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Evaluation of exploiting barite, the critical raw material in Slovakia, and benefits of its mining

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Abstract

Purpose. There are several deposits of critical raw materials in the Slovak Republic, but currently only one is mined. This is a barite deposit in Spiš, which shows an ever-lower volume of exploited raw material year-on-year. However, this area is rich in several confirmed barite veins, which represent potential strategic raw materials. The presented article analyzes in detail and describes the Jaklovce I. deposit, which is located in the Gelnica district in north-east of Slovakia. Despite the fact that Slovakia, as well as most EU countries, is dependent on imports of raw materials, the new deposits represent new potential. Determination of the economic value of these deposits creates a promising potential for the investor, but also, secondarily, a potential for the socio-economic development of regions, as well as for the state.

Methods. Based on the evaluation of dynamic economic variables, the article predicts the benefits which mining in this deposit would bring, which are also supported by SWOT analysis of barite exploitation.

Findings. According to the methods used during the financial evaluation of the single mined deposit of CRM in Slovakia, which was developed because of CRM criticality in EU, we showed, based on § 14 of the Mining Act no. 44/1988 Coll. the necessity of CRM mining from the view of regions, the state and investors. The present article summarizes impacts of exploiting the barite from Jaklovce I. deposit for the investor, as well as for the state, which is also underlined through SWOT analysis.

Originality. This study attempts to point out that mining critical raw materials is economically suitable not only for the state, but also for investors. SWOT analysis also pinpoints most threats, opportunities and some forecasts which should be taken into account while designing the investment project.

Practical implications. Investment project in mining area is one of the most critical and challenging decisions that experts have to make mainly based on geological, economical and geotechnical properties of the deposit, which are very specific. The same is true for the investment project which represents huge investments and rate of risk.

Keywords: *barite, critical raw materials, evaluation, mining, Slovakia*

1. Introduction

Barite is a critical raw material (CRM) which was included in the list of extremely rare raw materials (RM) only when it was reevaluated for the second time in 2017. CRMs are materials which are crucial for the EU, not only for their economic importance but also for the risk of their import [1]. Due to globalization and changes in the mining industry, which is characterized by aggressive competition and rapid technological development, the market environment undergoes transformations depending on global or local demand for the exploited RMs. For this reason, CRM are strategic raw materials with a higher rate of profitability, being in the focus of mining companies' attention [2]. Based on valid information on the market demand for CRM exploitation, mining companies can build and maintain their market share and become sufficiently competitive on the local or supra-regional market with the help of economic analyses within the framework of their business plans. All these facts depend on the realistic investment plan, the choice of appropriate analysis, economic indicators and subsequent assessment associated with this investment plan [3].

Barite is the only CRM mined in Slovakia. $BaSO_4$ is a white to gray-white mineral with a specific weight of 4.3-4.7 t/m^3, often containing impurities of Sr and Ca, rarely Pb and Ra. Different coloring of barite indicates contamination by Fe oxides, clay or organic impurities. The use of barite is conditioned by its high density, chemical inertness, high whiteness and ability to absorb X-rays. Barium (Ba), as a primary component of barite, binds to feldspars and mica of acidic and alkaline eruptive rocks. Barium-containing minerals are relatively few and rare (witherite, barite-

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celestine, sanborite). In hydrothermal veins, barite often occurs in associations with polymetallic minerals (Pb, Zn, Cu sulfides), pyrite and fluorite [4].

Barite is mainly used for heavy flushing in oil and gas wells (2/3 of world production), for the production of glazes, enamels, paints, and plastics. It is also a component of pesticides for extermination of rodents and insects. Barite is used in glass production, pyrotechnics (manufacture of signal rockets, detonators) and construction (in protective coatings and plasters against X-rays and radioactive radiation) [5]. There are currently six barite deposits in Slovakia, while only one is mined. The total reserves of barite in Slovakia amount to approximately 12000 kt, with only around 20 kt extracted annually, and mining is further declining. Almost all barite is exported, with up to 67% to the Czech Republic, 23% to Poland, 9% to Bulgaria and 1% to Hungary [6].

2. Current state of the problem

RMs represent a basic platform determining further development of an anthropogenic society, based on ensuring every increasing demand for tangible goods, which is also true for the economic development of the Slovak Republic. Since deposits of RMs are an integral part of the environment formed by biotic and abiotic components, characterized by complex interactions [7] it is necessary to manage their exploitation in accordance with the principles of sustainable development.

According to Hilson and Murck (2000) [8], the primary tools for ensuring sustainable development of RMs include the extended life of deposits through increased recycling of such RMs as metals. This will help prevent environmental problems from the beginning of the exploitation process by adopting proactive environmental standards in the extractive industry, pursuing the corresponding strategies and implementing smart ecological management to reduce the negative effects of contaminants and secondary products on the environment [9]. It is precisely for these reasons that increasing emphasis is currently placed on securing the national economic sectors of all countries of the EU, of which the Slovak Republic is an integral part, by supplying CRMs, whose lack has a much greater negative impact on the economy than that of other RMs.

Given the strategic importance of RMs for EU production and industry, it is important for the EC to introduce new measures to improve the EU's market position, which involves a wide range of changes meant to ensure the sustainability of affordable supplies of RMs quality [10]. The concept of CRM is becoming more and more declining as the costs associated with the extraction and processing of raw materials are affected by increasing focus on the production of quality products from these RMs. At the same time, the Slovak Republic, as well as the EU, has only a limited amount of reserves of ore and energy minerals and some non-ore minerals, which determines the long-term dependence on imports of deficit minerals to meet the RM needs of national economic activities. Hence, the European institutions have adopted a number of important documents in recent years reflecting the situation:

– the Raw Materials Initiative – meeting essential needs for growth and jobs in Europe [11];

– CRM for the EU – in 2008, the EC launched the EU Raw Materials Strategy [11]. The identification and assessment of CRMs for the EU was the first task of the strategy. The first list of CRMs for the EU was published by the EC in 2011 and updated every three years – in 2014, 2017 and 2020;

– in December 2019, the EC launched the European Green Agreement, the so-called EU Green Deal [12] to make Europe the first climate-neutral continent by 2050 with a modern, sustainable economy where economic growth is decoupled from resource use [13];

– the European Raw Materials Alliance (ERMA) was announced on 3 September 2020, as part of Action Plan on CRMs, in line with the publication of the 2020 List of CRMs.

In view of the above, an initiative has been proposed within the EU to address the challenges of access to raw materials. It is in this context that the CRMs list was compiled. Its main purpose was to clearly identify raw materials whose secure supply is at high risk, and which are of great economic importance, because reliable and unrestricted access to them is a priority for European industry and value chains. The list has been drawn up on the basis of an objective methodology to act as a tool to support trade, innovation and industrial policy measures aimed at strengthening the competitiveness of European industry, in line with the updated Industrial Strategy for Europe, through:

– identification of investment needs determining the reduction of Europe's dependence on RM imports;

– guidance on support for innovation in the field of RM supply within the Horizon 2020 program, EU Framework Program for Research and Innovation;

– accent on the importance of CRMs for the transition to a low-carbon, more resource-efficient circular economy.

CRMs are raw materials which are characterized by a high economic importance, as for the effective functioning of economy it is vital to eliminate the risk of their supply interruption. Their extraction can also cause negative environmental impacts, which makes it clear that their critical economic role also determines environmental policy [12]. At present, 30 CRMs are clearly defined in the EU (Table 1) after the original list of 14 CRMs from 2011 was expanded by 6 new ones in 2014, to which another 7 CRMs were added in 2017. During the last review in 2020, 4 new CRMs (bauxite, titanium, lithium, strontium) were added, while helium was removed.

Table 1. Critical raw materials for EU countries

Antimony	Gallium	Natural rubber	Tungsten
Barite	Germanium	Niobium	Vanadium
Beryllium	Hafnium	Platinum group metals	Bauxite
Bismuth	Heavy rare earth elements	Phosphate rock	Lithium
Borate	Light rare earth elements	Phosphorus	Titanium
Cobalt	Indium	Scandium	Strontium
Coking coal	Magnesium	Silicon metal	
Fluorspar	Natural graphite	Tantalum	

*Source: adapted from EC, 2020

3. Results and discussion

Evaluation of a CRM deposit defines the initial determinants for the choice of an effective strategy of CRM exploitation [14], which should also include steps to prepare the deposit evaluation.

It means to assess the necessary investment costs (labor costs, production costs, procurement costs of technical and

technological equipment, sources of financing, environmental fees, fees for the extracted mineral, extracted space, etc.), predicted sales and rates of updating all the mentioned variables entering the process as indicated in the diagram (Fig. 1).

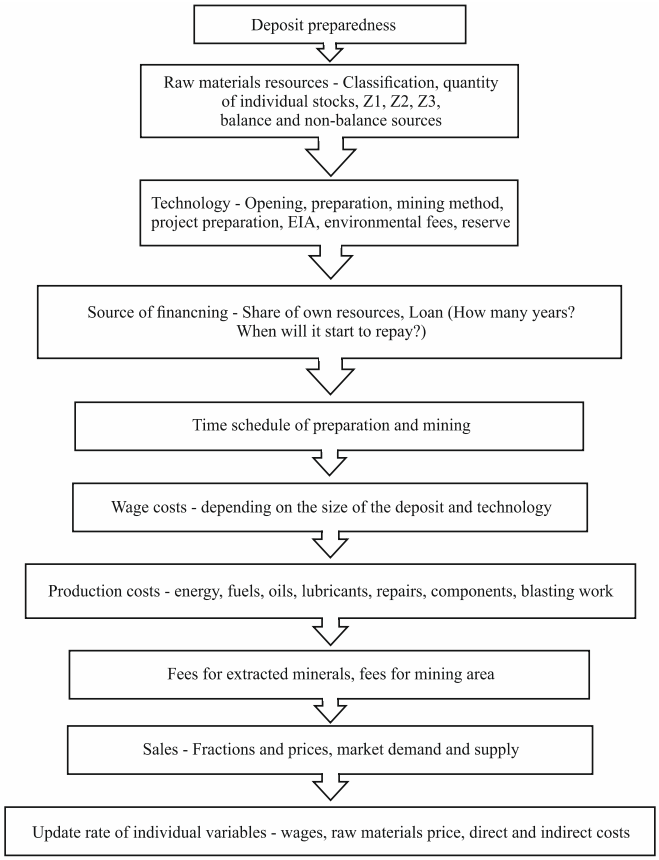

Figure 1. System steps of mineral deposit evaluation [15]

As seen in the above schematic representation, the basis of the valuation should be the type of mineral deposit determined by § 14 of the Mining Act no. 44/1988 Coll. amended by Act No. 498/1991 Coll. and SGÚDŠ Decree No. 6/1992 about the classification and calculation of exclusive deposits reserves in terms of the property rights of a particular enterprise. After supplementing the basic indicators of business management (in the case of mined deposit it will be real costs and revenues associated with mining and processing of raw materials and vice versa, in the case of unmined deposit – estimated costs and revenues based on market research results), it will be possible to establish the deposit value determined by the need and amount of foreign financing and to identify the repayment period and interest rate [15].

The overall evaluation of the deposit will include:

– *acquisition prices* of machinery and technical equipment by the type of raw material exploitation;

– *unit production costs* – depending on the deposit, the costs of blasting works range from € 0.60 to € 0.80, whereas costs for specific excavation technologies like mining by machinery and hydraulic mining are determined depending on the deposit, selected mechanisms, variability of operations and amount of mining;

– *plan of preparation, opening and mining* – prices for this step range from € 3.000 to € 6.000, depending on the raw material deposit;

– *EIA* – the detecting procedure costs range from € 2000 to € 3000, the mandatory assessment with the performance of a noise and dispersion study ranges from € 5500 depending on the type of mined raw material;

– *wage costs* – calculateon of the average wage by the number of employees taking into account costs of an employee social and health insurance which, according to the current legislation, constitutes 35.20%;

– *variable production costs* – material consumption, energy, transport, fuel, blasting work, etc.;

– *fixed production costs* – depreciation, taxes and fees, etc.;

– *fees for the mining area* – the company is obliged to pay an annual fee for the mining area € 663.87/each developed km^2 of the mining area (20% of this payment is the revenue of the state budget and 80% is the income of the municipality in which the mining area is located);

– *fees for extracted minerals* – the payment for extracted minerals is calculated for each quarter of the calendar year as the product of the ratio of the minerals mining costs to the total costs of making products from extracted raw material, revenues gained from the products sale and the rate of payment;

– *revenues from the sale of raw material* – depending on the mined raw material and the development of supply and demand in the market.

As there is a certain amount of raw materials on the territory of the Slovak Republic, part of which are CRM, the potential mining is associated with certain positive and negative aspects summarized in Table 2.

Table 2. Aspects of critical raw material exploitation

Establishment of a mining company	
Positive	Negative
Increasing employment in the region	Financially expensive construction of a mining company
Use of natural resources	Financial intensity of investment to ensure sustainable development
Tax profits for the state and region	Necessity of staff training
Diversification of competition	The need to build up customer cooperation with foreign countries
Potential investments in the region	Verification of pro – environmental measures

*Source: own processing

To provide a comprehensive assessment of the investment project of barite exploitation in the Jaklovce I. deposit and subsequent interpretation of the achieved results, several methods and methodological procedures were applied. We used mainly methods of analysis to identify the occurrence and extraction of CRM in the Slovak Republic. Synthesis methods were used in the presentation of the data about the barite deposit Jaklovce I. Method of comparison was utilized to juxtapose exploitation of CRM in the EU and Slovakia, and to present the obtained data of CRM exploitation we used the method of descriptive statistics. For evaluation of the barite deposit Jaklovce I., we used the cash-flow method of the investment project given in Table 3, according to the main relationship below:

$$CF = \text{Income } (R) + \text{Loan } (B) - \text{Investments } (I) - \\ - \text{Production costs } (E) - \text{Loan Repayment } (Rep) - \\ - \text{Interest Payment } (Int) - \text{Taxes } (Tax)$$

The investment project for the exploitation of a deposit must take into account the following variables related to its evaluation (Table 3).

Table 3. Annual CF breakdown with taxes and loan [15]

Y	Notes	Cash flow
0		$-I_0 = CF_0$
1	Beginning of loan drawing	$-I_1 + B = CF_1$
X		$-I_x + B = CF_x$
X	End of investments	$-I_x + B = CF_x$
X	Start of production	$-E_x + R_x = CF_x$
5	Start of loan repayment	$-E_5 + R_5 - REP_5 - INT_5 = CF_5$
“	First year of taxation	$-E_x + R_x - REP_x - INT_x - TAX_X = CF_x$
“		“ ”
N	Additional investment	$-I_N - E_N + R_a - REP_N - INT_a - TAX_A = CF_N$
“		“ ”
P	End of loan repayment	$-I_P - E_P + R_P - REP_P - INT_P - TAX_P = CF_P$
“		“ ”
N	End of project	$+R_V - E_N + R_N - TAX_N = CF_a$

Based on the cumulative *CF*, we determined the payback period of the investment project for the exploitation of the Jaklovce I. barite deposit, which we defined as the duration of the investment project from its beginning, when the cumulative *CF* begins to show positive values. The payback period is a key determinant of risk indicating the threat to the invested capital and thus the overall productive strength of the barite exploitation investment project. Making an economic decision concerning investment is based on the internal rate of return (*IRR*) of the investment project, which shows whether the investment will return without obtaining additional funding from the project.

In evaluation of the Jaklovce I. barite deposit, we used annually updated *CF*. Its sum is determined by the duration of the project and is generally referred to as the value of net profit (*NPV*), which was calculated based on the relationship below [16]:

$$NPV = \sum_{i=1}^{n} \left\{ \frac{\left(-I + CF_i\right)}{\left(1+a\right)^i} \right\}, \quad (1)$$

where:

NPV – net present value;
I – investments;
CF – cash-flow;
a – update rate;
i – current year;
n – project duration.

To define an effective strategy for the exploitation of barite at the Jaklovce I. deposit, we performed a SWOT analysis. In the frames of this analytical method, we firstly quantified the level of weights α and explicitly defined criteria of the analyzed areas of SWOT: strengths, weaknesses, opportunities and threats; while accepting the generally applicable condition $\sum \alpha_i = 1$. The weights were quantified on the basis of the Saaty matrix, whose dimensions *m x n* (where *m* = 1 ... *i* and *n* = 1 ... *j*) were given by the number of rows and columns, while observing the condition *m*= *n*. Thus we obtained a square matrix, which also corresponded to the fact that the method is based on an interactive comparison of all the defined criteria of the same order with the evaluation given in Table 4. Values 1 were plotted on the diagonal of the matrix because we accepted the equivalence of the same factors, but, if the factor listed in the row was preferred over the factor listed in the column, we assigned it a reciprocal value.

Table 4. Factor evaluation [17]

Value of criterion	Characteristics of the compared criteria
1	criteria *i* and *j* are equivalent
3	criterion *i* is slightly preferred over *j*
5	criterion *i* is strongly preferred over *j*
7	criterion *i* is very strongly preferred over *j*
9	criterion *i* is absolutely preferred over *j*

After the evaluation of individual factors, we created partial conjunctions of the rows in the matrix according to the relationship, where *f* is a number of factors and S_i is an individual factor:

$$S_i = \prod_{j=1}^{f} S_{ij}\, j = 1, 2, 3 \ldots f \ . \quad (2)$$

We further quantified the value of R_i for each criterion, i.e., row of the created matrix, according to formula:

$$R_i = \left(S_i\right)^{1/f} . \quad (3)$$

Based on such calculations, we got the sum R_i, which allowed to quantify the final value of individual weights α_i reflecting interactions of the compared criteria. Next we assigned points from the cardinal rate < 1, 5 > to the individual criteria according to the evaluation below:

1 – meets significantly below average;
2 – meets below average;
3 – meets average;
4 – meets above average;
5 – meets significantly above average.

In the next step, we realized the conjunction of the weights α_i and assigned points of individual factors. Their sum was defined as the vector boundaries of strengths and weaknesses of the internal environment, as well as opportunities and threats to the external environment. Subsequently, based on the vector sum, we identified an effective barite exploitation strategy at the Jaklovce I. deposit.

4. Results and discussion

The available data from the results of the survey work allow to assess barite reserves in the amount of 68.2 kt with quality 55% $BaSO_4$. The deposit body is a north-south barite vein with a directional length of 500 m, a width of 40 m and an average thickness of 1.3 m with an inclination of 65-87° to the west. The vein filling consists of barite, siderite (limonite), less quartz, inferior inclusions and accessory pyrite. The rock environment of the deposit consists of the Petrovohorská Formation (metaryolites, iyolite metavolcanoclastics, conglomerates, shales) and phyllites of the carbon and Rakovecká group. The deposit body is divided by younger tectonic lines directed towards:

– north-south (youngest) with steep slopes to the west but also to the east;

– northeast-southwest with slopes mainly towards the southeast, along which there were more significant movements;

– northwest-southeast with slopes to the southwest, but also to the northeast [18].

The barite raw material from the deposit can be used directly after extraction, sorting and grinding without flotation treatment in the glass industry (after separate extraction), in the production of paints, varnishes and plastics; and in the rubber industry as a filler [18]. Based on the available data from the exploited barite deposit in Rudňany (next to the analyzed deposit Jaklovce I.), it can be stated that this type of CRM is mined in a deep way. To evaluate the barite deposit Jaklovce I. and to assess the investment project for its exploitation, we considered the following aspects:

1) machinery and technical equipment necessary for efficient mining with depreciation calculation;

2) planned staff and real wages of employees considering twelve-year development with a wage valorization of 4%;

3) costs associated with mining;

4) annual extraction and development over twelve years;

5) sales and revenue growth over twelve years;

6) loan calculation;

7) calculation of *CF*, payback period, value of net profit *NPV* and determination of internal risk level *IRR*.

With regard to the above, we can conclude that for the purposes of assessing the investment project of barite exploitation at the Jaklovce I. deposit, it is necessary to procure machinery and equipment for deep mining of the mentioned CRM, including EIA and a certain financial reserve in the total amount of approx. € 2.2 mil with the following particular costs:

– machinery and technical equipment – € 1995550;

– EIA – € 12000;

– reserve – € 192000.

Due to the complexity of the assessment of the investment project for the exploitation of barite, we also considered foreign sources in the form of a loan in the amount of € 1 MM with an interest rate of 8.5% for the case of average annual extraction of 5683 t/year. For the needs of exploitation of the Jaklovce I. barite deposit, we also considered staffing and wage costs, as stated in Table 5, and direct production costs (Table 6) calculated on the basis of average production and barite mining, which is also reflected in the cost of the acquired CRM at the level of 1860 €/t.

In evaluating the barite deposit, we also took into account the following fees for the mined CRM and the mining area:

– the fee for extracted barite is set at 4% according to the valid legislation;

– payment for mining area = fee·area in km^2 i.e.: 1850 €/year.

The prices of extracted barite are reported monthly by the magazine Industrial Minerals, from where we found that the price of barite was in the range of 195-220 GBP/t with a content of about 95%. According to the National Bank of Slovakia as of May 20, 2020, GBP/EUR exchange rate was 1 EUR = 0.89535 GBP, so we set the price of barite in the range of 217.79-245.71€/t. Taking into account the quality of mined barite, which contains about 50% $BaSO_4$, we calculated the cost of the investment project to be 192 €/t. In evaluating the barite deposit Jaklovce I., we also considered the following update rates:

– price of CRM – 3% for the first three years, then 4%;

– direct costs – 3% for the first three years, then 4%;

– wage – 4% for the whole period.

Table 5. Wage costs

Position	Number of employees	Wage, €
Sales director	1	2000.00
Quarry leader	1	1500.00
Shift manager	2	1200.00
Drilling rig operator	2	1000.00
Driver	8	1000.00
Crusher operator	2	950.00
Maintainer	1	700.00
Guard	2	600.00
Accountant	1	1300.00
Local mining railway operator	4	900.00
Administrative	1	€ 1,000.00
Sorter operator	2	950.00
Total	26	11100.00
Levies	35.20%	3907.20
Social fund	8.00%	888.00
Total wage costs		15895.20

Table 6. Direct production costs

Mining costs	€
Wage costs	15895.20
Fuel	40000.00
Oil, lubricants	10000.00
Spare parts for machines	15000.00
Maintenance	5000.00
Repairs	20000.00
Fees for extracted minerals	12771.98
Fees for mining area	1850.00
Total	105895.20

We based our assessment of the barite exploitation investment project on the development trends of cumulative *CF*, according to which we clearly identified the payback period (*PBP*), which is a significant determinant of investment project risk indicating a threat to the invested financial capital. When quantifying the future *CF*, we also took into account the degree of updating, and the risk. The decision to invest in the exploitation of barite at the Jaklovce I. deposit was based on the internal rate of return (*IRR*), through which we expressed the return on the analyzed investment project (Table 7).

Table 7. Quantification of the payback period for the investment project

Net profit	1303892
Net present value (*NPV*)	961263
Internal rate of return (*IRR*)	102.5%
Payback period (*PBP*)	7 years

In view of the above and *CF* development trends, quantified on the basis of the Jaklovce I. barite deposit evaluation, we could state that in the seventh year it showed positive values (Fig. 2), as the established sales prices of barite were higher than the total production costs for its mining. We estimated the net value of the barite deposit (*NPV*) at € 961263; as defined from the assessment of the investment project economic efficiency during the period of twelve years considering the size and method of mining, deposit capacity and economic conditions (Table 7, Fig. 3). The payback period is set up to 7 years and the internal rate of return to 102.5% based on the update given by the parameters, the nature of the project over time and the development of economic parameters of the business environment of own investment sources.

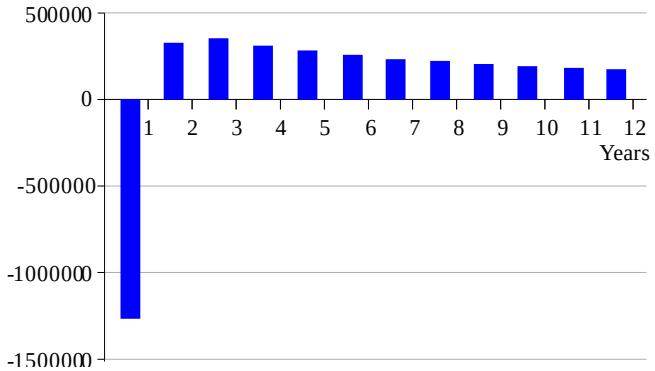

Figure 2. Development of updated CF

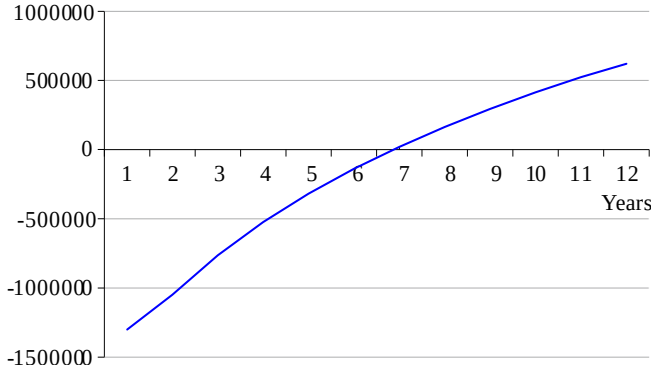

Figure 3. Development of cumulative CF

Implementation of the investment project for the barite Jaklovce I. exploitation would have economic impacts for the investor (Table 8) and for the state budget in the form of levies and taxes from dependent activity. The state revenue consists of social security levies of 35.2%, paid by the employer; and 13.4% of the employee's gross salary, paid by the employee, who also pays 19% tax on dependent activity. The state's income also includes payments for the mining area, 80% of which are the income of the municipality and 20% – the income of the state budget, plus corporate income taxes and VAT (Table 9).

Table 8. Economic impacts of the barite Jaklovce I. deposit exploitation for the investor

Economic indices	Period	Total [Eur]
Total investment costs	0-1 year	1995550
Total costs	project	2984899
Total revenue	project	4306185
Net profit	project	1303892
Net present value – income for the investor		961263

Table 9. Economic impacts of the barite Jaklovce I. deposit exploitation for the state

Economic indices	Period	Total [Eur]
Fees for mining area	12 years	22200
Fees for extracted minerals	project	135164
State budget revenues from levies and taxes on dependent activities	project	1744205
State revenue in the form of VAT	project	460906
State income in the form of corporate income tax	project	371726
Total state revenue from the project implementation		2734201

5. SWOT results

Evaluation of barite exploitation at the Jaklovce I. deposit and analysis of its impacts on the socio-economic area of regional development allowed to clearly formulate the effective strategy for the actual implementation of the investment project. Initially, we have identified the following factors of strengths (Table 10) of the barite exploitation investment project:

– S1 – job creation;
– S2 – source of the state budget;
– S3 – increasing the state security in CRM context;
– S4 – use of natural resources;
– S5 – potential investments in the region;
– S6 – source of the municipal budget.

Thus, by defining a key factor in the strengths of the barite deposit exploitation, we calculated the weights α_i in accordance with the Saaty matrix methodology.

Table 10. Quantification of weights α_i of strengths

Factor/ interaction	S1	S2	S3	S4	S5	S6	S_i	R_i	α_i
S1	1	1/3	3	3	1/3	1/3	0.33	0.83	0.11
S2	3	1	3	3	5	7	945.00	3.13	0.42
S3	1/3	1/3	1	3	5	5	8.33	1.42	0.19
S4	1/3	1/3	1/3	1	3	5	0.56	0.91	0.12
S5	3	1/5	1/5	1/3	1	1/3	0.01	0.49	0.07
S6	3	1/7	1/5	1/5	3	1	0.05	0.61	0.08
Total								7.39	1.00

Using the same procedure, we quantified the weights αi of the defined key factors of weaknesses (Table 11) related to the barite exploitation investment project:

– W1 – high investment costs;
– W2 – the need for foreign financial resources;
– W3 – risk of barite price changes;
– W4 – deep underground mining;
– W5 – complicated mining and technical conditions;
– W6 – formation of sludge pond and heap.

Table 11. Quantification of weights α_i of weaknesses

Factor/ interaction	W1	W2	W3	W4	W5	W6	S_i	R_i	α_i
W1	1	3	1/5	1/7	1/5	5	0.09	0.66	0.09
W2	1/3	1	3	1/3	1/5	1/3	0.02	0.53	0.07
W3	5	1/3	1	1/3	1/3	1/3	0.06	0.63	0.08
W4	7	3	3	1	1/3	3	63.00	1.99	0.26
W5	5	5	3	3	1	5	1125.00	3.22	0.42
W6	1/5	3	3	1/3	1/5	1	0.12	0.70	0.09
Total								7.74	1.00

The same procedure was used for quantifying the weights α_i of the defined key opportunity factors (Table 12) for the mentioned deposit:

– O1 – inflow of foreign investments;
– O2 – increasing the autonomy of the Slovak Republic;
– O3 – payback period;
– O4 – support for regional development;
– O5 – net present value – income for the investor.

Table 12. Quantification of weights α_i of opportunities

Factor/ interaction	O1	O2	O3	O4	O5	S_i	R_i	α_i
O1	1	5	3	3	5	225.00	2.95	0.46
O2	1/5	1	3	3	5	9.00	1.55	0.24
O3	1/3	1/3	1	3	3	1.00	1.00	0.16
O4	1/3	1/3	1/3	1	1/3	0.01	0.42	0.06
O5	1/5	1/5	1/3	3	1	0.04	0.53	0.08
Total							6.45	1.00

By analogy, we quantified the weights αi of the defined key threat factors (Table 13):

– T1 – production of mining waste;
– T2 – unopened deposit, without built infrastructure;
– T3 – high investment costs;
– T4 – the need to build a foreign customer portfolio;
– T5 – impact on the environment quality.

Table 13. Quantification of weights α_i of threats

Factor/ interaction	T1	T2	T3	T4	T5	S_i	R_i	α_i
T1	1	5	7	3	1/3	35.00	2.04	0.32
T2	1/5	1	1/3	5	1/3	0.11	0.64	0.10
T3	1/7	3	1	3	1/3	0.43	0.84	0.13
T4	1/3	1/5	1/3	1	1/3	0.01	0.37	0.06
T5	3	3	3	3	1	81.00	2.41	0.38
Total							6.31	1.00

6. Conclusions

Analysis of the issues related to the implementation of the barite exploitation investment project allowed to make the following preliminary conclusions:

– the investment project for the exploitation of barite at the Jaklovce I. deposit showed an *NPV* value of € 961263, with a payback period of 7 years and an internal rate of return of 102.5%;

– the analyzed investment project results in certain economic impacts for the investor (*NPV* = € 961263) and for the state (€ 273401 revenues) during the project lifetime. These facts clearly indicate the potential of the investment project to become an effective tool to support regional development, and a functional model of an anthropogenic society which eliminates threatening, damaging, and devastating living conditions; adequately utilizes natural resources and protects cultural and natural heritage [18];

– in the field of regional development, such investment projects are beneficial for the socio-economic area with the emphasis on increasing employment (creating new jobs) and thus raising the living standards and purchasing power of the population in the region;

– from the global perspective, investment projects focused on CRM exploitation enhance the autonomy and security of the national economic activities of the Slovak Republic;

– in the course of the research, these conclusions were justified and substantiated by SWOT analysis (Table 14 and 15).

In agreement with the methodological procedure of SWOT analysis, we calculated the values of individual vectors and then performed vector sums, the results of which are graphically represented in Figure 4.

Table 14. SWOT analysis of barite exploitation at the Jaklovce I. deposit (strengths and weaknesses)

Strengths	α_i	Points	Total
Job creation	0.11	4	0.45
Source of the state budget	0.42	5	2.12
Increasing the state security in CRM context	0.19	4	0.77
Use of natural resources	0.12	5	0.61
Potential investments in the region	0.07	5	0.33
Source of the municipal budget	0.08	4	0.33
Total	1.00		4.61
Weaknesses	α_i	**Points**	**Total**
High investment costs	0.09	4	0.3
The need for foreign financial resources	0.07	3	0.2
Risk of barite price changes	0.08	3	0.2
Deep underground mining	0.26	3	0.8
Complicated mining and technical conditions	0.42	3	1.2
Formation of sludge pond and heap	0.09	5	0.5
Total	1.00		3.27

Table 15. SWOT analysis of barite exploitation at the Jaklovce I. deposit (opportunities and threats)

Opportunities	α_i	Points	Total
Inflow of foreign investments	0.46	4	1.83
Increasing the autonomy of the Slovak Republic	0.24	3	0.72
Payback period	0.16	3	0.47
Support for regional development	0.06	4	0.26
Net present value – income for the investor	0.08	4	0.33
Total	1.00		3.60
Threats	α_i	**Points**	**Total**
Production of mining waste	0.32	4	1.29
Unopened deposit, without built infrastructure	0.10	4	0.41
High investment costs	0.13		0.00
The need to build a foreign customer portfolio	0.06	3	0.18
Impact on the environment quality	0.38	3	1.15
Total	1.00		3.02

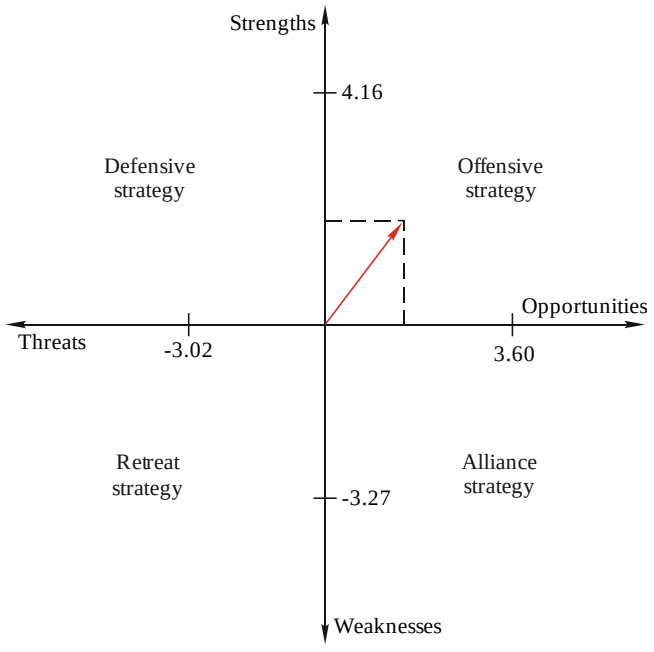

Figure 4. Graphical representation of SWOT analysis

From the graphical representation of the SWOT analysis, it is clear that the strengths of barite exploitation outweigh the weaknesses, and the opportunities outweigh the threats; which means that exploitation of the deposit should be guided by the principles of the so-called offensive strategy. The offensive strategy is generally determined by the harmony of external opportunities with the internal strengths. Hence, it can be concluded that the exploitation of the barite deposit should be done with modern machinery and equipment with the emphasis on the project economic value in favor of state revenues and the general budget, creation of new jobs and enhancement of employment.

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Оцінка розробки та переваг видобутку бариту – критично важливої сировини в Словаччині

З. Шимкова, Г. Паволова, Л. Беднарова

Мета. Визначення економічної цінності промислового освоєння родовища бариту в районі Гельніца на північному сході Словаччини для оцінки потенціалу інвестицій та соціально-економічного розвитку регіонів і держави в цілому із використанням SWOT-аналізу.

Методика. Загальна оцінка економічної цінності родовища бариту включала такі показники: собівартість одиниці продукції, план підготовки, розкриття і видобутку, витрати на заробітну плату, змінні виробничі витрати, постійні виробничі витрати, збори за зону видобутку, плата за видобуті корисні копалини, доходи від продажу сировини. При прийнятті економічного рішення щодо інвестування використовували норму внутрішньої прибутковості (IRR) інвестиційного проекту та величину чистого прибутку (NPV). Для визначення ефективної стратегії розробки бариту на родовищі Якловце I проведено SWOT-аналіз.

Результати. У даній статті узагальнені наслідки експлуатації родовища бариту Якловце I для інвестора та для держави, що детально розглянуто за допомогою SWOT-аналізу. Визначено показники інвестиційного проекту з розробки бариту на родовищі Якловце I: чиста приведена вартість – 0.94 млн євро, термін окупності – 7 років, внутрішня норма прибутковості – 102.5%. Ці факти достовірно вказують на потенціал інвестиційного проекту як інструменту підтримки регіонального розвитку. Відмічено, що інвестиційні проекти, орієнтовані на роботу CRM, збільшують автономію і безпеку національної економічної діяльності Словацької Республіки. Встановлено з графічного представлення SWOT-аналізу експлуатації бариту, що сильні сторони переважують слабкі, а також можливості над загрозами, що доводить, що при розробці родовища слід керуватися принципами, так званої, наступальної стратегії.

Наукова новизна. SWOT-аналізом виявлено більшість загроз і можливостей, а також зроблені деякі прогнози, які слід враховувати при плануванні інвестиційного проекту.

Практична значимість. Визначення основних показників інвестиційного проекту в гірничодобувній сфері є відповідальним і складним рішенням, яке фахівці повинні приймати, виходячи з геологічних, економічних і геотехнічних властивостей родовища, з огляду на суттєві витрати і значний рівень ризику.

Ключові слова: *барит, критична сировина, оцінка, видобуток, економічна цінність, Словаччина*

Оценка разработки и преимуществ добычи барита – критически важного сырья в Словакии

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Цель. Определение экономической ценности промышленного освоения месторождения барита в районе Гельница на северо-востоке Словакии для оценки потенциала инвестиций и социально-экономического развития регионов и государства в целом с использованием SWOT-анализа.

Методика. Общая оценка экономической ценности месторождения барита включала следующие показатели: себестоимость единицы продукции, план подготовки, вскрытия и добычи, расходы на заработную плату, переменные производственные затраты, постоянные производственные затраты, сборы за зону добычи, плата за добытые полезные ископаемые, доходы от продажи сырья. При принятии экономического решения об инвестировании использовали норму внутренней доходности (IRR) инвестиционного проекта и величину чистой прибыли (NPV). Для определения эффективной стратегии разработки барита на месторождении Якловце I проведен SWOT-анализ.

Результаты. В данной статье обобщены последствия эксплуатации месторождения барита Якловце I для инвестора и для государства, что детально рассмотрено с помощью SWOT-анализа. Определены показатели инвестиционного проекта по разработке барита на месторождении Якловце I: чистая приведенная стоимость составила 0.94 млн евро, срок окупаемости – 7 лет, внутренняя норма доходности – 102.5%. Эти факты достоверно указывают на потенциал инвестиционного проекта как инструмента поддержки регионального развития. Отмечается, что инвестиционные проекты, ориентированные на работу CRM, увеличивают автономию и безопасность национальной экономической деятельности Словацкой Республики. Установлено из графического представления SWOT-анализа эксплуатации барита, что сильные стороны перевешивают слабые, а также возможности над угрозами, что доказывает, что при разработке месторождения следует руководствоваться принципами, так называемой, наступательной стратегии.

Научная новизна. SWOT-анализом выявлено большинство угроз и возможностей, а также сделаны некоторые прогнозы, которые следует учитывать при планировании инвестиционного проекта.

Практическая значимость. Определение основных показателей инвестиционного проекта в горнодобывающей сфере является ответственным и сложным решением, которое специалисты должны принимать, исходя из геологических, экономических и геотехнических свойств месторождения, учитывая существенные затраты и значительный уровень риска.

Ключевые слова: *барит, критическое сырье, оценка, добыча, экономическая ценность, Словакия*