FOOTPRINT AND ECONOMIC ENVELOPE CALCULATION FOR BLOCK CAVING BASED MINES UNDER GEOLOGICAL UNCERTAINTY

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Introduction

Traditional long term **mine planning is done based on deterministic information**, therefore constructing plans and making **decisions that are not robust** and estimating value and production promises that cannot be achieved.

One example of this is **uncertainty on the resource model**: while techniques like **conditional simulations** to model the variability of grades are widely known and well developed, existing mine planning tools do not allow incorporating them into the planning procedure. **They only allow to integrate uncertainty in the planning process at its end**, by means of some sensibility analysis so that **variability is estimated, but not controlled**.

This work deals with developing a tool such that it can incorporate geological uncertainty in early stages of the planning process: defining the economic envelope in a massive underground mine.

Methodology

1. Develop a tool to optimize the economic envelope for each Z level.
2. Validate the tool against existing software alternative(s).
3. Extend tool to compute a robust footprint.

Optimizing the Economic Envelope

To get the economic envelope of a massive underground mine, the approach we use is to calculate an **inverted final** pit with some specific constraints by: (1) cutting the block model at each Z level, (2) inverting the Z coordinates, (3) evaluating the blocks in each column, (4) creating precedence constraints to control the difference of heights for adjacent columns, and finally (5) computing an ultimate pit.

All the steps described above are solved using the **BOS2M** software developed at the Delphos Mine Planning Laboratory of the University of Chile (BOS2M is an open-pit scheduler and sequencer), because this tool is very flexible and can be scripted to do this automatically.

As a result from this methodology, we obtain an approximation for the economic envelope of the underground mine

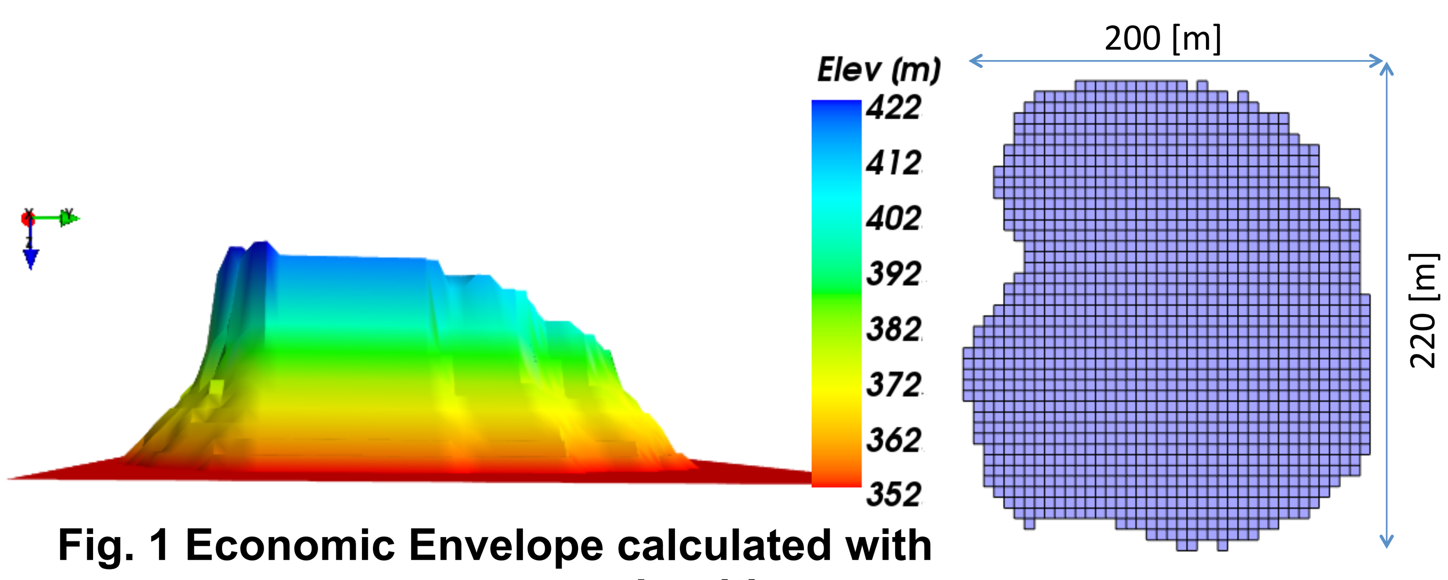

Fig. 1 Economic Envelope calculated with algorithm

Validation against known tools and results

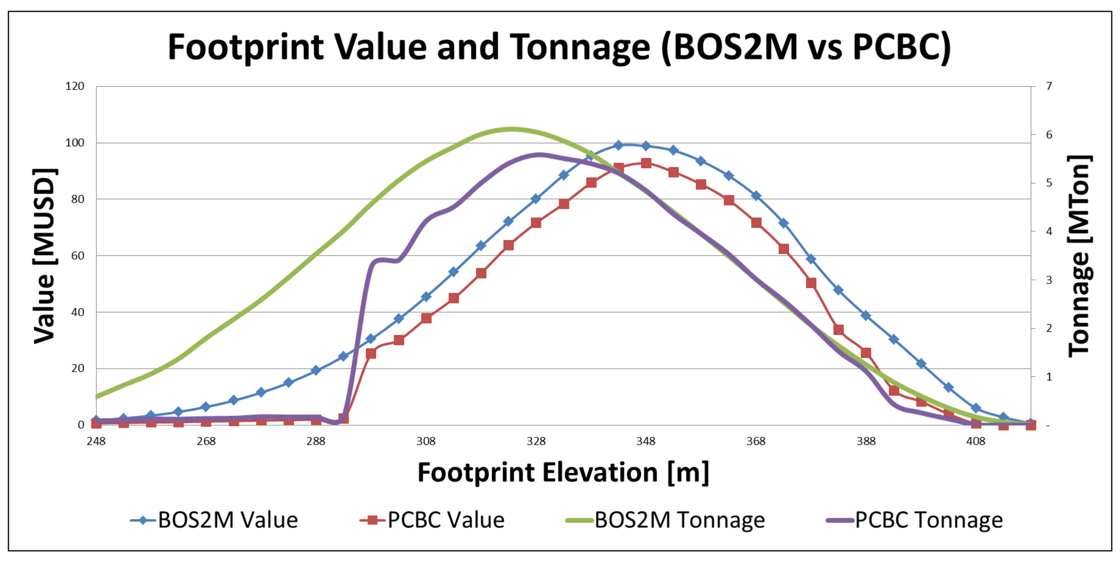

Fig. 2 BOS2 against PCBC Footprint

Extension to consider geological uncertainty

Once we have developed a tool to optimize the economical envelope, the geological uncertainty is introduced by **conditional Gaussian simulations** of a mineral deposit, generating S different resource models.

For each block model, we can then compute the optimal footprint at each different Z level.

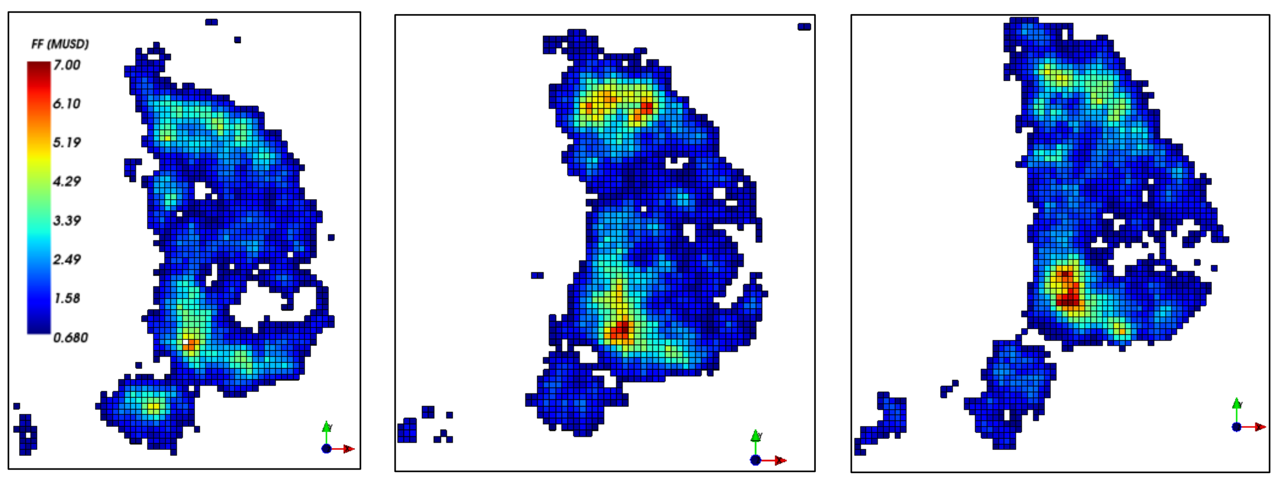

Fig. 3 Different footprint shapes at the maximum economic elevation, from left to right: worst, mean and best scenario.

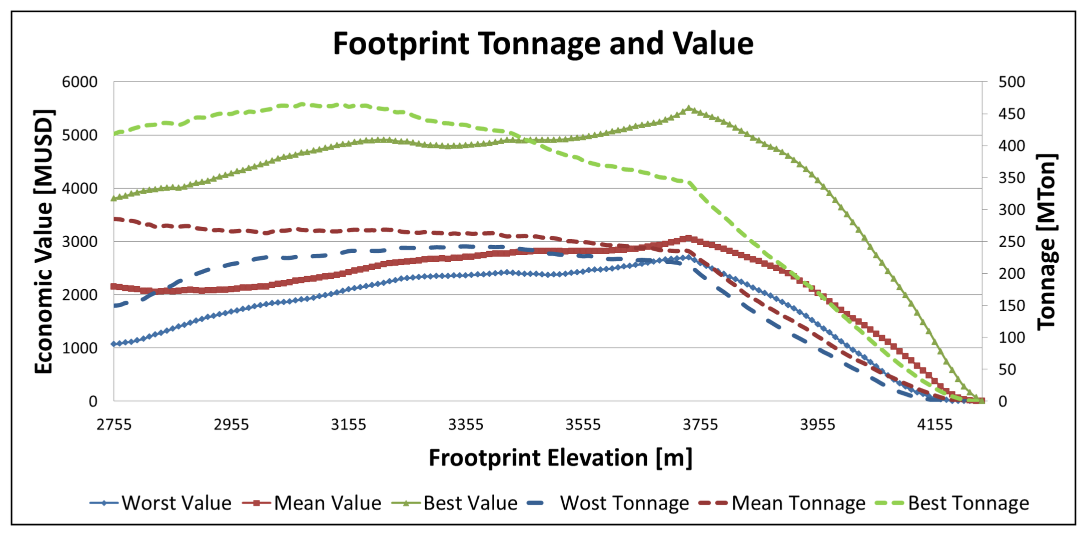

Fig. 4 Footprint Value and associated tonnage for each elevation (worst, mean and best scenario)

Finally, there are several alternatives to consolidate the results for each simulation into a final decision. We currently consider: Maximum Expected Value, Economic Envelope with given confidence level, Value at Risk, etc.

Conclusions

We have developed a software tool that computes the economic envelope for each Z level of a massive underground mine, and validated it against known solutions. **This tool is very quick and customizable**, so it allows us to **integrate geological uncertainty** through conditional simulations that show that the variations in the shape of the footprint and envelope can be significant. Currently we are defining some possible criteria to consolidate the different economic envelopes into a final decision.

***This presentation is part of a Master thesis**

Subject: Economic Envelope Calculation for Caving Based Mines Under Geological Uncertainty.

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