Valias Coal Mine - A Typical Case of Coal Mining in Squeezing locks

Valias Kömür Madeni - Sıkışan Kaya Ortamındaki Kömür Madenciliğinin Tipik Bt Örneği

HaxhiSAUKU*
*Thuma KORINI***

ABSTRACT

In this paper, a particular case of coal mining in Valias Mine (Albania) with very weak rocks around coal seams is presented. Rock characteristics, layout of the mine, development workings, and mining method are given. As a mine with mining problems, some local solutions employed in supporting drifts and mine working are described. Results of different studies for longwall face **stability** problems and surface subsidence developments are presented, and they are compared with the numerical modelling of the phenomena.

ÖZET

Bu bildiride, kömür damarlarını çevreleyen çok zayıf kayaçları olan Valias Madeni'ndeki (Arnavutluk) kömür madenciliğinin özel bir durumu sunulmuştur. Kaya karakteristikleri, madenin genel durumu, hazırlık çalışmaları ve üretim yöntemi verilmiştir. Madencilik sorunları olan bir maden olarak, galerilerin ve üretim alanlarıım tahkimatında kullanılan bazı yerel çözümler tanıtılmıştır. Uzunayaktaki duraylılık problemleri ve tasmanın gelişmesi ile ilgili farklı incelemelerin yüzey sonuçlan sunulmuş, ve bunlar olayın sayısal modellemesiyle kısmen karşılaşürılmışür.

(*) Prof. of Mine Constructions, Polytechnic University, Tirana, Albania
(**) Lecturer, Polytechnic University, Tirana, Albania

1. INTRODUCTION

Valias Coal Mine is situated in the center of Tirana Coal Basin, constructed 20 years ago, as a first great coal mine in Albania, which must be precede a developed coal industry,, for the fulfillment of the country energitical needs. But the mining conditions were very different in comparison with other known coal basins, so it was developed a very difficult and expensive subventioned mining.

The positive part of a such a mining was the acquisition of a vast experience of making different works in squeezing and partly swelling rocks and a potential possibility for scientific and design solutions in such conditions.

2. SHORT GEOLOGICAL CHARACTERISTICS OF TIRANA COAL BASIN

Tirana Coal Basin is formed during the late stages of the geotectonic development of Albanides (New Tertiary age). The sedimentary processes of coal-bearing is developed within the Tirana depression in a migrating situation from south east to north west (fig.l) (i). According to geological calculations this Basin has 75 percent of country's coal reserves.

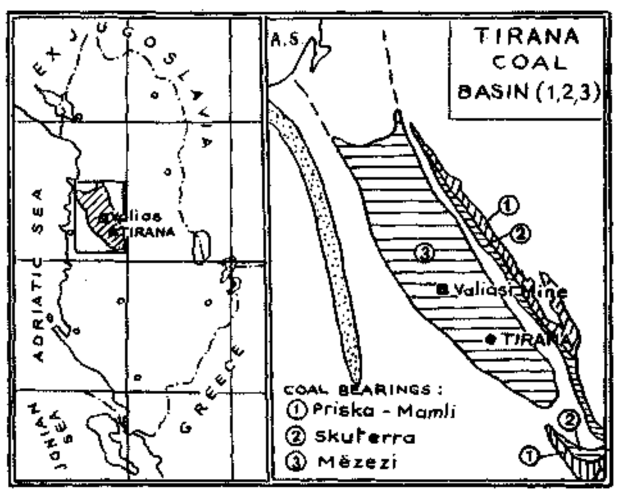


Figure 1. Tirana Coal Basin Bearings.

Valias Coal Deposit is in the upper part of the Basin and is represented as a group of coal seams with a dip of

4•.-7° and a thickness of 0.5-1.8 meters. About 657. of coal reserves belong to thin seams from 0.5 to 1.0 m. The average stratigrafic distance between coal seams is from 1.5m to 5.4 meters (2).

Just below the ground surface, from 2-3m to 28-55m, is situated a thick layer of uncemented water—bearing gravelstones. More than 607. of geological section is of clays and the remain part is of siltstones and si 1tstone-sandstones with very low strength characteristics, which *are* typical for squeezing rocks (3). The strongest rocks *are* the coal seams, which represent about *2'/.* of the section.

Tectonically the coal deposit is quite undisturbed. Faults are rarely observed, mostly transformed in flexures, but seams bedding is clearly ondulated.

3. SOME PHYSICO-MECHANICAL CHARACTERISTICS OF ROCKS

After laboratorical determinations the respective values as in table 1 and table 2 are obtained

Clays, in general, are very sensible against water. It is observed that in 20 hours, in presence of water clays lost their intergranular cohesion. Siltrocks also in the presence of the water may change in a plastic pasty mass.

Sand rocks have a very weak intergranular cohesion and *are* the main water containing and water infiltration to mine workings.

Swelling is a characteristic phenomenon of the clays and siltrocks, which, in water presence, develope a swelling pressure about 700kPa in no more than 24 hours.

Table 1. Physical properties of rocks

Nr	Rocks	Density ***r***	Porosity n	Humidity W	Plasticity number	Swel1ing index B
		kN/m^3	7.	7.		7.
1	Clays	21-5-22	15-5-25	4-5-8	28-5-50	26-5-50
2	Silt rocks	22-5-23	9-5-20	2.5-5-4	20-5-30	20-5-30
3	Sand rocks	17-5-19	30-5-40	0.3*1		
4	Coal	11-5-14	10-5-18	8-5-13		

Table 2. Mechanical properties of rocks

Nr	Rocks	U.Compr. Strength	Tensile Strength *ai*		Shear Strength T	Poisson's coeff. *v*	Elasticity modulus E
		MPa	MPa		MPa		MPa
1	Clays	1.24-3.5	0.25-	-0.8	0.54-1.5	0.354-0.45	8004-1600
2	Silt rocks	34-8	0.4-	-1.4	0.84-1.8	0.234-0.35	1204-250
3	Sand rocks	0.34-1.8	0.04-	-0.2	0.084-0.3		6004-1200
4	Coal	104-17	0.8-	-3	1.5-5-4	0.204-0.25	12004-2200

Coal is the strongest material, but it is also an water infiltration media, so, the water presence may influence negatively on rocks around.

4. MINE OPENING

By a mining project, opening of the Valias mine is carried out by vertical shafts of 4.2 and 4.5m in diameter till a depth of 160m under the surface. Lay out workings as main haulage and ventilation ones form the mining horizons as in figure 2. By them are served mining sectors of 900 to 1000m length. Actual face length is applied about 80, 60 and 50 meters to the different coal seams (26, 28 and 29).

HIIIEII E ITMTIBIIIT »HIS

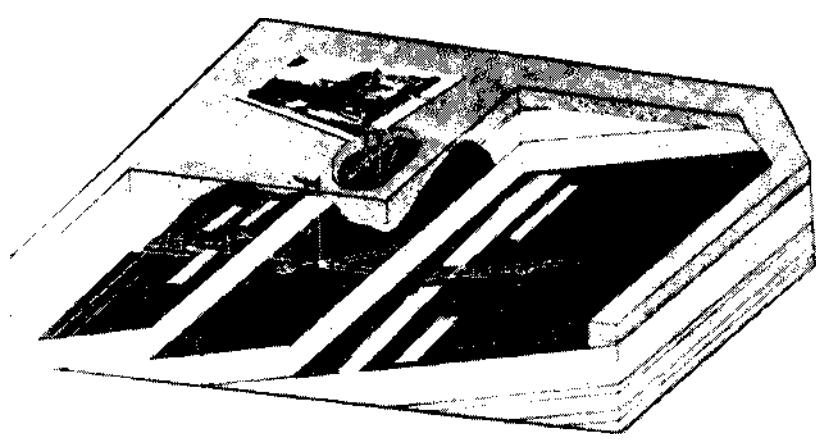


Figure 2. General view of Valias Mine

Shafts *a.rs* sunk partly by freezing method. In normal conditions *are* supported by a 40cm thickness concrete lining and at the frozen part are temporarily supported also by a suplementary 20cm reinforced concrete lining.

Main haulage and ventilation workings have a circular shape and are drifted in very difficult geological conditions. Their biggest cross section *area* in advancing is about 22m . The supports used *are* of concrete blocks, in the best conditions of 40cm thickness and in the aggravated situations the workings *are* supported with an other reinforced concrete lining of 20cm thickness (figure 3).

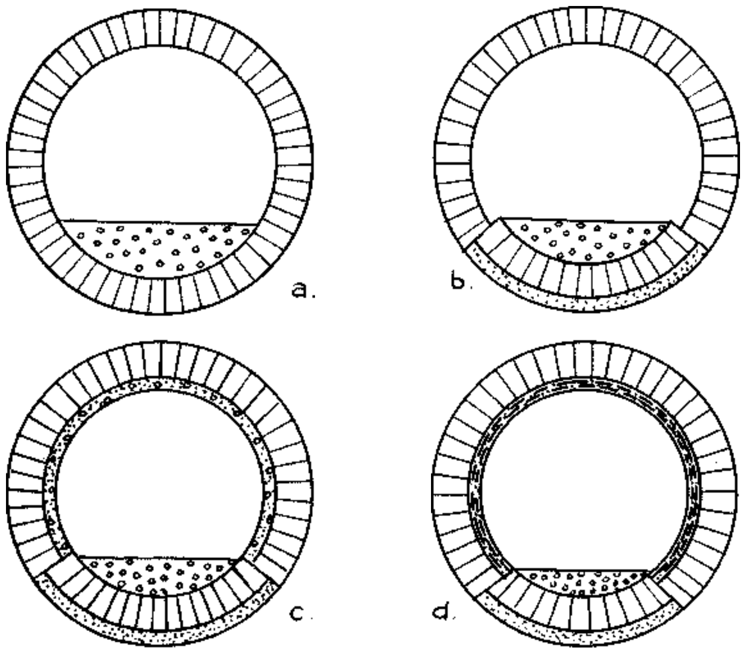


Figure 3. Gallery supports: a) by concrete blocks;
b) by concrete blocks and supplementary floor concrete water isolation layer;
c,d) double support system in very weak rocks around.

Gate ways are supported by four element yielding steel arches with V-23 section. Their density depends on the attended pressure field and in a 9m cross section it is 1.25-2.5 arches per meter (figure 4).

In drifting and mining the blasting is used, but more effectively may be the application of blastless technics.

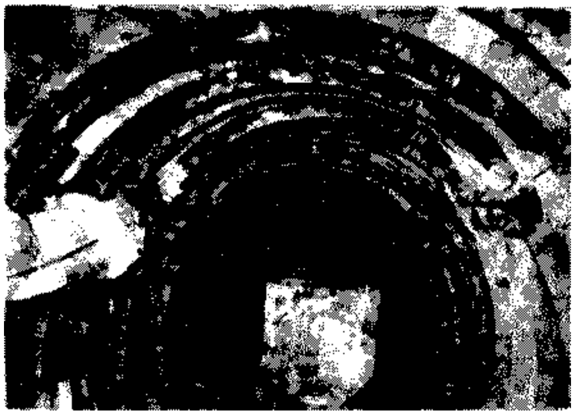


Figure **4. Bateway elliptic yielding supports**

S. MINING

In the three seams is used the long wall mining system by caving (figure 5, table 3). The coal breaking in the face is carried out by blasting in parts and supporting is realised by hydraulic posts and articulated caps. A systematic covering of the hangwall rocks by wooden wedges is needed (4).

Table 3. Some coal mining parameters of Valias Mine.

Nr.	Parameter	Unit	Value
1	Roof Rocks UCS	MPa	1.3 + 3.4
2	Floor Rocks UCS	MPa	4.0 -r 5.7
3	Coal seam UCS	MPa	8.0 ← 14
4	Mining depth	m	- 160
5	Panel dimensions	a m	460 x 70 x 11.7m
6	Interpanel pillar dim.	m	5
7	Diluition	7.	6
8	Wall advancing	m/month	16 * 18
9	Daily output	t/day	260
10	Worker's output	t/shift	1.8
11	Material consumption — wooden	m^3/i000t	22
	Material consumption — explosive	kg/m	0.140
12	Mined coal quality	kkal/kg	3700

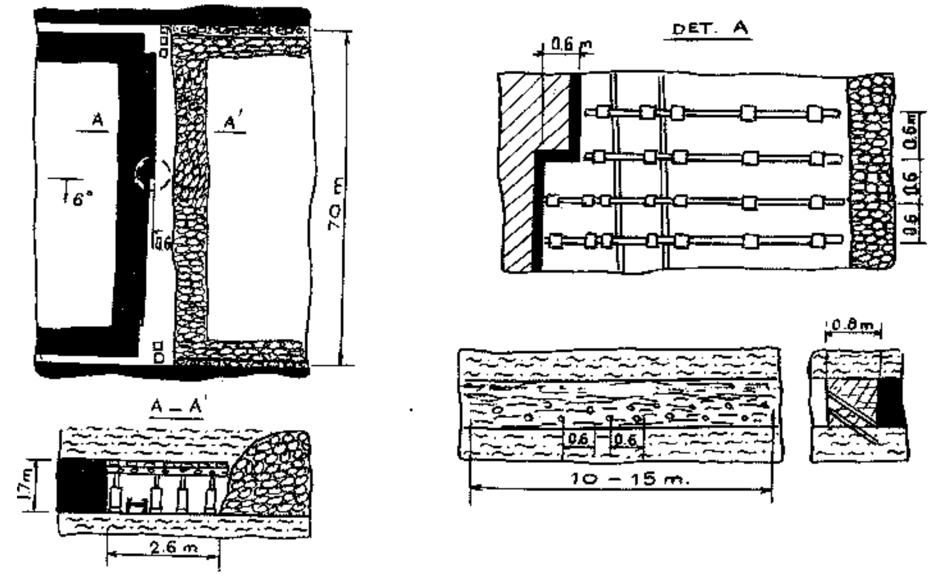


Figure 5. Some details of Valias coal mining method (longwall method by caving).

There are also stability problems in the floor rocks. In many cases ought to prevent the posts intrusion and different kinds of cuchons are used.

Most of the troubles in the mining face *are* caused by blasting works. A difficult control of the normal interaction of the used support systems with rocks around is observed; Intensive deformations and great convergence developments trudge the proceeding of mining. Often is occured the roof failure in the working face accompanied by water-in-flow and its total blockage is risked.

6. **OBSERVATIONS, MEASUREMENTS, AND PREVENTIVE MEASURES**

Valias mine, since its construction, has been in observation and on workings stability problems was paid a great attention (5).

a).As a mine with a high RLI index of workings (RLI=0.7-0.8), it is clearly distinguished between the other mines of the country (figure 6), for a high def ormab.il i ty of rocks around. So, some designed support constructions for lay out workings and technological procedures were tested in real conditions and redesigned. Firstly, by very expensive experiments, was definitively eliminated the use of opened support constructions (figure 7) and the reinforcing of floor rocks by bolting.

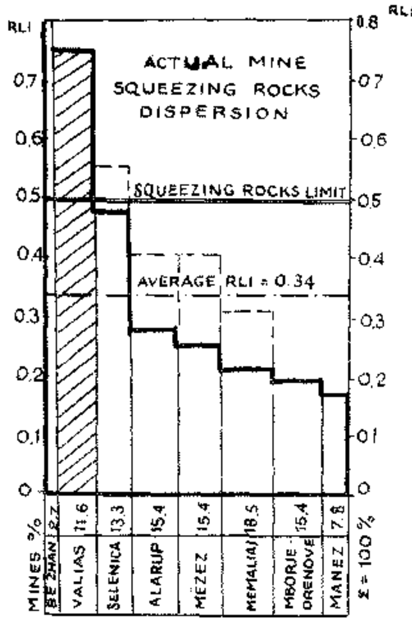
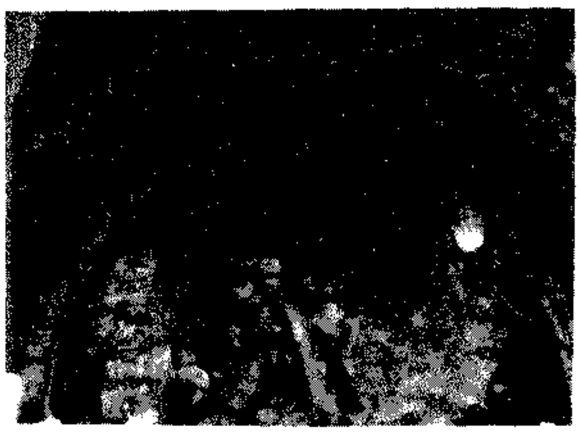
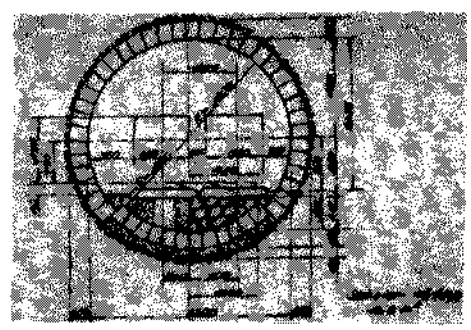


Figure 6, Coal Mines RLI,

Different types of support constructions were changed or modified time by time. So in galleries are used different reinforcing systems of concrete blocks lining as adaptations against swelling with water proof layer, of concrete, using of different steel reinforcing elements, etc. The same thing is true also for the support in gateways changing the type of steel section, their number, density and the characteristics of the floor arch.

In longwal1 workings *are* also changed the types of posts (from friction to hydraulic posts), their load an . deformation characteristics, their density and dispersion, etc.





Tiqure 7. The change to closed support constructions.

b).By calculations, observations and measurements, a great attention is paid to pillar dimensioning as in the cases of barrier pillars, protective pillars and interworkings pillars.

«n example is the determination of the thickness of intensive fractured zone caused by coal mining: By the method of Point Dilution of the Radioactive Traces (6) was measured groundwater flow velocity at different depths and different time in wells located inside and outside the rock mass movement zone (figure 8). So it is estimated that in Valias mine the intensive fracturated zone height on the coal seam position is about 26xthickness of the exploited coal seam.

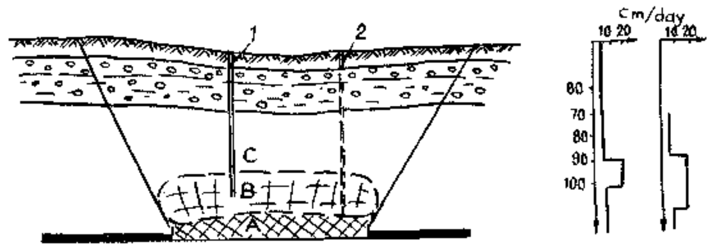


Figure 8. Rock masses movement zone around mine workings: A-Failure zone; B-Intensive fracturation zone; C-Quite bending zone; 1,2-0bservation and measurement wells.

Another example is the study of the character of the movement and deformations of the ground surface caused by the coal mining *(7).* By measured data it is observed the duration of the subsidence and it is also calculated the respective deformation speed (figure 9). In such observations it is concluded that surface deformations in Valias Mine have a high specific development caused by the presence of high plastic formations and the used mining method.

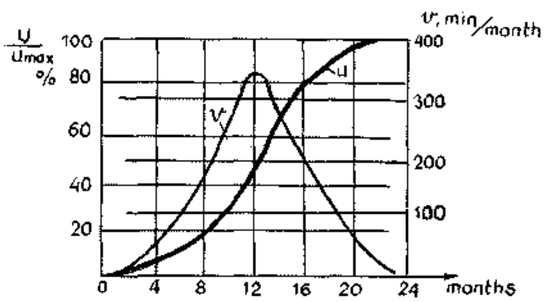


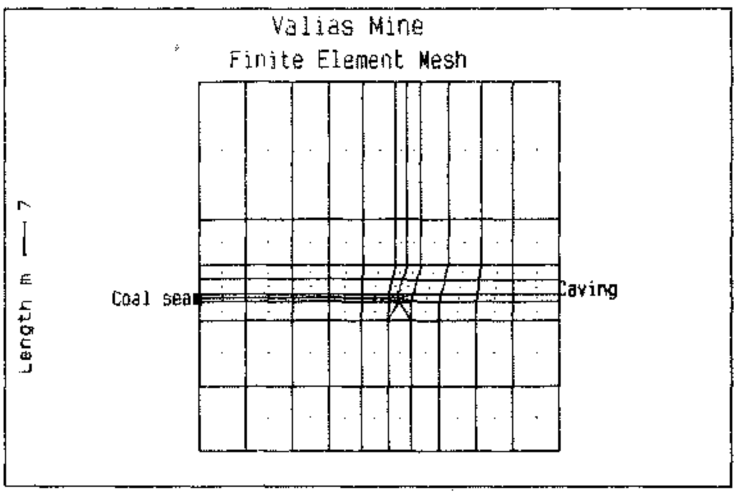
Figure 9. Surface susidence by coal mining in Valias Mine.

c) The silt mass forming around the mine workings and their massive penetration in the working space filling with such masses in some hours or days a great volume and blocking entirely their activity, is another problematic phenomenon in Valias mine. The repeating of such phenomenon in roadways drifts and in mining spaces, convinced the specialists to go deeply into a better recognition of their forming mechanism and to find out the ways of their prevention. It is sure that all begins with the preexisting fractures in the rock masses, their propagation and combination with water containing sands or very weak sandstones. But it is also a great influence of the subjective factors, mainly by the application of an improper technology.

At the Mining Department of Faculty of Geology and Mines, with a respective research modelling program, in the case of coal mining spaces, it is aimed to be obtained the localisation of such weakening hearths in the rock of the so called immediate and main roof on the coal face.

The modelling by F.E. method (8, 9) is used in order to understand the phenomena met during the application of the mining method. The modelling concerns a longwall mined by caving, The model considers the coal seam, the caving and the surrounding rock mass .The coal seam, the roof and the floor *are* assumed to have a perfect elastoplastic behaviour and their failure criterion is defined by the Mohr-Coulomb law, while the caving composed by fractured rock mass is assumed to be linear elastic and to be characterized by a low Young's modulus E and a Poisson's ratio *v* in accordance with the data found in the bibliography.

The 2-D Finite Element mesh which is utilized for stability calculations, consist in 95 2D elements with 505 nodes. Figure 10 shows a view of the mesh used.



F.'-jure 10. Finite element mesh for stability analysis.

The results of this analysis *are*> reported in figure 11 and in figure 12. In figure 11 is shown the plastified zone formed by minig (utilisation of caving method). We can see that this zone touch not only the imediate roof but also the main roof. This result explains the phenomenon observed in

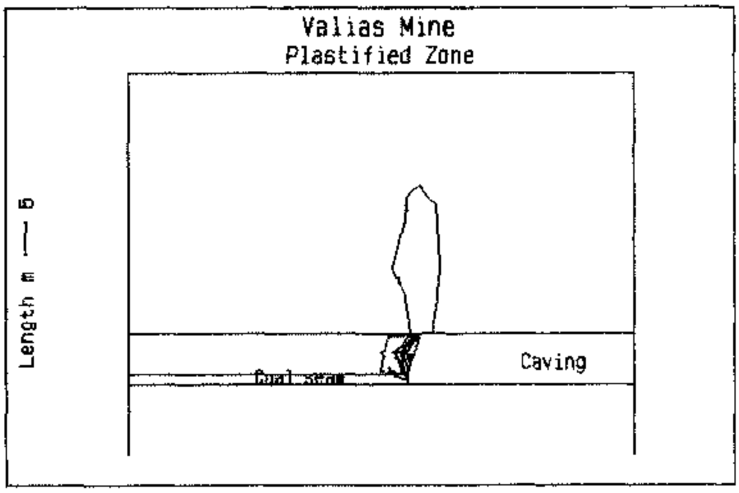


Figure 11. Extention of plastified zone in the immediate and **main roof.**

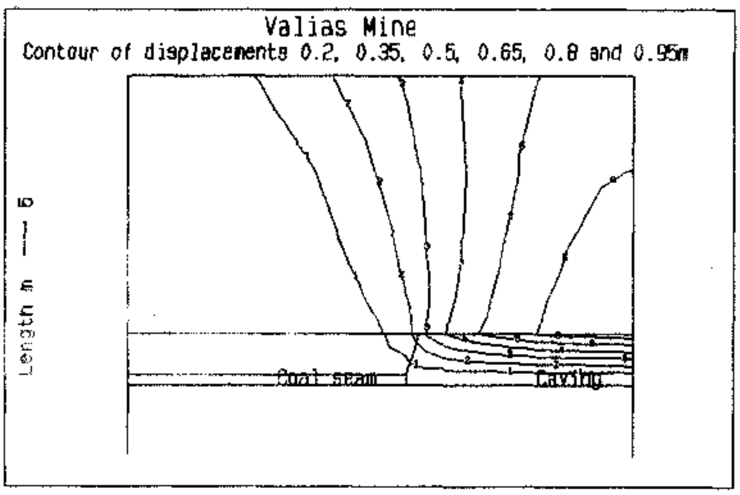


Figure 12. Contour of displacements induced by mining.

practice; the lost of stability in the roof immediatly above the coal face which comes with high pressure in the roof support. Figure 12 shows that the caving comes with relatively high displacements even near the coal face where we have found a displacement near to 20cm. Certainly, in quantitatively view, the results depend strongly on the parameters used and the hypothesis made, but qualitatively we have found the results which explain the phenomena observed in situ (figure 13).

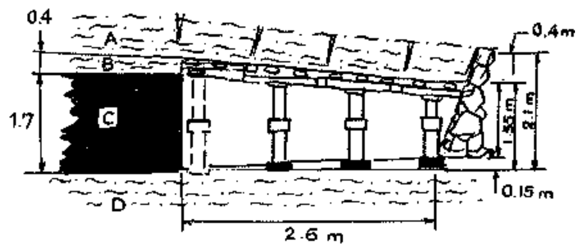


Figure 13. Convergence development in working face cross section.

7. ECONOMICAL ASPECTS OF THE MINING IN SQUEEZING ROCKS

After different reports on economical aspects of mining, Valias Mine, according to the state planifications, every year, is considered as a state subventioned mine. At the best conditions, the state has paid 30-407. of the factic cost of. the mined and washed coal.

Now, in the market economy, to reduce the expenses, the limitation of the coal mining at the 257. of the mine capacity is provided (10), mostly for the maintenance of the mine as long as new solutions, for coal mining in such conditions, will be found.

8. CONCLUSIONS

The phenomena observed in Valias Coal Mine are typical to them met in squeezing rocks. In this case RLI is more than 0.7 but we can meet similar situation even for RLI>0.5.

The numerical modelling allowed us to increase the degree of the understanding of such phenomena and to obtain qualitatively the results in concordance with observations made in situ.

For reducing the expenses we must improve the technology of construction and supporting, by applying a blastless technology for advancing and mining operations.

REFERENCES:

1. DIMO L., PASHKO P., VASO P. et al:. Coal bearing Basins in Albania and their perspective. Materials of National Scientific Conference, November 1989, Session of Beology (G.S.B. Nr.4, 1989, p.249-257).

2. DHRAMI F., STRATÖBERDHA R., SMOKTHINA S., QENDRAJ Q., Valias Coal Mine achievements a strong base for intensive mining of Tirana Coal Basin. Mining Sciences Bulletin, Nr.l, 1970, p.71-76.

3. BARLA G.j FORLATI F., ZANINETTI A., Prove di labboratorio su rocce tenere: Problematiche ed esampi P.T. Ill Ciclo di Conferenza di Meccanica e Ingegneria del le Rocco. p. 4-47, Novemre 1990, S6E Padova - ITALIA

4. SAUKU H., PEP0 S., BUXHA S., KAfllLI V., VASILI L., Data on the deformability of the immediate roof and floor in longwall workings applied in the Valias Mine Squeezing Rocks. Mining Sciences Bulletin, Nr.l, 1985, p.71-78.

5. GROUP OF AUTHORS: A study on the increasing of the production capacity of Valias Mine. ISK6JM, 1982.

6. AHMATAJ S., THERESKA J., EFTIMI R.: Determination of thickness of fractured zone on the coal seam caused by mining at Valias Coal Mine. M.S.B. Nr.1-2, 1987, p.51-56.

7. Z0T0 V., Surveying results of surface subbsidence at the Valias Coal Mine. Scientific Bulletin of Mining, Nr.l, 1986.materials and systems to substitute timbering (in albanian), Archive ISPM, Tirana, 1988, 168 p.

8. ZIENKIEWICZ O.C., The finite element method in engineering science. McGraw-Hill, 1977, New York, 3 edition, 787p.

9. TIJANI S.M., VOUILLE G., La méthode des éléments finis. Ecole Nationale Supérieure des Mines de Paris, 1985, 49p.

10. BAKIU A., QENDRO S., NUNE D. et al.: Technical and Economical Report of mining in Valias Coal Mine, ITNPM, October 1993.