"HYDROGEOLOGICAL CONDITIONS ASSOCIATED WITH THE FUTURE EXPLOITATION OF LIGNITE MINE IN POTAMIA BASIN, THESSALY, CENTRAL GREECE",

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Abstract: In Potamia basin, in central Greece, two deposits of $160x10^6$ tn of lignite, have been found. The exploitation process of the future open lignite mines is highly connected to the existence of surface and ground water in the area. In this paper the hydrogeological conditions and the hydrodynamic status of ground and surface water of the basin are described. A water management system of the water coming from dewatering process is suggested.

Key words: Lignite deposits, dewatering, open pit exploitation, water status.

Introduction

Potamia basin is located in central Thessaly, Greece. Two lignite deposits, Domeniko and Amourio, of $160x10^6$ tn, have been found there (Dimitriou D. 1997). The basin of Potamia is crossed by the Titarisios river, which drains an area of $85km^2$. The existence of Titarisios river with its often destructive floodings, combined with the indications of an important groundwater-bearing strata in the basin, made necessary the investigation of the hydrologic and the hydrogeological conditions of the basin, within the framework of preliminary studies concerning the exploitability of the deposits. The aim of this study is to determine the degree to which the future mine will be influenced by the existence of ground and surface water.

Geological settings

The basement of the Neogene basin of Elassona geotectonically belongs to the "Pelagonian Zone". It is consisted of :

⇒ Marbles of the middle Triassic, which form the north outcrops near Evagelismos and Paleokastro and part of the south-east boundary of the basin, near

Domeniko. They also have been penetrated by some boreholes in the basement of the basin.

⇒ Schists, gneiss-schists and gneisses, which underlay and form a "ring" around the above mentioned karstified marbles.

⇒ The paleozoic gneiss with acid intrusions of granites, which forms the western boundary of the basin.

The Pelagonian zone is overthrust over the mesozoic marbles of the autochthonous series, which form the northest boundary of the basin near Kefalovriso (Fig. 1).

The lignite deposits have been formed in the Neogene formations and represent a river regime. In Domeniko area the lignite deposit is overlain by alterations of Quaternary fine sands, clays, marls and conglomerates of fluvio lacustrine genesis. The Amourio lignite deposit is located west of the paleoflume of Titarisios. The overburden is consisted of recent sediments of pebbles, gravels and fluvial terraces.

Lignite Characteristics

According to the preliminary results of the research, (Zeppos I.1996) Domeniko deposit consists of 12-15 lignite layers varying in thickness from 1m up to 90m, alternating with waste materials. The roof of the lignite-bearing strata was found from drills at a depth 10m to 90m and its bottom at a depth 60m to 130m. The geological deposit was estimated at 146.7X10^6 tn and average ratio 6.87:1 m^3/tn. The Amourio deposit is much smaller, that is 15.4x10^6tn , with an average ratio 7.4:1 m^3/tn.

Hydrogeologic and hydrologic conditions

Potamia basin is more or less surrounded by impervious formations, schists, gneiss-schists and gneisses, which form impermeable boundaries. The overlaying marbles of the Pelagonian series are of limited extend and thickness, especially in the area of Evagelismos and in the basement of the basin. So they are of minor importance concerning their water storage capacity. In the same formation, south of Domeniko, groundwater flows mainly to the east and has a discharge point out of the basin.

The only karstic formartion of major importance is the one of the autochthonous series north of Kefalovriso. The springs at Kefalovriso with an average flow of 9.65 m^3/sec is the main discharge point of the above mentioned karstic aquifer. These marbles as well as the Titarisios river are the main sources of recharge for the aquifers of the filling of the basin at the northern boundaries of it.

Logs of approximately 100 drill holes, data from 21 pumping tests (Tsouflidou and others 1999-E.Vassiliou 1997) and monitoring of many piezometers indicated that the confined aquifer in the overburden of the future lignite mine in Domeniko (fig.2) has low transmissivity ($8x10^{-5}$ m^2/sec). But the second lignite deposit in Amourio is crossed by the Titarisios river and there are aquifers of significant capacity in the overburden, which are expected to influence severely the future mine.

In the alluvial formations at the central part of the basin, three different hydrogeological units are distinguished, due to the different hydraulic conductivity:

a) coarse-grained materials in the northern part (Magoula-Sikea area) b)beds of sandstone, central and southern part (Amouri area) c) fine grained sand (Pretori-Mesoxori area).

Generally the values of the transmissivity (T) are increased ($5x10^{-2}$ m^2/sec) towards the centre and southern boundary of the basin (fig. 3), but at the eastern boundaries in the area of the future Domeniko mine, the values are very small ($8x10^{-5}$ m^2/sec).

The shape of piezometric surface (fig.2) confirms that low permeability materials are prevailing in Domeniko mine while higher permeability sediments are expecting in the center of the basin. The main recharge boundary of the aquifers of the loose sendiments of the basin is the northern boundary along the line Evagelismos, Paleokastro, but more data are necessary to establish a reliable conceptual groundwater model. The increasing demands for irrigation have led to an over-exploitation of ground water, affecting the piezometric surface and a decline 1.5m has been observed the last 5 years

The annual average rainfall was estimated at 751mm, percolation at 20,3mm, evaporation at 496mm and flow off at 235,06mm (Beloukas S., 1987).

In 1997, E. Vassiliou reported that the precipitation had been reduced, the last 10 years, by 20%, the average temperature was about 14,3^{o}C and evaporation was estimated at 333mm.

Titarisios river has an average discharge 3.5 m^3/sec in winter, but it is almost dry for long periods, in the summer. The maximun discharge that has been measured is 52 m^3/sec but actually it is much higher occasionally and has caused the destruction of the bridges, which connect the villages of the area. The springs at Amourio area with an average discharge of 0.6 m^3/sec in the alluvial sediments of the basin, are used mainly for irrigation.

Conclusions

The exploitation of the lignite deposit in Amourio is strongly influenced by the unfavorable hydrological and hydrogeological conditions and the small size of the lignite deposit. The springs discharge in Amourio area and the Titarisios river flow through the lignite deposit. Due to the mentioned destructive floodings of Titarisios river, its diversion, which is inevitable, is expected to increase dramatically the exploitation cost. On the other hand, dewatering of the overburden, which is consisted of highly permeable materials, pebbles, gravel etc. is a necessity. But the hydraulic connection of these geological formations with the paleoflume of Titarisios as well as with its new flow path, makes it a complex and difficult process.

In Domeniko mine, Titarisios and Elassonitikos rivers flow far out of the boundaries of the mine. A small rivulet, which flows through the area of the mine, is rather a nuisance than a real problem. On the other hand, the very low permeability of the overburden and underburden does not permit the flow from the high permeability sediments around Titarisios to the area of the future mine. However, attention should be paid to the artesian aquifers of the area and their influence on the stability of the slopes of the mine. Choosing the proper drainage network will help to control the stability of the slopes (Louloudis.G, 1991).

Water pumped out for the protection of the mines could be used directly for irrigation or for the artificial recharge of the aquifers. In this way the potential of the aquifers will be maintained and increased quantity of water will be available during the irrigation period.

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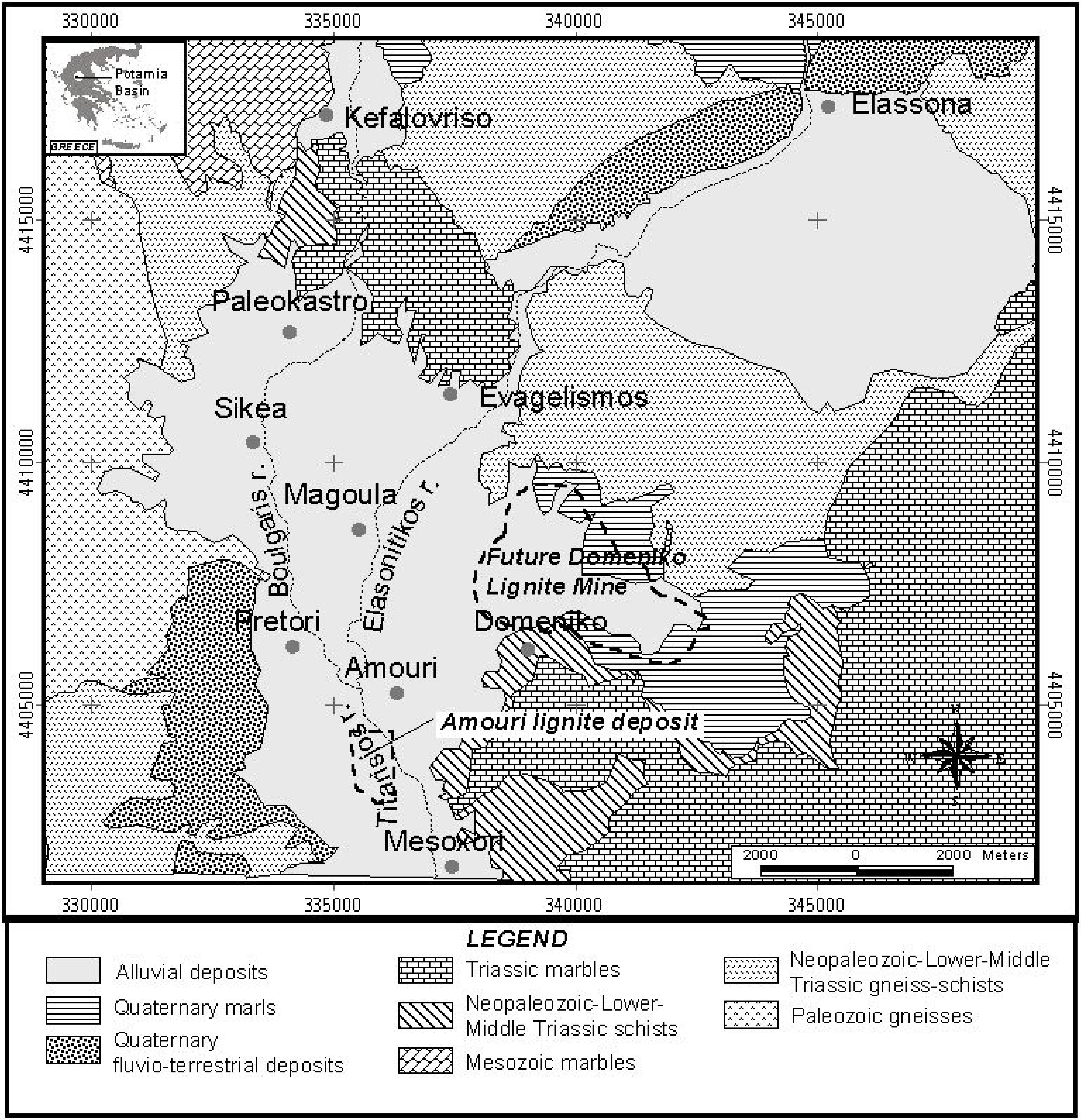
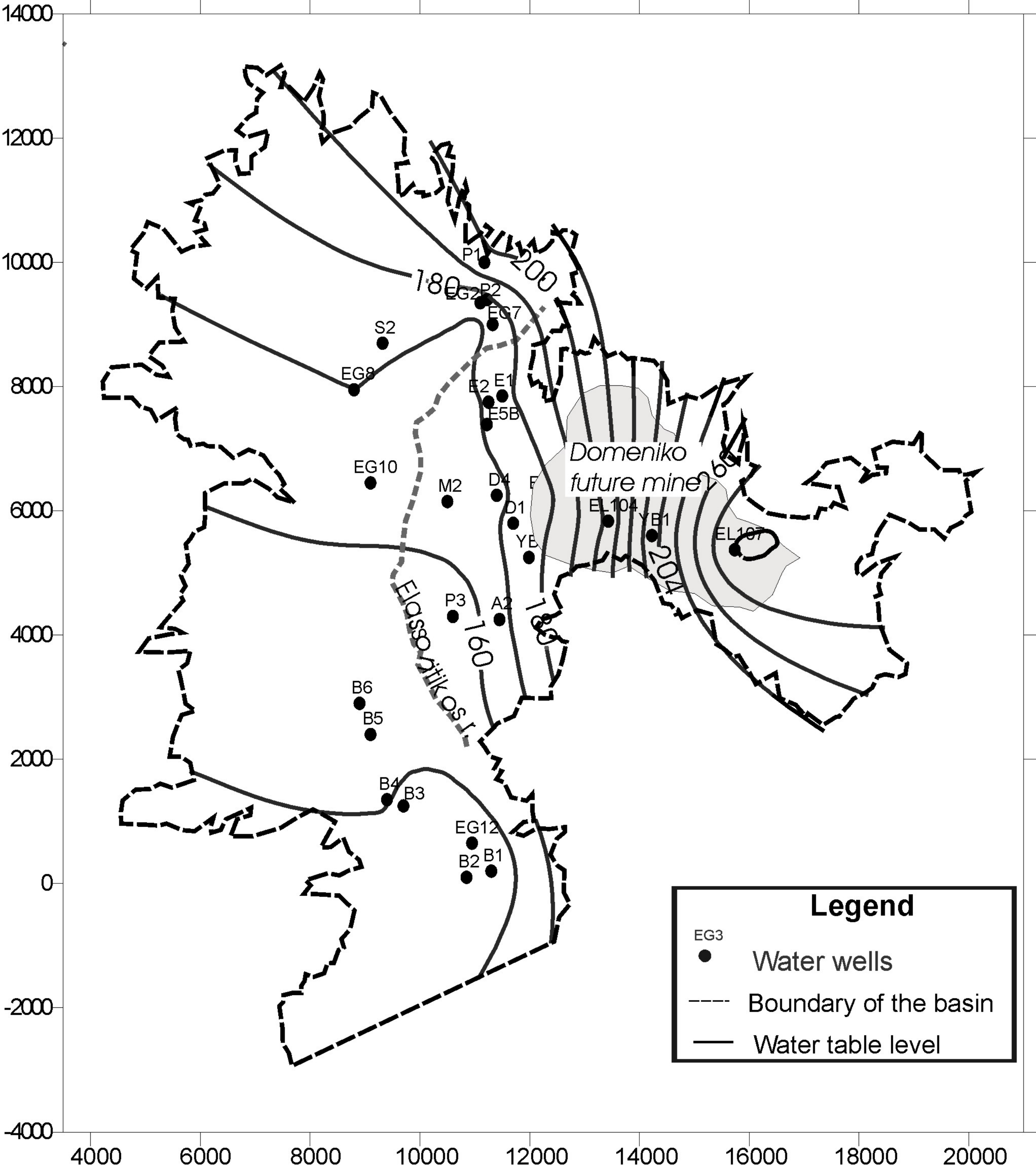
Figure 1: Simplified geological map of Potamia Basin

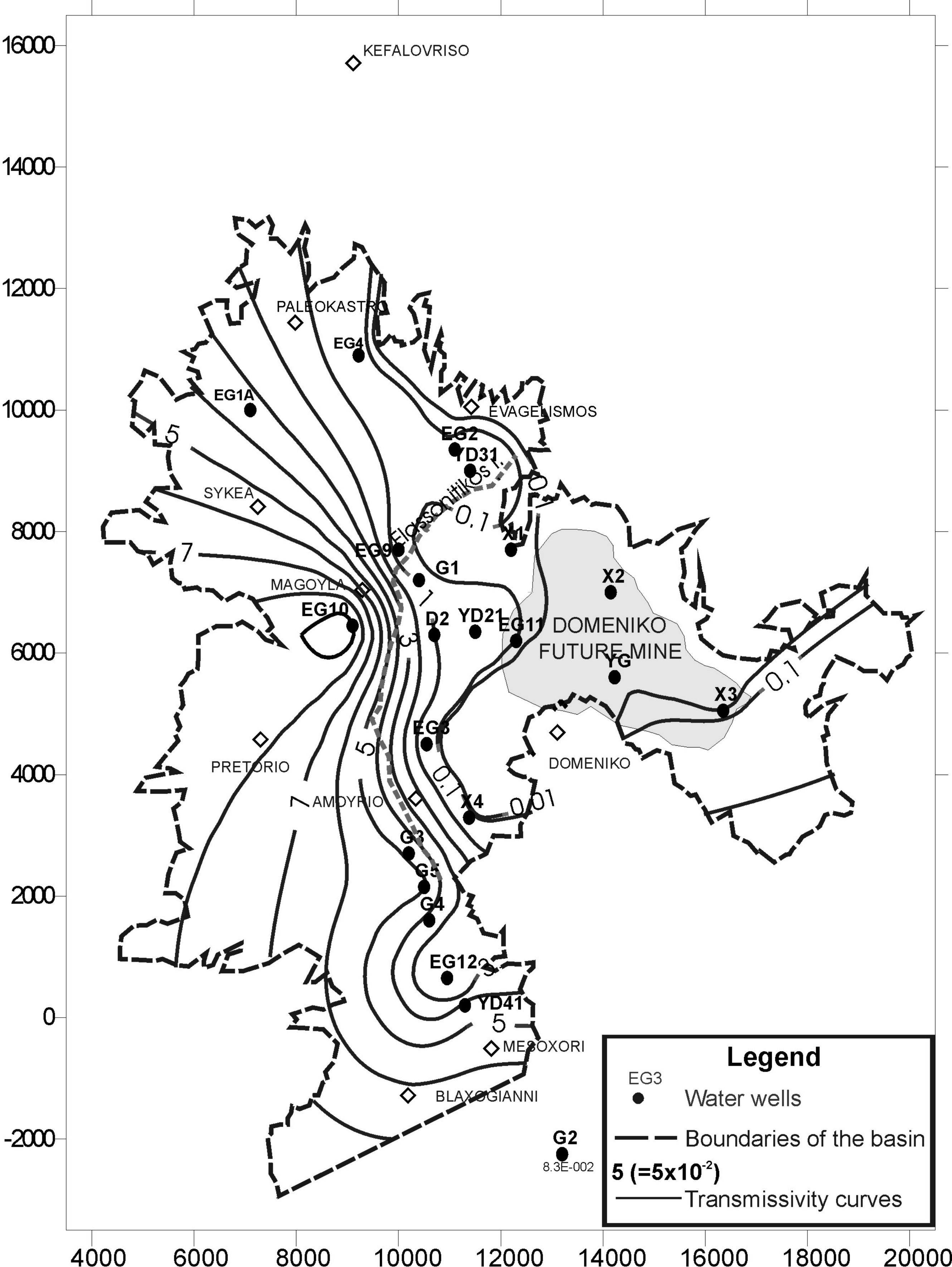
Figure 2: Piezometric map of February ’98

Figure 3: Transmissivity map of Potamia Basin (T-m^2/sec)


Potamia Basin
GREECE
Kefalovriso
Elassona
Paleokastro
Evagelismos
Sikea
Magoula
Boulgaris r.
Elasonitikos r.
Future Domeniko Lignite Mine
Pretori
Domeniko
Amouri
Amouri lignite deposit
Titanisios r.
Mesoxori
330000
335000
340000
345000
4415000
4410000
4405000
2000 0 2000 Meters
N
W
E
S
LEGEND
Alluvial deposits
Quaternary marls
Quaternary fluvio-terrestrial deposits
Triassic marbles
Neopaleozoic-Lower-Middle Triassic schists
Mesozoic marbles
Neopaleozoic-Lower-Middle Triassic gneiss-schists
Paleozoic gneisses



14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
4000
6000
8000
10000
12000
14000
16000
18000
20000
P1
200
180
EG2
P2
EG7
S2
EG8
E2
E1
E5B
EG10
M2
D4
D1
YB
Domeniko
future mine
EL104
YB1
EL107
204
P3
A2
160
180
Elassonitikos r.
B6
B5
B4
B3
EG12
B2
B1
Legend
EG3
Water wells
Boundary of the basin
Water table level


KEFALOVRISO
PALEOKASTRO
EG4
EG1A
EVAGELISMOS
EG2
YD31
Elassonitikos r.
SYKEA
0.1
X1
EG9
G1
X2
MAGOYLA
EG10
D2
YD21
EG11
DOMENIKO FUTURE MINE
YG
X3
EG3
PRETORIO
DOMENIKO
AMOYRIO
X4
0.01
G3
G5
G4
EG12
YD41
MESOXORI
BLAXOGIANNI
G2
8.3E-002
Legend
EG3
Water wells
Boundaries of the basin
5 (=5x10⁻²)
Transmissivity curves