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ANALYSIS OF SUITABILITY FOR DEVELOPMENT OF NEW MINING FIELD IN NORTHERN PART OF KOSOVO LIGNITE BASIN – SIBOVC

ANALIZA MOŻLIWOŚCI UDOSTĘPNIENIA NOWEGO OBSZARU WYBIERANIA W PÓŁNOCNEJ CZĘŚCI ZAGŁĘBIA WĘGLA BRUNATNEGO SIBOVC W KOSOWIE

This review describes the possibility of development a new lignite deposit in northern Kosovo lignite basin - Sibovc. Analysis of the initial state briefly evaluates Kosovo energy sector, geomorphological conditions and quality of lignite from Sibovc deposit. With using Dataminesoft it was created geological model and approximate calculation of lignite reserves in the deposit. The data obtained from Dataminesoft were used as starting points of the financial analysis of project. The result of the analysis is exactly describe the qualitative and quantitative characteristics of deposit Sibovc compared to other deposits in the area and creating of geological model with productive horizons deposit of lignite. Based on these data lignite deposit Sibovc was classified, according to the classification of deposits the UN, as economical.

Keywords: Sibovc mining field, Republic of Kosovo, lignite, geological model

W pracy tej omówiono możliwości udostępnienia nowego obszaru wybierania złoża węgla brunatnego (lignitu) w północnej części zagłębia węgla brunatnego Sibovc w Kosowie. W analizie stanu początkowego krótko scharakteryzowano sektor energetyczny Kosowa, warunki geo-morfologiczne oraz parametry jakościowe węgla brunatnego z zagłębia Sibovc. Przy pomocy pakietu Dataminesoft stworzono model geologiczny i przeprowadzono przybliżone obliczenia zasobów węgla brunatnego w złożu. Dane uzyskane przy zastosowaniu pakietu Dataminesoft zostały następnie wykorzystane jako dane wejściowe do analizy finansowej przedsięwzięcia. Na podstawie wyników analizy uzyskuje się jakościową i ilościową charakterystykę złoża w odniesieniu do pozostałych złóż w regionie. Opracowano model geologiczny ze szczegółowym wskazaniem poziomów wybierania lignitu. W oparciu o te dane dokonano klasyfikacji złoża węgla brunatnego (lignitu) w Sibovc zgodnie z międzynarodowymi zasadami klasyfikacji wykazując, że złoże będzie ekonomiczne.

Słowa kluczowe: obszar wybierania w Sibovc, Republika Kosowo, lignit, model geologiczny

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1. Introduction

The Kosovo lignite mines operate one of the most geologically favorable lignite deposits in Europe. The average ratio of stripped waste is 1,7 m^3 to 1 t of coal, coal production at Kosovo mines could potentially supply a very competitive fuel to the regions power plants, compared with international fuel and energy prices. The total estimated resources approximate 11,500 million t – one of the richest lignite sources in Europe, which would allow ambitious power generation and expansion schemes in the future.

The two opencast mines at Mirash and Bardh reached their maximum coal production 1988 with 10.6 million t. The design capacity, however, has been sufficient to supply the power plants Kosovo "A" and "B" with 790 MW and 678 MW worth of fuel respectively, has well as supplying a coal drying plant and other local consumers. At present the mines are operating uneconomically due to the numerous constraints caused by the recent war and the following post-war restructuring, consequently production is at a low level.

The Energy Strategy and Policy for Kosovo "White Paper" is based on use of the domestic lignite reserves for power generation. It also suggests the installation of new lignite fired power plants. However, the reserves in the boundaries of the existing mines will be depleted within the next few years.

In order to secure a safe and continuing supply of fuel a new lignite mine has to start coal production as soon as possible. The current rough estimate for the cost for opening a mine with annual coal production of some 11 million $t.a^{-1}$ is a 100 million EUR. For the time being Kosovo does not have the required funds. In order to attract foreign investors an Investor Friendly Environment must be created including a clear legislative and fiscal framework. In the following pages the current situation of the energy resources in Kosovo will be described. An outline of the general geological and tectonics features of the Kosova Basin and a more complex description of the new mining fields in Sibovc will be provided. The paper will conclude with the results of our basic economic analysis of Sibovc mining field potential yield. (Morvay et al., 2006).

2. Energy resources of Kosovo

Based on the exploration and known status of energy resources, the small territory of Kosovo has considerable coal reserves at different sites which are classifiable as lignite, hydro-potential, small reserves of uranium, low energy geothermal sources and a potential pocket of natural gas. A recap of Kosovo energy resources is shown in Tab. 1.

TABLE 1

Energy resources of Republic of Kosovo (Haxhiu, 2004)

Energy source	Unit	Reserves [10^3]					
		Total		Explored		Exploitable	
		t	t_{ce}	t	t_{ce}	t	t_{ce}
Lignite	10^6	-	-	14324	3761	11503	3004
Natural gas	$10^6 m^3$	Potential zone					
Uranium		Has not been balanced (approx. 20 t of ore @ 0.026%)					
Hydro-potential	$TWh.v^{-1}$	1982				681	

t_{ce} – equivalent tones ($t_{ce} = 29.31.10^9$ [J])

TABLE 2

Lignite reserves (Haxhiu, 2004)

Lignite Basin	Area [km^2]	Reserves [Million Tonnes]			
		Geological		Exploitable	
		t	t_{ce}	t	t_{ce}
Kosova	264	11500	2957	9804	2521
Dukagjini	95	2737	782	1625	464
Other		87	22	74	19
Gjithsej		14324	3761	11503	3004

t_{ce} – equivalent tonnes (t_{ce} = 29.31.10^9 [J])

There are two major lignite basins: **Kosova** lignite basin and **Dukagjini** lignite basin and also smaller lignite basins like: **Drenica, Malishevë, Babush i Muhaxherëve**, and one **potential** lignite basin in the southern part of Kosovo. A recap of lignite reserves is shown in Tab. 2. (Hofmann et al., 2002).

3. Detailed description of the new mining field

3.1. Geology, Morphology and Hydrology

The Kosova Basin, which has a longitudinal N-S extension and westward elevation, while the general extension of the basin is NNW-SSE. The Kosova Basin is situated from Mitrovica in the north down to Kaçanik in the south with a length of 85 km and average width of 10 km and a surface of around 850 km². The Basin is bounded by an elevated relief in the northwestern side formed by Kopaonik massif, Kozic, Zhegovc and Lisic in the eastern side, Montenegro massif and Skopje in the southern side, while the western side is bounded the Çicavica, Golesh, Carnaleva and Sharr mountains. The peaks bordering the basin are from 800 to 1500 m high. The Kosova Field has an average elevation above sea level of 650 m and be thought of as a mesa or plateau. The rivers flowing along this basin continue to the Aegean or Black Sea. The main water sump is the river Sitnica and its catchment area includes 80% of the basin, while the rest of parts drains to the Aegean Sea. From a morphological point of view the Kosova Basin can be is a valley where the differential between the lower and upper elevation does not exceed a height of 80 m. The morphological aspect of the basin can be divided into two parts:

- The central plane which includes the terrain around the Sitnica river.
- The elevated hillocks situated near the Çicavica Golesh, Sharr and other mountains.

The Kosova Basin has a dip from the south to the north with the lowest elevation of 500 m at the entrance of river Sitnica to the Ibër river system. The morphology of the Kosova Basin enables profitable coal exploitation by opencast mining. Fortunately the Kosova Basin contains a very developed hydrological network. The flowing water of the Kosova Basin is textbook it its presentation as it makes separation of two water sumps, the river Nerodime which feeds the Aegean Sea and the Black sea via the river Sitnica. The river Sitnica is major drain of the Kosova Basin, which flows almost throughout the basin. As it is engorged in the months with greater rainfalls, this river overflows the cultivable fields and has at times influenced the coal works at the eastern end of the Mirash mine.

3.2. Geological and tectonics setting of the Kosova Basin

The tectonics movements at the end of the Lowers Miocene has caused the formation of the tectonic depressions of Kosova, Dukagjin and Drenica. The Kosova Basin including its peripheral parts was constructed during the Palaeozoic, Mesozoic and (tertiary and quaternary) Cainozoic periods.

The tertiary neogene periods and layers of the basin have been investigation targets for a long time and this shows that the Kosova Basin has a mixed lithological construction both in its horizontal and vertical extension. Taking into consideration the lithological and palaeontological structure the basin divides into the following areas:

- Southern area unproductive.
- Northern area unproductive.
- Central area productive.

The central area is known as the "Kosova Coal Basin" and contains a surface of 300 km^2. The layers which form the productive area are as follows:

- Bottom layers.
- Coal layers.
- Top layers.

The bottom layer has a lithofacial character mixed in both its horizontal and vertical spread. In the vertical spread there are two lithological areas connected with each other by a gradual shift from one to the other. The first area contains the deepest part of the whole layer and is a green clay with a some fine carbonic sand present as well as frequent pockets of compact conglomerate sand. Based on the lithology encountered in this area the lack of flora and fauna as well as the bed of fine sand it is assumed that was created by shallow surface waters. The depth of the layer goes down to 250 m. The second area of this layer is green-grey clay with trace amounts of fine sand and greasy clay. The bedding is less expressed. The areas thickness here can be up to 50 m. The green clay, which is in a direct contact with coal, contains coal fragments and gradual fades into the coal layer.

The horizontal and vertical boundaries of the **coal layer** are based on research drillings. The boundary of this layer in relation to the unproductive areas is not clean but is indefinite. The coal layer merges gradually into the other layers on in the southern, eastern and northern boundaries, while on the western boundary of the basin there is a sharp intersection of the coal layer with the unproductive rock. Depending upon the thickness of the top layer and the general tectonics the coal series appears in a variety of different depths. While it has been observed that the coal layer as a whole has a centroclinal dip the coal layer is sinking in the direction of centre of the basin in a series of step like faults. These step faults are most pronounced where these tectonics movements are expressed, such as in the direction of Lajthishtë-Dobrajë e madhe.

The major depth of the coal series goes up to a depth of 110 m, while in the areas with more expressed erosion the depth of the coal deposit is decreased. In the places where the coal as been exposed to the surface a self-burning occurred and this burning has consumed up to 10 % of the series where the burning has occurred. This burning has created areas of pocelanit-brand. The intercalations in the coal series are clays, and this clay begins in the base of the coal deposit and gradually passes into the green-grey clay. Apart from clay there are lentils of silificated woods and thin-bedded dust masses - these intercalations influence in the coal quality in different places.

The Kosova Coal Basin belongs to the lignite type and there is coal with a wooden-xylite structure as well as a type of coal created from the tiny wooden fractions – coal-soil. These two coal types present as a single mass, however they are usually intercalated with each other. Based upon the drillings conducted thus far the xylite is prevalent on the top of coal series while the coal-soil is predominant in the bottom of coal series. The color of the coal varies from a light-taupe to a dark-taupe color. When the coal series is exposed to the air it looses its humidity, becomes fragmented and passes into taupe dust.

The top layer covers of the coal and consists of following lithological deposits: grey colour clay, yellow clay, brown sand, gravel and humus layer. The grey clay is in direct contact with the coal series and has a wide horizontal spread starting from Sibovc to Prelez. The thickest area of clay is in the part where the coal depth also increases. This clay is homogenous and in the vertical cutting is very strong. Sometimes there are fine sandy layers encountered as well as depositions of fossils. In the upper part of the roof layer the grey clay transfers into the yellow clay due to cracks, and under the influence of weather conditions as well as the presence of magnetite, manganese and $CaCO_3$. In the wet season the yellow clay increases in plasticity due to profusion and presence of fine sands, and this mass slides against its base (grey clay) in respectively to the compact clay, which is impermeable to water.

In the northwest part of the basin the grey clay, or sometimes the sandy clay too, were baked and it came to the creation of a brand new layer. This baking process occurred due to the self-combustion processes at the top of the coal seam.

In the area of Dardhishte-F.Kosove along the bed of the river Sitnica the coal series is in direct contact with a layer of sandy gravel, so that in this area there is an erosion of the coal seam. On the surface plateaus around the villages of Palaj, Lajthisht, Hamidi, Bivolak, and Gurakuq in the overlands there is a characteristic presence of “Brand- porculanitit”, created because of the combustion process of grey marly clays fed with coal clay that gives the terrain its distinctive red colored soils.

Tectonics of Basin

In order to have a clear view of the tectonics the intercommunications between the tectonics features of the periphery of basin and the centre must to be taken into account. The tectonics of the tertiary Kosova Basin have mainly developed along radial tectonic lines. It is expressed with big and small faults and folding systems, with the maximal dipping angle in the central part of the basin reaching up to 10°. The Pliocene series clearly the centroclinal dipping tendencies, so the basin has the form of a large syncline with a slight dip along the NNW-SSE axis. Around the frame of basin there are also signs of secondary faults and folding, too.

The faults system of basin have dual spreads. The first system of the faults has a parallel spread with a macroaxis along the basin and asecond system of the faults is crossed with these faults into different angles. The longitudinal faults are prevalent in the base and determine the tectonics of basin. The transverse faults have a general spread SW-NE. Fault creation is occurred from the Miocene up to Deluvion time. The border between the coal layer and the overburden was taken as a main reference point for the interpretation of the tectonics of the coal seams. This border is considered approximately rectilinear. Different variations of coal layer subsidence (up to 10 m) are apparently explained by tectonic oscillation or tectonic disturbances. In several places along the coal layer level there are emersed gasses amounts owing to the tectonic disturbances which happened in this narrow circle where the folding shapes (forms) were created over large distances.

3.3. Analysis of coal quality

The individual sample lengths vary between about two and ten metres. In total about 2400 coal quality samples are available. The coal quality analysis data comprises the following:

- Ash on 45% moisture basis – full sample sequence
- Lower calorific value on 45% moisture basis – full sample sequence
- Sulfur (total, in ash, combustible) on 45% moisture basis – only a few samples
- Coke on 45% moisture basis – only a few samples

There are also analyses reported on as received basis[1], however, the corresponding moisture analysis shows that these samples have evidently dried out to various extents.

Recalculation of Coal Quality Data

For any future mine planning the coal quality data must be based on a received standard which is equivalent to the quality in situ[2]. Therefore all analysis data on 45% moisture content were recalculated to account for the individual in situ moisture contents. There is a general correlation between the ash contents of lignite and the corresponding moisture contents. Though this relation is not yet exactly known for the Kosovo lignite. A lignite with no ash in this case would have 58% moisture, while the pure ash (clay parting) would still show about 15% moisture in situ. In order to arrive at in situ moistures the following calculation steps had to be performed:

- A recalculation of the ash analyses (on 45% moisture content) to reach the dry base figures.
- A calculation of in situ moisture using the ash/moisture correlation and the corresponding equation.

On the basis of this in situ moisture estimates of the calorific value analyses (on 45% moisture basis) can be recalculated to match in situ values. Fig. 1 shows the relationship between heating values on 45% average moisture contents and heating values based on the variable in situ moisture contents. High heating values (at 45% moisture content) are reduced by about 1500 $kJ.kg^{-1}$ due to the fact that these coals have in fact up to 55% moisture content while low heating values (at 45% moisture content) are increased by about 1500 $kJ.kg^{-1}$ as these coals have in fact a lesser moisture content of around only 35%.

3.4. Coal Quality Parameters

Moisture content

The average seam moisture contents vary between 42% and 49%. As there are no original reliable in situ moisture contents available, these data are only preliminary and need to be confirmed by future carefully performed sampling and testing procedures. Moisture contents at Bardh - Mirash are likely to be around 47,5%, while at Mirash East (Sitnica area) they could be up to 44% due to higher ash contents.

[1] The term „as received“ is used for coal quality parameters as they are received in the laboratory for analysis. They may deviate from “in situ” values when the time period between sampling and analysis is too long.

[2] The term „in situ“ is used for coal quality parameters as they are encountered in the mine.

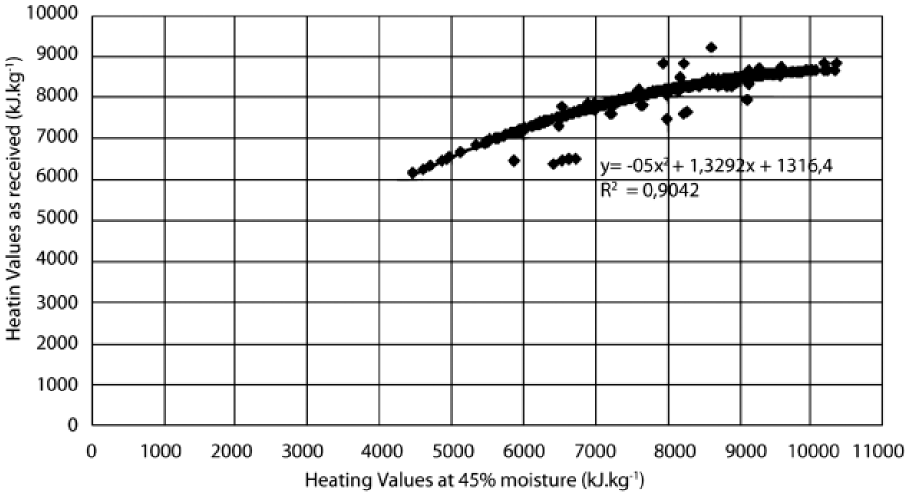

Fig. 1. Relation of heating values on 45 % moisture to as received basis (Haxhiu, 2004)

Ash contents

Ash contents vary between 7% and 35% within the coal seam. The average values are around 14% to 17%. High ash contents occur within the base 10 metres of the deposit. Average values there are around 20%. Lignite in the east of the present mines (Sitnica area) has an ash content of about 20%.

Heating values

The heating values used in this report are derived from the original reported heating values (on 45% average moisture content) which were recalculated on the basis of the variability of the best available estimates of moisture content. This new heating value data, however, need to be reconfirmed by sampling and testing in the future. Heating values are in the order of 7800 $kJ.kg^{-1}$ on average in the Bardh-Mirash area, while in the south-west part of the Sibovc area they show values around 8100 $kJ.kg^{-1}$.

Sulfur

Sulfur appears in different forms:

- sulfate sulfur (non-combustible)
- organic and pyretic sulfur (combustible)
- total sulfur includes all the sulfur forms

Total sulfur concentrations are around 1% in all parts of the mines/deposit. Fig. 2 shows the relation of total sulfur to combustible sulfur. The graph indicates that about 35% of the sulfur is combustible. That means that the average contents of combustible sulfur is in the range of 0.35% as the average total sulfur content is 1%.

There are only few a analyses available on combustible sulfur. It is, however, not likely that there will be much change in the combustible sulfur concentration after examining the on hand

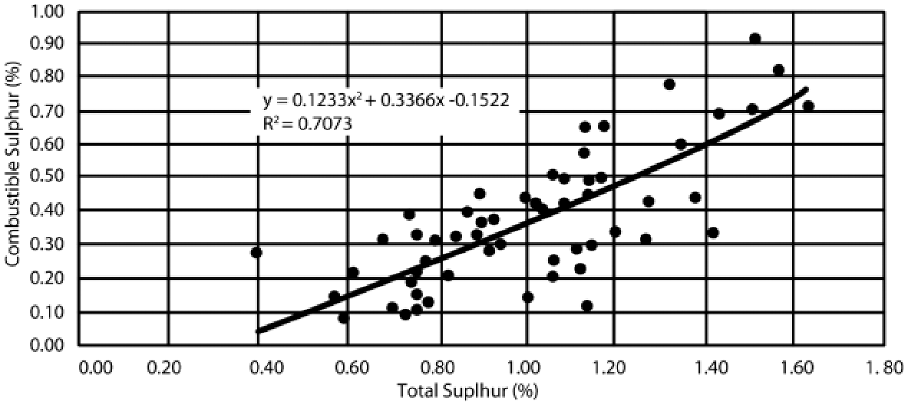

Fig. 2. Relation between total and combustible sulfur (Haxhiu, 2004)

analyses. Within the existing mines and Sibovc the total sulfur content is in the range between around 0.9% and 1.0%. There is only one small location where the value comes up to 1.5% at Mirash West.

3.5. Coal Quality in the active mines

The average values of lignite-quality parameters of the different mine areas are:

- **Moisture content:** vary between 35% and 50%.
- **Ash contents:** between 12% and 21% within the coal seam. The average values are around 14% to 17%.
- **Heating values:** 7800 $kJ.kg^{-1}$ on average in the Bardh-Mirash area, while 8,100 kJ/kg in the Sibovc area. From total reserves: 29% (> 8.4 $MJ.kg^{-1}$); 43% (7.7–8.4 $MJ.kg^{-1}$); 25% (5.8–7.7 $MJ.kg^{-1}$).
- **Sulfur:** 1% in all parts of the mines/deposits including an average content of combustible sulfur of 0.35%.
- **Lime:** Lime concentration is sufficient to absorb significant amount of SO_X during combustion so that <u>desulfurization of flue gases is not required</u>.

TABLE 3

Coal quality in different mining zones (Haxhiu, 2004)

Area	**Ash**	**Lower heating value**	**Moisture**	**Sulfur**	
	%	**$kJ.kg^{-1}$**	**%**	**% total**	**% comb.**
Bardh	14.1	7860	47.7	0.98	0.34
Mirash West	14.4	7750	47.5	1.01	0.35
Mirash East (Sitnica)	19.9	7928	43.9	0.94	0.33
Brand	16.5	7991	46.2	0.97	0.34
Sibovc	**13.85**	**8149**	**47.8**	**0.91**	**0.32**

3.6. Comparison of Coal Qualities

Table 4. shows major quality parameters (heating value, ash and sulfur) of different large lignite deposits in Europe and Australia. Compared to other deposits, Kosovo lignite has a still acceptable heating value and medium sulfur contents, but a high ash content. The high ash content and the relatively high sulfur content are adverse parameters for briquette fabrication.

TABLE 4

Coal quality data of different large lignite deposits (Haxhiu, 2004)

Parameter	**Kosovo**	**Australia**	**Bulgaria**	**Germany**	**Poland**	**Turkey**
	Sibovc	**Loy Yang**	**Maritza**	**Rhenish Lignite**	**Belchatov**	**Elbistan**
Calorific Value (kJ.kg^{-1})	**8100**	8000	6700	8900	7800	4400
Ash (%)	**14**	1.5	12	5	11	18
Sulfur (%)	**1.0**	0.4	1.9	0.3	0.6	1.7

4. Geological Modeling and reserve calculation

4.1. Geological modeling using Datamine Studio

All available digital data was used to build a geological block model using the mine planning software DATAMINE. The top and bottom of the lignite indicated in the drill holes as well as the provided contour maps of the lignite top wall were used to model the lignite seam.

The lignite qualities given in the drill hole logs (heating value, ash, moisture and sulfur) were re-calculated to an as received basis due to the fact, that the laboratory assay results are not on the same basis for all drill hole samples. (Cehlár et al., 2006) Some lab results are based on as received lignite samples, some samples were partially dried before testing, and most of the samples' test results were based on 45% moisture.

A block model was created covering the remainder of the actual mines and the Sibovc area. A size of 25 × 25 × 5 m in X, Y and Z direction was used for the cell dimensions of the model. In general the heating values of the lignite decrease from top to bottom of the seam. (Rybár et al., 2000) Therefore, a division into 5 m vertically was applied to respect the varying quality parameters. This division should provide for sufficient details to enable quality control of the lignite production. The re-calculated lignite quality parameters were used to interpolate values into the blocks of the geological model by the 'nearest-neighbour method[3]'.

Average values of total geological model of Sibovc area:

- Heating Value: 8149 kJ.kg^{-1},
- Ash: 13.85%,
- Moisture: 47.8%,
- Sulfur: 0.91%.

[3] To estimate the quality parameters (LHV, Ash, Moisture, Sulphur) of a single block within a geological block model, the information of the surrounding drillholes (within a user-defined search radius) are used in a linear dependency, i. e. the closer the drillhole information is to the specific block the more influence it has in the evaluation of that block.

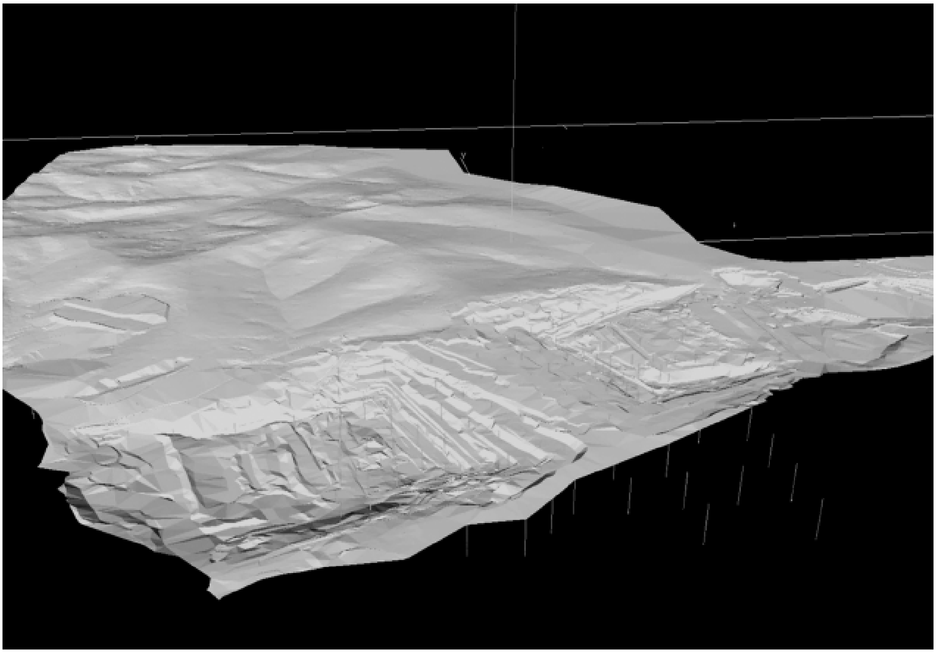

Fig. 3. DTM – Topography (Active mines and Northern field) (Haxhiu, 2004)

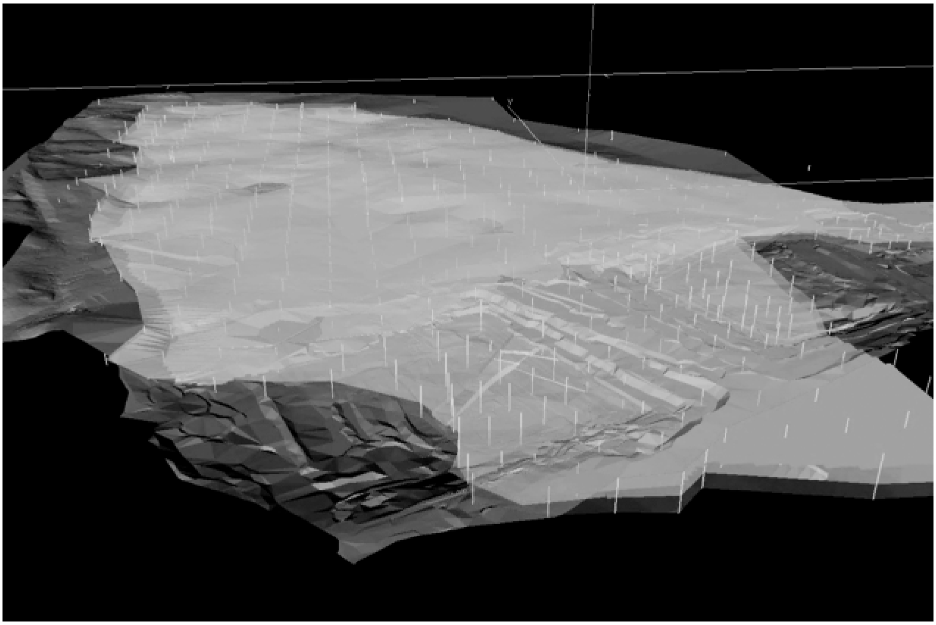

Fig. 4. Top and Bottom of lignite, drill holes and topography DTM (Haxhiu, 2004)

4.2. Reserve Calculation

The geological reserve calculation by means of the DATAMINE software resulted in the following figures:

- Volume of waste: 2,453,220,230 m^3,
- Volume of lignite: 1,524,789,740 m^3,
- Density: 1.14 $t.m^{-3}$,
- Metric Tons: 1,738,260,303 t,
- Ratio – Waste : Lignite: 1.41 m^3 to 1 t.

The stripping ratio and the coal quality for this part of the Kosovo lignite deposit is very favorable compared to other lignite deposits around the world. The deposit in the Rhenish lignite district in Germany can be considered as an example. Under comparable conditions with respect to the calorific value, RWE Rheinbraun is able to operate its mines with an average stripping ratio of 4.8 : 1 under economic conditions.

No major obstacles, which would reduce the calculated reserves in Kosovo are yet known. On the contrary, there are indications for additional coal reserves with relatively low stripping ratios in the south of the existing mining area.

4.3. Economic classification of Sibovc are using UNFC

For the economic classification of reserves and resources different systems and tools are applied world-wide. In order to have a uniform procedure for such classification, the United Nations Economic Commission For Europe (UNECE) introduced the "United Nations International Framework Classification for Reserves / Resources" in 1997. A "Key for the Classification of Reserves / Resources[4] has been prepared and submitted to UNECE by the Federal Institute for Geosciences and Natural Resources (BGR), Germany, in August 2001 order to facilitate the categorization of reserves and resources according to the framework.

Taking these documents as a guideline a deposit can be classified as economic when the following conditions are fulfilled:

- Geological data, economic and mining engineering data are available for the deposit.
- A feasibility and and/or a mining report are available.
- The conclusion of the feasibility and/or mining report are positive.
- The geological data were obtained during a detailed exploration.
- The reserves were identified as economic at the time of reporting.

Due to the fact that all of the above conditions are fulfilled, which will be shown by this study, the resources for the next 30 years can be classified as "proved mineral reserves" which according to the framework implies that they are **economic**. "Economic" in the context of this study means that the overall mining cost allow a competitive operation of the power plants for the next 30 years as far as the fuel supply for the power plants is concerned.

The remaining resources have not been subject to detailed mine planning but they have been explored in detail. These exploration **results indicate a probable positive result** to a future fea-

[4] Walter Lorenz – Key for the Classification of Reserves / Resources – UN International Framework Classification for Reserves / Resources – Paper for the eleventh session of the Committee on Sustainable Energy – 21-22 November 2001.

sibility study as per quality and quantity and the average stripping ratio. Therefore these reserves can be classified as "measured mineral resource" according to the framework which implies that they are **economic to potentially economic.** (Cehlár & Maras, 2001)

5. Conclusion

Reserve calculation and classification

Reserves calculation using Datamine Studio mine planning software resulted with the following table. Due to the fact that the evaluated zone has been explored very well and, as has been shown, the resources for the next 30 years can be classified as "proved mineral reserves" which according to the UN Framework (Haxhiu, 2004) for classification means that they are definably **economic**.

TABLE 6

Results of reserve calculation (Haxhiu, 2004)

	Geological	**Exploitable**
Overburden		
Volume	2,453,220,230 m^3	665,000,000 m^3
Lignite		
Volume	1,524,789,740 m^3	614,035,087 m^3
Density	1.14 $t.m^{-3}$	
Metric Tonnes	1,738,260,303 t	700,000,000 t
Ratio		
Waste : Lignite	1.41 m^3 : t	0.95 m^3 : t

References

Cehlár M., Engel J., Mihok J., Rybár R., 2006. *Surface mining*, Edičné stredisko/AMS F-BERG, Košice, 85-98.

Cehlár M., Maras M., 2001. *Economic evaluation of mining projects*, Elfa, Košice, 24-27.

Rybár P., Cehlár M., Treger M., 2000. *Oceňovanie ložísk nerastných surovín*, Štroffek, Košice, 120-127 (in slovak).

Haxhiu L., 2004. *Economical analysis of investments for opening of new mining field in northern part of Kosovo lignite basin – Sibovc*, PhD thesis, Technical University of Košice, Košice.

Hofmann L., Durchholz A., Beyer A., Pelzer W., 2002. *ESTAP – Energy Sector Technical Assistance Project*, World bank, UNMIK, Pristina.

Morvay Z., Kosir M., Limari S., Haxhiu L., 2003. *The White paper, Energy Strategy and Policy of Kosovo*, Energy Office – EU Pillar, Pristina.

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