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Research Article

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Organic Facies Characteristics of the Coaly Units, Şarkikaraağaç Neogene Basin (Isparta/Turkey)

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Abstract The Şarkikaraağaç Neogene Basin is located around the Isparta Angle which is known as common regional structure of southwesthern Anatolia (Turkey). In the basin, the Neogene units consist of conglomerate, sandstone, siltstone, claystone, coal, marl and limestone. The purpose of this work is to characterize the organic geochemistry of the Neogene coaly rocks of the Şarkikarağaç basin, to determine their kerogene type and to access their organic facies properties. Some 300 samples of coal and coaly units from the Neogene succession were collected from 7 wells, in the Şarkikaraağaç coal region (Isparta-Turkey). 37 core samples were screened for total organic carbon (TOC) content. Selected samples were than analyzed by Rock-Eval Pyrolysis. Visual kerogen analysis was also undertaken. Organic facies type C and CD were identified in the investigated units. Organic matter is composed predominantly of woody material, with a minor contribution of planty and coaly material. Kerogen in the deposits is type III, as indicated by organic petrographic observations and Rock-Eval data. Total organic carbon (TOC) values are generally between 10.19 and 47.05 %, HI values vary between 73-292 mg HC/g TOC and Tmax values vary between 398 °C and 443 °C, confirming the increase in maturation trends indicated by vitrinite reflectance data. Organic facies C is the "gas-prone" facies. The organic matter is dominated by terrestrial debris in various stages of oxidization. Sediments of organic facies C were commonly deposited on Tertiary and Mesozoic shelves and slopes of the continantel margins. Most coals are organic facies C. The organic facies CD reflects a mixture of source materials including terrestrial plant detritus, reworked and fine grained amorphous organic matter. It also occurs in carbonat sequences where the algal organic matter has been highly oxidized.

Keywords Neogene, Coal, Organic Facies, Isparta, Turkey

Introduction

The study area is located around the Isparta Angle (Figure 1). The Isparta Angle (SW Turkey), a triangular-shaped complex tectonic structure defined firstly by [1], constitutes the junction between the Cyprus and Aegean Arcs. The Isparta Angle contains shortened Mesozoic units and ophiolites that were thrust and stacked in Late Cretaceous to Miocene times, with opposing thrust vergences [2]. It comprises a continental succession bounded in the north, west and east, and overlying basement highs comprising folded and thrust metasediments ranging in age from Ordovician to Cretaceous as well as presumably Cretaceous ophiolitic rocks [3]. Thrusting within the Tauride nappes continued into the Eocene [4-5], and the Şarkikaraağaç Basin unconformably overlies this nappe system (Figure 2).

The Şarkikaraağaç Basin is located in the northern part of the Isparta Angle. The first geological studies on the stratigraphy of the basin concentrated mainly on lignite-bearing Neogene units [6-11] to evaluate the lignite content of the region. The coaly Neogene (Middle-Late Miocene) units are composed of conglomerates at the bottom and grades upwards into sandstone, siltstone, claystone, coal, marl and limestone.

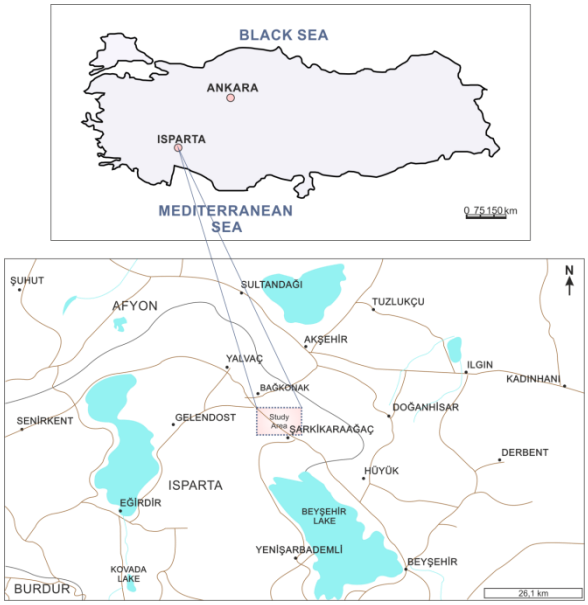

Figure 1: Location map of the investigated area

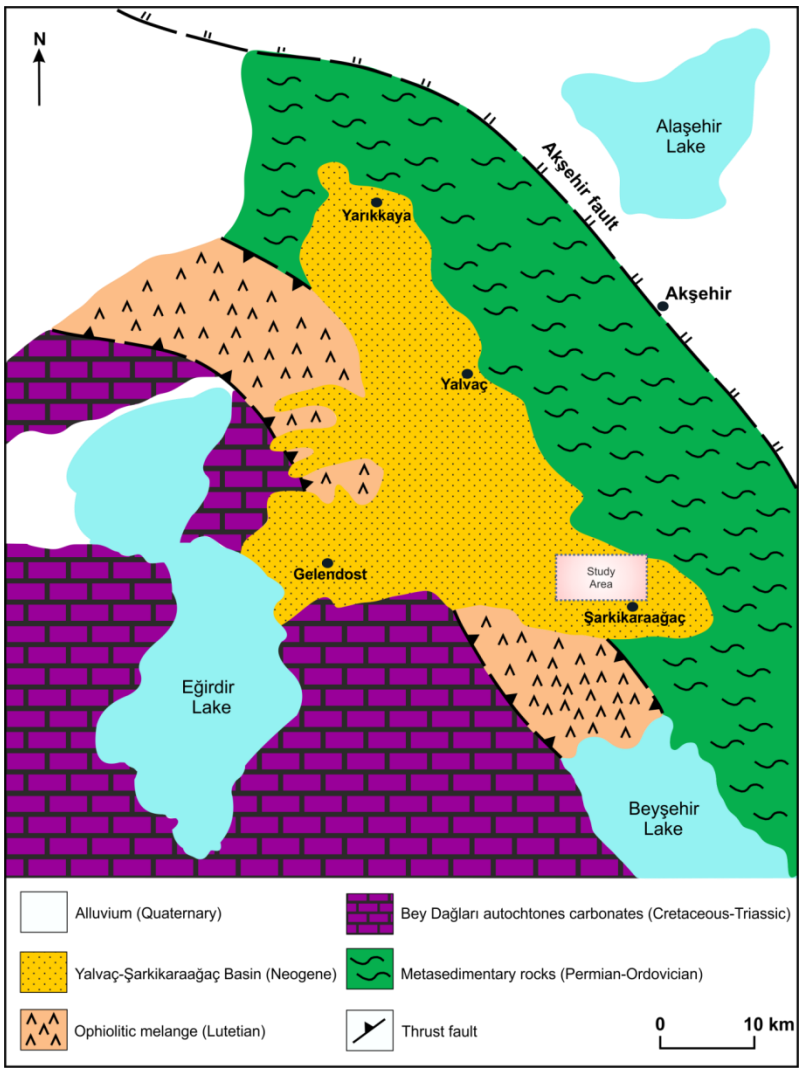

Figure 2: Simplified geological map of the investigated area

The coaly unit, unconformably overlies pre-Neogene units including low-grade metamorphic rocks and carbonates (Figure 3). The purpose of this work is to characterize the organic geochemistry of the Neogene coaly rocks of the Şarkikarağaç basin, to determine their kerogene type and to access their organic facies properties.

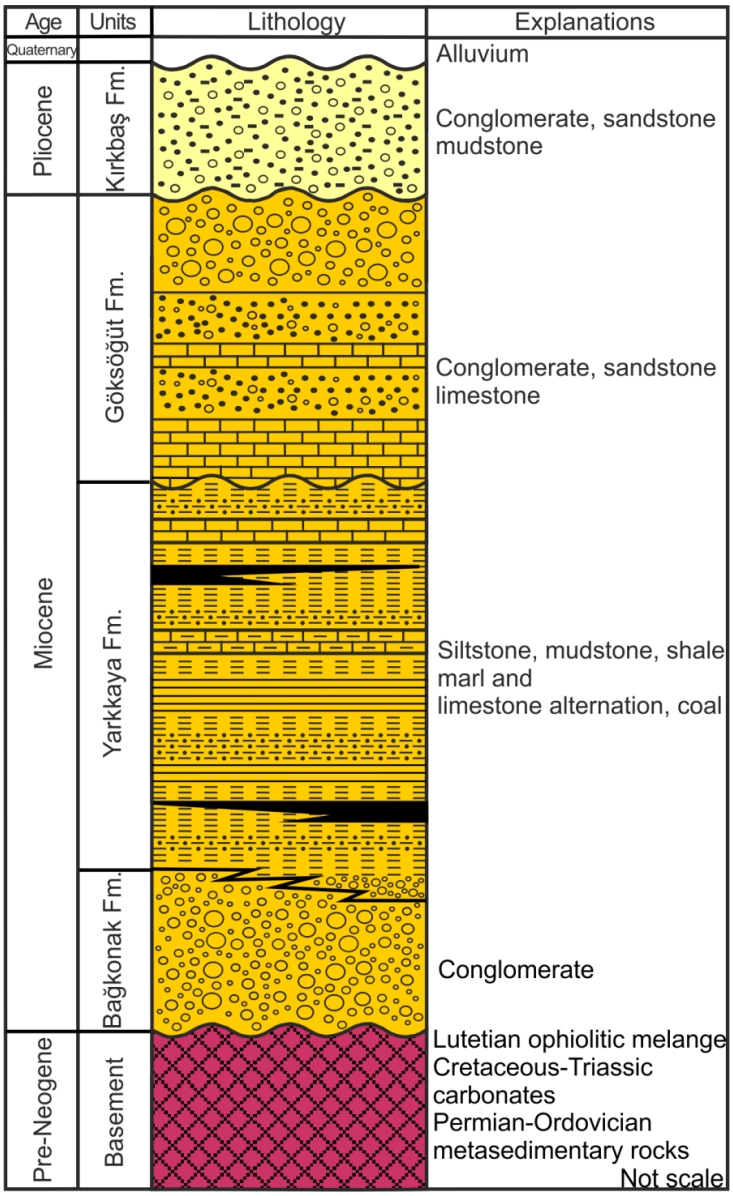

Figure 3: Generalized stratigraphic section of the investigated area

Materials and Methods

The samples were taken from seven bore holes in Şarkikaraağaç. Core materials were provided by the General Directorate of Mineral Research and Exploration (Turkey). 37 core samples were selected to determine the total organic carbon (TOC) content using a Leco analyzer. In order to determine the type of organic matter, a maturation Rock-Eval pyrolysis was carried out on samples with high organic matter content. Organic matter type was also determined by kerogen slide preparation. Total organic carbon, Rock-Eval pyrolsis (with Rock-Eval VI) analyses were performed in the Turkish Petroleum Company (TPAO) Laboratories (Ankara-Turkey), other analyses were carried out in Akdeniz University Geological Engineering Laboratories (Antalya-Turkey). Total organic carbon values measured in 37 samples. Analyzed samples were chosen coal and coaly samples in which organic matter can be traced microscopically. After grinding and adding acid, samples were ready to be placed in the Leco analyzer where total organic carbon values were produced in weight percentages. The

organic matter amount and type and maturation data were obtained by Rock-Eval pyrolysis. 50-100 gr rock samples were ground and heated using a heating programme in an oxygen-free environment.

Result and Discussion

Total Organic Carbon (TOC %) was determined 37 selected core samples. These are given in Table 1. The TOC content of the Şarkikaraağaç coal region samples in the Neogene units ranges from 10.19-47.05 wt % with an average of 32.4 wt %. The wide range of values can be related to lithology.

Table 1: Total organic carbon and Rock-Eval pyrolsis results of study area

Sample No		TOC	S1	S2	S3	Tmax	HI	OI	PI	S2/S3	PY	RC%	OF
IS11	253,50	32	2	54	33,96	427	170	106	0	1,60	56,14	26	C
IS11	280	18	2	18	22,56	415	101	125	0,1	0,81	20,59	15	CD
IS11	281,80	20	3	25	26,90	423	125	134	0,1	0,94	28,65	16	C
IS50	200,60	40	2	65	42,96	432	160	106	0	1,51	66,83	33	C
IS50	259,50	45	3	92	41,18	428	204	91	0	2,24	95,87	35	C
IS50	262,30	40	2	63	42,35	433	159	106	0	1,50	65,80	32	C
IS50	266,50	43	3	65	41,93	429	152	99	0,1	1,54	67,75	35	C
IS50	280,20	28	3	52	28,22	433	187	101	0,1	1,85	55,67	22	C
IS50	283,10	40	4	70	41,12	429	177	103	0,1	1,71	73,93	31	C
IS66	136,00	15	3	26	21,74	443	173	144	0,1	1,20	28,66	12	C
IS66	140,30	42	2	73	40,87	430	173	97	0	1,79	75,23	34	C
IS66	143,60	42	1	36	45,67	435	84	108	0	0,78	36,85	37	CD
IS66	155,40	32	3	45	36,69	433	141	115	0,1	1,23	48,05	26	C
IS66	157,90	22	2	37	31,32	438	167	140	0	1,19	38,97	18	C
IS88	160,00	21	2	30	24,78	431	143	118	0,1	1,21	31,65	17	C
IS88	173,00	40	3	81	47,21	429	204	118	0	1,72	84,82	30	C
IS93	317,80	10	2	14	14,89	408	130	142	0,1	0,91	15,49	8,3	C
IS93	365,50	36	3	60	44,37	423	165	122	0,1	1,35	63,24	29	C
IS93	367,00	35	3	55	39,46	428	158	113	0,1	1,40	57,97	28	C
IS93	369,90	29	2	43	36,13	426	149	125	0,1	1,20	45,59	23	C
IS93	372,30	24	2	33	34,09	425	136	140	0,1	0,97	34,74	20	C
IS93	374,40	31	2	33	50,18	420	104	160	0,1	0,65	34,42	26	CD
IS93	387,00	35	3	88	40,91	432	251	117	0	2,14	91,09	25	C
IS93	388,80	32	2	43	44,20	424	134	139	0,1	0,97	44,95	26	C
IS93	391,30	43	1	49	46,38	427	114	109	0	1,05	50,00	36	CD
IS98	71,70	10	1	12	12,30	436	115	121	0	0,95	12,24	8,6	CD
IS98	73,20	15	1	26	16,92	438	179	117	0	1,54	26,58	11	C
IS98	75,40	36	1	27	39,06	398	73	107	0	0,68	27,91	32	CD
IS98	84,45	29	2	57	36,19	434	198	125	0	1,58	59,52	22	C
IS104	275,60	27	2	34	36,59	426	128	137	0,1	0,93	35,83	22	C
IS104	277,00	28	1	36	32,18	431	128	114	0	1,12	37,35	23	C
IS104	278,40	44	2	54	42,84	426	123	98	0	1,25	55,56	37	CD
IS104	293,80	42	1	53	42,84	427	126	103	0	1,23	53,57	35	C
IS104	346,60	47	4	137	33,93	428	292	72	0	4,05	141,39	33	C
IS104	349,90	41	1	59	41,09	431	144	100	0	1,45	60,68	34	C
IS104	369,95	42	1	57	43,96	428	135	104	0	1,30	58,42	35	C
IS104	371,00	43	2	104	35,26	431	244	83	0	2,95	105,76	32	C

Interpretation of Rock-Eval pyrolysis data was made based on parameters and the experimental limits docemented by[12]. (1986) and[13]. In the Miocene coaly units the HI ranges from 73-292 mgHC/gTOC, with an average of 155 mgHC/gTOC, the OI ranges from 72-160mgCO_2/gTOC, with an average of 115 mgCO_2/gTOC and Tmax ranges from 398 to 443 $^{\circ}$C, with an average of 428 $^{\circ}$C. The available organic geochemical measurements of the samples were plotted on a modified Van Krevelen diagram to evaluate kerogen type (Figure 4). The results indicate that the samples contain Type III kerogen.

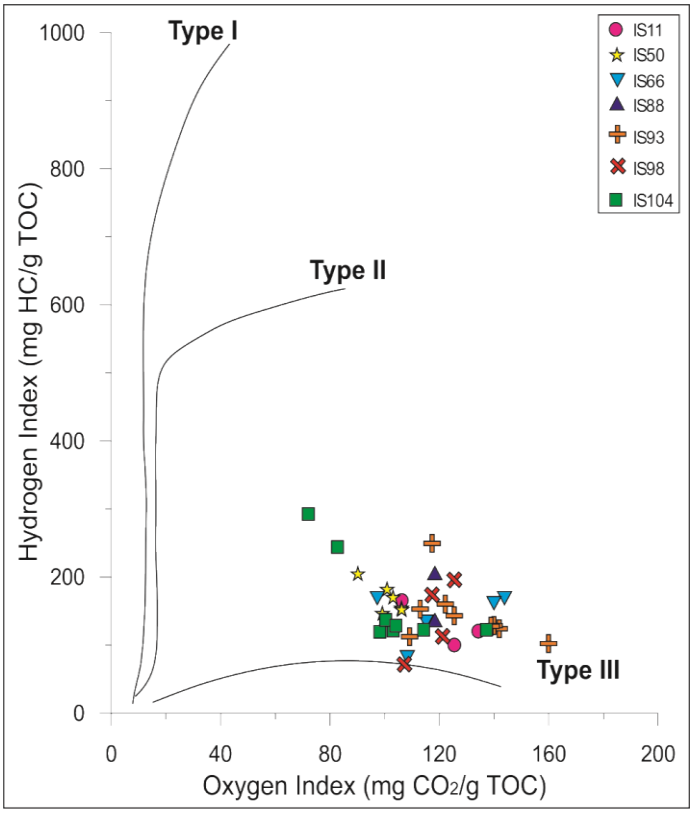

Figure 4: Hydrogen index versus oxygen index (modified van Krevelen type) diagram in which roman numbers indicate different types of organic matter

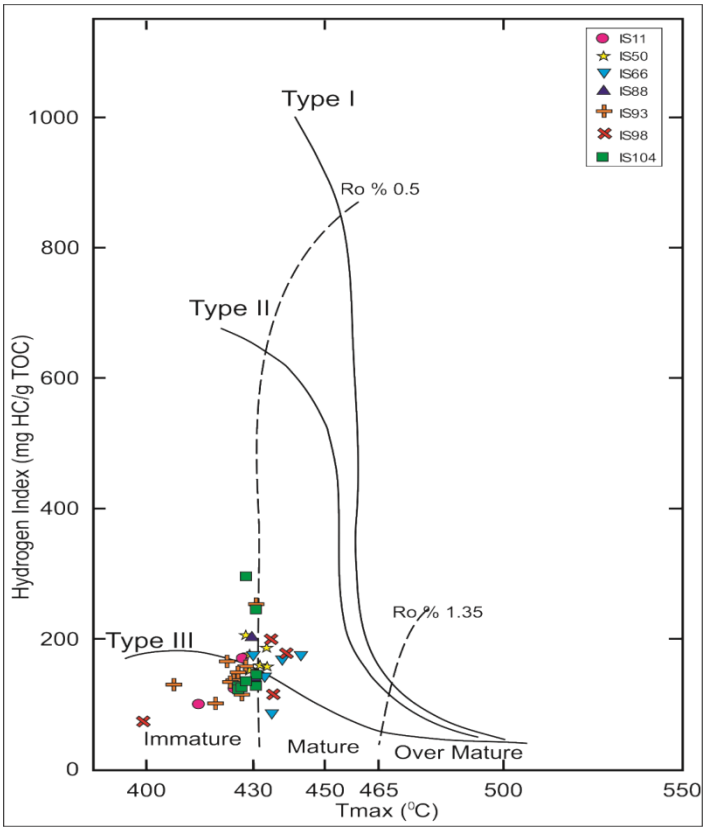

Figure 5: Kerogen typing using hydrogen index vs Tmax (from Espitalie' et al. 1986). Dashed lines show R_0 valus.

Kerogen type is also indicated by a plot of HI versus Tmax diagram which indicate that samples are located at the immature zone (Figure 5). Petrographically, the investigated samples are dominated by woody and coaly with minor amorphous, algal, herbaceous organic matter. Woody and coaly organic matterconsist of small, scattered fragments of woody and black materials; they form the main terrestrial organic matter at present.

As a result of investigation, we were able to differentiate two organic facies types (Table1). Organic facies classification proposed by [14] was used to evaluate organic facies. The two organic types were type C and CD. The geochemical variations are sufficient to differentiate organic facies types C and CD in the Middle-Late Miocene units of the Şarkikaraağaç basin. Organic facies C is the "gas-prone" facies. The organic matter is dominated by terrestrial debris in various stages of oxidization. Sediments of organic facies C were commonly deposited on Tertiary and Mesozoic shelves and slopes of the continantel margins. Most coals are organic facies C. The organic facies CD is most typically deposited as a massive unit containing moderately to well oxidized terrestrial organic matter and substantial amounts of residual organic matter. It also occurs in carbonate sequences where the algal organic matter has been highly oxidized.

Conclusions

The Miocene coal and coaly units generally contain high and very high levels of organic matter in the investigated well. Medium and high level of organic carbon were also measured in these levels. The TOC content of the samples in the Miocene coal/coaly units ranges from 10.19 to 47.05 wt %. The HI ranges from 73-292 mgHC/gTOC, with an average of 155 mgHC/gTOC, the OI ranges from 72-160 mgCO_2/gTOC, with an average of 115 mgCO_2/gTOC, the Production index (PI) ranges from 0.02-0.13, with an average 0.05 and Tmax ranges from 398 to 443 $^{\circ}$C, with an average of 428 $^{\circ}$C. Based on the microscopic studies, organic matter is composed predominantly of woody material. The values of Tmax shows diagenesis and low mature stage for the organic matter of Late- Upper Miocene coal/coaly units. The HI/OI and HI/Tmax cross-plots show that the organic matter is dominated by type II and III kerogen. The organic matter is partly oxidized/oxidized and reworked. Organic facies type C and CD were identified in the Neogene coal/coaly units.

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