SELECTING MINEABLE BLOCKS: EXPERIMENTAL RESULTS OBSERVED ON A SIMULATED OREBODY

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ABSTRACT. The problem of optimal selection from estimates is studied theoretically in a simple case: it is shown that the solution is to apply a cut-off criterion to the conditional expectation of each panel's grade; but if it is impossible to compute such an estimator, then no simple, nearly optimal substitute can theoretically be found. However, we know that kriging is the best linear least-square approximation of conditional expectation, so we may hope that it would be a good practical substitute: this is experimentally shown on a two-dimensional simulated orebody on which selection is performed with various estimators.

0. INTRODUCTION

When assuming that the true block's grades are known, it is easy to demonstrate that maximizing a linear benefit by selecting mineable blocks is achieved by using a cut-off grade criterion on the true block's grades. When reality is unknown, the problem is set in probabilistic terms: if the objective function is the expected value of a linear benefit, the optimal procedure consists in using a cut-off grade criterion on the conditional expectation of the block's grades. However, in practice the conditional expectation cannot be determined and will be replaced by a linear estimator of the block's grade. Hence it can be expected that the result obtained with this procedure will not be so good as the optimum selection. However, the actual loss in expected profit is difficult to determine theoretically. Therefore it is interesting to compare the results of the true and approximate selections made on a simulated orebody. Moreover, we shall take profit of the knowledge

of both true and estimated values to point out some experimental properties of the estimators used in geostatistics.

1. A VERY SIMPLE CASE OF SELECTION

In order to allow an easy theoretical exposition, let us imagine a simple situation: we mine a mineralized layer whose width is considered as constant, with a mining method based on elementary mineable panels of tonnage $T_i$. We essentially assume that no technical constraints of accessibility are imposed on mining, so that any subset of elementary panels $P_i$ is technically mineable.

We assume that the total profit $B$ yielded by mining a total tonnage $T$ of mean ore grade $m$ is:

$$B = p m T - p_1 T - p_2$$

$p$: sale price of metal/ton metal
$p_1$: mining and processing cost/ton of ore
$p_2$: fixed costs

To simplify the notation, we shall write the profit as

$$B = p [T(m-m_c) - r] \quad \text{with } m_c = p_1/p, \quad r = p_2/p$$

There is no loss of generality in taking $p = 1$.

1.1 Selection when the true block grades are known

We know each $m_i$, mean grade of the panel $P_i$. Selection will consist in choosing a subset $\{P_i, i \in I\}$ of the sets of panels $P_i$. Mining this subset will yield the total profit:

$$B = \sum_{i \in I} T_i (m_i-m_c) - r$$

Maximizing $B$ consists in choosing $I$ so that each term $(m_i-m_c)$ $\geq 0$, that is keeping each panel whose ore grade $m_i$ is greater or equal to the cut-off $m_c$. If the corresponding maximized profit $B$ is positive, mining the orebody is profitable for these precise economical conditions.