Recommendations on integrated evaluation of preparedness of coal deposits for mining

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Abstract. Considering high importance of geological information quality for mining business, a legal basis for the initiation of technical projects on mineral mining is the state geological survey report on the extent of exploration and preparedness of a mine field for industrial development. To ensure rationality, safety and efficiency of subsoil management, it is proposed to implement such integrated evaluation at the pre-project stage in two directions: technological and geological preparedness.

1. Introduction
Project design choices and current decision-making on mine construction and expansion are not based on the actual data but on perceptions of properties, quality and occurrence of subsoil mineral resources gained from geometrical models based on assaying results. Such models always differ from reality, i.e. have an error. Inaccuracy of geological information inevitably turns into wrong judgments on technology, investment, etc. and sometimes ends with substantial financial loss and abandonment of mining projects; for this reason, it is necessary that geological errors fall within industrial standards.

Considering critical importance of the quality of geological information for mining business [1–5], the Russian Government decrees that the expert report of the state geological survey should provide estimation of “…preparedness of a mineral deposit or its parts for industrial development…” assuming “preparedness” as the extent of exploration such that technical-and-economic performance of a mine project is achieved irrespective of possible difference between actual geological information and values revealed at the mine exploration stage. A positive expert opinion allows a subsoil user to start a mine project. However, there are some omissions.

A legal basis for the initiation of a mine project is the subsoil use licensing. De facto, a mining licensee acquires a legal right to destroy non-renewable mineral resources which belong absolutely to the nation. The key mission of Russia as an owner is efficient use of mineral wealth in the interests of the present and future generations of the country (RF Law on Subsoil, Article 35). Implementation of this function determines evaluation of reserves unrecoverable within a mine project and meant to be lost. Such evaluation is included in the state geological survey.

2. Development of recommendations for the evaluation of preparedness of coal fields
On the ground of the accomplished research findings [6, 7], the recommendations have been developed for the evaluation of preparedness of coal fields for the efficient development at an industrial scale. The evaluation has two directions (see Figure 1) described below.
Technological Preparedness. This is an estimate of technological capacities available in the mining and processing industry for the complete extraction of mineral reserves. It is set by the value of a technological preparedness coefficient which is a ratio of uneconomic reserves $Z_{\text{unec}}$ to total proved reserves $Z_{\text{tot}}$ inside a mining lease. When the ratio is higher than the permissible value (for coal fields, the standard is 20% unless otherwise is substantiated), a field is assumed technologically unprepared and off operation. Mining to be prospective in such fields should use non-conventional processes and technologies aimed to increase recoverable reserves.

With a view to delineating technologically prepared reserves, a geometrical model is constructed using the technological preparedness coefficient calculated from the structure maps of coal seams within the limits of a mining lease [7].

![Figure 1. Block-diagram of algorithm for integrated evaluation of mineral reserves preparedness for efficient development at industrial scale: $\tau_i$—preparedness criterion (capacity, ash content, etc.); $\tau_{\text{perm}}$—permissible value of $\tau$ for characteristic $i$.](image)

After the technological preparedness of a mine field has been acknowledged, the stage opens for the second evaluation.

Geological Preparedness. This is the quality of conformance between the geological exploration of a deposit and the objectives and claims of the industry. This estimate is governed by individual project designs targeted at mining efficiency and includes:

—determination of indirect measures in interwell space of exploration wells (coal seam hypsometry) and squares of network of exploration wells (other characteristics);

—conventional $P_{i}^{\text{conv}} = f(x, y)$ and alternative ($P_{i}^{\text{pes}} = f(x, y)$ pessimistic and $P_{i}^{\text{opt}} = f(x, y)$) optimistic geometrical modeling using the information on hypsometry and quality of coal seam and
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rock mass; analysis of efficiency of design choices on schemes of accessing and preparing mineral reserves;

—conventional \( P_i^{\text{conv}} = f(x, y) \) and alternative \( P_i^{\text{pes}} = f(x, y) \) pessimistic and \( P_i^{\text{opt}} = f(x, y) \) optimistic geometrical modeling of thickness and structure of coal seams, as well as other characteristics; analysis of efficiency of design choices on schemes of mining and time schedules.

It is worthy of mentioning that the condition of obligatory alternative modeling is the excess of the exploration extent criterion \( \tau_i \) of a permissible value \( \tau_{\text{perm}} \).

When the efficiency of design choices in the conventional models preserve in the alternative models of mineral deposits and mining, this is a proof of sufficient geological survey, extent of exploration and preparedness of a deposit for the commercial development. Otherwise, depending on the level of actual mismatch, it is required to carry out additional exploration within the limits of unacceptable discrepancy of actual data and modeling results, or to add the project with preventive measures which would mitigate disamenity due to incomplete knowledge on the mineral object.

This approach suggests including evaluation of coal field preparedness for industrial development in geological survey reports in the section Evaluation of mineral reserves exploration and preparedness for industrial development, or in project documentation in the subsection Geological exploration of underground (surface) mine field. The obligation of these sections in the geological and project documentation is dictated by the effective regulations. However, as practice shows, these section lack arguments required for reasoned decision-making. This omission is explained by complexity of the evaluation of mineral reserves preparedness for development and by the absence of proper instructions and guidelines on the implementation.

3. Conclusions

The integrated evaluation of coal field preparedness for the efficient commercial development, with sub-evaluations of technological and geological preparedness, included in the geological survey and mine project documentation submitted for the state expertise enables reasoned and viable decision-making. For a subsoil user, such evaluation is a proof of the conformity between the extent of geological exploration of a mineral deposit and objectives of individual design choices or sustainability and performance of a mining investment project. For the nation as a subsoil owner, this evaluation is a guarantee that the subsoil user will fulfill obligations on resource conservation as well as on industrial and ecological safety of mineral mining.

This approach in the subsoil management is aimed at decrease of risks, sustainable utilization of mineral wealth and at promotion of unconventional innovative technologies of mining and processing in implementation of mining investment projects.

References
[1] McCarthy P 2003 Managing technical risk for mine feasibility studies Mining Risk TheAuslMM ISBN 978-1-920806-00-2
[2] Rogova TB and Shaklein SV 2011 Reliability of coal reserves Quantitative Assessment and Monitoring LAP LAMBER
[3] Bogatsky VV 1971 Possibility of a quantitative estimation of reliability of results of prospecting of stratal minerals Geology of Coal Deposits Moscow: Nauka Vol 2 (in Russia)
[4] Kazhdan AB 1977 Prospecting of Mineral Deposits Moscow: Nedra (in Russia)
[5] Australian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (The JORC Code) Prepared by the Joint Ore Reserves Committee of the Australasian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Minerals Council Of Australia (JORC) 2004.
[6] Pisarenko MV and Shaklein SV 2014 Evaluation of the preparedness of solid mineral deposits to industrial development Miner. Resursy Rossii No 6 pp 42–45
[7] Pisarenko MV 2016 Mining and geometric support for evaluation of the technological preparedness of the field for development Markscheder. Nedropolz. No 3 pp 40–43