Abstract

Optimisation of the Net Present Value (NPV) needs to consider cut-off grade as well as the block model size. This study considered the impact of these on the optimisation of the NPV. The orebody could be mined sub-optimally due to the misunderstanding of the relationship between cut-off grade and block model size. The research was based on an iron ore deposit mined through open-pit mining method in South Africa.

The main objectives of the study were: to understand the importance of cut-off grade; to determine the effect of block model sizes on the average grade; to determine the effects of the block sizes and cut-off grades on the NPV, and to determine which block sizes and cut-off grade maximise the NPV. It was found that there were different cut-off grades at different levels of the exploitation of the iron ore deposit. These differences can lead to the deposit not being mined optimally. Therefore, it was important to understand the importance of cut-off grades, hence the need to investigate the effects of cut-off grades. The effect of block sizes on the NPV was included because there was insufficient research on the topic.

From the literature review, the cut-off grade was defined as the boundary that separates material that is discarded from the material that is taken further for treatment. The cut-off grade determines whether the material will be considered as waste or ore. If the cut-off grade is too high, more material will be discarded as waste while a lower cut-off grade increases the entire mining capacity. The lower the cut-off grade, the higher the Mineral Reserve. It was shown from the literature that the determination of the cut-off grade is determined by factors such as the price of the commodity, production costs, grade distribution, environmental factors and other factors.

The literature review highlighted that a block model is a representation of orebody characteristics, whereby a single cube will have sizes (x, y and z). The single cube will be allocated with grades, volumes, rock types, densities and many more attributes assigned to it depending on what information is required. The block model dimensions should represent the minimum block that could be selectively mined, that is, the smallest selective mining unit. The block model sizes are selected at the initial stages of creating the block model. The block size is also dependent on the sample spacing. The block size should be one-half or one-fourth of the sample spacing. When the

selective mining unit is selected it should take into account the excavator that will be used to load the material. The selective mining unit is important since it determines the amount of dilution that will be encountered during mining. The larger the selective mining unit, the more the dilution, which decreases the grades.

The methodology that was used to analyse the effects of cut-off grade and block sizes on the NPV was through the use of grade-tonnage curves and the DCF for different block sizes and cut-off grades. NPV is the sum of the DCF's and the NPV assists in projecting the future revenues in terms of mines that are already in production. The DCF's for this report were done only for 10 years because it was enough to create data of a high level of confidence. The cut-off grades that were used were 53%,60%,63% and 64% Fe as they covered the definition of the ore for the iron ore deposit. The base block model size 6.25m x 6.25m x10m.The base block-model was re-blocked into sizes: 12.5m x 12.5m x 10m; 25m x 25m x 10m and 50m x 50m x10m. Grade-tonnage curves were created for each block model size including the base 6.25m x 6.25m x 10m block model. The obtained tonnes and an average grade above certain cut-off grade were used to create the DCF in Excel to obtain the NPV.

The results showed that an increase in the cut-off grade decreases the tonnes above the cut-off grade while increasing the average grade. The larger the block size, the lower the average grade due to increased dilution. The larger block sizes result in a lower NPV if the effects of mining selectively are not considered. However, if the effects of selective mining are considered, larger block sizes result in an optimised NPV. Some of the conclusions were that small block sizes result in an optimised NPV only if the effects of selective mining are not considered while larger block sizes result in an optimised NPV when the effects of selective mining are considered. The 25m x 25m x 10m which is a larger block model size is not affected by selective mining and it resulted in a higher NPV when compared to the 12.5m x 12.5m x 10m,therefore,it is better to work with larger block model sizes to avoid selective mining. It was recommended that a 60% Fe cut-off grade paired with a 12.5m x 12.5m x 10m block size to be used when the effects of selective mining are not considered since it increases the tonnes above the cut-off grade, thus increasing the LOM and the NPV is optimised. A 60% Fe cut-off grade paired with a 12.5m x 12.5m x 10m block size was also recommended to be used when the effects of selective mining are considered

as this optimises the NPV. A 60% Fe cut-off grade paired with a 25m x 25m x 10m block size is recommended since it does not require to be mined selectively.