X-TH JUBILEE NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION OF THE OPEN AND UNDERWATER MINING OF MINERALS

НАУЧНО-ТЕХНИЧЕСКИ СЪЮЗ ПО МИННО ДЕЛО, ГЕОЛОГИЯ И МЕТАЛУРГИЯ

SCIENTIFIC AND TECHNICAL UNION OF MINING, GEOLOGY AND METALLURGY

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X –TH JUBILEE NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION OF THE OPEN AND UNDERWATER MINING OF MINERALS

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“Мини Марица–изток ЕАД” - европейското лице на българския въгледобив

„Мини Марица-изток” е най-голямата компания за открит въгледобив у нас и едно от най-крупните предприятия в България.

Миньорите от „Марица–изток” добиха 24 690 000 т. въглища през изминалата 2008 г. Това е с над 750 000 т. повече в сравнение с 2007 г. Постижението бележи рекорд в работата на дружеството през новото хилядолетие. Изкопани, транспортирани и насипани през 2008 г. са 97 000 000 куб.м. земна маса /откривка – на технически език/. Постижението е с над 3 000 000 куб.м. повече в сравнение с миналата година.

„Мини Марица-изток” реализира за 2008 г. инвестиционна програма в рамките на 104 млн. лв.

2008-ма беше година на развитието на кадрите и 2440 работници и служители преминаха през различни квалификационни курсове на обучение. Това е повече от ¼ от списъчния персонал на дружеството.

Една от основните задачи на мениджмънта на дружеството е разработването, внедряването, сертифицирането и поддържането на интегрирана система за управление на качеството, околната среда и здравословните и безопасни условия на труд.

За 2009 г. бизнес планът предвижда годишен добив на въглища в обем от 25 250 000 т. въглища и инвестиционна програма в размер на 100 млн. лв.

За 2009 г. ръководството на дружеството разработи антикризисна програма, която дава възможност за гъвкавост и прилагане на различни варианти в зависимост от конкретната пазарна конюнктура.

„Мини Марица-изток ЕАД” си поставя високи цели и подхожда отговорно и професионално към тяхното реализиране. Знае какво е значението на дружеството за страната и региона и това дава самочувствие на работещите в компанията. Следва неотклонно амбицията да бъде европейското лице на българския въгледобив.

Dear Ladies and Gentlement,

Dear Colleagues,

Dear Guests,

It is a great honour that the CONFERENCE OF THE OPEN AND UNDERWATER MINING OF MINERALS celebrate its X $^{-TH}$ JUBILEE in style. On behalf of the National organizing committee I have the pleasure to greet all of us for participation in this scientific forum. I am particularly proud that **the Scientific and technical Union of mining, geology and metallurgy** host **X–th JUBILEE NATIONAL CONFERENCE WITH INTERNATIONAL PARTICIPATION OF THE OPEN AND UNDERWATER MINING OF MINERALS.**

The objective of the conference is to highlight key developments, stimulate interaction and share knowledge between the Business and the Science, and to expose participants to initiatives, practice and technology that are potential keys to our future.

The experts in the field of the open and underwater mining of minerals will be informed about the new equipment, high technologies, computer systems, new software products and last directions in ecological monitoring.

The forum will be an arena for exchange scientific and practical experience on technologies in open pits and quarries. It will be an outstanding opportunity to meet and exchange new ideas with all already known colleagues, to make new contacts and partnerships.

May I wish that this Jubilee forum will be realized successfully with the interaction of the scientists and create enough motives to pave the way for a tangible industry and academia collaboration.

I shall be glad to great you with the cordial Bulgarian "Welcome" in our country and to wish you fruitful work and pleasant stay at the pearl of Bulgarian Black Sea coast.

Good luck and success!

Dr. Eng. Tzolo Voutov

Chairman of the Organizing committee

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FROM THE NATURE TO THE PEOPLE, FROM THE PEOPLE TO THE NATURE!

Минно-обогатителен комплекс „Асарел-Медет" АД е първата, най-голяма и водеща българска минна компания за добив и обогатяване на медни и други руди. От създаването си през 1964 г. традиционно е пионер в отрасъла по внедряването на нови върхови техника и технологии. Компанията е основен фактор за социално-икономическото развитие и облика на община Панагюрище и Пазарджишка област, има структуроопределящо значение и уникално място в българската икономика.

„Асарел-Медет"АД е първата българска компания от минния бранш и тежката индустрия, сертифицирана по трите основни международни стандарта - за управление на качеството ISO 9001, за опазване на околната среда ISO 14001 и за здравословни и безопасни условия на труд OHSAS 18001. Това е първата българска компания, която през 2005 г. получи Сертификат за Инвеститор Първи клас заради мащабния си проект за модернизация на производството, възлизащ на над 100 млн. щ.д.

За реализацията на инвестиционната си програма през 2007 г. „Асарел-Медет" беше обявен за Инвеститор на годината в добивната промишленост от Българска агенция за инвестиции. През 2007 г. се нареди и сред най-добрите работодатели в страната в националното проучване на Hewitt, в категорията „Големи компании". В годишната класация на Българския форум на бизнес лидерите за социално-отговорен бизнес „Асарел-Медет" бе отличен с трето място в категорията „Инвеститор в околната среда" заради реализираната екологична програма.

Визията на „Асарел-Медет" АД е в дългосрочен план да реализира динамично, успешно и устойчиво корпоративно развитие с фокус върху добрите традиции, инициативата, иновациите и екологията. Екипът от около 1300 професионалисти-съмишленици отговорно отстоява новаторското фирмено мото:

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Orica Mining Services има обширна мрежа от производствени, дистрибуторски и сервизни центрове навсякъде в Европа, Средния Изток, Африка и ОНД.

Продуктите се произвеждат в стратегически места и гъвкавостта на нашите морски, земни и въздушни дистрибуторски средства ни позволява да отговорим на нуждите и промените в този географски разнообразен пазар.

Нашият BBS-екип включва най-голямата и най-опитна група от взривни технолози в региона и може да подпомага клиентите от рудници, кариери и строителство за оптимизиране взривните резултати.

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Орика Мед България АД

Дружеството, широко известно с досегашното име Дино НитроМед, е джойнт-венчър на Орика Майнинг Сървисиз и Асарел-Медет.

Регистрирано е през 1996, в работа е от 01.07.1997 и настоящем е най-големия производител на експлозиви и инициращи системи за промишлена употреба в България.Фирмената политика е озаглавена "Да изпълним обещаното",

два от разделите са "Ценете хората и природата" и "Творчески решения за нашите клиенти".

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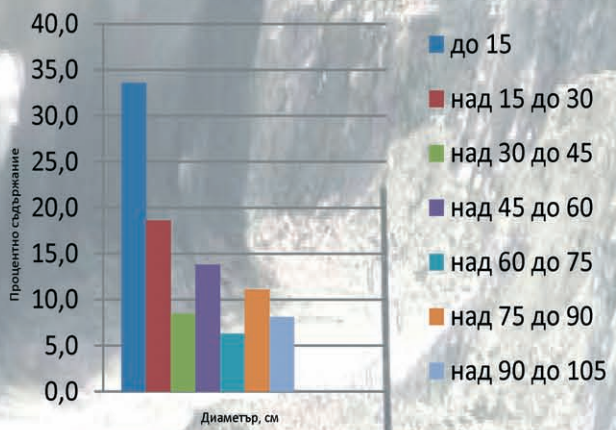
"Експлозивпрогрес- ГТМ" ООД е основано в началото на 1999 г. като дъщерна фирма на "Геотехмин" ООД.Дружеството е специализирано в консултантски и инженерингови услуги главно в областта на пробивно - взривните работи. То разполага с апаратура, инструментариум и програмни продукти за извършване на взривосеизмични измервания, определяне на зърнометричния състав на взривената минна маса, измерване на скоростта на детонация на взривни вещества в сондажи и в патронирани проби.

Апаратура за измерване на скоростта на детонация.

"Експлозивпрогрес-ГТМ" ООД осъществява търговска дейност с продуктите на взривна фабрика „Елаците":

- Водоустойчиви емулсионни взривни вещества- търговски марки "Елацит 710" /чувствителен към капсул детонатор/ и "Елацит 1100" /нечуствителен към капсул детонатор/.
- Полуфабрикатът за производство на "Елацит 1100"- матрица разтвор N.O.S.
- Взривно вещество с търговска марка "АНФО Е", представляващо смес на висококачествен порьозен амониев нитрат и дизелово гориво.
- В най-скоро време на потребителите ще бъде предложен нов продукт - водоустойчиво емулсионно взривно вещество търговска марка „Тежко Анфо 501 Е" , представляващо смес на матрица- разтвор и АНФО.

Апаратува за извършване на взривосеизмични измервания.



Зърнометрична характеристика на взривена минна маса

МИНСТРОЙ ХОЛДИНГ АД

В хармония с природата !

Минстрой осъществява проектиране, строителство, доставка и монтаж на оборудване, производство на нестандартни метални конструкции и съоръжения и пълен инженеринг на обекти "под ключ" в областта на промишленото и гражданско строителство, минната промишленост, инженерната инфраструктура и магистралните тръбопроводи.

Особено голям дял напоследък фирмата има в строителството на моделни хотелски комплекси и инфраструктурни обекти. В състава на фирмата е и "Институт по строителство и минно дело", оборудван със съвременна техника и едни от най-добрите специалисти в областта на строителството и минното дело. Изпълнява проучвателни и проектни работи във всички нива на проектирането - от идейни до работни проекти.

Организационната структура на холдинговата компания дава възможност за привличане на подходящи изпълнители от системата, в зависимост от спецификата и териториалното разположение на проектите, както и на допълнителни ресурси от други дружества. Освен в република България, Минстрой осъществява проектна, строителна и търговска дейност в чужбина: Германия, Русия, Сирия, Алжир, Тунис, Нигерия, Македония и др.

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SCIENTIFIC AND TECHNICAL UNION

OF MINING, GEOLOGY AND METALLURGY

The Scientific and technical Union of mining, geology and metallurgy is a voluntary, non-governmental, politically uncommitted, uncommercial professional association.
About 1800 scientists, engineers, technician and other specialist in the field of mining, geology and metallurgy participate in the Union. Many juridical persons from the country and abroad who are working in this field are members of this association. The Union is an association in private favour and realizes its activity in favour of its members. The Scientific and technical union of mining, geology and metallurgy is a regular member of the FEDERATION OF THE SCIENTIFIC ENGINEERING UNIONS.

14 regional organizations, 34 scientific-technical associations and clubs and 6 incorporated associations function within the Union.

There are 25 collective members at present - juridical persons from mining and metallurgical branches and geology.

Governing bodies of the Union are the General meeting, the Managing committee and the Control committee. The latter two are elected by the General meeting and are authorized for 3 years.

The Scientific and technical union of mining, geology and metallurgy cooperates on problems in these fields with **the Ministry of economy**, **the Ministry of regional development and public works, the Ministry of environment and water, the Ministry of energy and energy resources, the Bulgarian mining chamber, the Bulgarian academy of sciences, the University of mining and geology, the University of chemical technology and metallurgy, the Union of scientists in Bulgaria** and other organizations and firms very actively.

The Union is member of 19 related international social organizations and academies. The most important are:

- The World Mining Congress
- The Academy of mining sciences of Russia
- The International Academy of Ecology & Life Protection Sciences
- The International Academy of mineral resources

<u>The Balkan associations:</u>

- The Balkan union of metallurgists
- The Balkan committee of mineral processing
- The Balkan geophysical association
- The Balkan association of mining experts “BALKANMINE” and others.

The Union is a co-founder of the publishing house “Earth93” and a co-publisher of the journal “Mining and geology”.Useful information about national and international publications and activities in these fields is accumulating and exchanged in the Secretariat of the Union.

National and international scientific-technical publications and literature keep coming in (the journal **“Mining and geology”**, **“Geology and mineral resources”**, the magazine **“Science and society”**, **“Mining Journal”**, **“Mining magazine”**, the Russian journals **“Non-ferrous metals”**, **“Ferrous metals”**, **“Coal”** etc.).

The Union is the basic organizer of scientific-technical conferences, symposia, discussions and other initiatives on national and international level. The union members participate in the preparation and discussion of bills, normative and others documents in the field of mining and metallurgical branches and geology.

By its national and regional structures the Union is ready for collaboration with international and national authorities and organizations on problems of geology, mining and metallurgy.

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- "Chukurovo" mine JSC
- Open pit Coal Mining – Pernik
- "Bobov dol" mine JSC
- "Devnja varovik" JSC
- "Inertni materiali" JSC
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- "Zlatna Panega Cement" JSC
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- "Andela" JSC
- "Andezit" Ltd.
- "Minstroy Rodopi" JSC
- Geostabil SD
- "Bumar" JSC
- "NOAC" Ltd.

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3. **Information technologies, computer systems, software products in geological prospecting, mine surveying and mining activity.**

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6. **Ecological monitoring. Recycling and waste utilization. Reclamation of broken lands.**

7. **Organization and management of the technological processes and production works in the mining of minerals. Markets and realization of the products.**

8. **The mining legislation and his harmonization with European normative base. Education, qualification and specialization of mining experts of opencast and underwater mining of minerals.**

ENVIRONMENTAL AND STABILITY ASPECTS OF EXCAVATION IN LANDSLIDE ZONE AT A COAL MINE "SUVODOL" - R.MACEDONIA

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ABSTRACT
On a NE part of coal mine "Suvodol", near town Bitola in R.Macedonia, during longer time, a landslide with enormous length and volume exists. Its occurrence is connected with a process of sliding, which happened in several phases, with initial signs of sliding in 1993. The moment of global instability happened on a 27.10.1995. Till now, several phases of reactivation are known. Its volume is about 30 000 000 m^3. As a result of mass movements, about 8 000 000 tones of coal is concentrated (blocked) at the toe of the landslide. Upper of the main scarp, spaced about 250 meters, the earth-fill dam with a length of about 1000 meters exists. The ground water artesian effects are also present. At the toe of the landslide, the coal is partially involved in a process of self-burning and it produces environmental not friendly gases. The stability of the sliding during 2007 was near limit equilibrium. All this aspects shows a very specific combination of natural and man-made elements that control the stability of the environment at this part of coal mine. Having this in mind, the specific approach used in an excavation at the toe of sliding mass, with parallel supporting (always near limit equilibrium) is shown briefly. The results from the stability tests, with some specific comments, are summarized in this paper.
***Key words**: landslide, coal mine, stability, artesian waters etc.*

1.0 INTRODUCTION

The surface coal mine "Suvodol" is placed in the S.W part of the Republic of Macedonia. The coal layer and the unproductive layers have been formed with a process of sedimentation in lake conditions during upper Pliocene. Mainly. This coal mine is a main source for thermal-electricity plans in the country, with a production of about 6.500.000, 00 tons per year.

During 1995 large landslide appeared and it is active even today. Its volume is about 30 million cubic meters and depth of the sliding mass in some places is deeper than 50 m.

The appearance of the landslide caused some difficulties in the normal work of the exploitation systems and is a potential danger for the earth dam and the artificial lake which is about 250 m form the main scarp of the landslide.

In order to adopt the techniques and technology of the excavation to the newly created conditions, the authors of this paper investigated the N.E part of the mine in several phases. The idea of investigation was to create conditions for real definition of the physical model of the terrain which

will serve as a base for all the analyses of the stability, conditions for protection from the groundwater's, excavation conditions and so on. The authors are also involved in several phases of design measures.

2.0 MAIN ELEMENTS OF THE LANDSLIDE

After the main phase of sliding during 1995, the area of landslide is investigated in details. These investigations have been made in the sense of solving the entire geological, geotechnical and hydro geological situation on the terrain. The main idea of the methodology applied was these investigations to include evenly and wholly the space in which it is expected mutual influence of the engineering activities and the natural environment.

The following procedures has been applied: detail mapping of the wider area, investigation drilling (more than 55 investigation boreholes), installation of piezometers, investigations of the chemical composition of groundwater's, field investigation of filtration coefficient, as well as laboratory analyses of physical and mechanical properties [3].

The position of the landslide with main geological elements is shown on Fig.1.

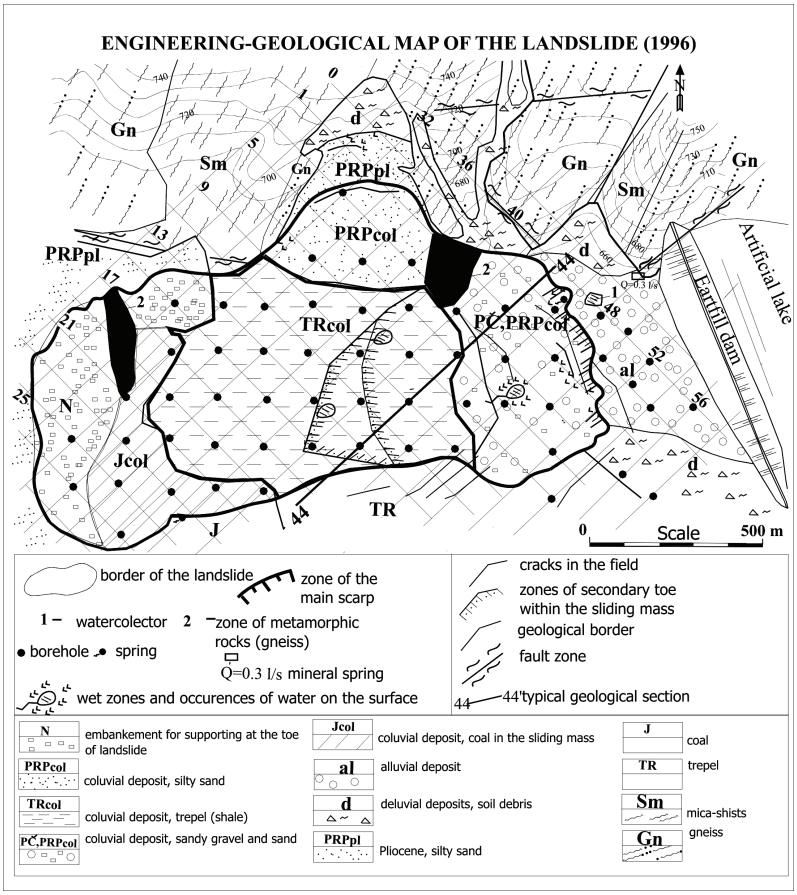


Fig.1 Simplified engineering-geological map of the landslide in relation to the earth fill dam:

It was concluded that the whole investigation area has great lithological heterogenity which is the reason why there is great heterogeneity of geotechnical and hydrogeological characteristics. A detail of the geological composition along one typical section is given on Fig. 2.

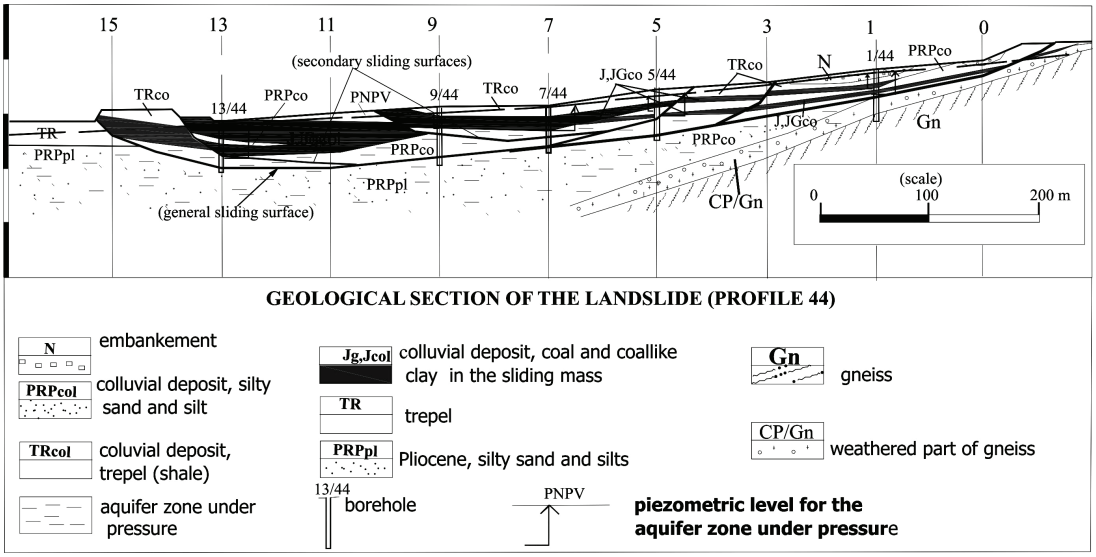


Fig. 2. Detail of geological composition along profile 44.

The most important characteristics for the main kinds of sediments are the high plasticity of coal like clay and Pliocene silts, high value of the coefficient of inhomogenity $C_{u,}$ and low shear strength of coal-like clay and silts with high plasticity. The typical granulometric curves and the plasticity chart of clay are given on Fig. 3.

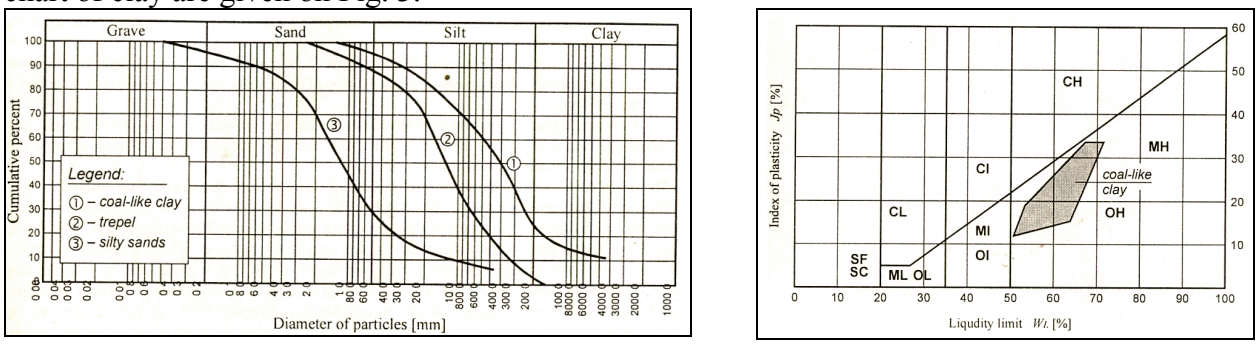


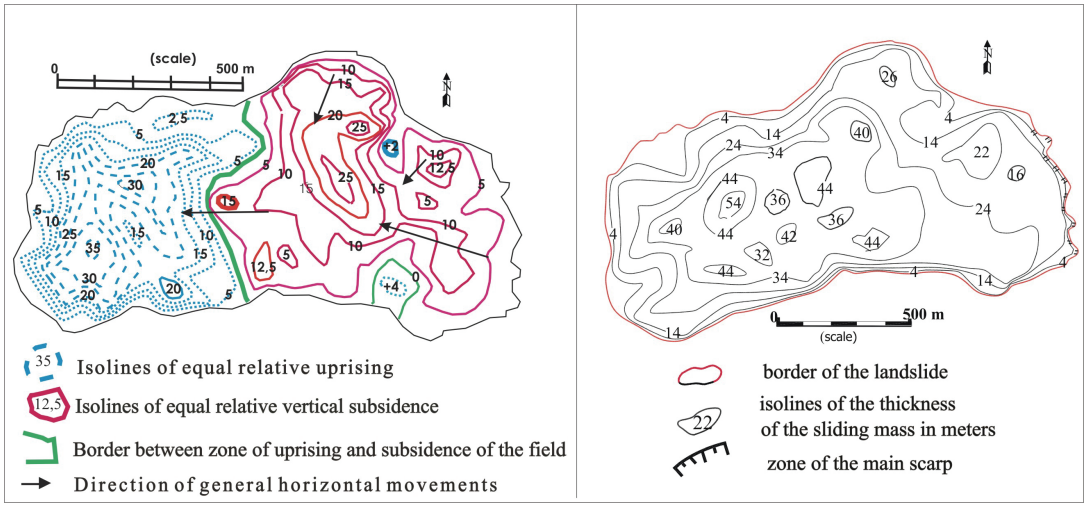
Fig. 3. Typical granulometric curves of the most characteristic sediments and plasticity chart for coal-like clay

Just to illustrate the scale of the event, the main elements of the landslide are given in table 1, while some data about the scale of mass movement's vertical uprising or settlements in some zones on a Figures 4 and 5.

Table 1: Main geometrical elements of the sliding mass

Length (m)	Wide (m)	Ddepth of sliding (m)	Area (m^2)	Volume (m^3)
about 1500	min 650 max 880 usually 700	min 14 max 55 mainly > 25	1 050 000	About 30 000 000

From the Fig. 4, it is obvious that the range of horizontal and vertical displacements is very large, as well as the thickness of the landslide body is very high. With a one word, the event can be described as a "small tectonic".



a **b**

Fig. 4. a- Isolines of relative vertical uprising and settlements in meters
b-isolines of thickness of the sliding mass in meters

Having in mind that the groundwater has the greatest influence on the stability of the terrain, the big attention in all phases of landslide investigations, was paid to the groundwater condition. The most important data were obtained by building in of so called group piezometers. The presence of the aquifer zone under pressure (with often artesian effects and gas influences) is defined in all area bellow the disturbed coal layer (Fig. 5).

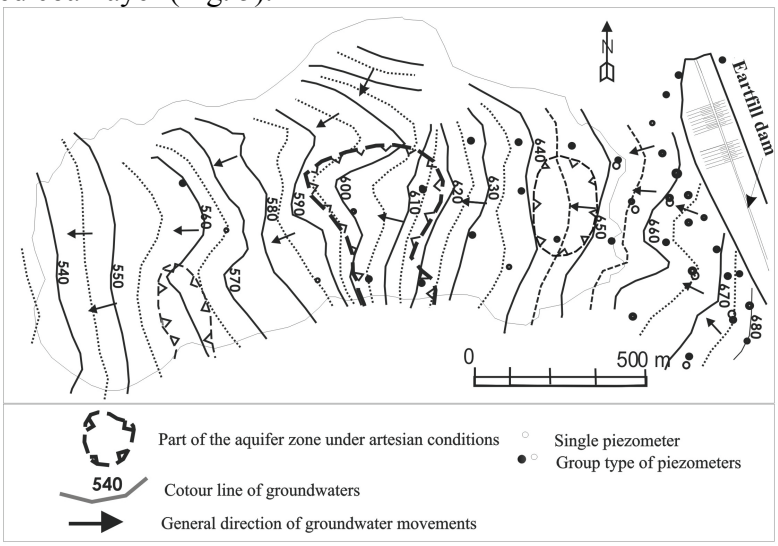


Fig. 5. a- Contour map of the groundwater flow pats for the aquifer zone under pressure

If we consider this short description of the landslide, it is obvious that this is a unique case in the practice, with very complex conditions of the area. Existing earth fill dam with a height about 20 meters and length about 1000 meters upstream of the landslide zone, is a high hazardous factor for any mining activities of excavation of the coal from the zone of the landslide. In such complex situation, the nature of the process during time force to prepare some technology of excavation, which is shortly, explained bellow.

3.0 MAIN RISK SCENARIOS

Analyzing the behavior of the landslide from the time of its occurrence till present days, some facts can be underlined:

- After the main movements, the initial measures was prepared in order to minimize any

further retrogressive development of sliding to the dam direction,

- The excavation of the coal was stopped at this area, or it was with minimal quantities,
- The toe of landslide was supported with embankment zone (see Fig.1),
- The hydrostatic influences of the aquifer zones for the zone between earth fill dam and the main scarp was decreased with dewatering well,
- The whole surface of the landslide was planed and drained for fast atmospheric water influences etc.

Beside this, there were several phases of smaller landslide reactivations. An important new element and very restrictive additional factor which happened after the sliding was a process of self-burning which happened because of coal direct exposition on the fresh air. The responsible persons at the coal mine Suvodol were in fact faced with two main scenarios, shortly explained on a Fig. 6.

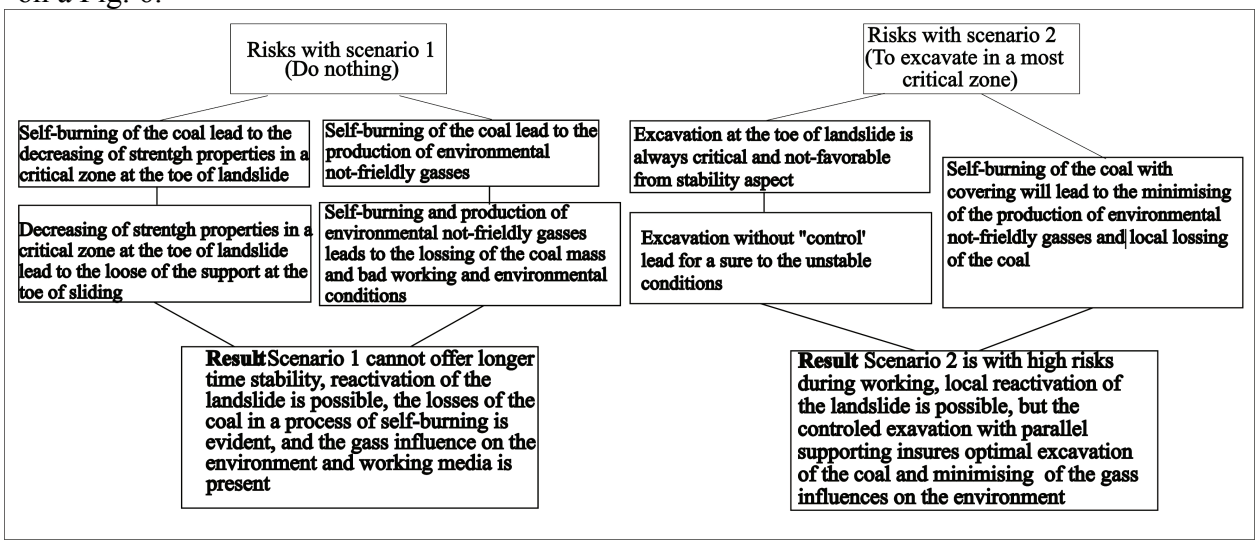


Fig. 6. Possible risk scenarios

Both scenarios have possible negative influences on the environment, and working conditions, but the main argument to accept the scenario 2 was the following:

- The process of self-burning lead to constant losing of the coal mass, and decreasing of the mechanical properties at the most critical zone from stability aspect
- Covering of the zone of self-burning will lead to final closure of this zone and losing of coal mass.

So, that was a reason to try to prepare possible solution for this not typical mining practice. This article gives only a short overview of some main outputs from stability analyses, while the details from the Main Mining design are given in a Design Documentation [7]

4.0 MAIN RESULTS FROM STABILITY ANALYSES

Having in mind all restrictions and known practice in landslide and geotechnical engineering, the Designers were involved in the Risk Scenario 2. Namely, we decide that it is better to start with excavation which will be analyzed in details with all possible negative consequences, than to allow to lose a high quantity of coal in a process of self burning, and finally to face the same situation - to have instability due to decreasing of the volume of the coal in the toe of the landslide. Shortly, the solution can be explained with few words as a methodology of parallel excavation and supporting. Namely, the excavated zone as soon as possible is additionally supported with embankment with larger volume and weight, compared with extracted coal mass.

Detailed stability analyses were prepared for some representative profiles. The software package SLIDE 5 , product of company RocScience is used. The input parameters are defined earlier during the phases of investigations as well as with back analyses. The main properties are given bellow.

Table 2: Main physical and mechanical parameters of the materials in a sliding mass

Material type	Residual cohesion C (KPa)	Angle of internal friction φ (o)	Unit weight γ (kN/M^3)
Disturbed trepel	0	13	15,64
Coal-like clay	0	9-10	16,63
Silty sands	0	21	21,25
Silts with high plasticity	0	11	19,5
Crushed coal in a sliding mass	15	25	11,61
Gneiss	200	50	26

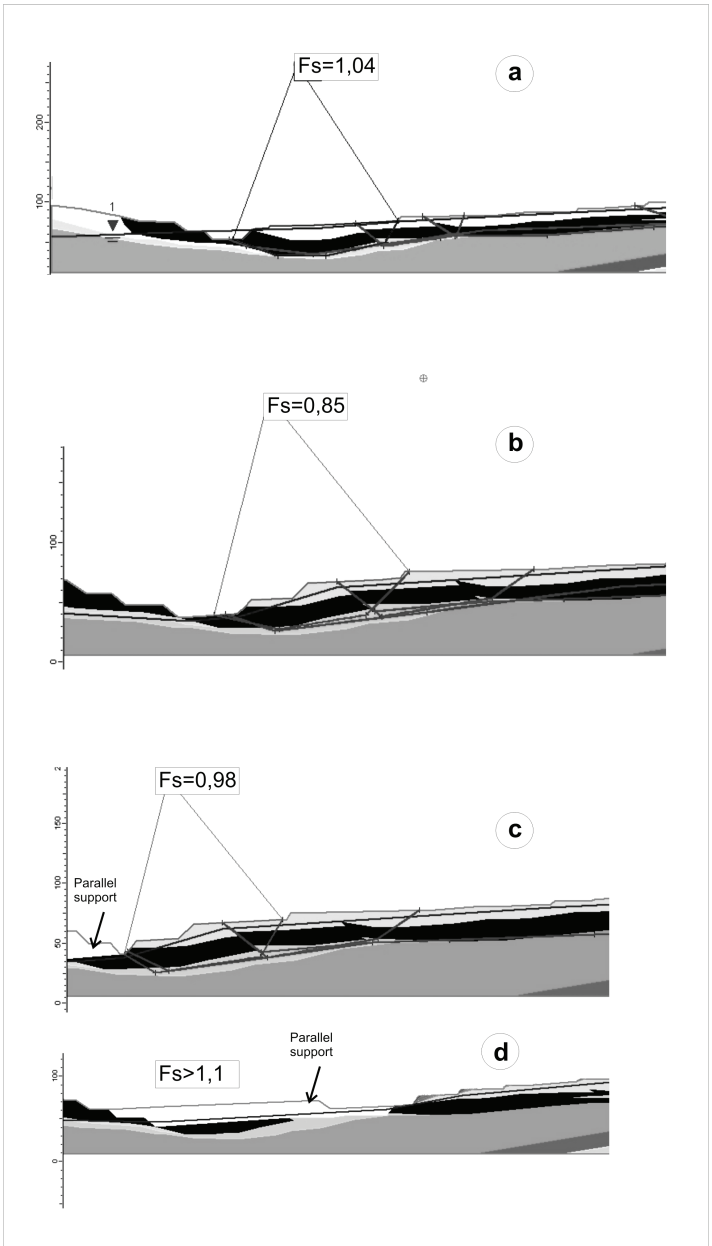


Fig. 7. Some typical outputs from stability analyses (explanations in the text)

In calculating the safety factor, different scenarios are involved. In Fig. 11, we illustrate some of the results. Namely, the Fig.7a, gives a value of safety factor Fs=1,04, as an illustration of stability conditions before any kind of engineering activities. It is clear that the value is almost near limit equilibrium. The Fig.7b, gives a hypothetical analytical case of decreasing of artesian pressure but without any kind of support. For this case, value of safety factor Fs=0, 85, which indicates that in

the practice this cannot be allowed. The Fig.7c, gives a hypothetical analytical case of parallel support and decreasing of artesian pressure. For this case, value of safety factor Fs=0, 98. In a practice, this case can be explained as a state of allowable deformations in a term of slow (controlled) sliding, which is expected during initial phases of excavations.
The Fig.7d, gives a hypothetical analytical case of parallel support and decreasing of artesian pressure for the phases of latter excavations. For this case, value of safety factor Fs>1, 1, which can be treated as a satisfactory values.
What can be concluded from the analyzed cases?
All the variants are with values of safety factor that are usual not allowed in the mining practice.
For this case, the Designers went into the calculated risk to excavate some quantity of the coal from one side, and from the other to stop the process of self-burning. All measures of surface dewatering, visual and geodetically observations during the work for control of possible rapid movements.
The excavation was done with discontinue type of equipment which can be evacuated in a fast way if necessary.
It can be noted that till now, in total about 4 000 000 tons of coal are already excavated at this critical zone, with parallel support at the toe.
As it was expected, some minor movements were observed during the excavations, but without rapid movements.

5.0 CONCLUSION

Authors believe that this is a rare case in a practice, but they cannot recommend such kind of mining for other practical cases. In an opposite, the real engineering way is not to allow to have a sliding in such volume, but to have excavation all the time according to slopes defined with analyses, as well as with engineering judgment during the exploitation phase. It is fundamental for successful design of each engineering activity to get acquainted in detail with the properties and conditions of natural environment. Without an adequate methodological approach in investigating, which will be completely adopted to the characteristics of the natural environment, it is not possible to define the physical model of the terrain. The physical model of the terrain must be the base for all numerical and mining analyses.
Sometimes, in the practice is necessary to deal with unusual cases and to face with high risks, but this must being not a rule but only the exceptions from the rules.

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