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Evaluating the Loss of "Geological" Lignite in "Zebra" Type Deposits

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ABSTRACT: Zebra type lignite deposits are characterized by the multiple interchanges of lignite and thin sterile intercalations consisting mainly of clays, marls and sands. In zebra type deposits knowledge of the geometry and of the quality characteristics of both the lignite and the sterile intercalated layers is of the utmost importance in designing the optimum lignite recovery of lignite reserves. The application of selective excavation requires the determination of recoverable lignite blocks fulfilling specific technical and quality criteria. This procedure results in losses of thin "geological lignite" layers having thickness < 50 cm and losses due to the cleaning of interfaces between lignite and sterile blocks. Both losses are included in the term "geological" lignite losses.

1 INTRODUCTION

The Southern Field Mine, the biggest lignite mine in the Balkan peninsula, is located in Ptolemais basin and has fed the Agios Dimitrios Power Plant since 1983. The annual excavations range between $80x10^6$-$90x10^6$ m^J (bulk), while the lignite production ranges between 18-22 tons. Between 2001-2004 mining activities are being developed in an area of 2.4 Km" as it is shown in Figure 1.

The Southern Field Mine deposit is characterized as a "zebra" type or multiseam lignite deposit, presenting multiple interchanges of lignite and thin sterile intercalations of marly limestones, marls, clays and sands. This type of lignite deposit require'.- selective excavation, where thin sterile layers are unavoidably coexcavated with lignite ones thus reducing the mined lignite quality (Kolovos et al. 2002a. b). Furthermore, for mining reasons, thin lignite layers having thickness < 50 cm have to be removed as sterile layers resulting in the loss of "geological" lignite.

In selective mining, lignite and sterile layers are excavated as individual layers or as blocks of layers. The determination of excavated layers or block of layers is a matter of special study work, known as borehole evaluation. During borehole evaluation lignite layers and thin sterile intercalations are combined together according to specific technical and quality criteria in order to maximize the thickness of excavation blocks to achieve productive mining (Karamalikis 1993; Mevorach et al. 1994; Kolovos 2001). Tliese criteria are described in the "Materials and Methods" section. In order to avoid further reduction in lignite quality due to dilution from the top and bottom excavated sterile layers or block of layers, careful cleaning of interfaces between lignite layers or block of layers is required. However for a better mining design, this dilution has to be taken into account subtracting 10 cm from the top and 10 cm from the bottom of the lignite layer or block of layers, thus resulting in further "geological" lignite loss.

The knowledge of the quantity and the quality of "geological" lignite as well as its distribution is of the utmost importance in order to design the optimum lignite exploitation.

2 MATERIALS AND METHODS

For the purpose of this project 1179 lignite samples from 36 drilled boreholes were studied. The investigated area is presented in Figure 1.

"Geological" lignite is considered any lignite layer having thickness > 10 cm and ash (db) content < 40%. "Recoverable" lignite is considered to be any lignite layer or block of layers having thickness <50cmandash(db)<40#.

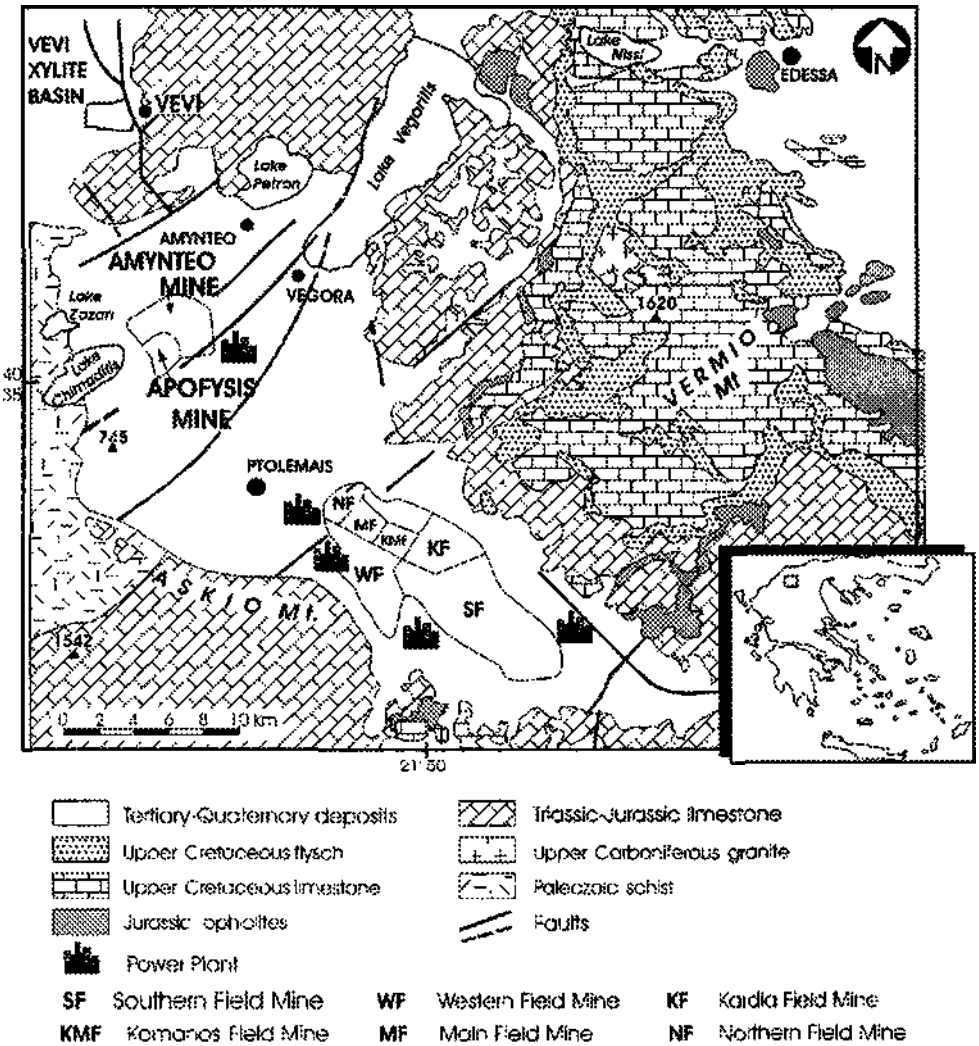

Figure 1. Geological map of the study area

The evaluation of boreholes was carried out by a computer program called METAL, developed by the Public Power Corporation of Greece (PPC) (Karamalikis 1993) and the following criteria were used:

- The geometry and quality characteristics of sterile layers included in recoverable lignite blocks
- The geometry and quality characteristics of sterile layers or block of layers to be dumped
- The geometry and quality characteristics of recoverable lignite layers or block of layers
- The specific gravity of lignite
- The ash (db) content of sterile layers
- The specific gravity of sterile layers
- The calorific value of sterile layers
- The moisture content of sterile layers
- The loss of lignite due to the cleaning of interfaces (the removal of 10 cm from the top and 10 cm from the bottom of lignite blocks).

The aim of borehole evaluation is to achieve the maximum lignite deposit recovery with an average

ash (db) content < 30% and net calorific value > 1300 kcal kg"'.

3 RESULTS AND DISCUSSION

The distribution of geological lignite thickness is presented in Figure 2.

Boreholes presenting small lignite thickness are located near faulted zones or near the east edge of the basin. The number of lignite layers per borehole ranges from 9 to 60 with an average value of 32.7.

In Table 1 the results of site investigation and borehole evaluation are presented. The total lignite thickness is 1202.99 m, and the total geological lignite thickness per borehole ranges between 5.95 m and 55.2 m with an average value of 33.4 m.

The distribution of the number of layers per borehole is presented in Figure 3.

After borehole evaluation, 390 lignite blocks were formed with a total thickness of 1253.22 m. The thickness of the recoverable lignite per borehole ranges between 5.5 m and 62.2 m with an average value of 34.8 m. The distribution of the

.....TaWeJLjtesulfciof site investigation and borehole evaluation

	Recoverable lignite blocks					Geological Lignite layers				
Borehole	Lignite thickness (m)	Number of blocks	Total moisture content (%)	Ash <%)	Net calorific value (kcal kg'[1])	Number of strata	Thickness (m)	Loss due to selective mining ¡¦ⁿ>	Loss due to .small thickness (m)	Addition of intercalations (111)
1	28.88	12	57.01	24.48	1390	42	30.61	2.40	1.35	2.02
2	54.10	11	54.98	29.23	1390	43	46.90	2.10	0.00	9.30
3	39.40	8	56.47	26.13	1415	3t	39 20	1.60	0.40	2.20
4	40.17	12	58,33	28.23	1275	57	41.14	2.20	1.60	2.8.3
5	28.02	17	58.31	27.38	1290	57	32.94	3.40	2.05	0.53
6	51.60	6	56.44	29 00	1370	39	47.10	1.00	0.40	6.00
7	41.20	14	53.83	28.75	1439	34	39.90	2.40	0.50	4.20
8	62.60	12	54.24	32 02	1341	47	55.20	2.10	0.40	9.90
9	59.05	12	55.95	28.63	1331	46	54.35	2.20	0.90	7.80
to	41.30	8	56.42	28.17	1399	30	39.30	1.60	0.00	3.60
11	39.25	11	58.07	24.27	1479	19	41.40	2.20	0.00	0.05
12	54 00	10	54.92	30.04	1334	40	48.80	1.60	0.85	7.65
13	39.08	22	58.44	28.12	1391	60	42.42	3.90	1.20	1.76
14	44.05	8	54.68	28.24	1356	32	42.45	1.50	0.00	3.10
IS	38.30	12	53.60	25.96	1558	36	37.20	2.00	0.40	3.50
16	56.10	7	51.50	31.29	1481	37	49.10	1.30	0.30	8.60
17	37.80	10	52.13	29 99	1477	28	34.40	1.70	0.70	5.80
18	57.15	17	54.96	30.33	1316	46	52.70	3.20	0.95	8.60
iy	21 35	8	56.59	28.21	1396	12	21.10	1.50	0.00	1.75
20	41.19	15	58.10	30.37	1302	55	42.05	2.70	2.65	4.49
21	38.10	9	52.40	31.14	1238	30	36.00	1.60	0.00	3.70
22	27.85	15	55 67	31.08	1336	52	33.66	3.00	4.37	1.56
23	20 93	11	54.51	32.22	1293	49	26.02	2.20	5.02	2.13
24	54.30	12	52.79	34.78	1155	37	41.70	1.60	0.00	14.20
25	25.60	8	48.17	37.04	13.39	19	18.10	1.20	0.90	9.60
26	5.50	7	53.75	31.14	1455	12	7.80	1.40	0.90	0.00
27	22.20	7	48.58	32.67	1380	17	17.90	1.20	0.00	5.50
28	23.50	8	52.82	30 68	1290	19	20 90	1.40	0.00	4.00
20	20.60	11	57.87	27 71	1401	13	22 80	2.20	0.00	0.00
30	28.80	13	53.77	28.19	1385	31	29.50	2.50	0.00	1.80
M	7 55	6	47.98	34.26	1370	9	5.95	0.90	0.20	2.70
12	25.70	19	54.22	28.9	1.334	29	27.30	3.60	0.00	2.00
33	23.90	7	54.64	34.79	1218	21	24.20	1.30	0.00	1.00
34	13.80	7	45.47	34.16	1451	14	12.80	1.00	0.20	2.20
35	20.80	8	51.16	34.6	1022	15	19.30	1.40	0.00	2.90
36	19.50	10	54.73	26 27	1243	21	20.80	2.00	0.20	0.90
Sum	1253.22	390				1179	1202.99	71.10	26.44	147.87

thickness of the recoverable lignite is presented in Figure 2. The number of recoverable lignite blocks ranges between 6 and 22 with an average value

losses of less than 3 m, while 33 of the 36 boreholes (91.7%) have total lignite losses of less than 5 m. These values indicate the goixl lignite

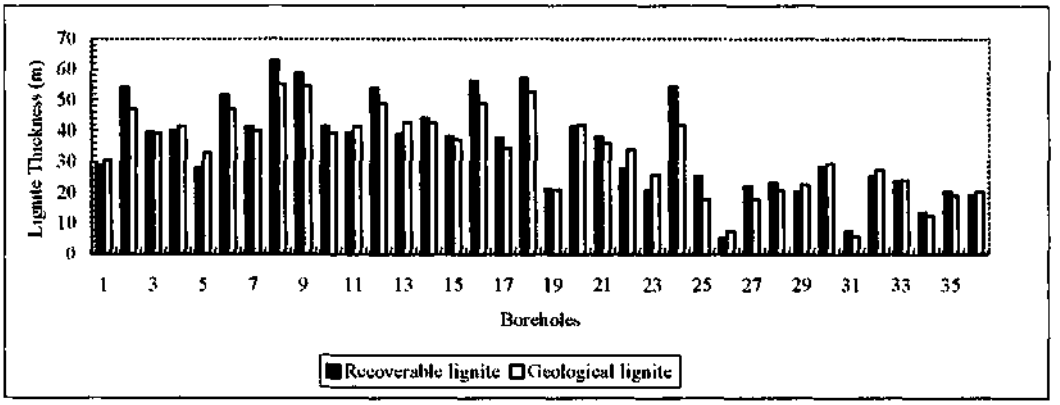

Figure 2 Distubution ot geologic.il lignite and the thickness of recoverable lignite

10.8 Its distribution is presented in Figure 3.

According to the borehole evaluation the recoverable lignite thickness seems to be greater than the initial "geological"' lignite thickness. This is because thin sterile intercalations are included in the recoverable lignite blocks.

The total geological lignite loss due to thin lignite layers is 26.44 m. The thickness of geological lignite loss due to thin layers ranges between 0 and 5.02 in. It is indicated that 14 of the 36 boreholes (38.9%) have no geological lignite losses and 34 of the 36 boreholes (94.4%) have lignite losses less than 3 m. The distribution of the losses due to thin lignite layers is presented in Fıguıe 4.

The total geological lignite loss due to selective mining is 71.10 m. This lignite loss ranges between 0.9 m and 3.9 m with an average value of 1.97 m. 24 of the 36 boreholes (66.7%) have total lignite

recovery characteristics. The distribution of the selective mining losses per borehole is presented in Figure 4.

Due to selective mining thin sterile intercalations are co-excavated with lignite layers thus increasing the thickness of the recoverable lignite block. The total thickness of thin sterile intercalations co-excavated with the lignite layers is 147.87 m. The thickness per borehole ranges between 0 m and 14.2 m with an average value of 4.1 m. The distribution of the co-excavated intercalations is presented in Figure 5.

Boreholes evaluation indicates that the recoverable "geological" lignite is

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1202.99 m - 26.44 m = 1176.55 m (97.80%).
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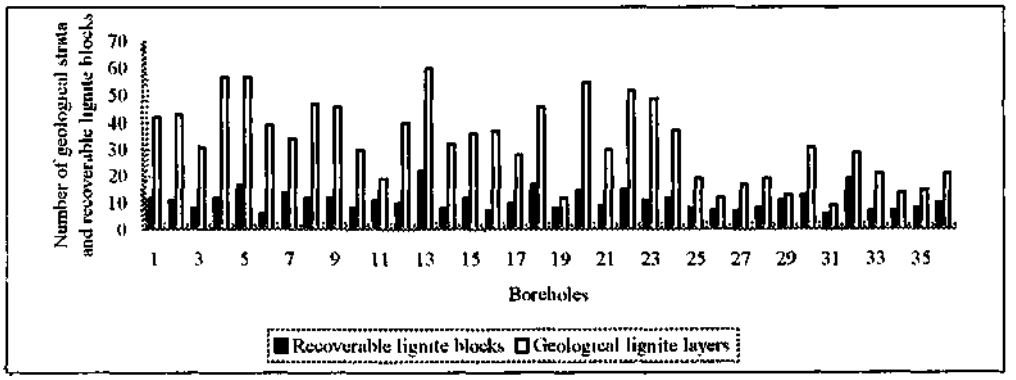
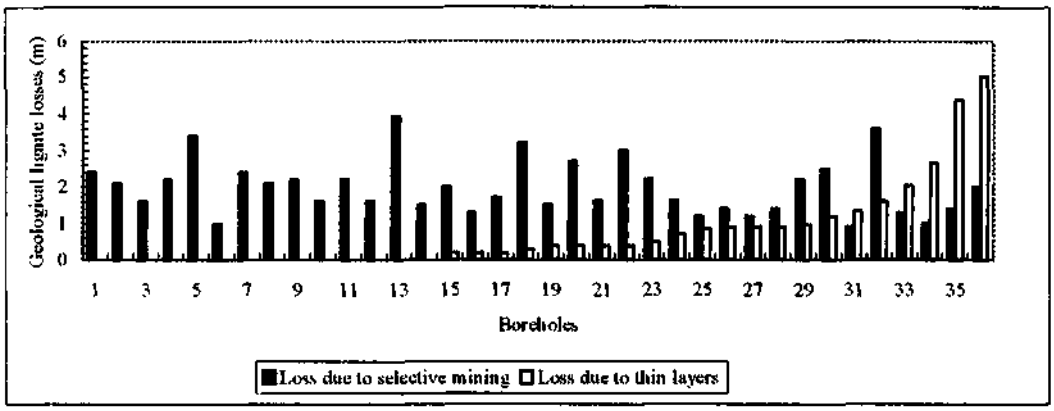
The geological lignite loss due to thin layers <50 cm is



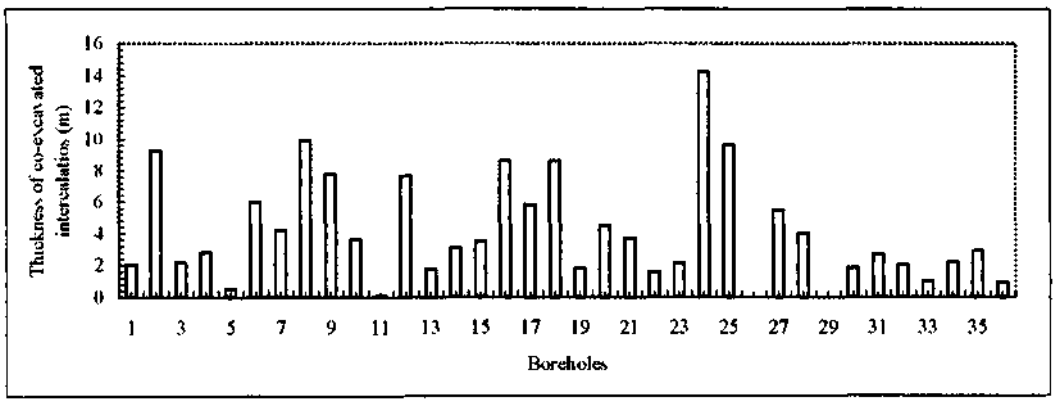
F-ıgue 1 Dıstıhuıtun ofgeologic.il lignite and recoverable lignite layers

26.44 m / 1202.99 m = 2.19%.

moisture content of 54.68%, an ash content of 29.72% and a net calorific value of 1353 kcal kg'".



Figuie4 Geological lignite losses



Figuie 5 The distribution of thin 1nierc.1ljt10iKcocxcdV.1ted with lignite

The geological lignite loss due to selective mining is

71.10 m/1202.99 m = 5.91%

The total '"geological" lignite recovery

is 100 % - 5.91 % - 2.19 = 91.90%.

It is stated that this percentage is not the amount of recoverable lignite since thin sterile intercalations are coexcavated with ""geological" lignite due lo selective mining. The recoverable lignite contains

147.87 / 1253.22= 11.8% sterile intercalations.

Following borehole evaluation the quality of the recoverable lignite is characterized by a total

4 CONCLUSIONS

Zebra type or multiseam lignite deposits are characterized by the multiple interchanges of lignite and thin sterile intercalations. This type of deposit requires selective excavation where thin sterile intercalations are unavoidably coexcavated with lignite thus reducing the recoverable lignite quality.

Borehole evaluation has to consider lignite losses due to both the thin lignite layers and the cleaning of interfaces due lo selective mining. The recoverable "geological" lignite of the South Field Mine is 97.8%, however after the selective mining losses this becomes 91.90%. This lignite is not the actual amount of recoverable lignite, since due to selective mining, thin sterile intercalations are

coexcavated with lignite inci easing the total ıecoveıable lignite quantity Theietoie the final ıecoveıable lignite contains 118% slenle intetcdidtions

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