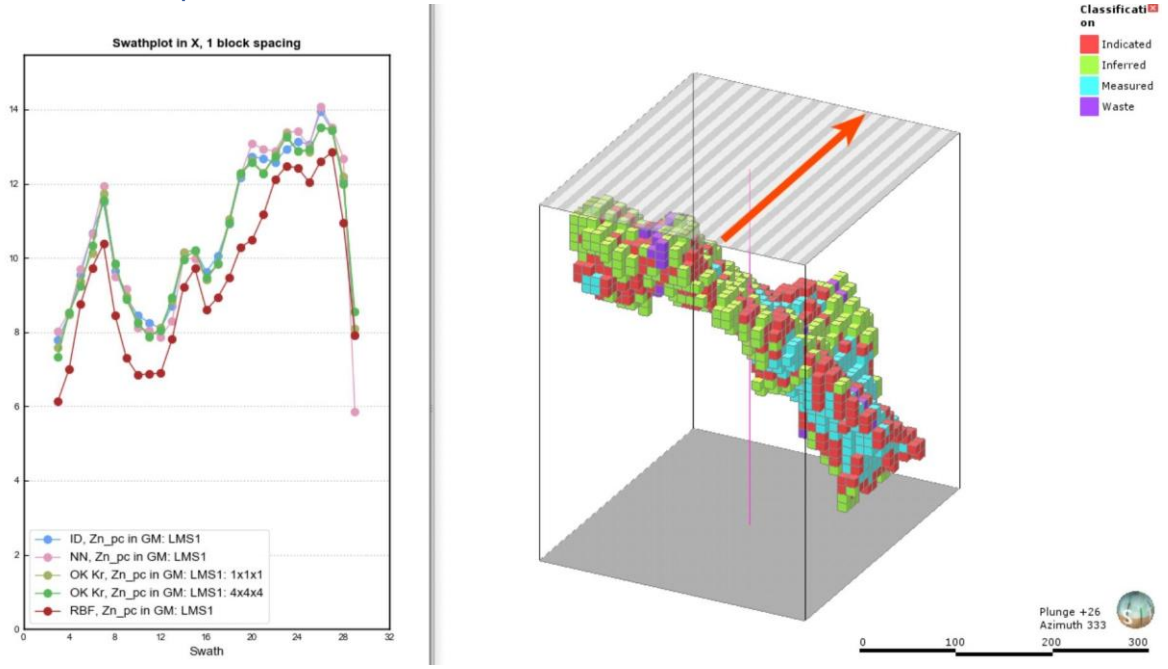
What is a swath plot?

In the mineral industry, mineral resource estimators typically prepare moving window mean plots as part of the validation of block model grade estimates. This process involves dividing the block model and the data used to estimate the blocks into slices of appropriate width – typically some multiple of the drill spacing – with slices created along the northing, easting and elevation directions.

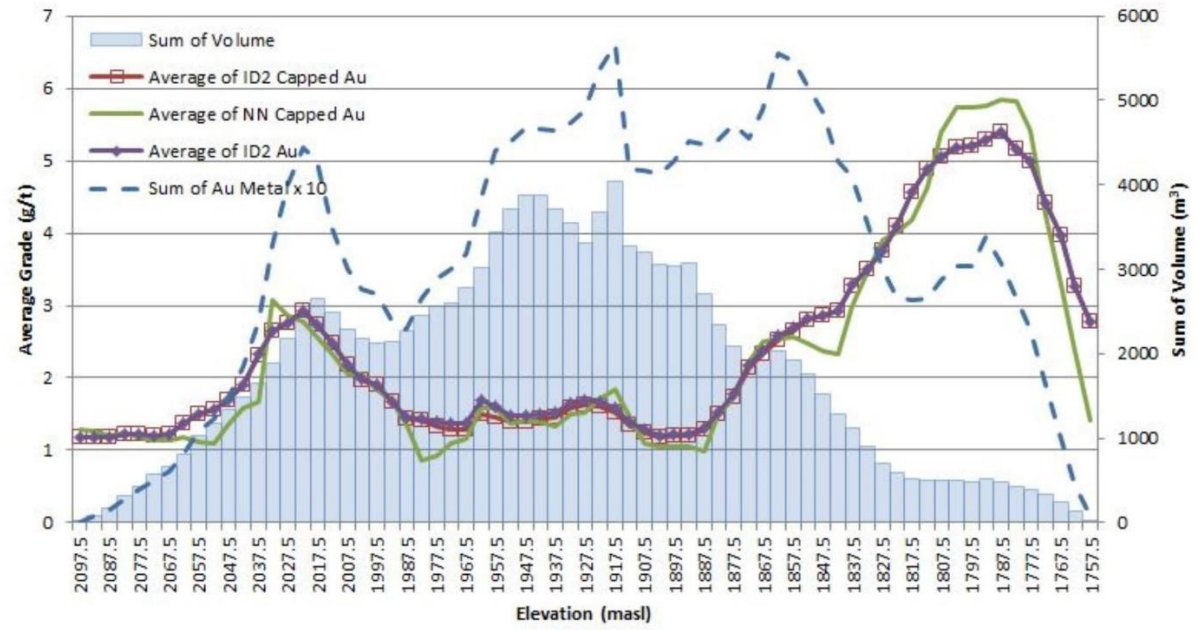
The mean grades of the all sample composites (usually with each composited weighted by a spatial influence value) within each slice are then plotted on either a line or dot plot so the modeller can assess whether the blocks in the model and samples within each slice have similar grades, and whether the overall grade trends in the data for a given slicing direction are acceptably reproduced in the block model. The industry colloquialism for these moving window average plots is 'swath plots' presumably to allude to the swath of composite or block grades cut by each slice.

Below are a two examples of swath plots found published on the web.

Swath Example 1



Swath example 2



The first example on is a compound X-direction swath plot showing the results of four different estimates, with the pink line (possibly) the estimation data and the red and dark blue lines the block model estimates. The second example is more complex but a bit more informative (it has elevation on the horizontal axis) although it is not too clear from the legend which trend line is the data and which are the block estimate lines.

However, the green line has more variation, so this is probably the mean of the data for each moving window slice as the data tends to have more variation (is less 'smooth') than the block estimates. This second swath plot also has a bar plot of the volume associated with each slice but neither plot tells the number of samples in each slice.

Now these are just two quick-find examples and I've seen many other examples that are more informative in public reports. However, my experience is that common industry practice is to assess each swath plot in isolation without considering the magnitude of the differences between the values compared and with no consideration (in the graphic) of the underlying spatial distribution of samples and blocks.

What makes a good graphic?

For some time, I've been attempting to follow the recommendation of Edward Tufte for the preparation of graphics in my mineral resource estimation work. If you don't know about Tufte's ideas perhaps have a look at this link for summary of the key concepts.

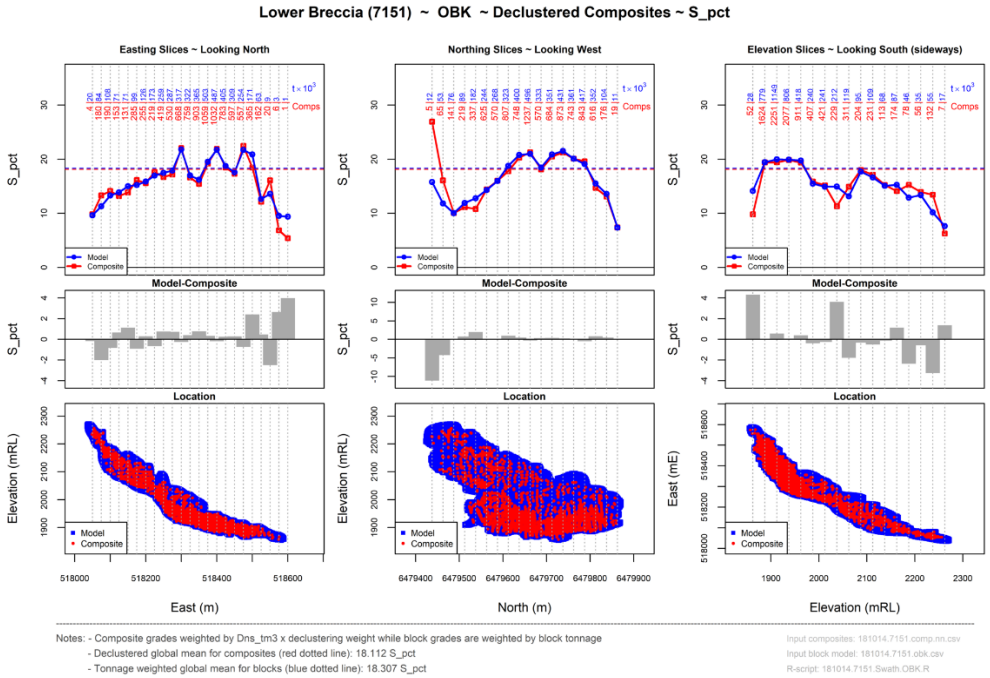
Briefly, the key Tufte takeaways I try to think about when designing a graphic are:

- Show the data - as much data information as possible
- Minimise the amount of non-data ink
- Separate layers of information (avoid dual scales)
- Utilise the micro information to support the macro presentation
- Use labels where appropriate
- Use small multiples to increase the information presented, show relationships and tease out layers of information
- Use colour conservatively.

So, let's look at applying these ideas to the swath plot analysis.

Murphy's Swath Plot

Below is an example of swath plots that I've been tinkering with for some years now that has been prepared using R software. The example is for sulphur grade in one of the estimation zones of the IGO's Nova-Bollinger deposit in Western Australia.



The 3×3 matrix of plots includes the swath plots for all directions in the first row of plots, grade difference plots in the second row, and projection plots of the data and blocks that relate to each swath direction.

I've attempted to include the many Tufte-like features to make this a 'better' swath plot. Firstly, the method of multiples has been used to display all the swath plot directions (north, east and elevation on the one image) rather than on three separate images. This allows quick visual assessment of all domains – the legend is also simple with model means (blue) and sample composite means (red) apparent in the top row of plots. On each swath plot, labels have been used to give the number of sample composites in each slice against the slice tonnages. I think this better than using bar plots and secondary scales as this can make the plot seem too cluttered and I prefer to know actual values rather than bar-read estimates. Also, included on the swaths are horizontal dotted lines that represent the zone mean grades of composites and blocks, which nearly over print each other in this example. The notes at the base of the plot give the actual global mean values. This is an example of teasing out an additional layer of information (related to global means) on the same plot as the moving window means.

The use of small multiples continues in the second row of the graphic above. This time a separate layer is used for the different information, but still aligned with the moving window slices of the swath plots in the top row. As it is sometime visually difficult to read-off the magnitude of grade differences between composites and blocks from the lines on the swath plot, the second row of the graphic has three bar plots of the difference between composite and block grades for each slice (model – composite) -aligned for each swath plot direction. This is an (abstract) example of teasing out the micro from the macro for the viewer. Ideally, there will be some symmetry of over and underestimation and, in this case, it is easy to see that big grade differences occur at the margins of the model where there are fewer data informing the estimate, particularly the last few easting slices and the first two northing slices.

Again, using the small multiples approach, the lower row of plots are sectional projections (looking north, west and vertically) of the sample composite locations and the block model block centres, which are aligned with the slices of the swath plots and difference plots. These plots allow assessment of grade difference between data and model in relation to data spacing, distribution and clustering. Where the spacing is wider (and samples fewer) the difference between block and sample grades is greater, which indicates the model uncertainty is likely greater in the near surface, western part of this zone.

For this application, using statistics and space, this graphical interpretation seems to fit into Tufte's time and space 'narrative' theme of a graphic. Also, included in this graphic are the reference details of the input files and R script used to prepare the plot, which I've found invaluable when needing to find the data source several years after the production of these types of image.

With a bit of patience, I expect most resource geologists can reproduce what I have presented here in Microsoft Excel, which seems to the favoured platform for many for this type of analysis. Hopefully some of the geostatistical software vendors out there will take notice and include this type of swath plot (or something similar) in their next software upgrades. If you want to have look at the R-code used to create this plot you can find it here.

Thanks to IGO for providing permission for me to publish the swath plot graphic for the Nova-Bollinger sulphur estimates. Also, thanks to the two reviewers of the draft of this article for their helpful comments and suggestions.