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Optimization of geological study's degree for iron ore deposits at mining exploration

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SUMMARY

Probabilistic nature of geological information is usually not taken into account in the geological and economic assessment of deposits to the full. This is main reason of non-confirmation of the quantity and quality of ore reserves. As a result, it can lead to non-compliance with extraction and production plans, expected quality and composition of minerals; it worsens economic indicators of mining enterprises and lead to economic losses.

A theoretical analysis of economic losses of mining enterprises of Ukraine is carried out. It is reviewed losses which are realized as a result of errors in determining geological parameters of iron ore deposits. The optimal levels of geological information probability at the geological and economic estimation of balance reserve are determined. The principles of economically expedient degree of mining exploration for iron ore deposits are theoretically justified.

The economically optimal level of geological parameters prec ision should be determined separately for each deposit (even within the same genetic type) and be based on the main patterns of error of geological parameters and dependencies operational losses on geological information probability. The economically optimal level of geological information probability varies for each deposit within fairly wide limits and depends primarily on the complexity of the geological structure of the ore deposits.

Introduction

Geological study of iron ore deposits is carried out within the framework of exploration stages, which is regulated by legislative documents [1,2,5].

Ukrainian iron ore deposits have a complicated structure of reserves, which are the object of exploration, additional exploration and mining exploration. The method of exploration is determined by peculiarities of geological structure and occurrence of iron ore deposits, taking into account recommendations of the Instruction [1] and requirements for complex study and reserves calculation of associated minerals and components and mining waste. At the same time, within large deposits it is assumed a relative concentration of exploration working's grid within typical areas as well as areas of priority development, where reserves should provide ore output for mining enterprise for the period of capital investments return.

Within areas of priority development sampling, assaying, contouring of ore deposits is conducted with optimum exploration working's grid for finding of explored reserves. It's also recommended to realize semi-industrial and industrial technological studying for verification of mineral processing scheme; detailed study concerns geological, mining, technical and environmental conditions for development of mineral deposits and ore processing, conditions for sale of commodity output of mining. Within areas of long-term development of the mining enterprise, assaying, contouring of ore productive zones are done with rarefied exploration working's grid to prove the analogy of their geological structure and mining conditions to the priority development areas.

In the case of additional exploration at exploited deposits, exploration system is corrected according to comparison results of mining and exploration data as well as recommendations of the State Commission of Ukraine for Mineral Reserves and Resources, given during expertise and assessment of mineral resources.

Additional exploration and mining exploration are carried out at deposits which are exploited. Additional exploration is carried out in insufficiently studied parts of deposits (flanks, deep or upper horizons, isolated areas, etc.) and is realized sequentially in accordance with the plans for mining operations.

Mining exploration, which is in advance of mining operations, specifies morphological data determined by exploration, internal structure, and occurrence conditions of mineral deposits, specifies geometrization of ore bodies with a high ore-bearing coefficient as well as quality of mineral materials according to additional drill-holes or workings that are done before mining operations. Mining exploration data is used for mining and cutting work planning and annual planning of mining productivity.

Mining exploration, which accompanies mining operations, specifies quantitative and qualitative indicators of mineral deposits according to data from drill-holes and clearing mine workings, etc. According to the accompanying exploration, the contours of mining workings are designed in accordance with adopted mining system, the calculation of wastewater volume, of mining losses are determined.

According to the mining exploration results at exploited deposits reserves are transferred to relevant categories of geological study, calculation and accounting of additional detected and recovered reserves are carried out. Conditionally balance reserves and off-balance reserves that are involved in exploitation are transferred to balance group. Reserves of iron ore deposits prepared and ready to be extracted, as well as existing ones in protective blocks are calculated and accounted separately in accordance with their industrial value, the degree of geological and technical and economic study.

Most of Ukrainian iron ore deposits, for which permits (licenses) have been issued, are exploited. This has led to special importance of mining exploration, which is associated with high costs. The optimal ratio of scope and cost of exploration work is determined by geological and economic assessment of deposits.

Methods and results

Geological and economic assessment of iron ore deposits should be based on sufficiently complete and reliable geological materials [6]. Geological information at any exploration stage and exploitation is characterized by a certain probability and contains various errors in value and magnitude [3,4]. This is a consequence, firstly, of the natural variability of properties and parameters of ore deposits, and secondly - of a limited number of their direct observation points that are fixed at an insignificant part of geological objects.

However, the probabilistic nature of geological information is usually not taken into account in the geological and economic assessment of deposits to the full. This is main reason of non-confirmation of the quantity and quality of ore reserves. As a result, it can lead to non-compliance with extraction and production plans, quality and composition of minerals; it worsens the economic indicators of mining enterprises and lead to economic losses [4, 6].

Analysis of features of geological structure within iron ore deposits shows that parameters determination errors for balance reserves are associated primarily with degree of geological spatial indicators variability. The variability of iron ore deposits parameters, in turn, depends on the complexity of internal structure of the deposits: the development of multi-order folding and faults, etc. With an increase of concentration of exploration drill-holes grid, the shape of ore deposit is more accurately approximated and likelihood of additional expenses for the discovery and processing of ore, caused by non-confirmation of geological indicators, decreases. In the same time drilling now has a very high cost. In the case of constant improvement of the exploration grid, costs for their drilling can be evened out and even exceed costs of additional extractive of overburden rocks and ore processing, due to the error in determining geological parameters of ore bodies. Therefore, the choice of an economically feasible level of error in geological parameters is a very important factor in the economic value of industrial reserves.

The general losses of mining enterprises due to errors in determination of geological indicators consist of losses of errors in ore reserves calculation according to exploitation horizons, types and varieties of ores; losses from errors in determining contours of conditioned ore bodies, as well as their types and varieties; losses of forecasting of technological parameters of ores according to their types and varieties (iron content in concentrate, concentrate output, extraction of iron to concentrate, etc.).

Conclusions

It is economically unprofitable to have either too high level of precision of geological parameters, and too low. In the first case, the costs of geological study are compensated, in the second, the low level of geological information probability leads to an increase in operational losses of mining enterprises.

The economically optimal level of geological parameters precision should be determined separately for each deposit (even within the same genetic type) and be based on the main patterns of error of geological parameters and dependencies of operational losses on geological information probability. The economically optimal level of geological information probability varies for each deposit within fairly wide limits and depends primarily on the complexity of the geological structure of the ore deposits.

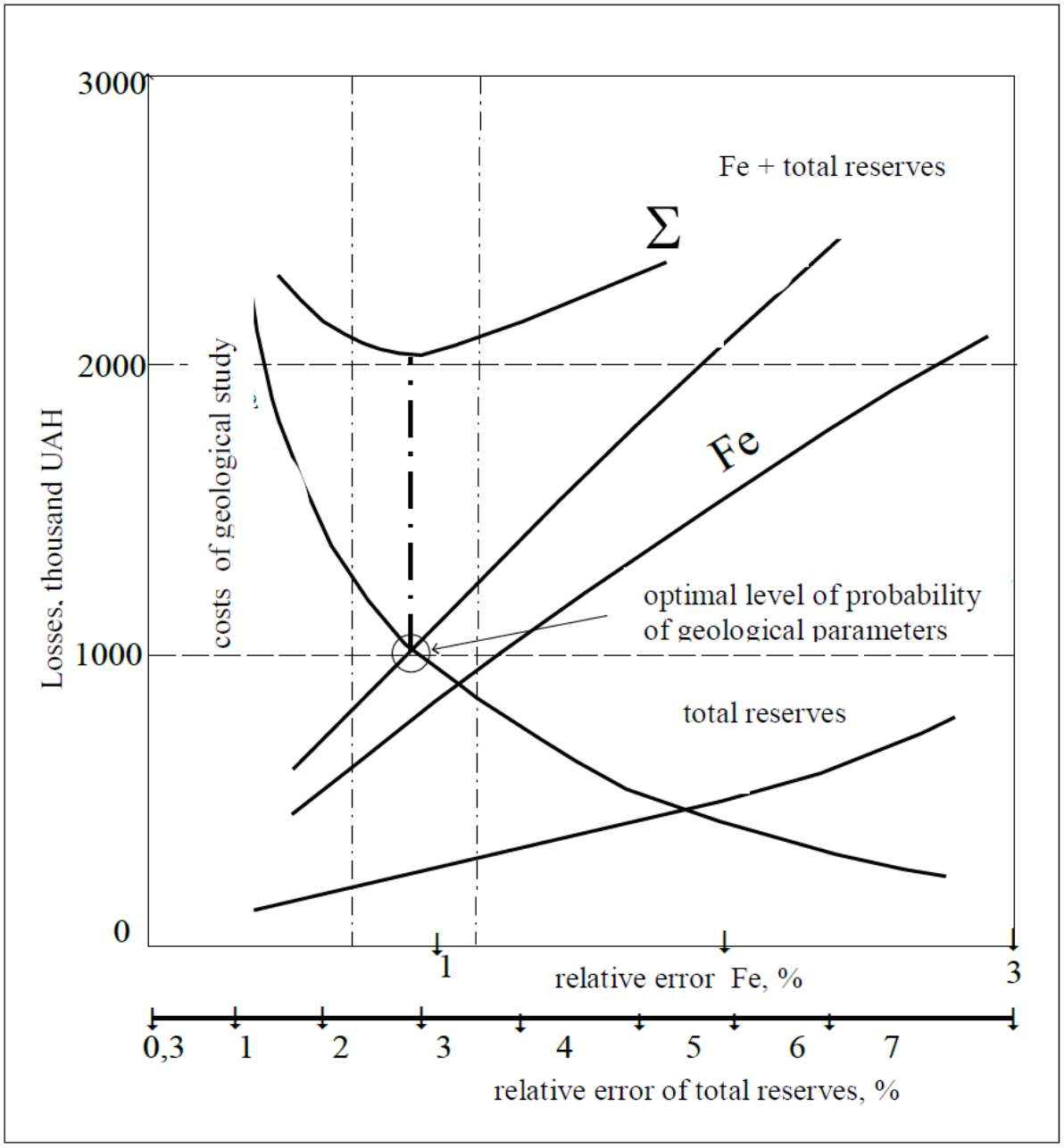

Figure 1 *Determination of the economically optimal degree of geological information probability.*

Σ - Dependence level of operational losses on the total error in determining qualitative and quantitative parameters of balance reserves

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