

REVIEW
on the dissertation of
SHUKURLU ELNUR

on the topic «Scientific substantiation of the technology of explosive demand of gold-bearing quartzite», submitted for the degree of Doctor of Philosophy
in the field of knowledge 18 Production and Technologies
specialty 184 Mining

Relevance of the dissertation topic

The topic of the dissertation covers two tasks that have to be solved simultaneously at open pits mining gold-bearing quartzites: a substantiated choice of the direction in which mining operations develop, and the achievement of the required quality of blast fragmentation with the lowest possible dust-and-gas load. The candidate brings them together within a single study, relying on geoinformation analysis of the deposit and on the improvement of the material used for stemming the borehole charge.

The relevance of this approach follows from the state of the industry: gold production in Azerbaijan is increasing, new open pits are being brought into operation, and the growing volumes of blasted rock raise the price of every percentage point of oversized material, which converts directly into the cost of secondary breakage and into lower productivity of the excavating and haulage equipment. At the same time, the requirements for the air quality in the working zone are becoming stricter, so a technological solution must improve fragmentation without increasing emissions. The transition from sand to foam stemming, to which the dissertation is devoted, is precisely such a solution.

Validity, reliability and novelty of the scientific results

The objectives set for the work have been completed in full: the mechanism of gold-bearing quartzite fragmentation has been analysed; the influence of the stemming material on the formation of toxic post-blast gases has been studied; numerical modelling of the retention of explosion energy and of fragmentation efficiency has been performed; the methodology for assessing the particle-size distribution over large volumes of rock has been improved; and a procedure for analysing a gold ore deposit has been developed by combining geodetic monitoring with GIS technologies.

The validity and reliability of the results are ensured by the use of well-established software tools (Surfer, ANSYS Explicit Dynamics, WipFrag), by the mutual consistency of the analytical estimates, the numerical modelling and the field measurements, and by the confirmation of the conclusions through production blasts at the Tulallar open pit and the certificate of implementation.

The scientific novelty of the results obtained is as follows:

- a digital geospatial model of the Tulallar deposit has been created in the Surfer 3D software package which, on the basis of the spatial analysis of ore bodies and mineral concentrations, makes it possible to select optimal directions for the development of mining operations;

- polynomial relationships have been established describing the variation over time in the pressure of the detonation products of a borehole charge for sand and for foam stemming;

- the influence of the stemming material on the distribution of harmful post-blast gases within the working zones of the open pit has been revealed and verified in practice;

- new quantitative and qualitative relationships have been obtained by numerical modelling between the ejection time of stemming made of different materials, the stress-strain state of the rock mass and the degree of quartzite fragmentation; these are confirmed by field data and made it possible to reduce the yield of oversized material from 9% to 5%.

The practical value of the work lies in the digital geospatial model of the Tulallar deposit, the improved borehole stemming material and the procedure for photographic recording of the size distribution of blasted rock, all of which are suitable for use under the conditions of an operating open pit.

Content of the dissertation, its completeness and compliance with the principles of academic integrity

In terms of content, the work corresponds to the draft Higher Education Standard for specialty 184 Mining and to the research directions of the educational programme “Geoengineering”; it is complete and reflects the personal contribution of the candidate. The text-matching check revealed no signs of falsification, compilation, fabrication, plagiarism or unattributed borrowing; the ideas, results and texts of other authors are accompanied by references to the relevant sources.

Language and style of presentation of the results

The work is written in English; the presentation is consistent and clear, the terminology corresponds to that accepted in mining engineering, and the illustrative material is commented on in the text. The dissertation consists of an introduction, four chapters, conclusions, a list of references and one appendix; the main body occupies 141 pages of printed text, and the total length is 150 pages.

Chapter 1 builds a three-dimensional model of the Tulallar deposit from exploration drilling data and proposes a procedure for assessing the prospectivity of the direction of mining operations.

Chapter 2 analyses the behaviour of the stemming during the blast and substantiates the transition to a foam composition with a 5% chalk additive.

Chapter 3 shows, on the basis of modelling in ANSYS Explicit Dynamics, that fragmentation efficiency is governed by the retention time of the detonation products rather than by the peak pressure.

Chapter 4 confirms, through field trials and digital photo analysis of the muckpile, the reduction of oversize yield from 9% to 5%. Each chapter ends with its own conclusions, and the appendix contains the certificate of implementation.

The dissertation is formatted in accordance with the requirements of Order No. 40 of the Ministry of Education and Science of Ukraine of 12 January 2017 “On approval of the requirements for the formatting of a dissertation”.

Dissemination of the results of the dissertation

The results of the dissertation have been published in 11 works of the candidate, including 8 papers in journals included, as of the date of publication, in the list of professional scientific publications of Ukraine, and were reported at 3 scientific conferences. The publications correspond to the topic of the work and fully reflect its main results; no violations of the principles of academic integrity have been found.

Shortcomings and comments on the dissertation

1. The isosurface of the economic ore body is constructed for a cut-off grade of 2.5 g/t, yet the choice of this value is not argued in economic terms. In addition, the modelling results are not accompanied by quantitative figures – the volume and tonnage of ore, the average grade and the resource category within the identified southwestern zone – so the statement about the prospectivity of this direction of mining remains largely qualitative.

2. The foam stemming has been tested for a single chalk content – 5% – without varying this parameter. The claim that such a composition is optimal therefore remains unconfirmed, and the balance between the reduction of dust-and-gas emissions and the decrease in the porosity of the material from 80% to 67–69% has not been optimised.

3. In Chapter 3 the maximum stress for the variant with foam stemming turned out to be lower ($3.41 \cdot 10^8$ Pa against $5.49 \cdot 10^8$ Pa), which is not quantitatively consistent with the conclusion about better fragmentation of the rock mass. To resolve this contradiction it would be advisable to introduce an integral indicator – for example, the volume of the damaged zone or an averaged degree of damage.

4. The limiting size of oversized material is given in the work in three different values: at the beginning of Chapter 4 it is no more than 60 cm, in Section 4.1 no more than 70 cm, while in Section 4.2 fractions larger than 60 mm are treated as oversized. In addition, it is stated that the mean fragment size and the uniformity of the distribution were recorded from the photo analysis, yet their numerical values are absent from the text – only the percentage of oversized material is given.

5. The indicators of the environmental effect differ across the parts of the work: Section 2.3 reports a 10% reduction in nitrogen oxide emissions and a 20% increase in dust suppression efficiency, the novelty propositions report a reduction of the average concentrations of harmful gases by approximately 40%, and the general conclusions report reductions of about 45% for NO_2 , 65% for CO and 63% for dust. These values need to be reconciled and the basis of comparison indicated.

In my opinion, the comments made are not of a decisive nature; they do not diminish the overall scientific novelty and practical significance of the results and do not affect the positive assessment of the dissertation.

Conclusion on the dissertation

In my opinion, the dissertation of SHUKURLU ELNUR, candidate for the degree of Doctor of Philosophy, on the topic «Scientific substantiation of the technology of explosive demand of gold-bearing quartzite» has been performed at a high scientific level, does not violate the principles of academic integrity and constitutes a completed piece of research, the body of theoretical and practical results of which solves a scientific task of substantial importance for the field of knowledge 18 Production and

Technologies. In terms of relevance, practical value and scientific novelty, the dissertation fully meets the requirements of the current legislation of Ukraine set out in paragraphs 6–9 of the “Procedure for awarding the degree of Doctor of Philosophy and for revoking the decision of a one-time specialised academic council of a higher education institution or research institution on awarding the degree of Doctor of Philosophy”, approved by Resolution No. 44 of the Cabinet of Ministers of Ukraine of 12 January 2022.

The candidate, SHUKURLU ELNUR, deserves to be awarded the degree of Doctor of Philosophy in the field of knowledge 18 Production and Technologies, specialty 184 Mining.

Reviewer:

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