AEGS-3: Procesamiento de la Información geocientífica

Express modelling of geology, the road without a map

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Geological modelling has being the core of this industry for so long that we lost sight of its importance. Developing faster and faster tools that have changed the market many times we lose focus on the main point, determine a well-informed geological boundary that allows us to determine volume and certainly tonnage.

The Geological Modeling is the undisputed point of split of any type of mining method, the effect that the vision and experience of the geologists is propagated trough the development of the project and is an important part of the final success.

The collection of information is taken in stages. In earlier stages uses the greater part of the budget and the strategy to store and manage this data collection, as its performing will define the destiny of the deposit and of the business. With this background the geology and its modeling receive great attention from the industry and care providers being a fertile field in research and innovation. For sure the most fertile field seconded by metallurgy which has begun a race on innovation given the lack of high grade deposits. In this environment of so much fertility high requirement of hardware processes and complex mathematical techniques have been implemented recently and the implicit modeling (1) has found a wide market.

Where do we must arrive with the simplification of the geology and what effects has in the life of a project is what we intend to evaluate. This work stablish a serious analysis free of commercial interests in the applicability of the implicit modeling to the geology and to any model that want represent in 3D directly from data.

We do not intend to develop or explain implicit modeling techniques and its theory more that the obvious and well stablish, this work focuses on stablish an indicator of suitability of each modelling technique and derogate the modeling paradox, setting the restart bottom to the essential and fundamental facts of geological modelling.

How do we start?

In simple words, implicit techniques based rather on RBF (Radial Basis Functions) to interpolate a multivariate function that fits a large number of restriction and allows us to access to the shape of the "contact" between units or any interpolation technique such kriging or inverse distance it is simply a transformation of the data using distance functions that determine a field of distances to the contact between units and allow us to interpolate them and reveal the shape of the cero distance limit.

In general simplifying the multivariate problem in to a linear function fitting or a linear interpolation seems to be the solution to a very complex problem. But how far can we go hiding variables under the carpet, how do we know if we are missing something? First let's list dismissed variables, then evaluate the desire outcome from a geological model and measure the effect of each variable on the results.

Variables that matter

Modelling geological morphologies can be considered as a function of log data; and log data can be represented as a vector of spatially distributed information Lij(x) with actual location for each data. In addition to this vector of variables other non-spatially located however spatial distributed data as observed related information, relational information and such regional structures orientation and finally none spatially either distributed or located as geological knowledge and experience. Grouping these variables as direct, relational and non-direct variables the problem can be reduced in order of impact to measure the impact of these sets of three major variables.

Log data, located and traceable, account for the spatial distribution and the amount of information will have a direct impact on the certainty of the resulting interpolated model. However it is being proven that three spatial points can generate one unique plane, four spatial points will generate two sets of spatial planes (see figure 1), going forward, five spatial points will generate 10 planes, finally we know that the combinatory of number of data over 3 will be the number of valid planes from the constraining data. However not all those planes are valid parts for a 3D model. Some set won't be possible to include since crossing planes are not allowed, the problem it is now increased in constrains. Normally we can spec n/2 more restriction in terms of crossing planes, for #n data.

We can go on and determine a valid number of feasible set of planes that define a 3D solid given a certain number of log data, the final goal will be capture volume, and for each feasible solution we can spec a range from -20% to +20% variance on the volume and data capture may not be ensured. Translate this range of variations to tonnage made a big "question mark" on just using optimization/interpolation on the volume given any amount of data restrictions.

By adding geological knowledge it is possible to introduce local control or restrictions to the mathematical modeling, the geological knowledge will be introduced as new continues functions of restrictions since all current modelling options works well interpreting continues functions, even when modelling introduce gaps/faults there is no randomness on the modelling. However this randomness is often observed on nature and current tools won't let us duplicate that fact, this is very important on control local uncertainty and final volume, since is the geological knowledge not the data distribution the actual TOOL of modelling, it is this variable the one that control the effect of information and the dilution according the stage of each project.
Addition of related information sometimes can easily be managed as a function of log data, sometimes these functions have a local effect or drift and that externality most of the times need to be visited locally and fast tracking the model attempts against this need.

In short the following matrixes resume variables and its indicators based on targeting proper location and tonnage ordered by importance.

What do we expect?

Users expect the 3D model to be predictive, accurate with the data, volumetrically precise and exact. We expected to get it fast too? To be predictive the geological knowledge plays a vital role. Only by understanding the relational component of a geological proposal we can achieve predictability which is that information that the model implies. To be accurate with the data, and include all the data, we shown that snap the model is not enough. It is important to check how the planes include each data and the volumetric role we want them to play.

Volumetrically precise it will be have in average the same resulting volume on a restricted/specified area each attempt of the model and exact will means that the model relate similarly to their boundaries on each attempt.

All three results won't be express and if we get express we will be missing the point, spend a lot of money on information that the trained eye won't see leaving the modelling to a software app.

The 3D Paradigm

When 3D really contribute with true information? Laser scanning tools provide dense grids of actual location data that allows miners to determine real volume. In several exercises we observed that topography density curves from 10 m to 5 m in fairly plain topographies produce a change up to 15% of the total tonnage to strip. That is huge when material movement contracts are arranged by tonnage, even worst when affects timelines and schedules. Therefore 3D has become a standard. However in regard geological modelling we forget that it is a MODEL and as such does not represent the true, it should represent the *expected* true. In order to provide integrity, as in topography interpolations, "snapping to data" becomes "the way" to prove integrity with data, however snapping does not ensure enclosing, which is the aim of all modelling.

The final goal on 3D modelling is to transfer the model to the final SMU and is in this place where dilution takes place. Having an accurate 3D interpretation allows to determine predictive dilution model however how can we get to do a good an accurate 3D interpretation from an express modelling? Interpretation introduce the use of sets two and three of variables (geological knowledge and relational data) given them great weight and by taking the shortage of using only located data and simplifying other variables we lose that important control.

In the other hand SMU size will determine the scale of our modelling and not in the other way. Over prediction on smoothing it is only possible from very extensive data collection which is not the case on Geological modelling.

Figure 1 show how on a vein type modelling the SMU scale plays an even more important role on the scale and using express modelling based on the SMU grid will be enough.

Convex, Concave

Finally, these two terms have being forgotten on modelling, convex shapes increase volume and concave shapes reduce volume. In order to be smooth as a new standard for modelling, we were forced to choose, concave or convex.

Moving forward

3D modelling has become increasable popular and the loose of perspective on what we want to achieve is overwhelming. Spending high amounts of money on exploration data does not goes along with going cheap on time and dedication to an accurate geological model, which will be the frame that set the project going forward. Having express tools need to be addressed in order to determine when why and how we will use them. The aim of this review so not the blame any geological modelling technique is to stop and think on the consequences and the expectation we set of the results of our modelling.

Express modelling is the future however having nice and good shaped models introduces bias and one way to avoid that is setting an SMU scale. RBF and any interpolation technique will 're-do" the whole set of planes that conform the 3d Modelling and not always that is something affordable. We expect the community think about outcomes and consequences, use tools in an orderly fashion and never give up any information available in order to produce faster results. Not doing so is driving the road without a map.

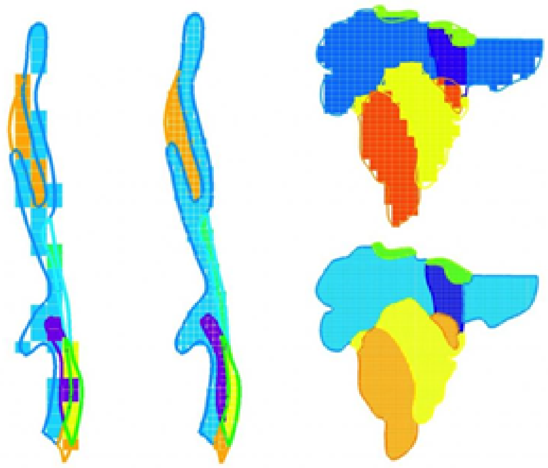

Figure 1 SMU representation of a vein type geological modelling at two SMU scales and its effect on dilution.