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## Organic Facies Characteristics of the Triassic Ispartaçay Formation, Antalya Nappes, Western Taurus, Turkey

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### Abstract

In the Antalya Nappes (SW Turkey), the Triassic Ispartaçay Formation consists of radioaria, chert, turbiditic limestone and sandstone. Detailed data from thick Triassic sediments (Ispartaçay Formation) made it possible to construct an organic facies framework using different zonation. Organic matter is composed predominantly of woody material, with a minor contribution of plant and woody 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 0.16 and 1.36 %, but reach 5.24 % in the formation. Tmax values vary between 331 and 602°C, confirming the increase in maturation trends indicated by vitrinite reflectance data. Organic facies type D was identified in the investigated units. Organic facies D is related to sandstone and limestone lithofacies. This facies is characterized by average values of HI around 18 (equivalent to type III kerogen), TOC around 0.85 %, and an average of S2 of 0.19 mg HC/g of rock. The organic matter is highly oxidized, decomposed and reworked. Organic facies D is non generative.

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### 1. Introduction

The investigated area is located in the western part of the Taurus Belt (SW Turkey). This region exhibits a complex structure involving two autochthonous units (Anamas-Akseki platform and Beydağları platform) surrounded with the allochthonous complexes (Antalya Nappes, Lycian Nappes and Beyşehir-Hoyran Nappes) (Figure 1).

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The autochthonous units are parts of the Beydağları micro-plate to the west and of the Anatolian micro-plate to the east (Anamas-Akseki platform).

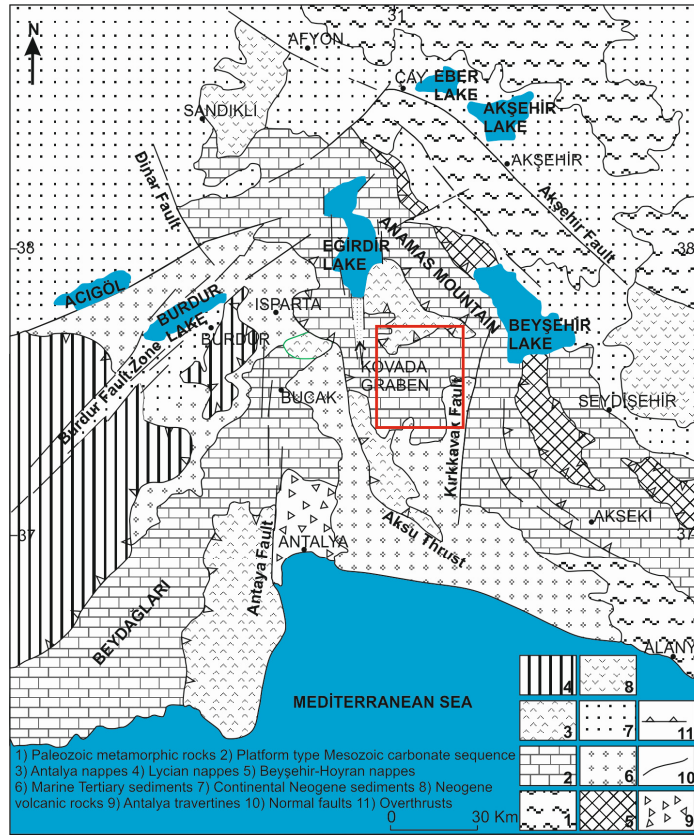


Figure 1. Simplified geological map of the Isparta Angle and surrounding areas (modified from Şenel, 1984, Poisson et al. 1984, Yağmurlu and Şentürk 2005).

The Antalya nappes comprise roughly three types of units: (i) ophiolites (mainly peridotites and gabbros), (ii) shallow-marine platform carbonates, (iii) basinal sequences with, in places, volcanic intercalations (Vrielynck et al., 2003). In the study area; Antalya nappes are represented by Ispartaçay Formation (Early Middle Triassic radioaria, chert, turbiditic limestone and sandstone) and ophiolitic complex (Figure 2, Figure 3).

General geological investigations and reports have been presented by Özgül (1976), Poisson (1977), Gutnic et al. (1979), Hayward (1984), Akay et al. (1985), Görmuş, and Hançer (1997), Flecker et al. (1998, 2005), Robertson (2000), Sarı and Özer (2002) and Poisson et al. (2003), who studied the sedimentological character and tectonics of the study area and environments. Petroleum-geological studies have also been carried out; important ones include the works of Altunsoy (1999), Demirel et al. (2001, 2002) and Özçelik et al. (2005, 2014).

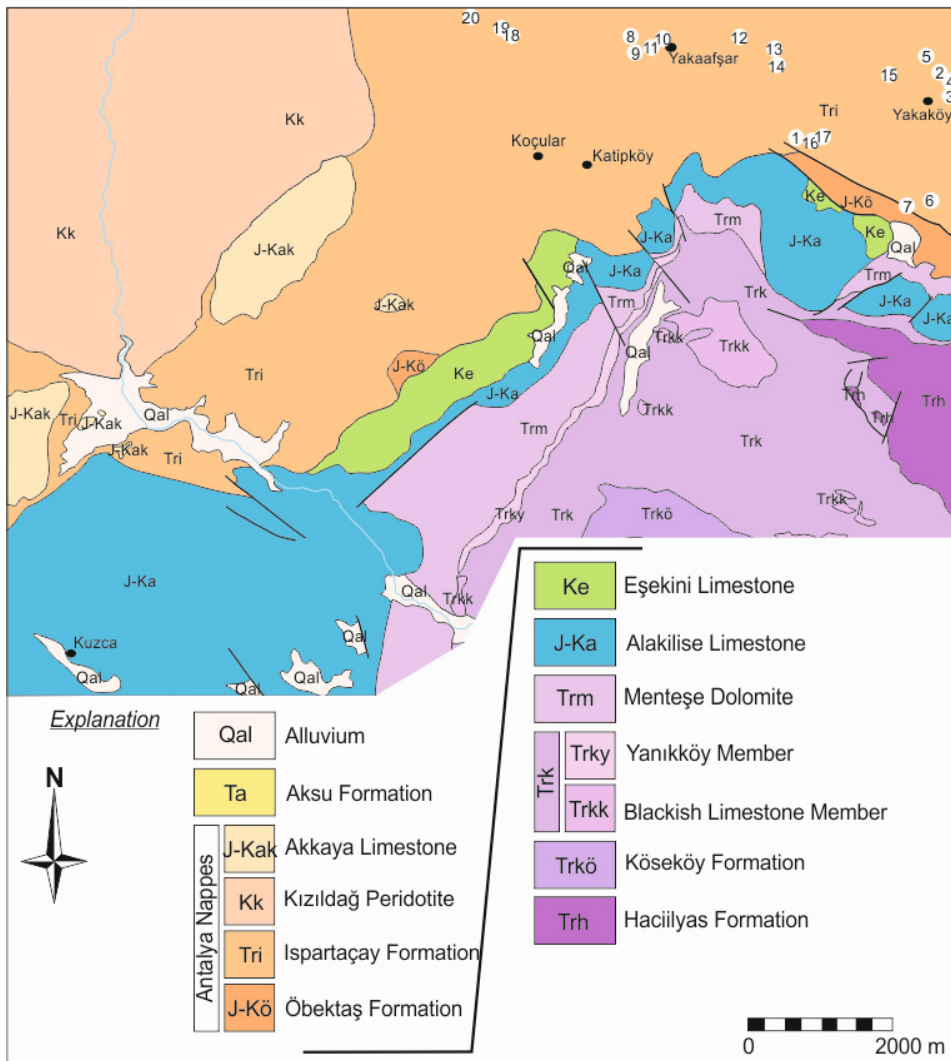


Figure 2. Geological map of study area.

In this study, we describe organic facies characteristics of the Triassic Ispartaçay Formation sediments of the Antalya Nappes in the western Taurides. In order to determine the amounts, types and maturation of organic matter in these strata, outcrop samples of carbonates and sandstones were collected.

## 2. Organic Facies Investigations

The Triassic Ispartaçay Formation (Antalya Nappes) has been studied with respect to their organic facies characteristics. About 30 outcrop samples were collected from surface stations. Selected 17 samples, representing the Trias sequence, were obtained from sandstone and limestone units in locations. For analysis, the selection of samples was based primarily upon changes in colour, type of lithology and other sedimentary characteristics. In order to determine the nature of the organic matter, a number of organic-petrographic and geochemical analyses were made upon kerogen isolated from the outcrop samples. Total organic carbon (TOC), Rock-Eval pyrolysis, vitrinite reflectance ( $R_o$ ) analyses were undertaken in the Turkish Petroleum Research Centre (Ankara, Turkey). Other microscopic studies were carried out in the laboratories of Akdeniz University (Antalya, Turkey). Rock-Eval

pyrolysis provides information on the quantity and type of organic matter in a sedimentary rock, in addition to the level of organic maturation (Espitalié et al., 1985). Samples from each interval were pulverized, and about 100 mg from each sample was analysed using a Rock-Eval/TOC analyser (RE-6, Institut Francais du Pétrole Standard) following techniques outlined by Espitalié et al. (1985).

Eirathem	System	Series	Stage	Group	Formation	Member	Thickness (m)	Lithology	Symbol	Description
Cenozoic	Quaternary						I		Qal	Clay, sand, conglomerate
	Neogene	Miocene	Tortonian		Aksu Formation		200-800		Ta	Loose cemented poorly graded conglomerate
				Paleogene	Paleocene - Eocene	Antalya Nappes	Akkaya Limestone		I	J-Kak
	Kızıldağ Peridotites		Kk				Radiolaria, chert, turbiditic limestone, sanstone			
	Ispartaçay Formation		TRI				Chert, limestone, pillow lava, serpentinite			
			Öbektaş Formation		J-Kö					
Mesozoic	Jurassic - Cretaceous	Lower-Middle-Upper	Upper		Eşekini Limestone		150-175		Ke	Micritic limestone
			Lower		Alakilise Limestone		400-1000		J-Ka	Thick bedded, massive limestone, dolomitic-oolitic-pelletic limestone
	Triassic	Upper	Carnian - Norian	Resiye	Menteşe Dolomite		150-200		Trm	Thick bedded, massive dolomite
					Yanıköy Member			Trky	Thin bedded limestone with interbedded shale	
					Blackish Limestone Member			Trkk	Reefal limestone	
					Kasımlar Formation		1300-1500		Trk	Thin to medium bedded shale-sandstone alternations with a few interbedded limestone
				Köseköy F.		150-200		Trkö	Polygenic, medium to thick bedded conglomerate	
Middle	Anisian-Ladinian			Hacıilyas F.		150-175		Trh	Thick bedded dolomitic recrystallized limestone	

Figure 3. Generalized stratigraphic column section of study area.

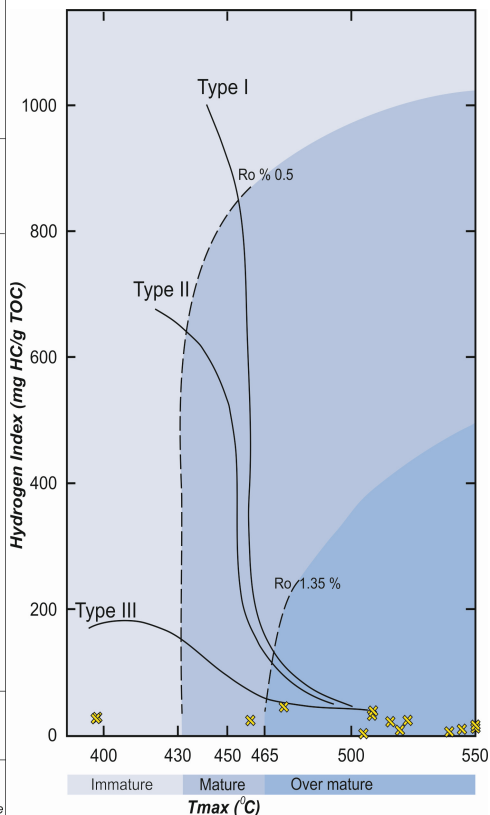


Figure 4. Classification of the kerogen types by Hydrogen Index vs. Tmax (°C) diagram.

Kerogen was isolated from the rock matrix using standard palynological preparation procedures. Organic-petrographic analyses were undertaken using transmitted-light microscopes at Akdeniz University (Antalya, Turkey) and in the Research Group Laboratories of the Turkish Petroleum Corporation. Vitrinite-reflectance measurements followed established procedures (Stach et al., 1982).

Table 1 illustrates the values of total organic carbon, and Rock-Eval pyrolysis for the Ispartaçay Formation samples. Total organic carbon values were measured on 17 samples (Table 1). The obtained data show that the total organic carbon values are between 0.16 and 5.24%, with an average around 0.85%.

Table 1. Total organic carbon and Rock-Eval pyrolysis values.

LN	SN	TOC	S <sub>1</sub>	S <sub>2</sub>	S <sub>3</sub>	Tmax	HI	OI	PI	S <sub>2</sub> /S <sub>3</sub>	RC	OF
1	IS01	0.33	0.02	0.1	0.26	333	30	79	0.17	0.38	0.31	D
2	IS02	1.36	0.05	0.16	1.24	589	12	91	0.26	0.13	1.3	D
3	IS03	0.46	0.01	0.13	0.19	523	28	41	0.07	0.68	0.44	D
4	IS04	0.94	0.01	0.31	0.31	507	33	33	0.03	1.00	0.9	D
5	IS05	1.02	0.02	0.3	0.25	509	29	25	0.05	1.20	0.98	D
6	IS06	0.21	0.03	0.06	0.23	331	29	110	0.32	0.26	0.19	D
7	IS07	0.46	0.02	0.06	0.21	602	13	46	0.29	0.29	0.44	D
8	IS08	5.24	0.01	1.21	2.89	516	23	55	0.01	0.42	5.02	D
9	IS09	1.2	0.02	0.57	0.55	473	48	46	0.03	1.04	1.13	D
10	IS10	0.55	0	0.06	0.24	544	11	44	0	0.25	0.53	D
11	IS11	0.48	0	0.05	0.23	519	10	48	0	0.22	0.47	D
12	IS12	0.52	0	0.03	0.77	539	6	148	0	0.04	0.49	D
13	IS13	0.16	0	0	0.56	-	0	350	0	0	0.14	D
14	IS14	0.4	0	0	0.46	-	0	115	0	0	0.39	D
15	IS15	0.16	0	0	0.4	-	0	250	0	0	0.15	D
16	IS16	0.39	0	0.01	0.54	505	3	138	0.01	0	0.37	D
17	IS17	0.51	0	0.14	0.13	459	27	25	0.02	0	0.49	D

TOC: Total Organic carbon (wt %). S<sub>1</sub>: Free Hydrocarbons in rock (mg HC/g rock). S<sub>2</sub>: Hydrocarbon generated from the thermal breakdown of kerogen (mg HC/g rock). S<sub>3</sub>: CO<sub>2</sub> value (mg CO<sub>2</sub>/g rock). Tmax; Maximum temperature (°C). HI; Hydrogen Index (mg HC/g TOC). OI; Oxygen Index (mg CO<sub>2</sub>/g TOC). PI; Production Index (mg HC/g TOC). S<sub>2</sub>/S<sub>3</sub>; Hydrocarbon Type Index. PY; Potential Yield (mg HC/g TOC). OF; Organic Facies. LN; Location no. SN; Sample no.

The total organic carbon contents of the outcrop samples indicate that the Ispartaçay Formation has insufficient organic matter to be hydrocarbon source rocks. In the sediments, hydrogen index ranges from 0 to 48 mgHC/gTOC, with an average of around 18 mgHC/gTOC. PI ranges from 0 to 0.32, with an average of 0.07 and Tmax ranges from 331 to 602 °C, with an average of 496 °C. Organic geochemical measurements of the samples were plotted on a hydrogen index-Tmax diagram (Figure 4); the results indicate that the samples contain dominantly type III kerogen. In the Ispartaçay sediments, hydrogen index Tmax and production index show that the organic matter in the samples is mature to over mature. The main composition of organic matter in Ispartaçay Formation sediments are woody (99%) with minor portion of planty (1%).

Organic facies classification proposed by Jones (1987) was used to evaluate organic facies. As a result, we were able to differentiate only one organic facies type. This organic facies was type D. The geochemical parameters of the formation exhibit D organic facies (Table 1). Organic facies D is associated with the sandstone and limestone lithofacies. The D facies consists of highly decomposed, reworked organic matter. These types of organic facies generally appear to be weakly sorted in marine and lake sediments. Organic facies D is no generative; it can be said that the samples of Ispartaçay formation have been deposited in the organic facies D.

### 3. Conclusions

Ispartaçay Formation sediments are characterised by low amounts of organic matter. During Mesozoic time, TOC decreased and limestone components became dominant. In the sandstone and limestone, the organic matter can be classified as type III kerogen, and these sediments indicate catagenesis stage.

Kerogens from the limestones are dominated by woody organic matter. Organic matter in these sediments is not sufficient for hydrocarbon occurrence, and the sediments can be plotted in organic facies D. Rock-Eval Tmax and Production index values are about 496 °C and less than 0.32 respectively. Organic facies D is related to sandstone

and carbonate lithofacies. Organic facies D is nongenerative; the organic matter is highly oxidized, decomposed and reworked.

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