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Sandra Milutinović[*], Miomir Mikić[*], Miloš Stojanović[*]

THE USE OF MULTICRITERIA DECISION-MAKING METHODS IN DETERMINING THE OPTIMAL SOLUTION IN THE FORM OF SELECTION THE PRIORITY IN EXPLOITATION THE ORE DEPOSIT IN EASTERN SERBIA[**]

Abstract

Using the methods of AHP, VIKOR and TOPSIS, the methodology of ore deposit selection was determined. Selection of the best deposit is presented, as well as a comparative analysis of the output values of the applied methods.

Keywords: *AHP, TOPSIS, VIKOR, VKO, MCDM*

INTRODUCTION

Decision-making is a selection of action between several alternatives. The result of a decision is a decision. Decision-making at the social and business level is mostly of multi-criteria, and often of a collective type. Many factors are taken into account, also more stakeholders participate in the decision-making process. Most often, these factors are in conflict with each other, and even direct interests are opposed there.

In order to reach the best (compromise) solution, in the last five or six decades, the decision support methods of this type have been developed, the so-called multi-criteria decision - making (VKO) methods. Numerous methods have been developed for these purposes and applied in practice.

Some of the best-known methods to support multi-criteria decision making are:

- PROMETHEE (I, II) - *Preference Ranking Organization Method for Enrichment Evaluation [4], Jean-Pierre Barns*
- ELECTRE (I, II, III, IV) - *Elimination Et Choix Traduisant la Realité (Elimination and Choice Expressing Reality) [5], Bernard Roy*
- AHP - *Analytical Hierarchy Process [1], Thomas L. Saaty*
- TOPSIS - *Technique for Order of Preference by Similarity to Ideal Solution [3], Ching-Lai Hwang*
- VIKOR - *Multi-criteria Optimization and Compromise Solution [2], S. Opricovic*

Three VKO methods - AHP, VIKOR and TOPSIS, are applied in this paper.

The analyzed area of Eastern Serbia has several deposits on which the base metal that can be found is copper, followed by a certain amount of silver and gold. If the right ore deposit, which has the best characteristics, is chosen for exploitation, the contribution will be of great importance, especially for the economic growth in Eastern Serbia. The compari-

[*] *Mining and Metallurgy Institute Bor*
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son was performed for five deposits, as follows:

A_1 – Čukaru Peki – Upper Zone (located about 6 km from the urban area of Bor),

A_2 – Veliki Krivelj (north from the urban area of Bor),

A_3 – Majdanpek – South Mining District,

A_4 – Majdanpek – North Mining District,

A_5 – Cerovo (located in the ore field Mali Krivelj - Cerovo).

In this paper, using the VKO method, it will be analyzed which deposit should have priority in exploitation.

The basic criteria for selection of ore deposit are:

- k_1 - Copper content in the ore (%) - the higher copper content in the ore, the more favorable deposit,
- k_2 - Silver content in the ore (g/t) - the higher silver content in the ore, the more favorable deposit,
- k_3 - Gold content in the ore (g/t) - the higher gold content in the ore, the more favorable the deposit,
- k_4 - Tested quantities of minerals in the ore deposit - better tested deposits have priority,
- k_5 - Location - Better traffic infrastructure and spatial position are an advantage,
- k_6 - Mining-geological parameters - include many characteristics of the ore deposit that have an impact on the costs of exploitation.

Other criteria, such as harmful and dangerous substances in the deposits, environmental protection, economic aspect, etc. are not taken into account in this paper.

The basic data required for preparation of this paper are given in Table 1

Table 1 *Basic data*

Alternative/Criteria	Cu content (%) k_1	Ag content (g/t) k_2	Au content (g/t) k_3	Tested quantities of minerals in the ore deposit k_4	Location k_5	Mining-geological parameters k_6
Čukaru Peki – Upper Zone	2.71	3.16	1.7	Very high	High	High
Veliki Krivelj	0.322	0.79	0.7	High	Medium	High
Majdanpek – South Mining District	0.316	1.365	0.178	High	Medium	High
Majdanpek – North Mining District	0.298	1.730	0.238	High	Medium	High
Cerovo	0.340	1.8	0.11	High	Low	Very low

APPLICATION OF THE AHP METHOD

Analytical Hierarchical Process (AHP) is one of the most well-known methods of scientific scenario analysis and decision making by consistent evaluation of hierarchies whose elements are goals, criteria, sub-criteria and alternatives.

The conceptual and mathematical setting of the AHP method was given by Thomas Saaty (Saaty, 1980). Analytical hierarchical process belongs to the class of methods for soft optimization. It is basically a specific tool for forming and analyzing the decision-making hierarchies. The AHP first enables the interactive creation of a hierarchy of problems as a preparation of decision-making scenarios, and then evaluation in pairs of elements of the hierarchy (goals, criteria and alternatives) in the top-down direction. In the end, the synthesis of all evaluations is performed and weight coefficients of all elements of hierarchy are determined according to a strictly determined mathematical model. The sum of the weight coefficients of the elements at each level of hierarchy is equal to 1, which allows the decision maker to rank all the elements in the horizontal and vertical sense.

The application of method it self is very wide, with the possibility of adapting to the specific circumstances. A great advantage of the AHP method is that although it is basically easy to use, it still provides extremely high-quality output data. The basic principle of the AHP method is to break down a complex problem into simple factors, which are then compared in pairs. Each component in the model hierarchy is compared in pairs using the Saaty scale of relative importance, shown in Table 2.

Table 2 *The Saaty scale of relative importance*

Importance	Definition	Explanation
1	Same significance	Two elements are of identical importance in relation to the goal
3	Weak dominance	Experience or reasoning slightly favors one element over another
5	Strong dominance	Experience or reasoning significantly favors one element over another
7	Demonstrated dominance	Dominance of one element confirmed in practice
9	Absolute dominance	Dominance of the highest degree
2,4,6,8	Intermediate values	Compromise or further division is needed

The basic result of comparison the elements is the numerical value of priority significance coefficient (W).

By calculation the significance coefficient of each element of the analysis by the equation:

$$W = \sum_{j=1}^{n} \frac{W_i}{W_j} = W_i \left(\sum_{j=1}^{n} \frac{1}{W_j} \right), \qquad i = 1, \dots, n \tag{1}$$

a possibility of forming a mathematical matrix M is created by calculation that gives a solution according to a certain criterion or sub-criterion.

$$M = \begin{bmatrix} w_1/w_1 & w_1/w_2 & \cdots & w_1/w_n \\ w_2/w_1 & w_2/w_2 & \cdots & w_2/w_n \\ \cdots & \cdots & \cdots & \cdots \\ w_n/w_1 & w_n/w_1 & \cdots & w_n/w_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n1} & \cdots & a_{nn} \end{bmatrix} \tag{2}$$

Error checking is the last step in the AHP method, i.e. checking the consistency of a decision maker. Mathematical verification of the CI consistency index is performed using the following equation:

$$CI = \frac{(\lambda_{max} - n)}{(n-1)} \quad (3)$$

In which λ_{max} represents the maximum value of calculated matrix and is determined by the following equation, while n is the number of analyzed objects.

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \lambda_i \quad (4)$$

The random CR consistency index is determined by the following equation:

$$CR = \frac{CI}{RI}$$

Where RI is a random index that depends on the number of analyzed objects n (Table 3, Saaty, 1991).

Table 3 *Values of random RI index*

n	1	2	3	4	5	6	7	8	9	10
RI	0.00	0.00	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

The condition for the correctness of method is that the result of calculated value of the random consistency index is less than 0.1 (i.e. less than 10%).

In this paper, a mathematical model is applied in order to determine the optimal solution in the form of selection the priority in deposit exploitation.

The initial decision matrix is shown in Table 4.

Table 4 *Initial decision matrix*

Alternative/ Criteria	**Cu content (%) k_1**	**Ag content (g/t) k_2**	**Au content (g/t) k_3**	**Tested quantities of minerals in the ore deposit k_4**	**Location k_5**	**Mining-geological parameters k_6**
	max	max	max	max	min	max
A_1 - Čukaru Peki – Upper Zone	2.71	3.16	1.7	Very High	High	High
A_2 - Veliki Krivelj	0.322	0.79	0.7	High	Medium	High
A_3 – South Mining District	0.316	1.365	0.178	High	Medium	High
A_4 – North Mining District	0.298	1.730	0.238	High	Medium	High
A_5 - Cerovo	0.340	1.8	0.11	High	Low	Very low

The first step is to define the weighting factors (preference factors) of considered criteria using the Sarty scale, after which their mathematical calculation should be performed.

The next step is to check the consistency of a decision maker (using formula (4)): λ_{max} = 6.3232, n = 6.

From Table of values of the random index, RI is 1.25 and according to formula (3), the value of 0.06464 was obtained for the consistency index CI and random consistency index CR is 0.051712 ~ 5.2% <10%

So, the value of the preference vector is shown in Table 5.

Table 5 *Preference vector value*

Criteria	Preferences
Cu content (%) k_1	0.275
Ag content (g/t) k_2	0.021
Au content (g/t) k_3	0.146
Tested quantities of minerals in the ore deposit k_4	0.075
Location k_5	0.036
Mining-geological parameters k_6	0.446

The next step in analysis is the evaluation of alternatives in selection, in relation to the defined criteria.

The first sub-criterion to be analyzed is the copper content (%). All necessary input values for calculation the alternatives according to the criterion of copper content are:

Table 6 *Input values according to the criterion of Cu content*

	Cu content (%)	A_1	A_2	A_3	A_4	A_5
A_1	2.71	1	9	9	9	9
A_2	0.322	1/9	1	3	5	1/3
A_3	0.316	1/9	1/3	1	3	1/5
A_4	0.298	1/9	1/5	1/3	1	1/5
A_5	0.340	1/9	3	5	5	1

After calculation the matrix of weight coefficients according to the copper content, the consistency is checked:

$\lambda_{max} = 5.39$ n=5

From Table of values of the random index, RI is 1.11, and according to formula (3) the value of 0.0975 was obtained for the consistency index CI and the random consistency index CR is 0.0878 ~ 8.8% <10%.

Other sub-criteria are checked in the same way: silver content, gold content, tested quantities of minerals in the ore deposit, location, mining-geological parameters.

Table 7 shows the last step in application of AHP method, which is the weighting of calculated coefficients of significance of alternatives in selection according to different criteria, and coefficient of significance (preference) of these criteria:

Table 7 *Final report of parameters for defining the value of alternatives according to all criteria*

Criteria	Significance factor		A_1	A_2	A_3	A_4	A_5
Cu content (%)	0.275	k_1	0.669	0.09	0.044	0.076	0.17
Ag content (g/t)	0.021	k_2	0.51	0.03	0.06	0.12	0.27
Au content (g/t)	0.146	k_3	0.51	0.27	0.06	0.13	0.03
Tested quantities of minerals in the ore deposit	0.075	k_4	0.44	0.14	0.14	0.14	0.14
Location	0.036	k_5	0.04	0.2	0.23	0.23	0.3
Mining-geological parameters	0.446	k_6	0.24	0.24	0.24	0.24	0.04

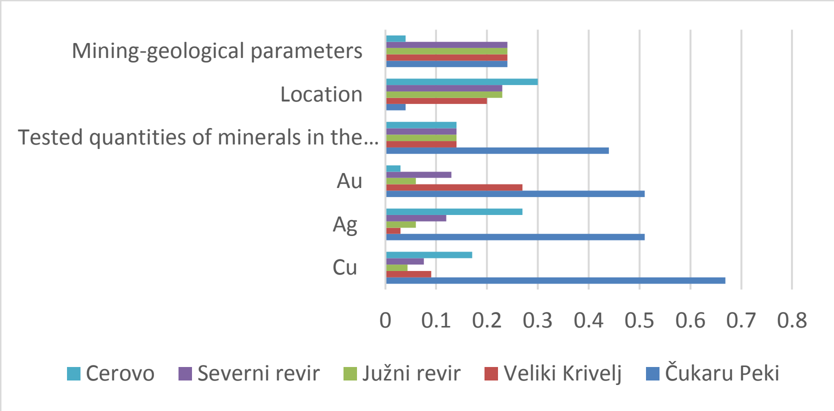

Figure 1 *Analysis of results according to the criteria and alternatives analyzed*

Figure 1 shows the analysis of criteria and alternatives, and Table 8 shows the results of this method application, where it can be seen that the best ranked deposit is Čukaru Peki.

Table 8 *Results of application the AHP method*

Ore deposit	coeff.	%	Rank
Čukaru Peki – Upper Zone	0.3165	31.65	1
Veliki Krivelj	0.1616	16.16	2
Majdanpek – South Mining District	0.129	12.9	5
Majdanpek – North Mining District	0.156	15.6	4
Cerovo	0.1585	15.86	3

APPLICATION OF THE VIKOR METHOD

The VIKOR method is a very commonly used method for multi-criteria ranking, suitable for solving various decision-making problems. It is especially suitable for situations where criteria of a quantitative nature prevail.

The VIKOR (Multi-criteria Optimization and Compromise Solution) is a multi-criteria method for optimization and decision-making developed by Serafim Opricović, for the purpose of solving the decision-making problems when considering conflicting and heterogeneous criteria that affect the decision-making. The method is based on the assumption that a compromise is acceptable for resolving the conflict, that a decision maker wants the solution that is closest to the ideal, and that the alternatives are evaluated according to all set criteria. This method ranks alternatives and determines the compromise solution that is closest to the ideal. In essence, the method represents a compromise between desires and possibilities.

The mathematical calculation of method begins with the formation of a decision matrix:

$$M = \begin{matrix} & \begin{matrix} C_1 & C_2 & \dots & C_m \\ w_1 & w_2 & \dots & w_m \end{matrix} \\ \begin{matrix} A_1 \\ A_2 \\ \vdots \\ A_n \end{matrix} & \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \end{matrix}$$

The VIKOR method consists of 4 Steps, as follows:

1. Determining the maximum (x_i*) and minimum (x_i^-) values of a given criterion. When a decision matrix is formed, the maximum and minimum values are required for each criterion.

$$x_i^* = \max_j x_{ij}$$

$$x_i^- = \min_j x_{ij}$$

2. Calculationthe values of S_j of the pessimistic solution and R_j of the expected solution. The decision maker prefers what weight coefficients will be assigned to these values.

$$S_j = \sum_{i=1}^{n} w_i \,{}^{(x_i^* - x_{ij})}\Big/_{(x_i^* - x_i^-)}$$

$$R_j = \max_i \left[w_i \,{}^{(x_i^* - x_{ij})}\Big/_{(x_i^* - x_i^-)} \right]$$

where w_i – criterion weight

3. Calculation the values of Q_j - compromise solution

$$S^- = \min_j S_j \,;\; S^* = \max_j S_j$$

$$R^- = \min_j R_j \,;\; R^* = \max_j R_j$$

4. Ranking is performed by sorting the alternatives according to measures R_j, S_j and Q_j. The best alternative is the one for which the value of measure is the lowest and it takes the first place on the Rank list. Alternative *a*j is better than alternative even if Qj <Qk. This is how three Rank lists are obtained. The measure Qj is a linear function of the weight of strategy that satisfies most of the criteria (*v*), so the position on the Q list is a linear combination of the position on the R and S lists. The order according to the VIKOR method can be performed with different weights, thus considering the effect of weights on the proposal of compromise solution.

The results of these steps are the basis for deciding and adopting the final solution (multi-criteria optimal solution).

Table 9 shows the input values for application the VIKOR method, and for the preference functions the same values were adopted as for the AHP method.

Table 9 *Input values for application the VIKOR method*

Alternatives/Criteria	**Cu content (%) f_1**	**Ag content (g/t) f_2**	**Au content (g/t) f_3**	**Tested quantities of minerals in the ore deposit f_4**	**Location f_5**	**Mining-geological parameters f_6**
	max	max	max	max	min	max
A_1 - Čukaru Peki – Upper Zone	2.71	3.16	1.7	9	1	7
A_2 - Veliki Krivelj	0.322	0.79	0.7	7	5	7
A_3 – South Mining District	0.316	1.365	0.178	7	5	7
A_4 – North Mining District	0.298	1.730	0.238	7	5	7
A_5 - Cerovo	0.340	1.8	0.11	7	7	1

For each criterion, the maximum and minimum values for all five ore deposits analyzed are derived.

Table of intermediate values is formed in the following step by formula:

$$(f_i max - f_{ij}) / (f_i max - f_i min) \cdot w_i$$

Table 10 *Intermediate values*

0	0	0	0	0	0
3.601	47.4	6.451	13.157	18.518	0
3.609	35.9	9.819	13.157	18.518	0
3.636	28.6	9.432	13.157	18.518	0
3.573	27.2	10.258	13.157	27.777	2.242

The pessimistic *Sj* and optimistic *Rj* values are formed, presented in Table 11:

Table 11 *Pessimistic Sj and optimistic Rj values*

	Sj	***Rj***
A_1	0	0
A_2	89.127	47.4
A_3	81.003	35.9
A_4	73.343	28.6
A_5	84.207	27.777
max	89.127	47.4
min	0	0

Table 12 shows the intermediate results *QSj* and *QRj*, calculated by the following formulas:

$$QS_j = (S_j - minS_j) / (maxS_j - minS_j)$$

$$QR_j = (R_j - minR_j) / (maxR_j - minR_j)$$

Table 12 *Intermediate results QSj and QRj*

	QSj	***QRj***
A_1	0	0
A_2	1	1
A_3	0.910	0.757
A_4	0.823	0.603
A_5	0.944	0.586

The last step in the VIKOR method is the analysis of calculated results for three different rates *v* (0.5; 0.6 and 0.7). The values of Qj obtained for three rates *v* are shown in Table 12.

The used formulas are:

$$Q_j = (S_j + R_j)/2$$

$$Q_j = v \times QS_j + (1 - v) \times QR_j$$

Table 13 *Results of the VIKOR method*

	v=0,5		v=0,6		v=0,7	
	Qj	Rank	Qj	Rank	Qj	Rank
A_1	0	1	0	1	0	1
A_2	1	5	0.24	2	0.21	2
A_3	0.8335	4	0.8488	5	0.8641	5
A_4	0.713	2	0.735	3	0.757	3
A_5	0.765	3	0.801	4	0.8366	4

On the basis of results, shown in Table 13, it can be concluded that with this method, similar results were obtained applying different rates and that, as with the AHP method, the best ranked deposit is Čukaru Peki.

APPLICATION OF THE TOPSIS METHOD

In the TOPSIS method, the idea of selection the best alternative based on the distance from the positive ideal solution (PIS) is expanded with the additional requirement that this alternative be at the same time as far away from the so-called negative ideal solution (NIS).

Problem solving comes down to the following seven steps [5]:

- Step 1: Collecting the input data on performances for *n* alternatives with *k* criteria. It is necessary to normalize the input data.
- Step 2: Determining the weights for each criterion and multiplying the weights with quantitative indicators of criteria for each alternative.
- Step 3: Identification of the ideal positive solution A^*.
- Step 4: Identification of the ideal negative solution A^-.
- Step 5: Calculate the distance of all alternatives in relation to the ideal positive solution A^* and in relation to the ideal negative solution A^-.
- Step 6: For each alternative form the function $D_p(a_i)$.
- Step 7: Ranking of alternatives according to the results from the previous step.

The mathematical model of this idea requires that in addition to the ideal solution

$$A^* = (f_1^*, f_2^*, f_3^*, \dots, f_k^*)$$

which in this method is called a positive ideal solution with components

$$f_j^* = \max_{a_i \in A} f_j(a_i)$$

introduce also a negative ideal solution

$$A^- = (f_1^-, f_2^-, f_3^-, \dots, f_k^-)$$

with components

$$f_j^- = \min_{a_i \in A} f_j(a_i).$$

A distance of alternative i *a* from the negative ideal solution is denoted by:

$$d_p^-(a_i) = \left(\sum_{j=1}^{k} w_j^p \left(f_j - f_j(a_i) \right)^p \right)^{1/p}$$

In order to identify in a set of alternatives the alternative that is closest to the positive ideal solution, and at the same time the furthest from the negative ideal solution, it is necessary to form a function for selected metric:

$$D_p(a_i) = \frac{d_p^-(a_i)}{d_p^*(a_i) + d_p^-(a_i)}$$

The best alternative (there may be more) is the one for which this function takes the maximum value. If it is necessary to make a Rank list of alternatives, it is formed by decreased values of this function.

Based on the step to be performed, the input data was normalized (Table 14), the sum of square matrixs (Table 15), obtaining the rij - normalization (Table 16), multiplied by wi - weighing (Table 17); the ideally and anti-ideal solutions should be shown.

Table 14 *Initial matrix and preference value*

	K1(max)	K2(max)	K3(max)	K4(max)	K5(min)	K6(max)
A1	2.71	3.16	1.7	9	1	7
A2	0.322	0.79	0.7	7	5	7
A3	0.316	1.365	0.178	7	5	7
A4	0.298	1.73	0.238	7	5	7
A5	0.34	1.8	0.11	7	7	1
Preferences	0.275	0.021	0.146	0.076	0.036	0.446

Table 15 *Matrix of square sum*

A1	7.3441	9.9856	2.89	81	1	49
A2	0.103684	0.6241	0.49	49	25	49
A3	0.099856	1.863225	0.031684	49	25	49
A4	0.088804	2.9929	0.056644	49	25	49
A5	0.1156	3.24	0.0121	49	49	1
Sum	7.636444	18.705825	3.480428	277	125	197
Root	2.76341166	4.325023121	1.865590523	16.64331698	11.18033989	14.03566885

Table 16 *Obtaining rij – normalization*

A1	0.980671841	0.730631932	0.91123962	0.540757591	0.089442719	0.49872935
A2	0.116522632	0.182657983	0.375216314	0.420589238	0.447213595	0.49872935
A3	0.114351403	0.315605249	0.095412148	0.420589238	0.447213595	0.49872935
A4	0.107837715	0.399997862	0.127573547	0.420589238	0.447213595	0.49872935
A5	0.12303632	0.416182746	0.058962564	0.420589238	0.626099034	0.07124705

Table 17 *Multiplication with wi - aggravation*

A1	0.269684756	0.015343271	0.133040985	0.041097577	0.003219938	0.22243329
A2	0.032043724	0.003835818	0.054781582	0.031964782	0.016099689	0.22243329
A3	0.031446636	0.00662771	0.013930174	0.031964782	0.016099689	0.22243329
A4	0.029655372	0.008399955	0.018625738	0.031964782	0.016099689	0.22243329
A5	0.033834988	0.008739838	0.008608534	0.031964782	0.022539565	0.031776184

Table 18 *Ideal solution*

	0.269684756	0.015343271	0.133040985	0.041097577	0.022539565	0.22243329

Table 19 *Negative ideal solution*

	0.029655372	0.003835818	0.008608534	0.031964782	0.003219938	0.031776184

The next step is to calculate the relative proximity to the ideal solution and anti-ideal solution.

Table 20 *Deviation from ideal solution*

							SUM	**SQRT(SUM)**
A1	0	0	0	0	0.000373248	0	0.000373248	0.019319627
A2	0.05647326	0..000132421	0.006124534	8.34079E-05	0.000041472	0	0.062855096	0.250709186
A3	0.056757402	7.5961E-05	0.014187385	8.34079E-05	0.000041472	0	0.071145628	0.266731378
A4	0.057614105	4.82096E-05	0.013090849	8.34079E-05	0.000041472	0	0.070878044	0.266229307
A5	0.055625113	4.36053E-05	0.015483435	8.34079E-05	0	0.036350132	0.107585693	0.328002581

Table 21 *Deviation from negative ideal solution*

							SUM	**SQRT(SUM)**
A1	0.057614105	0.000132421	0.015483435	8.34079E-05	0	0.036350132	0.109663502	0.3311548
A2	5.70423E-06	0	0.00213195	0	0.000165888	0.036350132	0.038653675	0.196605378
A3	3.20863E-06	7.79466E-06	2.83198E-05	0	0.000165888	0.036350132	0.036555343	0.191194516
A4	0	2.08314E-05	0.000100344	0	0.000165888	0.036350132	0.036637196	0.191408453
A5	1.74692E-05	2.40494E-05	0	0	0.000373248	0	0.000414767	0.020365819

Determining the Rank (shown in Table 22), the conclusion was made that, as with the other two methods, the best Ranked deposit is Čukaru Peki.

Table 22 *Rank*

A1	0.944875786	**1**
A2	0.439523757	**2**
A3	0.417522832	**4**
A4	0.41825319	**3**
A5	0.058460582	**5**

CONCLUSION

Based on the obtained results from calculation of all three methods, it was concluded that the ore deposit Čukaru Peki - Upper Zone is the best choice in the existing conditions, for all three methods. After it, the Veliki Krivelj deposit is at the second place. For other deposits, all three methods give different results.

Based on the results of application all three methods in selection the best deposit, it is concluded that Čukaru Peki is the best deposit with the most optimal parameters for its exploitation, what could be concluded through the amount of useful components and good operating conditions.

A methodology based on these three methods helps in selection the ore deposit and can be useful in the preliminary analysis. Selection of ore deposits can be based on other criteria, not only those given in this paper, so that different results can be obtained.

REFERENCES

[1] Thomas L. Saaty: Analytical Hierarchy Process

[2] Opricović S.: System Optimization, Faculty of Civil Engineering in Belgrade, Belgrade, 1992 (in Serbian)

[3] Ching-Lai Hwang: Technique for Order of Preference by Similarity to Ideal Solution.

[4] Jean-Pierre Barns: Preference Ranking Organization Method for Enrichment Evaluation.

[5] Bernard Roy: Elimination Et Choix Traduisant la Realité (Elimination and Choice Expressing Reality)