

DEFINITION OF PETROLEUM TRAPS ARAUND NARLI (K. MARAS) USING SEISMIC METHODS

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ABSTRACT

The purpose of this research was to define petroleum traps around Narlı. The main part of the research is the preparation of seismic cross-sections. Interpretation of seismic cross-sections were carried out using the two deep wells data. Being prospect in the South-Eastern Anatolia region, Mardin group was chosen for the first target.

A number of researchs related surface geology in the region were performed up to now. Region was covered by young deposits. From this point, it was expected that seismic surveys may give good results.

By this research, stratigraphy and tectonical structures were explained and new prospect petroleum traps were discovered in the region. These traps are formed by Mardin group and Besni formation at Bakırca, A, B, and C fields. Beside that new lithologic and stratigraphic traps were discovered. Source, reservoir and cap rocks were determinated. As a result, it was decided that Mardin group carbonates was most promising explorations.

1. INTRODUCTION

Research site is located in South-Eastern Anatolia which is most prospect region on petroleum potentials of Turkey (Figure-1). This research was supplied by Turkish National Petroleum Corporation.

The most of the geological units of the region are covered by young deposits. Research site has two deep wells namely K. Kaya-1 and Karadag-1. As it is mentioned, research site are covered by young deposits. From this point, main part of the research was shifted to seismic surveys. The wells in the region played great role in interpreting of the seismic lines.

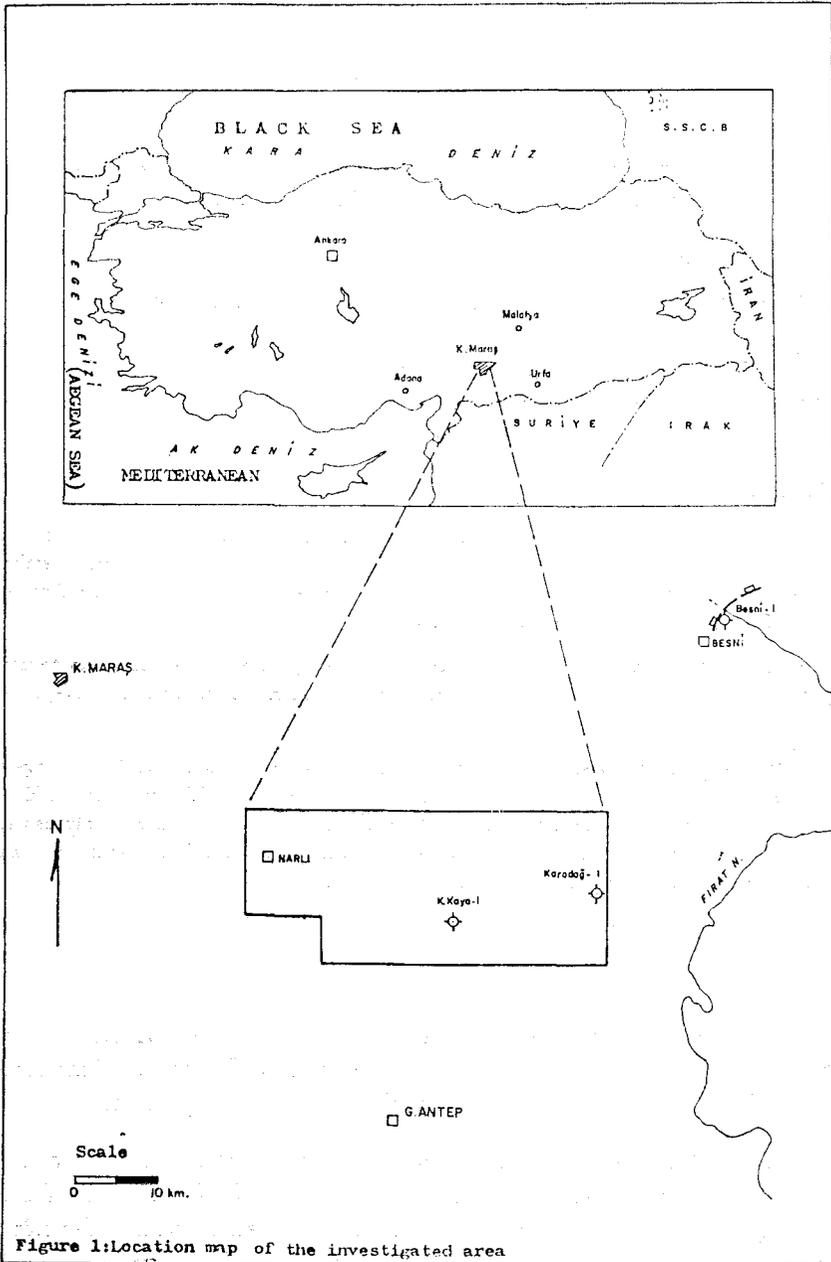


Figure 1: Location map of the investigated area

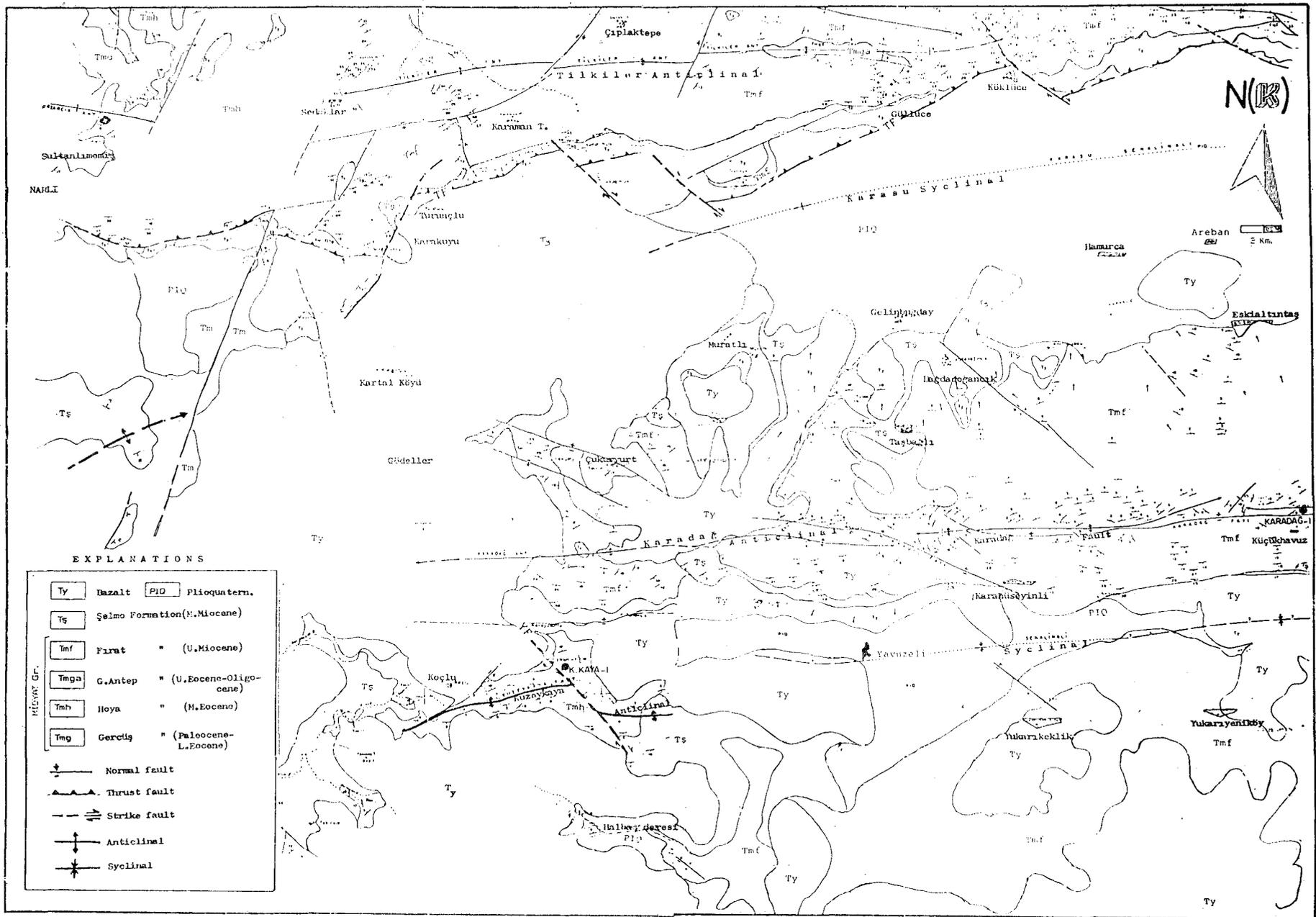


FIGURE 2: GEOLOGICAL MAP OF THE AROUND NAMLı (K.M.1045)

The main purpose of this research was to define petroleum traps and prospect areas by using seismic measurements and well data. From this point, Mardin group and Besni formations were first targets. Because they are known to be most prospect levels in the region.

Hoya, Firat and Selmo formations basaltic lava flows and Plio-Quaternary deposits could be mapped (Figure-2) Up to now, a number of researchers have carried out geological surveys at the region and surrounding areas (Yoldemir and Peksu 1987; Tuna 1973, 1974, 1975; Dulger and Celikdemir 1987; Wagner and Pehlivan 1985; Esso Company 1959; Wilson 1957; Cemen 1987).

2. STRATIGRAPHY

Geological units in and around research area were deposited at the time period of Albian-Pliocene (Figure 3). The drilled two wells in the area give only the stratigraphy of autochthon units (Figure-4).

Specifications of the units in and around the area are as follows;

2.1. Allochthonous units

a. Kocali Complex (JKk): It is composed of ultrabasic rocks, volcanics, serpentinites and limestones including radiolites and cherts.

b. Karadut Complex (Kkd): It is composed of siliceous limestones including cherts, shales, conglomeratic and fossiliferous limestones and argilliteous limestones.

2.2. Autochthon Units

A. Mardin group (Km): It includes of Areban, Sabunsuyu, Derdere and Karababa formations.

A.1 Areban Formation: It is composed of successive layers of sandy limestones, dolomites, limestones, and shales.

A.2. Sabunsuyu Formation (Km): It is composed of limestones and dolomites

A.3. Derdere Formation (Kmd): It is composed of limestones and dolomites.

A.4. Karababa Formation (Kmk): It has three members. A member is composed of pelagic biomicrites. B member is composed of dolomites, glauconites and phosphate rocks. C member is composed of loosely deposited biomicrites including mollusks and echinides.

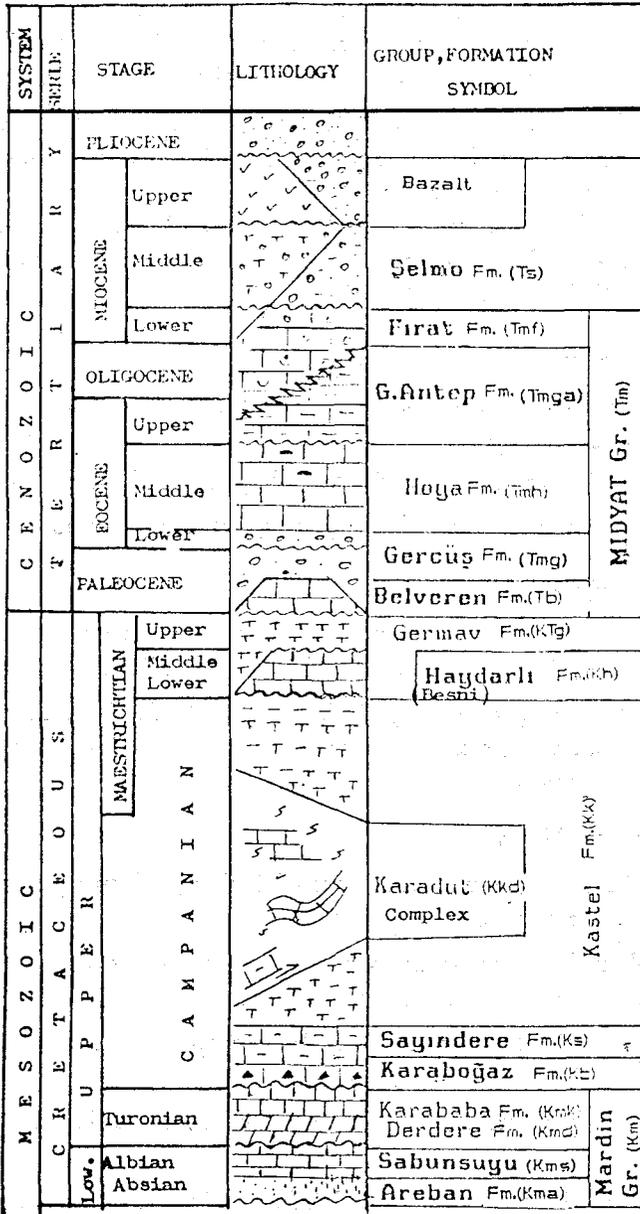


Figure 3: Stratigraphic columnar section of around Narlı (K. Maraş)

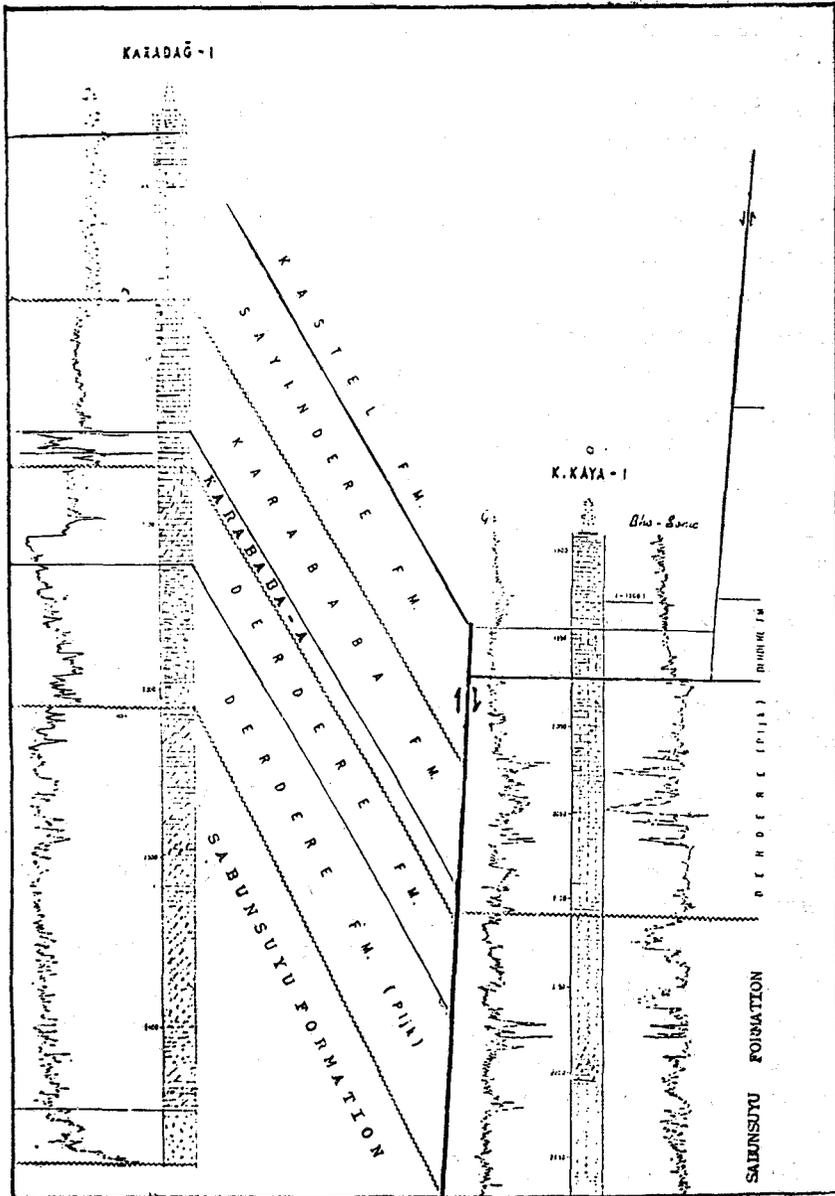


Figure 4: Correlations of K.Kaya-1 and Karadağ-2 wells

5. Karaboğaz Formation (Kb): It is composed of graybrown colored. Weakly porous limestones having fine grains and including chert rounds.

6. Sayindere Formation (Ks): It is argilliteous, pelagic, loose deposited biomicrites including foraminiferas.

7. Kastel Formation (Kk): It is composed of successive layers of gray+green colored shales and marls. It may include pebble and sandstone bands becoming from ophiolites.

8. Haydarlı Formation (Besni Formation) (Kh): It is composed of neritic and coral characted limestones and argilliteous limestones.

9. Germav Formation (KtTg): It has two different lithologies. These are marls consisting limestone blocka and sandstone bands and sandstone+pebble successive layers.

10. Belveren Formation (Tb): It is composed of gravels originated. From ophiolites and limestones at lower parts with dolomites at upper parts.

B. Midyat Group (Tm)

B.11. Gercus Formation (Tmg): It is composed of successive layers of conglomerates, sandstones, siltstones, limestones and shales having polygenetic elements and coarses grains.

B. 12. Hoya Formation (Tmh): It is composed of gray+white colored, hard and fossilifereous limestones.

B.13. Gaziantep Formation (Tmga): It is composed of argilliteous limestones.

B. 14. Firat Formation (Tmf): It is composed of coal charaected thick and massive limestones

15. Selmo Formation (Ts): It is composed of fine grained sandstones and pebbles originated from Mardin group carbonates and gravels originated from allochthon units.

3. SEISMIC AND TECTONICS

Research site is located at cross point of Dead Sea Fault and East Anatolian Fault and Sotheren part of subduction zone. Consequently tectonics of the site is controlled by three effects. Deposition of allochton units coming from subduction zone and related deformation are accepted

as one of the effects. The others are East Anatolian Fault and Dead Sea Fault.

3.1. Seismic Studies

By interpretation of approximately 300 km. seismic cross-section time maps were prepared. These maps are reflecting Mardin and Besni formations tops (Figure-5 and 6). For the correlations of seismic cross-sections, data of K. Kaya-1 and Karadag-1 wells were the starting point. K. Kaya-1 well has check-shot. As for the Karadag-1, Sonic Log was used.

3.1.1. Seismic Data Processing

Some difficulties arose in interpretations. Especially, Some applications in data processing affected the interpretations in negativ side. Band Pass Filter applications before Demux was rounded the signal characters. Because of this applications, phase skipping probability arosed and signal correlation became difficult.

Encluding a few cross sections no migration process was not performed to the cross-sections of the site. Because of high migration velocity level extensions were affected in the migrated cross-sections. Enerally, 48 CDP (Common Depth Point) cross-sections were used. One of the residuel statiscs was CDP MEADN. Predictive Decon (Lag 40 Ysec.) was applicated as a Decon Operator. Because of this application, Stratigraphic interpretation became difficult.

3.1.2. General Basic Rules of Seismic Interpretation

We will try to explain basic rules of seismic methods for one which is not familiar to this method. Seismic data which is gathered along profiles at the field are processed in processing center in order to get seismic sections that is tought to be picture of gathered signals from underground. These signals are known with the peculiarities of the frequency, amplitude, phase etc. Some of the factors that affect these peculiarities are contrast between two layers (Such as, difference of velocity and density), depth and other physical properties of lithology. A layer and /or layer boundry is followed by continuity of the signals. Place of discontinuity of signals may have been interpreted as fault, sudden slope, surface conditions, burried complex environments etc. During signals correlation, their peculiarities such as frequency, amplitude, phase etc. are used. If the attention is given to the pitfalls, errors in interpretations can be reduced.

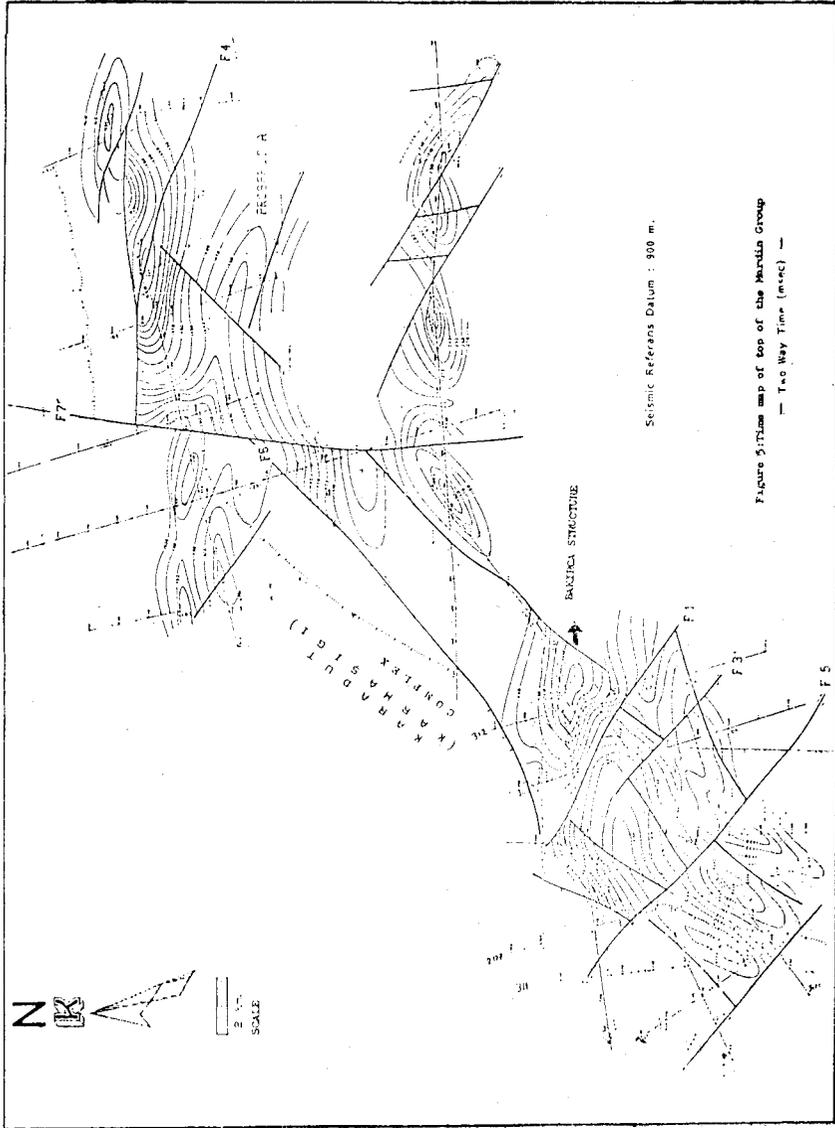


Figure 5: Titium map of top of the Maridın Group
— Two Way Time (msec) —

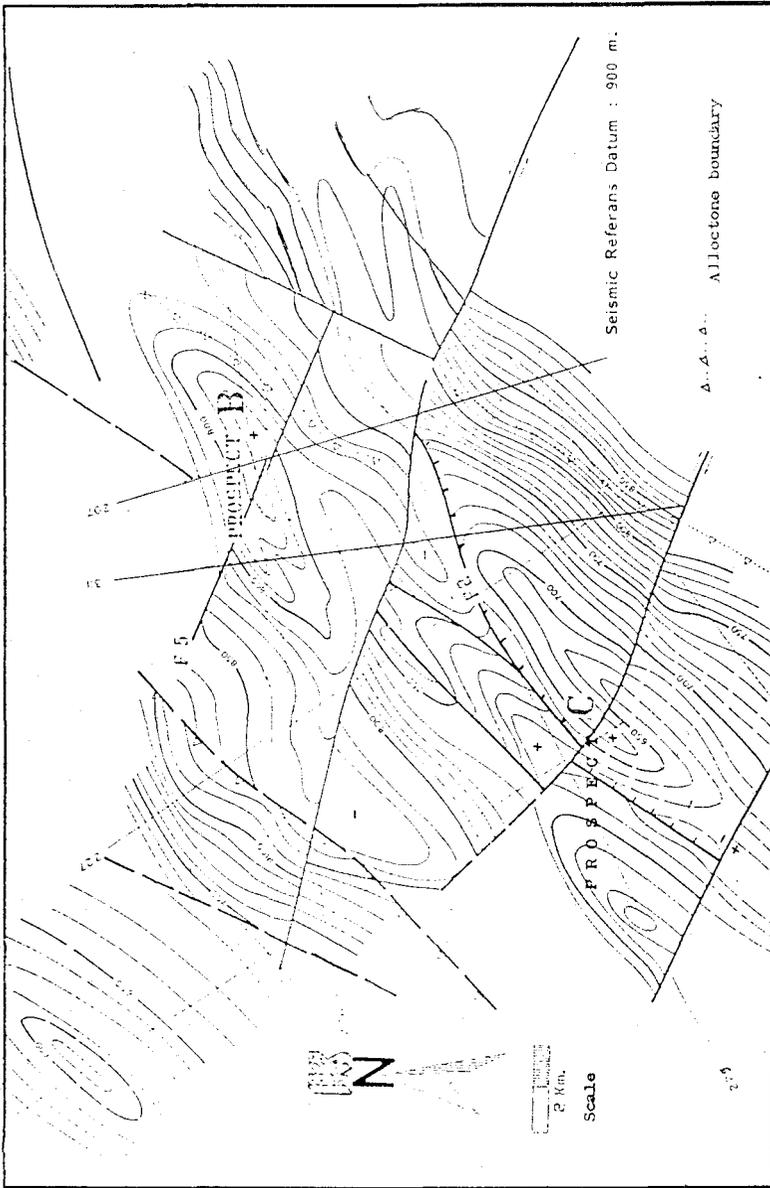


Figure 6: Time map of top of the Heani (Haydarli) formation - Two Way Time (msec) -

During the interpretations of the seismic cross-sections knowledge of surface and subsurface geology and tectonical structures of the area must be taken into account.

3.1.3. Interpretation of The Seismic Cross-Sections

While the seismic interpretations were being carried out. During task of the K. Kaya-1 well was going on. Seismic profiles which were interpreted, were seen in the Figure-5 and 6. Interpretations were started from 226 numbered cross-section (Figure-7). According to the interpretation of the cross-section, top of Mardin group level is seen as a paleo-high at eastern part of the cross-section. This cross-section was transformed into geological model (Figure-8). After Mardin group, Sayindere formation was deposited. At the beginning of Kastel formation depositions, allochthonous units come from Northern and North-Western sides. Only Karadut complex among the allochthonous units have the this region of the area and Kastel formation deposition continued during allochthonous units movements. Because of compressional forces of allochthonous units deformation in the units took place. Kastel formation deposition followed by Germav deposition. After, that, disconformities of Besni and Haydarli formations are seen. At the west, at base of Germav formation, a horizontally transition is seen between Germav formation and Besni formation which has coral character. As it was mentioned before, some negative effects of data processing methods. Seismic-Stratigraphic interpretations which were necessary for coral peculiarities of Besni formation become more difficult. Because Karadut complex compressions and settlements created a high blocks. Naturally, karstic and coral places are existed in the area. As a result, undulations of the reflectors in the seismic sections are in a harmony. Midyat group depositions come with a second discordance. Miocene aged normal fault (F1) which were cut through by K. Kaya-1 well, from eastern high block that, compressional forces are not seen in the cross-section during the Mardin group and Sayindere formation depositions in a contrary manner. It is controlled by normal faults like F5.

According to 227 numbered cross section (Figure-9) Upper Cretaceous aged Besni and Kastel units moved towards south-east and north-west as back - thrust because of compressions (It is shown as F2 in the figures of 9 and 6). As it was mentioned before, Mardin group north by normal faults. Later, deposited Karadut complex is tried to be described by complex environment in the cross-section. Especially, signal characters of reflections in 206, 207, and 203 numbered cross-sections become

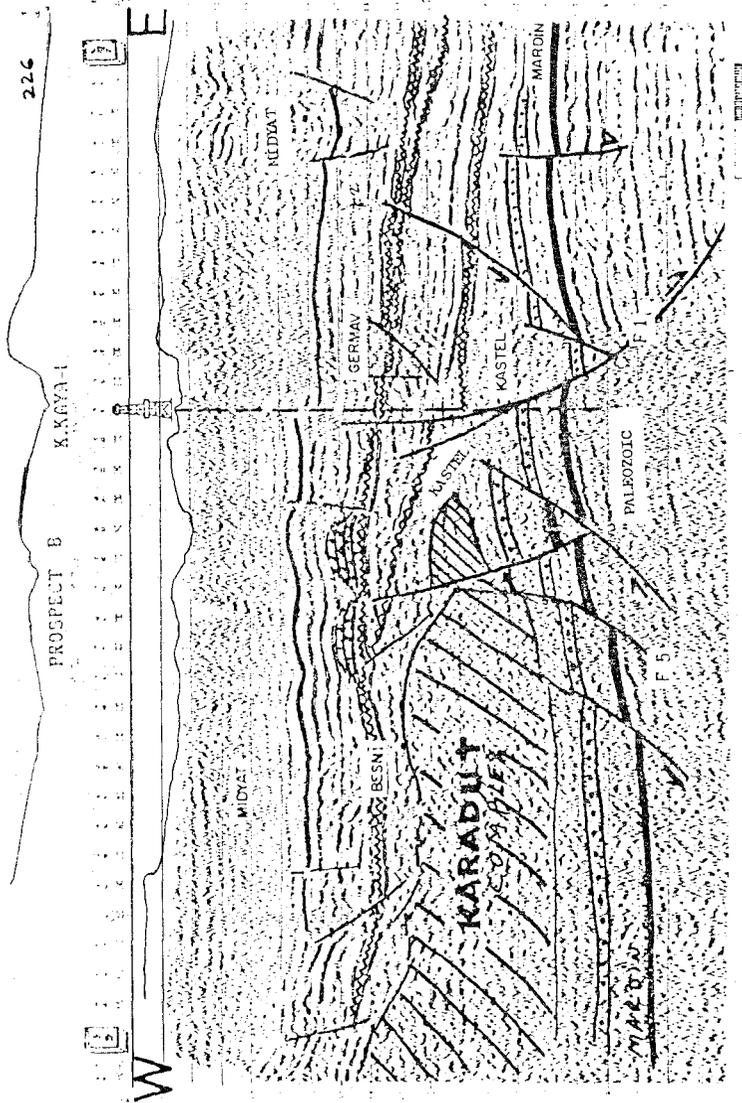
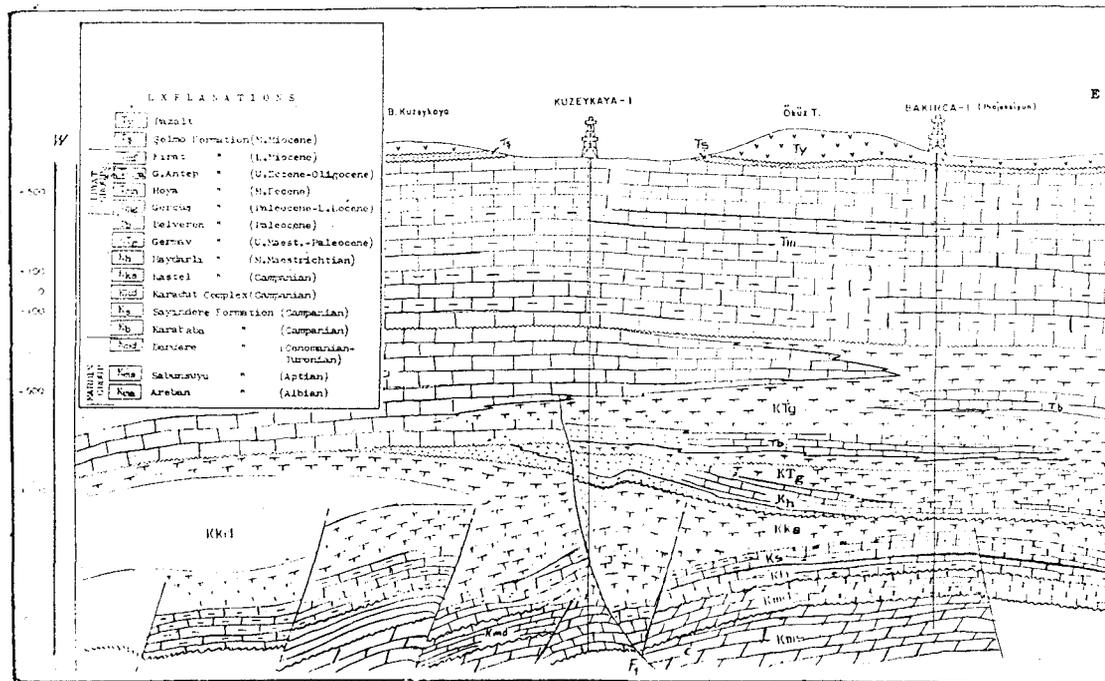


Figure 7: seismic cross section of 226 numbered profile, E-W direction



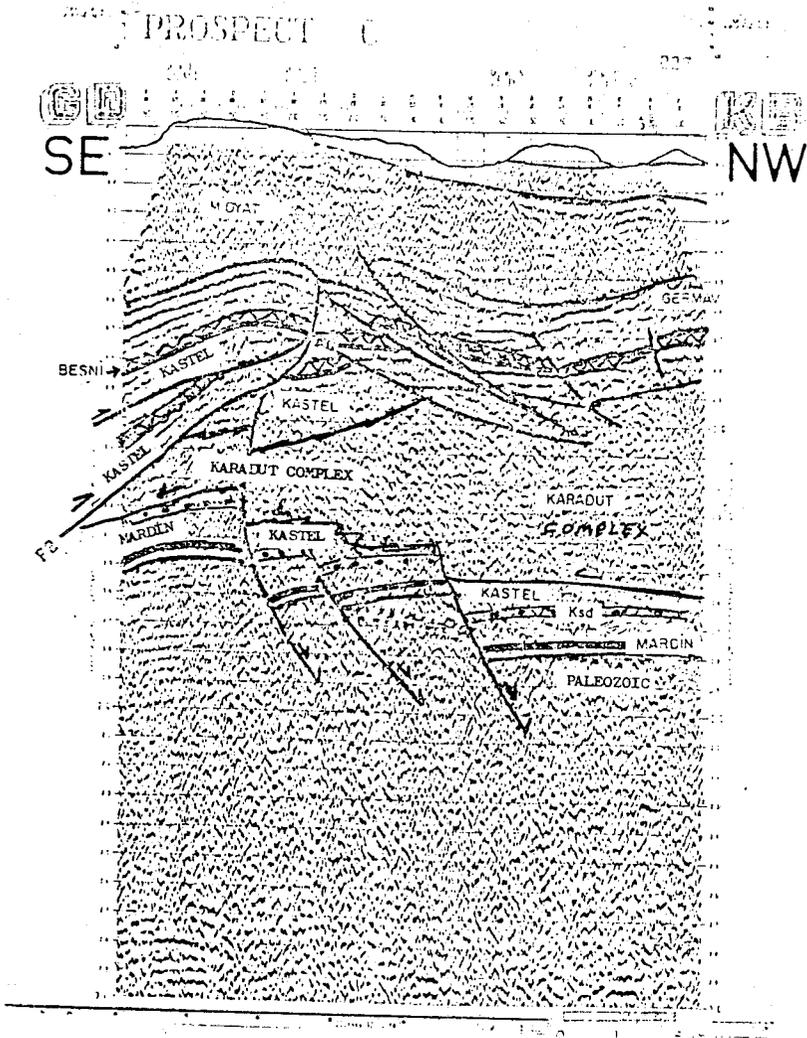


Figure 9: Seismic cross section of 227 numbered profile, NW-SE direction

monotonous because of processing procedures. Therefore, Signal correlation and facies changes can not be followed. Because, penetrations of seismic waves became difficult at the places of covered by high-velocity limestone and quality degraded. However, better quality results were got on the Selmo formation and the spaces covered altered basalts.

Complexities of allochthonous units affected signal. The stacking procedures of the signals coming from Cretaceous and older units were affected. As a result, continuity of reflections were demolished. The Arban plain is a graben area. There is a lower Miocene aged thrust fault at just north of this place (Figure-13). Cretaceous structures are put in front of these allochthonous units and Cretaceous units are becoming deeper where the allochthonous units are becoming thicker (Figures 14, 15, and 16). At the same time allochthonous units at lower part strike slip fault.

Karadag trend is seen further south of the graben area. This trend is described by post compressional movements (Figure-14).

4. PETROLEUM POSSIBILITIES

In the research site two wells namely K.Kaya-1 and Karadag-1 have been drilled. Karadag-1 was drilled by Shell Company in 1960. Heavy oil show at Besni formation cut by K. Kaya-1 well have been observed.

4.1. The Source Rock Facies

Fine grains are accepted as petroleum source rocks. According to this definition argilliteous sediments and micritic limestones are accepted as petroleum source rocks. These rocks are seen as the places in which organic materials are collected.

An ideal source rock must have fine texture, dark color and rich planktonic faunas which has rich organic materials (Guillomat, 1964). Organic materials are 2% of rock body. % 0.05 was determined as minimum value for total organic carbon.

The samples of Karababa and Derdere formations cut through by Karadag-1 well and Derdere formation cut through by K.Kaya-1 well were analysed by Esso company. Besides, samples were analysed by Soylu (1975) in Research Center of TPAO (Turkish National Petroleum Corporation). TOC (Total Organic Carbon) values of Derdere formation are 1.5 % in K. Kaya-1 well and 1.2 % in Karadag-1 well as average

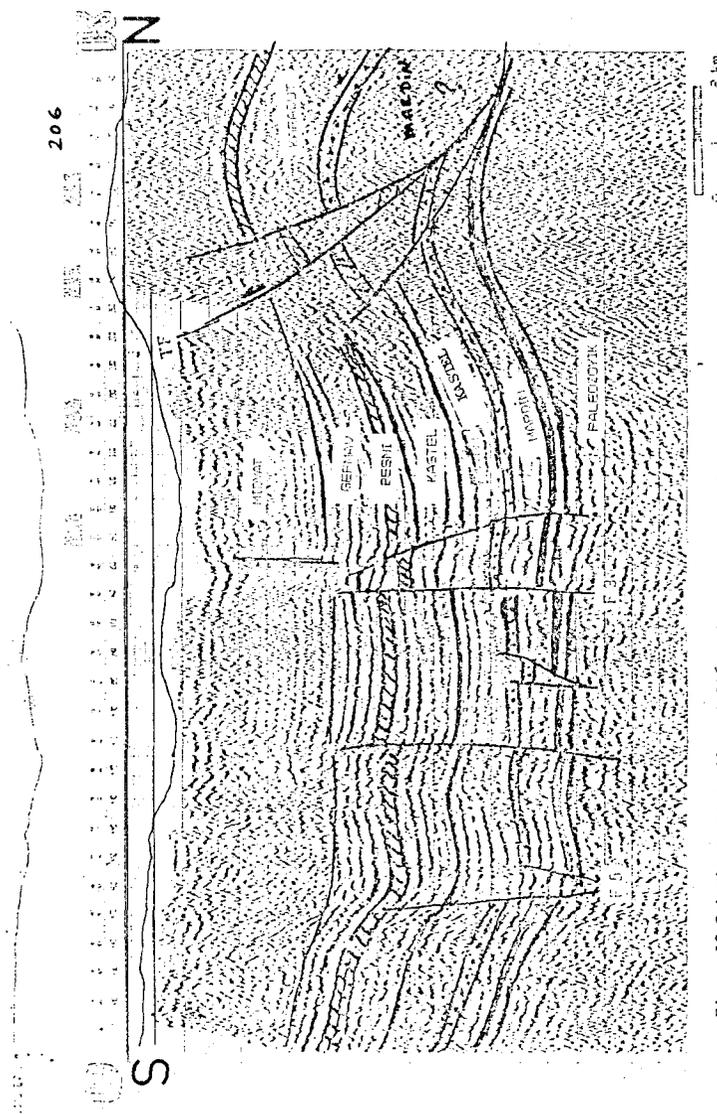


Figure 10: Seismic cross section of 206 numbered profile, N-S direction

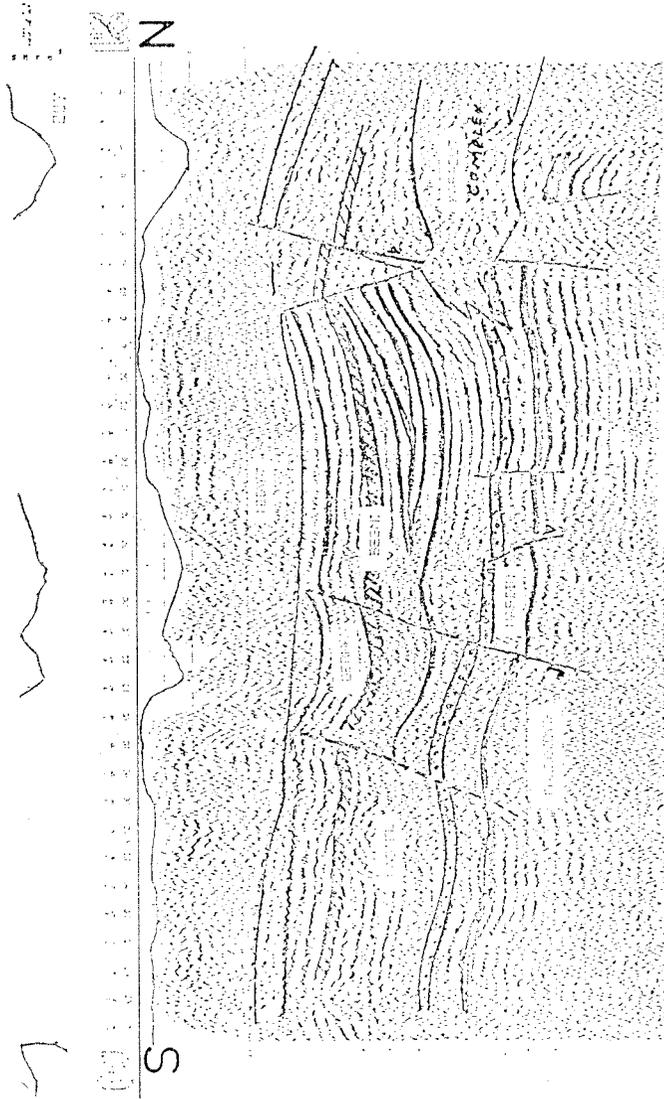


Figure 11: Seismic cross section of 207 numbered profile, N-S direction

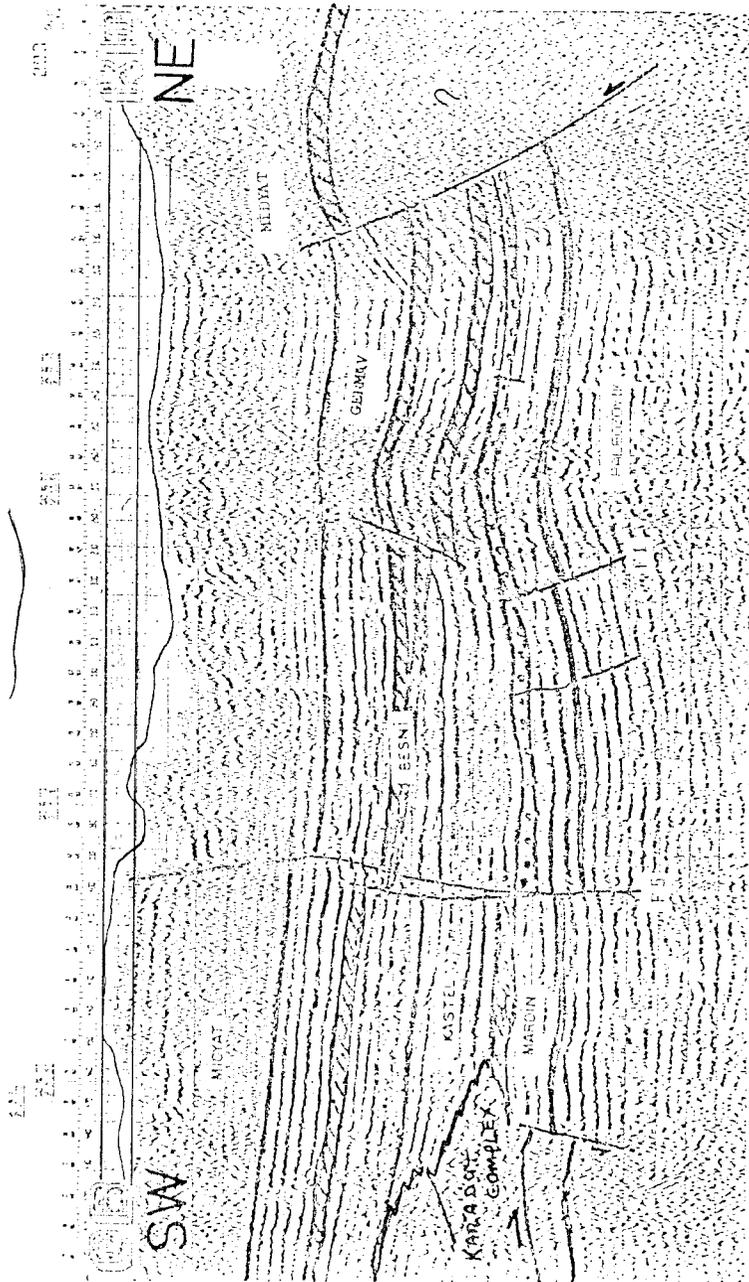
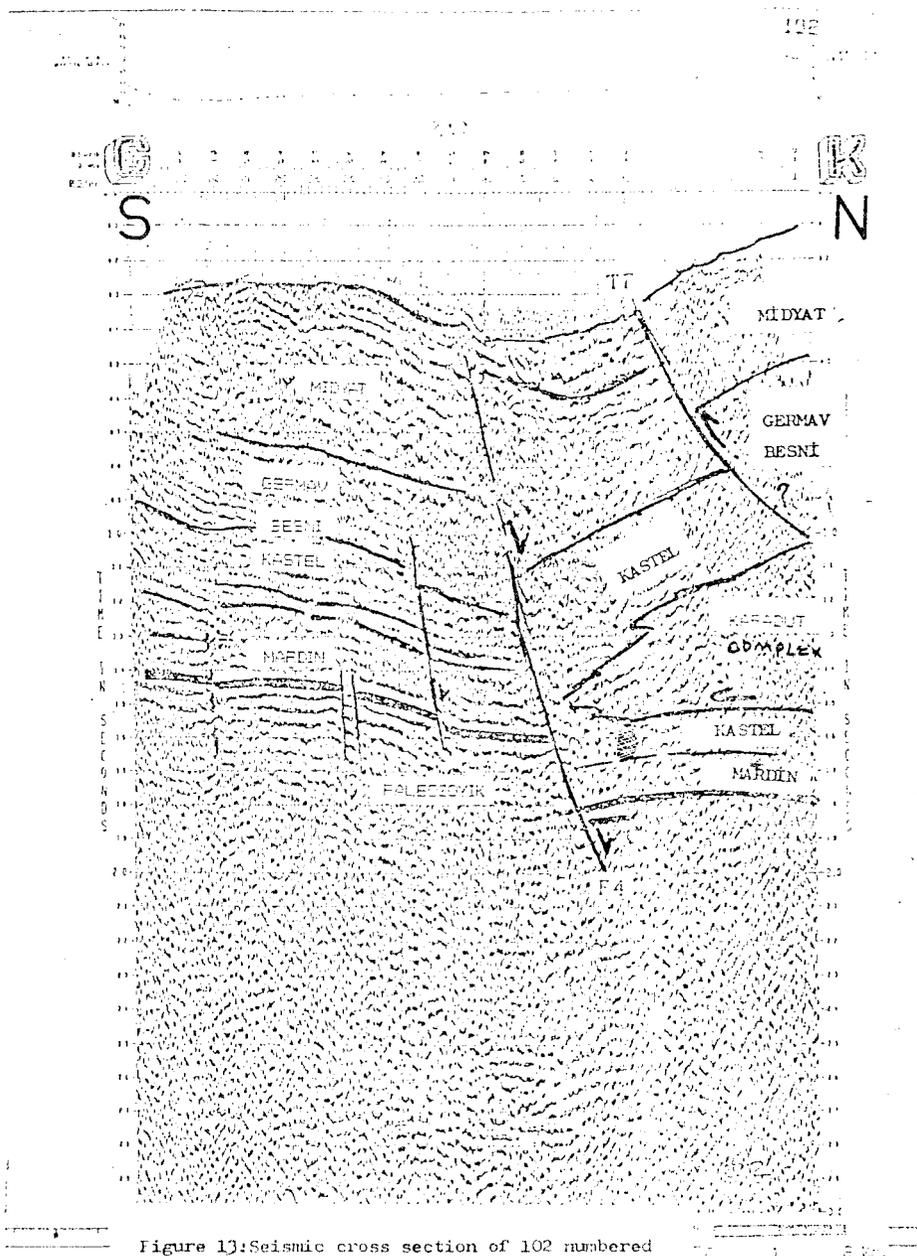


Figure 12: Seismic cross section of 206 numbered profile, NE-SW direction



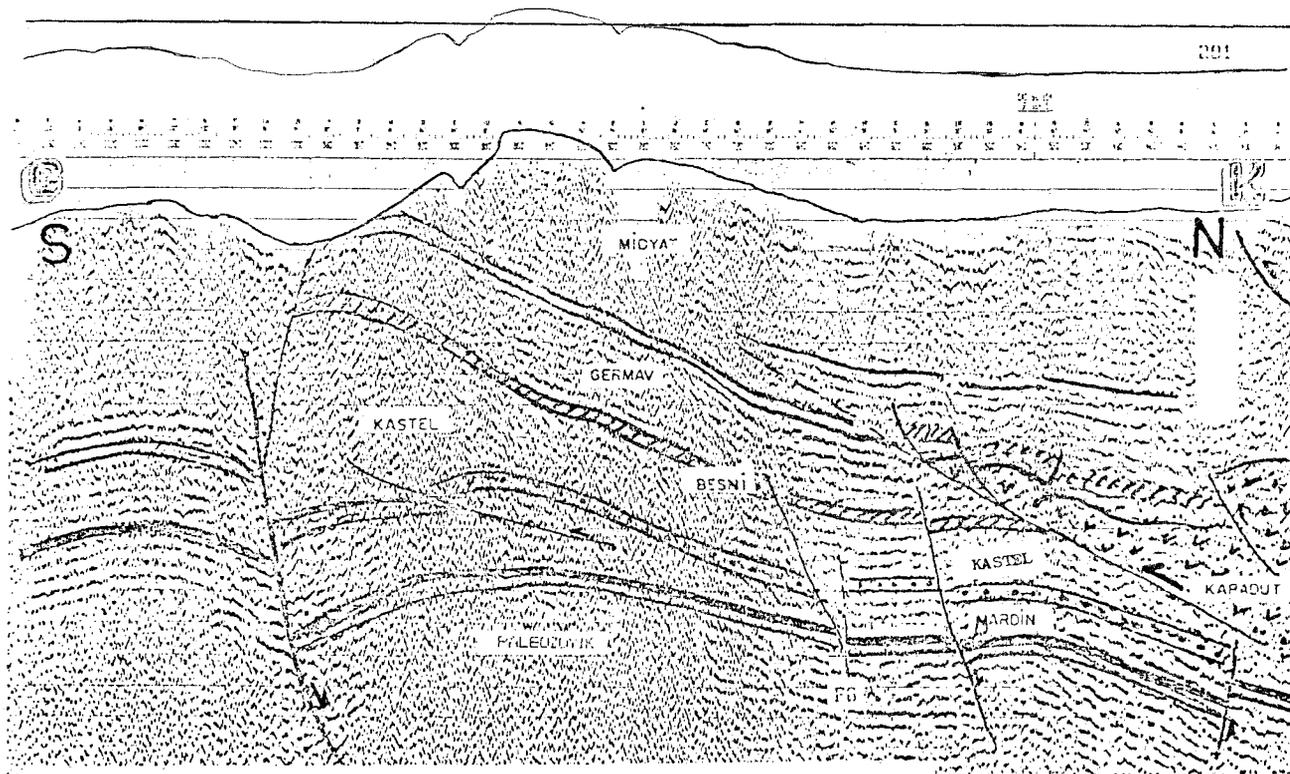


Figure 14: Seismic cross section of 201 numbered profile, N-S direction

values. This value get nearer to 2.5 for Karababa formation. There mainly two units which have source rock character in the area a member of Karababa formation and Derdere formation. The samples which were taken from well base among pelagic parts were examined in order to learn organic material amount and maturity. It was determined that samples were early-medium mature and produced petroleum. T (max) 430 and 465 santigrad-degree intervals which are maturity limits versus hydrogen index values are shown in the figures 17 and 18. This diagram is known as "Van Krevelen" diagram is described as numerical approach for HI (Hydrogen index) and (T (max) values (Figure 19). Units of HI and T (max) are mgHC/g TOC and C respectively (Yoldemir, 1988). According to laboratory analysis, mentioned formations can be good quality source rocks and can produce petroleum. According to their lithologies, Kastel and Germav formations have source rock apperenced. But there is no source rock analysis up to now. Therefore certain determination can not be done.

4.2. The Reservoir Rock Facies

It is necessary to have sufficient porosity and permeability for petroleum reservoir rocks. Being porous is to have gaps among grains for a reservoir rock. If these gaps have connections to each others, it is mentioned useful porosity and this one of the very important character. Size of porosity is related to size of rock. Having a good porosity for one rock shows having good permeability for this rock too. For being petroleum bedding, migration of petroleum, an environment having good porosity and permeability and suitable structures are desired. Dolomite level which has porosity among crystals and limestone level at Derdere formation among Mardin group carbonates have good reservoir rock appearances.

Besni formation having both coral and calciturbitide charactered. Calcarenites has also reservoir character. Belveren formation having dolomite and dolomitic limestone characters has reservoir peculiarities too.

Derdere formation with its limestones having seconder porosity and dolomites having porosity of among crystals have also reservoir rock character. This formation is a prospect level in 5 th. and 6 th. regions.

Hoya formation of rich fossilifereous limestone facies belonging to Midyat group has a reservoir rock appearance because of developed karst

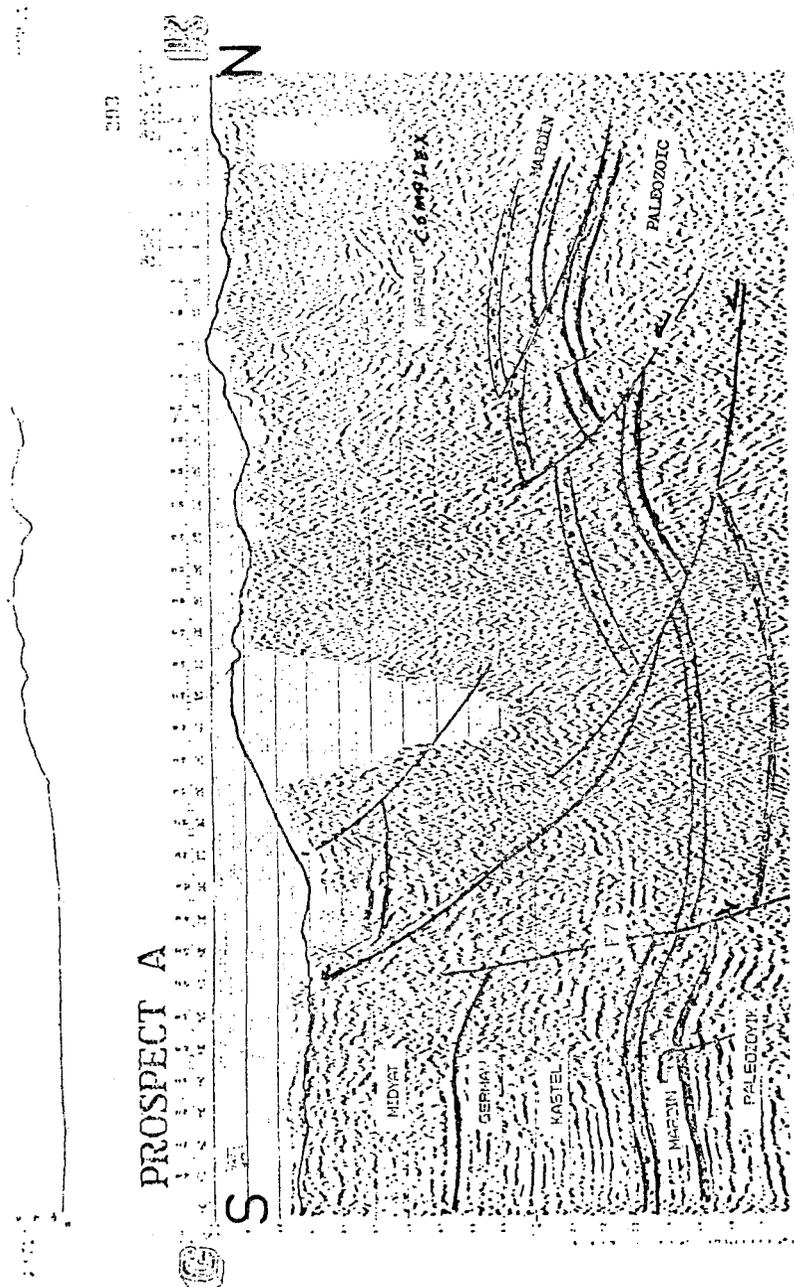


Figure 15: Seismic cross section of 303 numbered profile, N-S direction

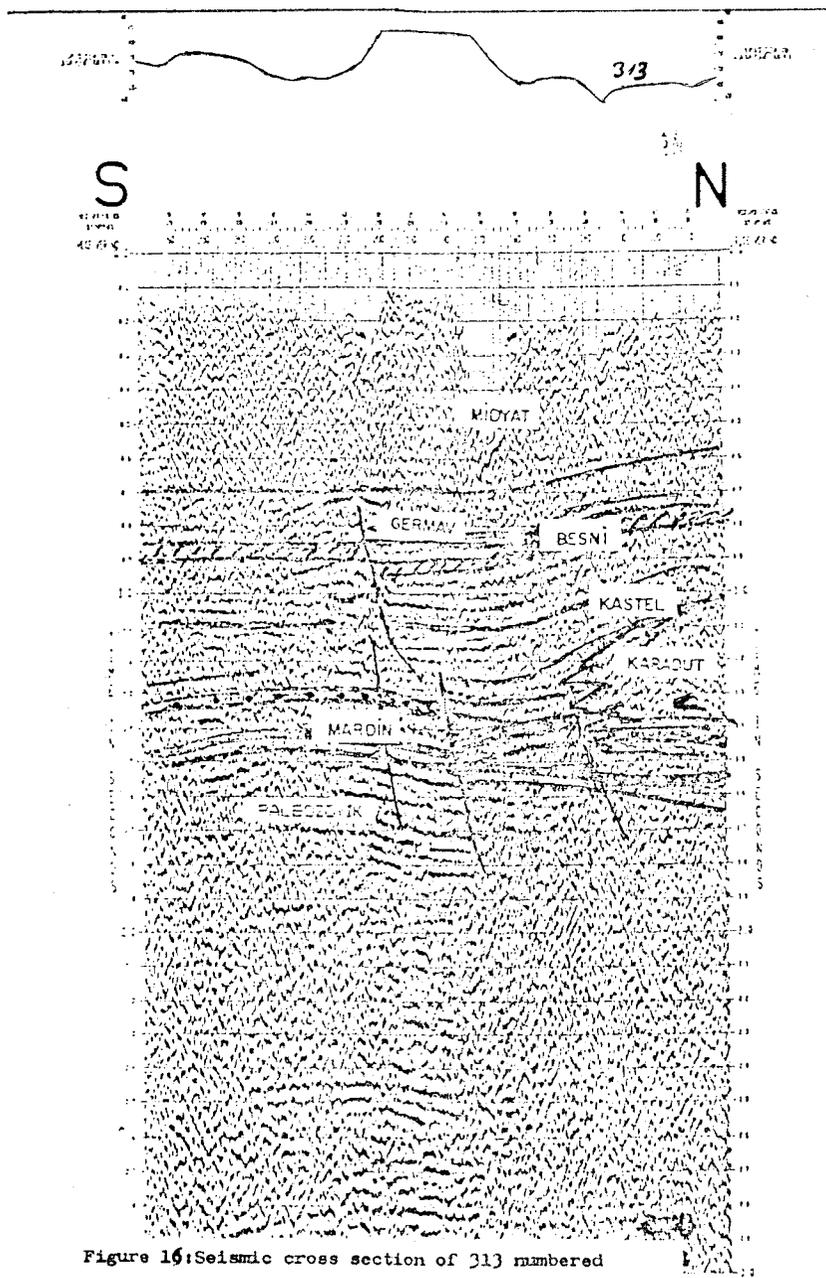


Figure 16: Seismic cross section of 313 numbered profile, N-S direction

0 5 10 15 20

W E L L	Forma- tion	Sample No	Total Organic Carbon % TOC																		
			0.0	0.3	1.0	1.5	2.0	2.5	3.0	3.5											
KUZEYKAYA - I	B E R D E R E	1																			
		2																			
		3																			
		4																			
		5																			
		6																			
		7																			
	AVERAGE																				
KARADAĞ - I	BERDERE	1																			
		2																			
	AVERAGE																				
KARADAĞ - I	KARASABA	1																			
		2																			
	AVERAGE																				

Figure 17: Total organic carbon values of source rock examples taken from near wells (TOC)

topography. Firat formation in same group is considered a reservoir rock because it has coral charecter in various points. Another reservoir rock is sandstone levels of Gercus formation.

4.3. The Cap Rock Facies.

It is necessary a cap rock for keeping petroleum which migrated from source rock to the trap. The cap rock must be fine grained, Closly textured and unpermeable. Some good examples of these type rocks are anhydrite, claystone, shale, argilliteous, marl and micritic closly fabriced limestones.

At research site, Sayindere formation has cap rock charecter for Mardin group reservoirs. As it was mentioned before, Sayindere formation is of limestone facies. The Kastel formation becomes cap rock for Mardin group where Sayindere formation becomes thin and/or not settle.

Where the Germav formation composed of shale and marl facies this can be a cap rock for Besni formation which is thought to be a reservoir rock. Gaziantep formation composed of argilliteous limestone facies can be a cap rock for Hoya formation.

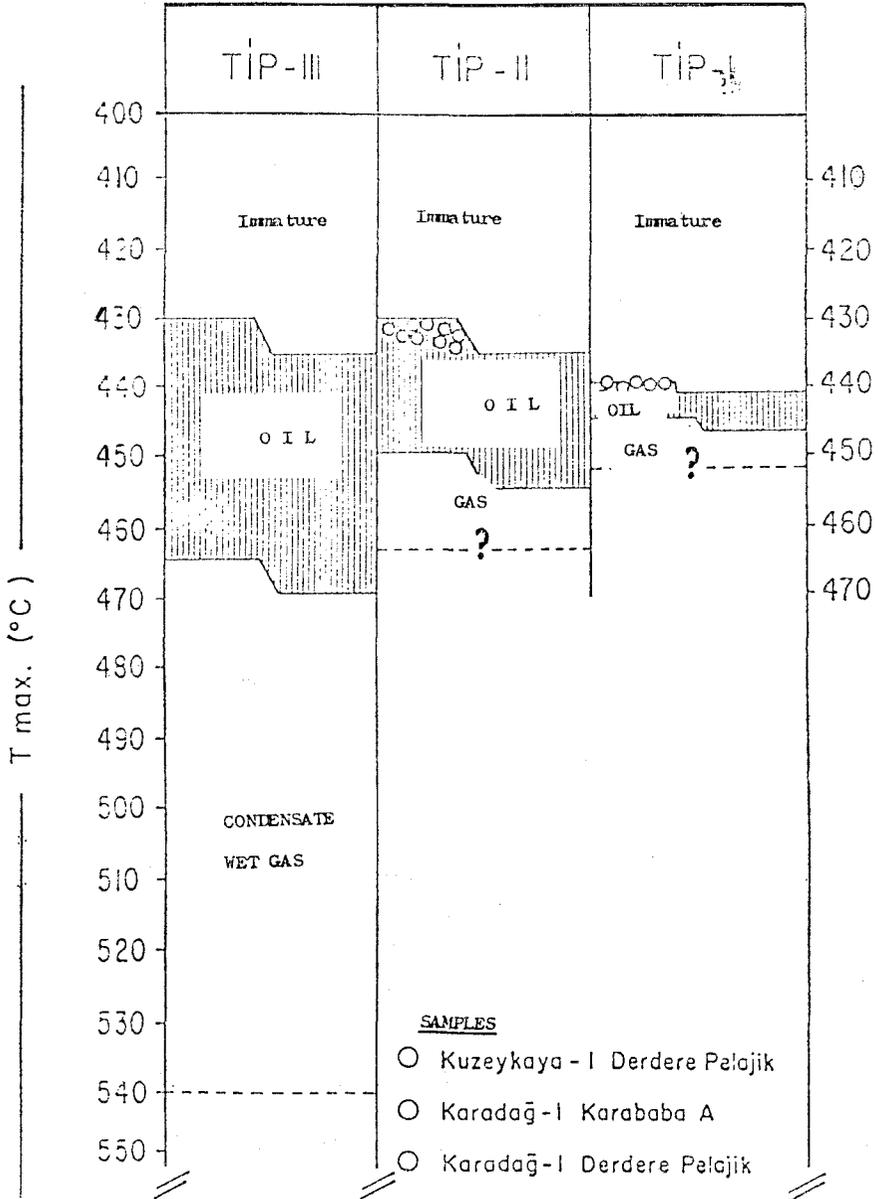


Figure 18: According to organic materials maturity

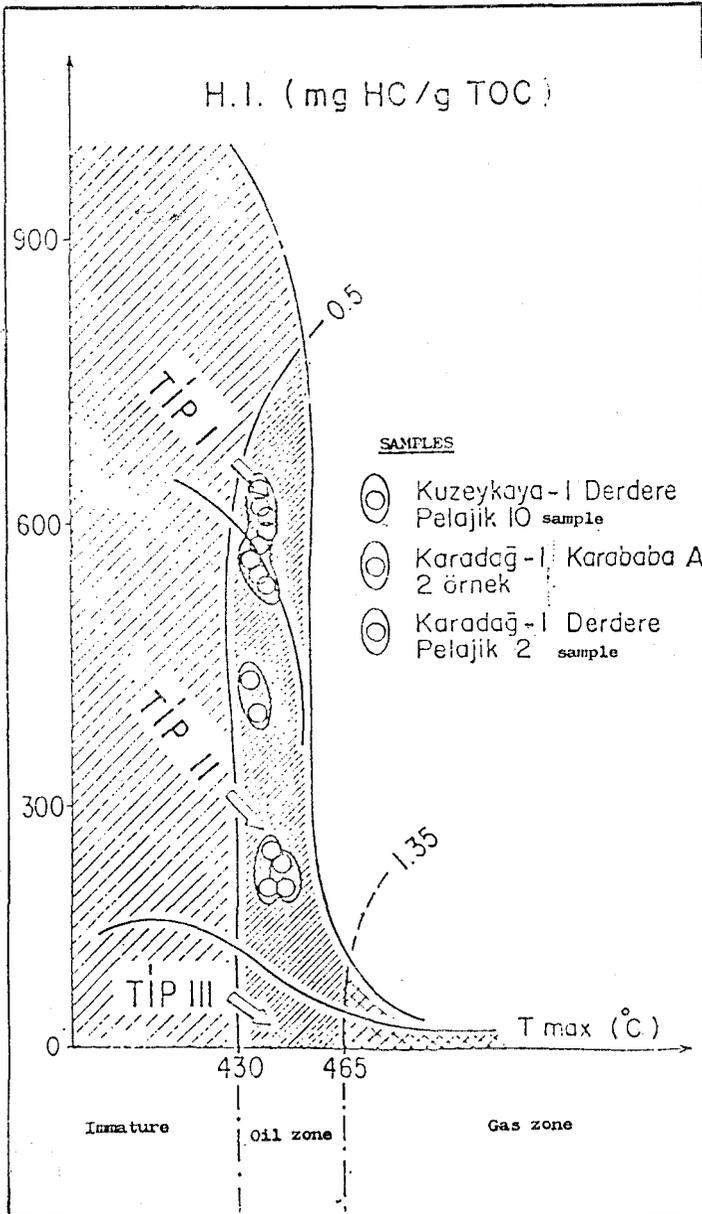


Figure 19: Organic material type and maturity

4.4. Petroleum Traps

There are structural, stratigraphic and discordance traps in the field. Structures of anticlinal, fault and mixed at these two kinds from structural traps are determined (Figure 5 and 6). In general, structural traps were determined by interpreting the seismic cross-sections. In order to determinate stratigraphic traps seismic cross-section don't have sufficient quality and charecters. Size of folds and structures are not so big in the area which has number of faults.

4.4.1. The Structural Traps

Bakirca area is shown as a sample of anticlinal traps. Dimensions of Bakirca structure is 1.5 km. by 2.5 km. and its closure is about 70+80 m. Bakirca structure is located at crossing point of 226, 203 and 312 numbered cross-section (Figure+8, 12, 20). Probable, depth of this structure aimed Mardin group is around 2260 (-1600) m. Dimensions of other structures are around this value. From the view point of petroleum maturity, prospect A is more positive. Probable depth of this prospect aimed Mardin group is expected around 2400 (-1700) m. Its lenght is 3 km. with 1 km. In addition, other faulting and anticlinal structures are shown in time a map of Mardin group (Figure-5).

Best example of faulted structures is prospect C which is shown in time map of Besni (Figure-7). It is placed at south-west of Bakirca structure belonging Mardin group at lower part. This structure aimed Besni formation is a thrust faulting structure. Because of compression of allochthonous units from north-west, it become a back-thrust structure (Figure-9 and 22). Expected depth of this prospect is around 1600 (-1000) m.

4.4.2. The Stratigraphic Traps

By stratigraphic trap (Lithologic trap) it is mentioned corals inside the Besni formation. It is described as prospect B in the time map of Besni formation (Figure-6). It is placed North-West of Bakirca structure belonging to Mardin group at lower part. Target of this map is coral charecters of Besni formation. Probable depth is around 1650 (-1000) m.

Sand lens, canal fillings and lithology traps etc. could not be determined. However, if depositional conditions of Gercus and Firat formations are taken into account, lithological traps may develop inside these units.

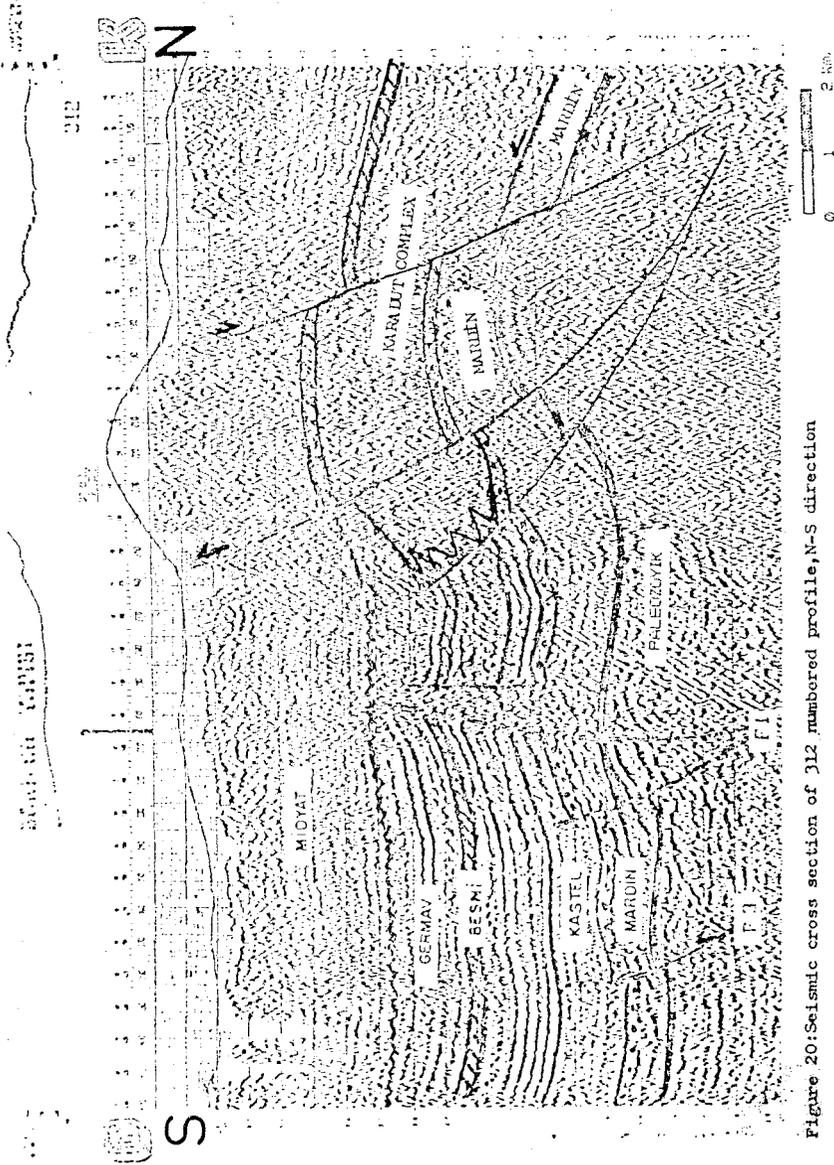


Figure 20: Seismic cross section of 112 numbered profile, N-S direction

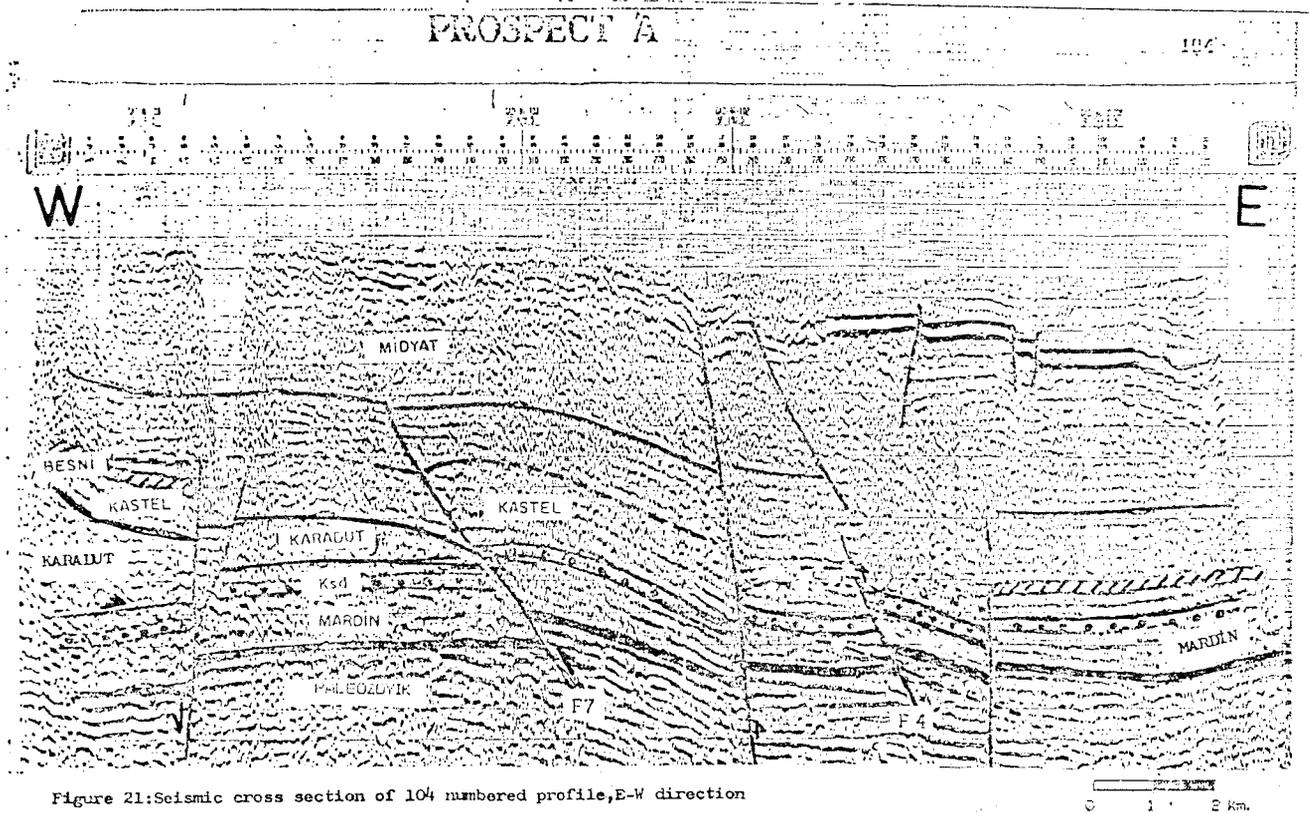


Figure 21: Seismic cross section of 104 numbered profile, E-W direction

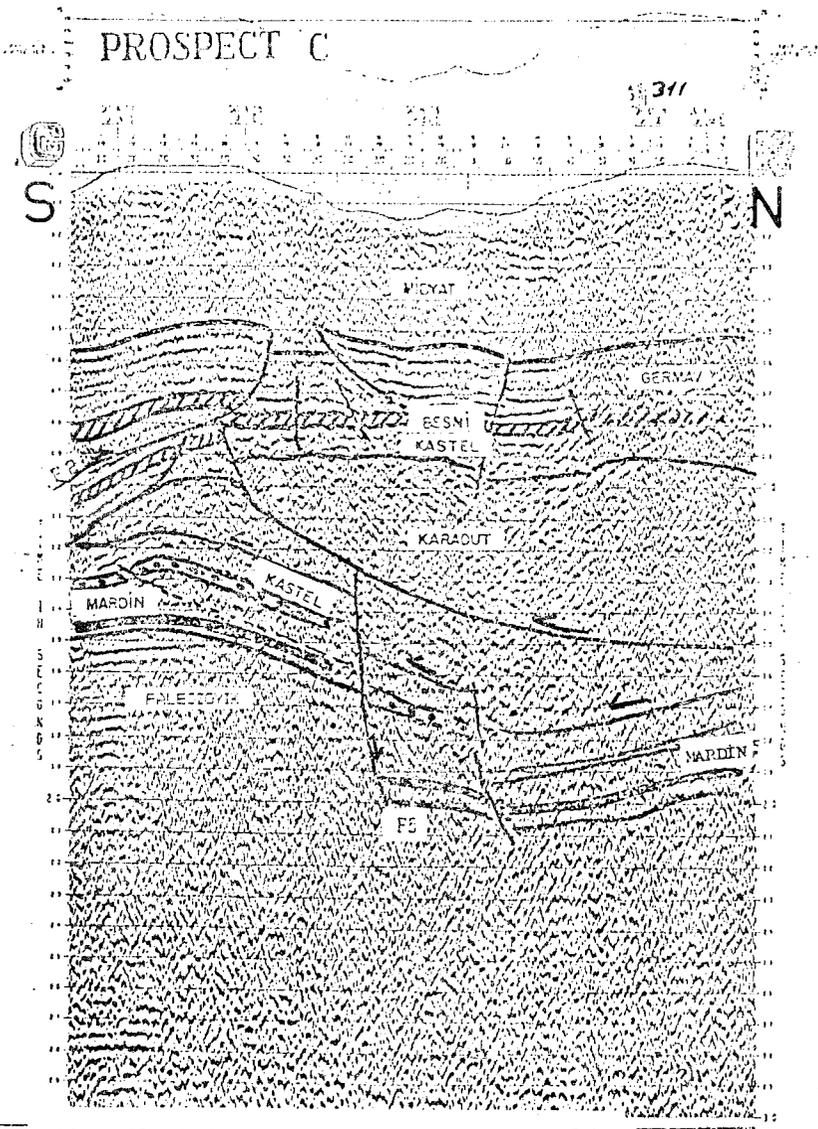


Figure 22: Seismic cross section of 311 numbered profile, N-S direction

4.4.3. The Discordance Traps

Disconformities between; Sabunsuyu and Derdere, Kastel and Haydarli, Gercus and Hoya, Hoya and Gaziantep, Fırat and Selmo formations indicate that there are discordance traps. There is a parallel disconformity between Karaboğaz and Karababa formations. This disconformity is between Derdere and Karaboğaz formations where Karababa was not deposited. Besni formation is discordantly placed upon Kastel formation. Germav formation discordantly covers Besni formation.

5. CONCLUSIONS

By this research, well data and seismic cross-sections were interpreted together. It was tried to discover petroleum traps at the area. By this research, new prospect areas were discovered called Bakırca, A, B and C.

According to time maps, it is thought that Mardin group and Besni formation are important for petroleum surveys.

Stratigraphic units of research site is explained by means of well data and seismic cross-section.

Tectonical structures of the site are explained via well data and seismic cross-sections.

It is concluded that the area has structural, stratigraphic and discordance traps.

The area has source, reservoir and cap rock facies.

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