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Research Article

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Comparision of Major and Trace-Element Enrichments of Pliocene Coal Fields from Karapınar and Ilgın (Konya) Basins (Turkey)

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Abstract In this study, the element contents of two seperate Pliocene aged coal units (from Ilgın and Karapınar coal fields, Konya Basin, Turkey) have been compared. First of these areas, The Karapınar area is east of Konya, and the second area (Ilgın) is west of Konya city (Turkey). Both areas are analyzed for their main and trace element enrichments and compared. In the Karapınar area; pre-Neogene basement rocks comprise Jurassic-Cretaceous units. These units are overlain by Neogene fluvial sediments and lacustrine deposites. Coals are found in the lacustrine sediments. In the Ilgın area; the pre-Neogene rocks are made of Paleozoic-Mesozoic metamorphic rocks and crystalline limestone. Coal bearing sediments lie unconformably on the Mesozoic-Paleozoic rocks. The Pliocene coal bearing units are made of conglomerate, sandstone, siltstone and claystone. When Karapınar coals are compared to the average universal coal content, high element values are found for As, Cs, Ni, Sr, U and V. In the case of Ilgın, Ti, Cs, Rb, Ta, Th, As, Nb, La, Ce, Pr, Nd and Sm are above average. Only As and Cs are the enriched elements in both areas. Lithologic differences of the areas are the cause of the variations of the element enrichments.

Keywords Pliocene, Coal, Major and Trace Element, Konya, Turkey

Introduction

The studied regions are located within the Central Anatolian (Figure 1a and Figure 2a). In the investigated region Karapınar, the Pre-Neogene basement rocks comprise serpentinite, schist, and crystallized limestones [1]. These units are overlain by Neogene fluvial sediments and lacustrine deposits. Fluvial sediments (conglomerate, sandstone, mudstone, and green claystone) are thick at the margin of the basin and thin laterally toward the center of the basin, where lacustrine units (limestone, clayey limestone, and white claystone) dominate. Jurassic-Cretaceous aged rocks form the basement of the basin. The Upper Miocene-Pliocene rocks have been subdivided into the İnsuyu and the Hotamış Formations [2] (Figure 1c). İnsuyu Formation is composed of limestone, sandstone, and claystone. Hotamış Formation consists of two lignite seams, which are associated with claystone, mudstone, and sandstone. Quaternary alluvium is the youngest unit to outcrop in the environs of Hotamış Formation (Figure 1b).

Second study area is located in eastern Ilgın, Konya-Turkey (Figure 2a). In order to determine the character of the major trace element contents in the coaly units, samples were collected from KI26 and KI30 bore holes (Figure 2b). Miocene Çiğil Formation is just above the foundation. This formation contains coal deposits, which do not give any outcrops in the study area. The investigated area is high lignite concentrated Pliocene Dursunlu Formation formed over the Miocene Çiğil Formation in conformity. The lithologic content is as follows: white, yellow, gray, green and red sandstone in the base followed by siltstone, claystone, marl, mudstone and random lignite levels. Sandy clay and mudstone are found in the top layers. The thickness is between 100 and 300 m Previous studies specified the age of the formation as Pliocene based on macrofossils found in the coals. On the

top of all these units, Quaternary deposits are located in outcrops of fan deposits, slope debris and alluvium (Figure 2c).The purpose of this study is to compare two seperate Pliocene aged coal units found in eastern and western part of the Konya Basin located in Central Turkey in terms of their element content. First of these areas, The Karapınar coal units are 100 km east of Konya (Turkey), and the second unit Ilgın is about 90 km west.

Material and Methods

The samples used in this study were taken from cores that were retrieved from drill holes in the Karapınar and Ilgın basin (Central Turkey). Inorganic geochemical analyses were performed by Acme Laboratories (Canada) on samples collected in the field. Samples were prepared with lithium metaborate/tetraborate fusion and nitric digestion. XRD analyses of the samples were done by the TPAO (Turkish Petroleum Corporation), and whole-rock and mineral XRD analyses were accredited by the Turkish Accreditation Agency (TÜRKAK) according to the TS EN ISO/IEC 17025:2005 standard. Standard XRD wholerock pattern scans are done over the 2-60 2 theta interval at 2 degree/minute, but scanning speeds may vary and be done at either 1 or 2°/min on the basis of sample type. Standard XRD clay patternsare acquired from clay pellets prepared from each sample, and include a normal scan at 1°/min overthe 2–30 2 theta interval, an ethylene glycol scan of the 2–20 2 theta interval, and a heated scan of the2–15 2 theta interval. An "overnight" XRD whole-rock scan was one done of the 2–60 2 thetainterval at a speed of 0.125°/min over an 8-h period [3].

Result and Discussion

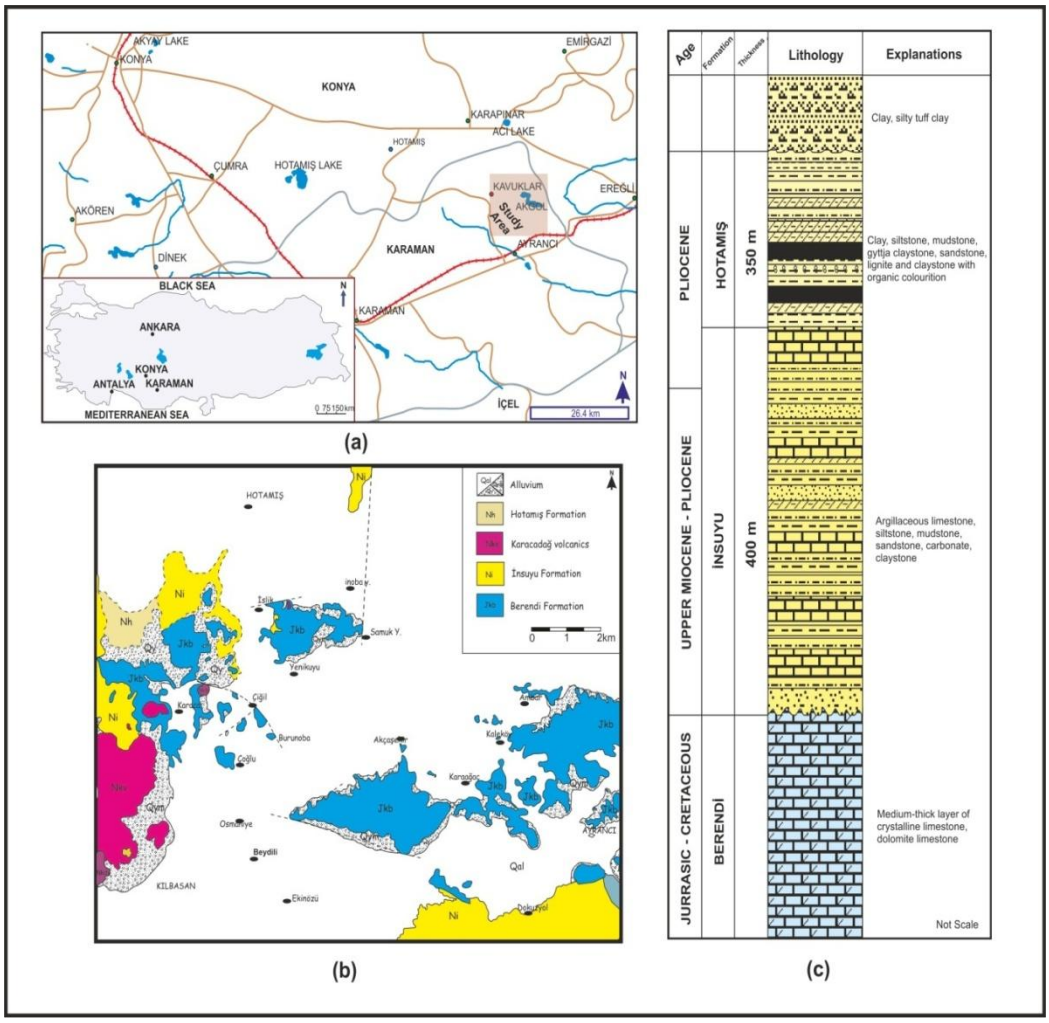

Figure 1: (a) Location map of the Karapınar Area; (b) Geological map of the Karapınar Area; (c) Generalized stratigraphic section of the Karapınar Area [1].

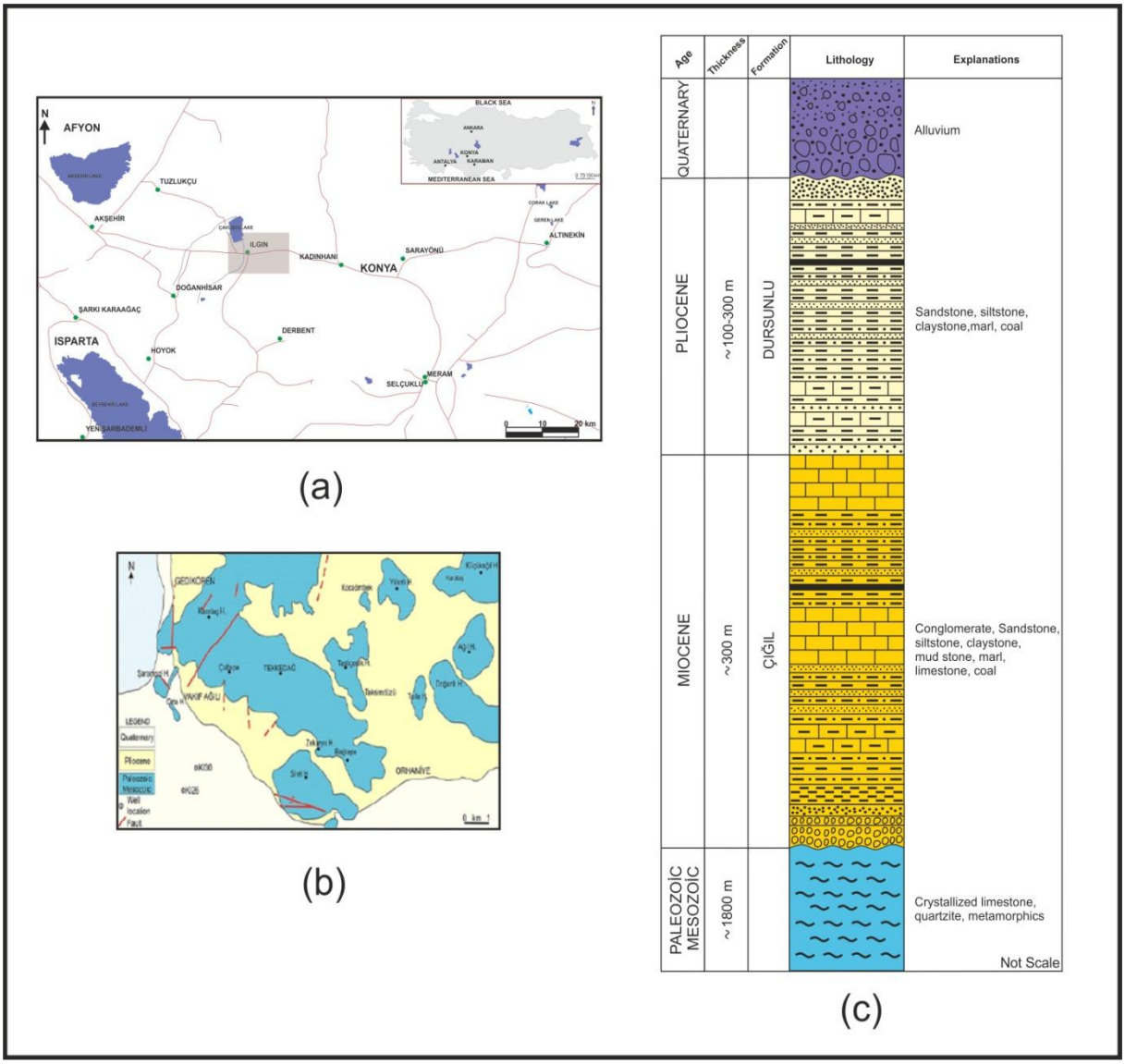

Figure 2 (a): Location map of the Ilgın Area; (b) Geological map of the Ilgın Area; (c) Generalized stratigraphic section of the Ilgın Area [2]

Karapınar and Ilgın (Konya/Turkey) areas are analyzed for their main and trace element enrichments and compared. In the Karapınar area; Pre-Neogene basement rocks comprise Jurassic-Cretaceous units. These units are overlain by Neogene fluvial sediments and lacustrine deposites. Coals are found in the lacustrine sediments. In the Ilgın area; the Pre-Neogene rocks are made of Paleozoic-Mesozoic metamorphic rocks and crystalline limestone. Coal bearing sediments lie unconformably on the Mesozoic-Palaeozoic rocks. The Pliocene coal bearing units are made of conglomerate, sandstone, siltstone and claystone. When Karapınar coals are compared to the average universal coal content, high element values are found for As, Cs, Ni, Sr, U and V. In the case of Ilgın, Ti, Cs, Rb, Ta, Th, As, Nb, La, Ce, Pr, Nd and Sm are above average. Only As and Cs are the enriched elements in both areas. Lithologic differences of the areas are the cause of the variations of the element enrichments. The results of XRD whole rock and clay mineral analyses of samples are shown in Table 1. The results of XRD whole rock analysis indicate that coaly units contain quartz, calcite, feldspar, dolomite, mica, illite, kaolinite, and chlorite and smectite type. Clay minerals are also notably abundant. Mineralogical compositions of coralliferous units in the basin show significant variations along both horizontal and vertical directions.

Table 1: Results of whole rock and clay minerals of the studies samples [2-4].

Area	Well	Sample No	Whole Rock Results	Clay Mineral Paragenesis
ILGIN	KI26	1	Quartz, Clay mineral, Feldspar, Calcite, Biotite, Chlorite	Illite, Kaolinite, Smectite, Chlorite
		2	Quartz, Calcite, Clay mineral, Feldspar, Mica Biotite)	Illite, Kaolinite, Chlorite, Smectite
		3	Quartz, Clay mineral, Feldspar, Mica (Muscovite, Biotite)	Kaolinite, Illite, Smectite
		4	Quartz, Clay mineral, Feldspar, Mica (Muscovite), Chlorite, Dolomite	_
		5	Calcite, Quartz, Clay mineral, Dolomite, Feldspar	_
		6	Quartz, Feldspar, Clay mineral, Mica (Muscovite)	Illite, Kaolinite
		7	Quartz, Clay mineral, Feldspar, Dolomite, Mica (Biotite)	Illite, Kaolinite
		8	Quartz, Clay mineral, Feldspar, Mica (Biotite), Dolomite, Chlorite	Illite, Kaolinite, Chlorite
		9	Quartz, Clay mineral, Feldspar, Mica (Biotite)	Illite, Kaolinite, Smectite
	KI30	1	Quartz, Calcite, Clay mineral, Feldspar, Mica (Biotite)	Illite, Kaolinite
		3	Quartz, Clay mineral, Feldspar	Smectite, Kaolinite, Illite
		4	Calcite, minor Quartz and Mica	_
		5	Calcite, Quartz, minor Clay mineral and Mica	Smectite, Illite, Kaolinite
		7	Calcite, Quartz, Clay mineral, Feldspar	Kaolinite, Illite, Smectite
		12A	Quartz, Calcite, Clay mineral, Feldspar, Mica (Biotite)	_
		13	Quartz, Clay mineral, Feldspar, Biotite	Illite, Kaolinite
		16	Quartz, Clay mineral, Feldspar, Mica Min. (Biotite)	_
KARAPINAR	KK103	83	Calcite, Gypsum, Dolomite, Feldspar, Mica, Clay mineral	Kaolinite, Illite, Smectite, Chlorite
		93,5	Calcite, Quartz, Feldspar, Mica	_
		102,5	Calcite, Quartz, Dolomite	_
		104	Calcite, Quartz, Mica, Feldspar, Chlorite, Kaolinite, Gypsum, Dolomite	_
		116	Calcite, Quartz, Feldspar	_
		127	Calcite, Quartz, Dolomite	_
		130	Calcite, Gypsum, Mica	_
		144	Calcite	_
		147	Calcite	_
		158	Calcite, Feldspar, Quartz, Dolomite	_
		167,3	Calcite, Feldspar, Quartz, Mica	_
		173	Calcite, Feldspar, Quartz, Gypsum	_
		186,9	Calcite, Feldspar, Mica	_
		204	Calcite, Quartz, Gypsum, Feldspar, Dolomite, Mica, Clay mineral	Kaolinite, Illite, Chlorite, Smectite
		212,5	Calcite, Quartz, Mica	_
		226	Dolomite, Quartz	_
		236,5	Calcite	_
		239	Calcite	_
		243	Calcite, Feldspar, Mica	_
		254	Calcite	_

	KK140	99	Calcite, Quartz, Feldspar, Mica	_
		125	Calcite, Quartz, Feldspar, Mica	Kaolinite, Illite, Chlorite, Smectite
		129	Calcite, Quartz, Dolomite, Mica, Chlorite, Feldspar, Clay mineral	Kaolinite, Illite, Smectite, Chlorite, Talc
		140	Calcite	_
		143,8	Calcite, Quartz, Feldspar, Mica	_
		159	Calcite, Quartz, Feldspar, Mica	_
		165	Quartz, Gypsum, Feldspar, Calcite, Cristobalite, Mica, Chlorite, Caolen	_
		169	Calcite, Dolomite, Quartz, Feldspar	_
		184	Calcite, Quartz, Feldspar, Mica, Clay mineral	Illite, Kaolinite, Chlorite
		214	Calcite, Quartz	_
		217	Calcite, Quartz, Feldspar, Mica, Clay mineral	Kaolinite, Illite, Smectite
		248	Calcite, Quartz, Feldspar, Mica, Dolomite, Clay mineral	Kaolinite, Chlorite, Smectite, Illite
		258	Calcite, Quartz, Dolomite, Mica, Chlorite, Clay mineral	Kaolinite, Smectite, Illite, Chlorite, Talc
		269	Calcite, Quartz, Feldspar, Dolomite, Clay mineral	Kaolinite, Smectite, Illite
		276	Calcite, Quartz, Feldspar, Mica, Clay mineral	_
		307	Calcite, Dolomite, Hematite, Quartz, Feldspar	_
		330	Calcite, Quartz	_
		369	Calcite, Feldspar, Gypsum, Mica, Clay mineral	_
		408	Calcite	_
		417	Calcite, Quartz	_
		422	Calcite, Quartz	_

In the samples from the study area of Ilgın, the major element Ti and the trace elements Cs, Rb, Ta, Th, La, Ce, Nd, Sm, Gd, Lu, As show enrichment in the study area coals relative to the coals of the world [5] when calculated enrichment factors are considered. In the samples from the study area of Karapınar, the trace elements Ni, Sr, Lu, As, Cd show enrichment in the study area coals relative to the coals of the world averages [5]. when calculated enrichment factors are considered. Among the trace elements considered to pose a threat to the environment and human health, following values were determined for Ilgın area: average As 133.2 ppm, Th 12.12 ppm; for Karapınar area: As 111.96 ppm, Cd 15.75 ppm (Table 2).

Table 2: Comparison of Karapınar and Ilgın areas element content [3, 4]

ELEMENTS	**KARAPINAR**	**ILGIN**	**WORLD COAL, Swaine (1990)**
	Element Concentration (ppm)	**Element Concentration (ppm)**	
%SiO2	18.98*	38.405*	-_
%Al2O3	4.89*	11.1*	-_
%Fe2O3	2.7*	4.7*	-_
%CaO	31.69*	16.87*	-_
%MgO	3.89*	1.1*	-_
%NaO	0,75*	0.52*	-_
%K2O	0.7*	2.15*	-_
%TiO2	0.2*	0.53* (H)	0.001-0.2
%MnO	0.06*	0.05*	5-300
%P2O5	0.08*	0.07*	20-3000

Ni	128.52 (H)	42	0.5-50
Sc	5.86	9.25	0.1-10
Ba	171.29	603.2	20-1000
Be	1	2.85	0.1-15
Co	13.46	18.2	0.5-30
Cs	3.98	29.45 (H)	0.5-5
Ga	5.59	12.36	1-20
Hf	1.56	4.4	0.4-5
Nb	5.45	19.15	1-20
Rb	31.5	89.9 (H)	2-50
Sn	1,14	3.5	1-10
Sr	525.51 (H)	386.25	15-500
Ta	0.56	1.3 (H)	0.1-1
Th	4.58	12.12 (H)	0.5-10
U	4.44	8.52	0.5-10
V	60.33	74.7	-
W	0.88	1.9	0.5-5
Zr	54.72	160.9	5-200
Y	9.09	18.12	2-50
La	12.31	46.15 (H)	1-40
Ce	23.97	97.35 (H)	2-70
Pr	2.68	9.405	1-10
Nd	10.34	34.32 (H)	3-30
Sm	1.86	6.06 (H)	0.5-6
Eu	0.44	1.2	0.1-2
Gd	1.72	4.89 (H)	0.4-4
Tb	0.28	0.54	0.1-1
Dy	1.51	3.68	0.5-4
Ho	0.31	0.58	0.1-2
Er	0.89	1.69	0.5-3
Tm	0.13	0.25	0.5-3
Yb	0.85	1.59	0.3-3
Lu	0.13 (H)	0.24 (H)	0.03-1
Mo	2.55	4.57	0.1-10
Cu	14.21	14.75	0.5-50
Pb	12.31	23.37	2-80
Zn	26.14	68	5-300
As	111.96 (H)	133.2 (H)	0.5-80
Cd	15.75 (H)	0.47	0.1-3
Sb	0.26	0.27	0.05-10
Bi	0.26	0.35	2-20
* %			
(H) - Element average value is above from World Coals value range			

Conclusions

In the Karapınar Area, Hotamış Formation consists of two lignite seams, which are associated with claystone, mudstone, and sandstone. Via XRD analyses, the samples were found to comprise, in order of abundance, calcite, quartz, dolomite, feldspar, mica, clay minerals and gypsum. In the Ilgın Area, Pliocene Dursunlu Formations lithologic content is as follows: white, yellow, gray, green and red sandstone in the base followed by

siltstone, claystone, marl, mudstone and random lignite levels. For Ilgın samples, XRD whole rock analysis indicate that coaly units contain quartz, calcite, feldspar, dolomite, mica, illite, kaolinite, and chlorite and smectite type. Clay minerals are also notably abundant. In the samples from the Karapınar area, the major elements Mg, Ca, Na, and Mn and the trace elements Cs, Sr, Ni, and Cr show enrichment in the study area coals relative to the coals of Turkey, China, the world, and the USA, and to continental crustal averages when calculated enrichment factors are considered. In the samples from the Ilgın area, the major element Ti and the trace elements Cs, Rb, Ta, Th, La, Ce, Nd, Sm, Gd, Lu, As show enrichment in this area coals relative to the coals of the world [5]. Among the trace elements considered to pose a threat to the environment and human health, following values were determined for Ilgın area: average As 133.2 ppm, Th 12.12 ppm; for Karapınar area: As 111.96 ppm, Cd 15.75 ppm.

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