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PROPERTIES OF THE OIL SOURCE ROCK THE BOYABAT/SINOP BASIN UNITS

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ABSTRACT

Among The Boyabat Basin's deposits, there are some units reflecting petroleum source rock appereances. Our target has been determinations of Kusuri and Çağlayan formations source rock potentials. A research, included of petroleum source rock, has no been carried out till now.

Deposits in the basin have flish characters in general but it is also possible to observe carbonates including volcanic matters.

In order to determine source rock specifications of the area, measured stratigraphical cross-section were drown and systematic samples were collected. A number of analyses, such as organic carbon amount, pyrolise, organic matter type, maturity and clay X-ray difractometer analyses, were applied on the shale samples.

According to the analyses results, keregone types are Tip II and Tip III, there are sufficent amount of organic matters, maturity is good enough to give petroleum and gas.

As for the Kusuri formation, due to low amount of organic carbon and staying in limited area. It is not determinated as a petroleum source rock.

1. INTRODUCTION

From the wiev point of petroleum expolaration in Black Sea region, Boyabat basin is an impotant area (Figure. 1). General characteristics and thickness of the deposits in the area make the basin attractive place. Because of these properties of the area petroleum companies and researchers are interested in the area. Surveys for the purpose of different aims have been carried out in surrounding area up to now (Ericson, 1938; Blumental, 1940; Budgeleg, 1959; Ketin, 1962; Eren, 1979; Gedik, 1981; Gedik and Korkmaz, 1984; Akarsu and Aydın, 1986; Sonel and etc., 1988).

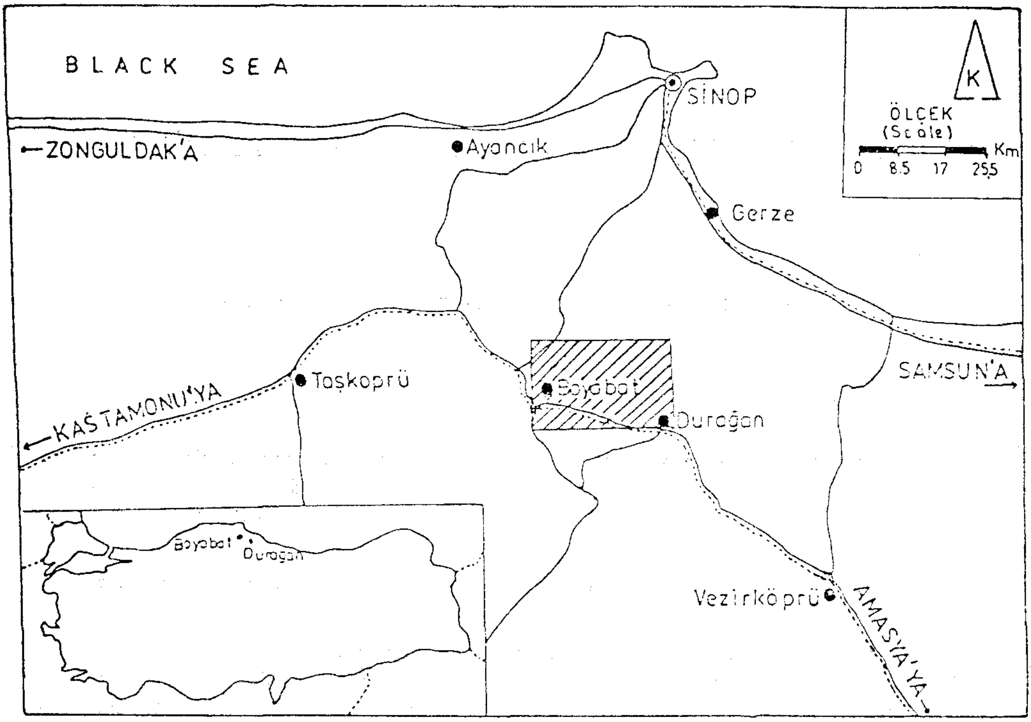


Figure-1:Location map of studied area

A number of surveys in the basin also have been performed. Surveys in the basin have aimed on pointing out general geological, stratigraphical and litho-stratigraphical conditions.

Although deposits in the area are prospects, laboratory analyses based on petroleum potential of the deposits couldn't be done till now. Owing to lacking of these analyses, our task have focused on this matter and aimed on pointing out petroleum potential of the basin by means of laboratory analyses. Deposits having more than 700 m. thickness and composed of different types sediments in Boyabat basin go on from Lias to end of Oligocene reservoir in these units (Fig. 3) For accurate determination, 4 measured stratigraphical cros-sections were done (Fig. 2). Systematic samples were taken and some of them were analysed Clay minerals, amount of total organic matter and maturity experiments were carried out (Fig. 4,5,6).

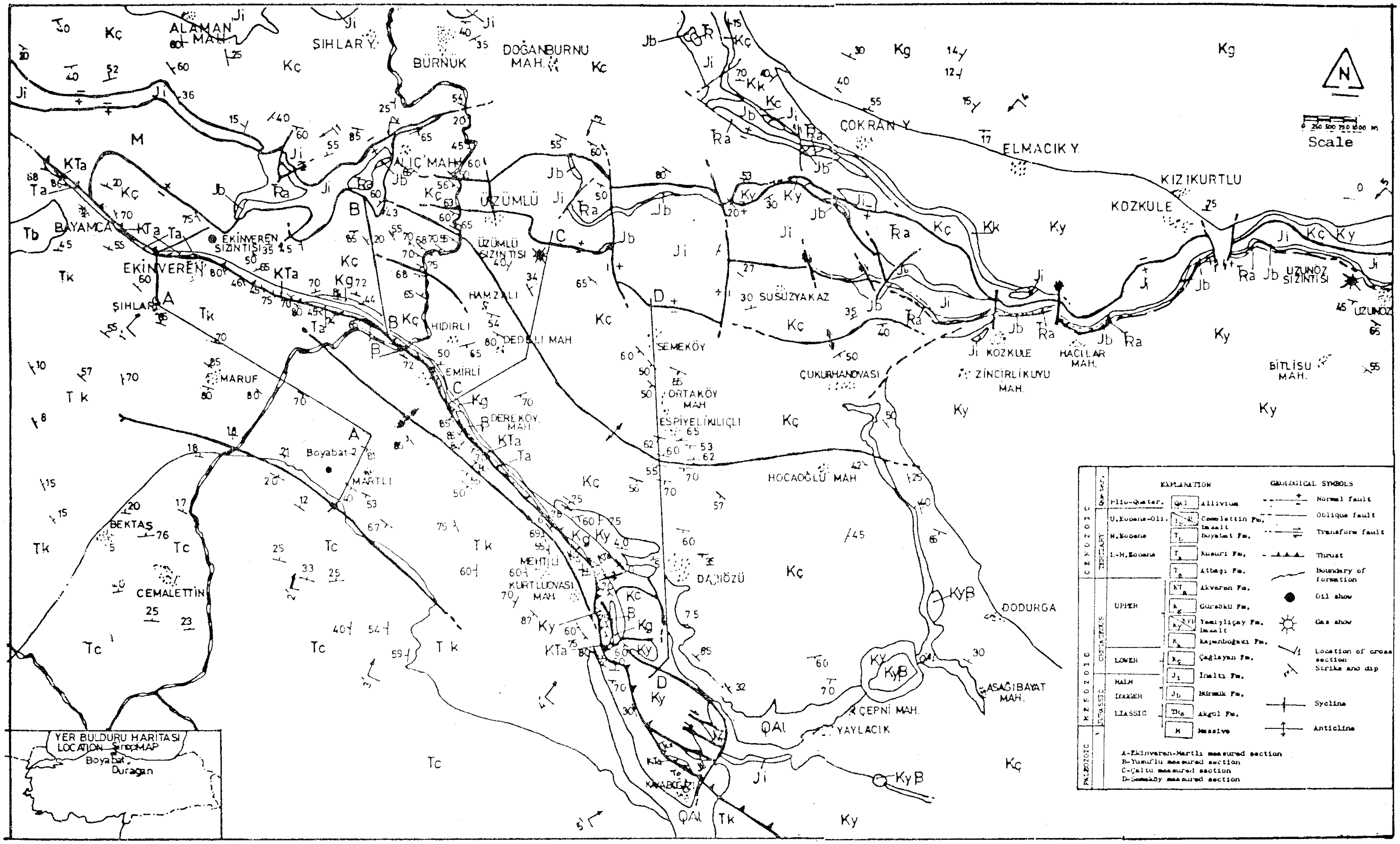


Figure-2: Geological map of the Northeast Boyabat (Sinop) area

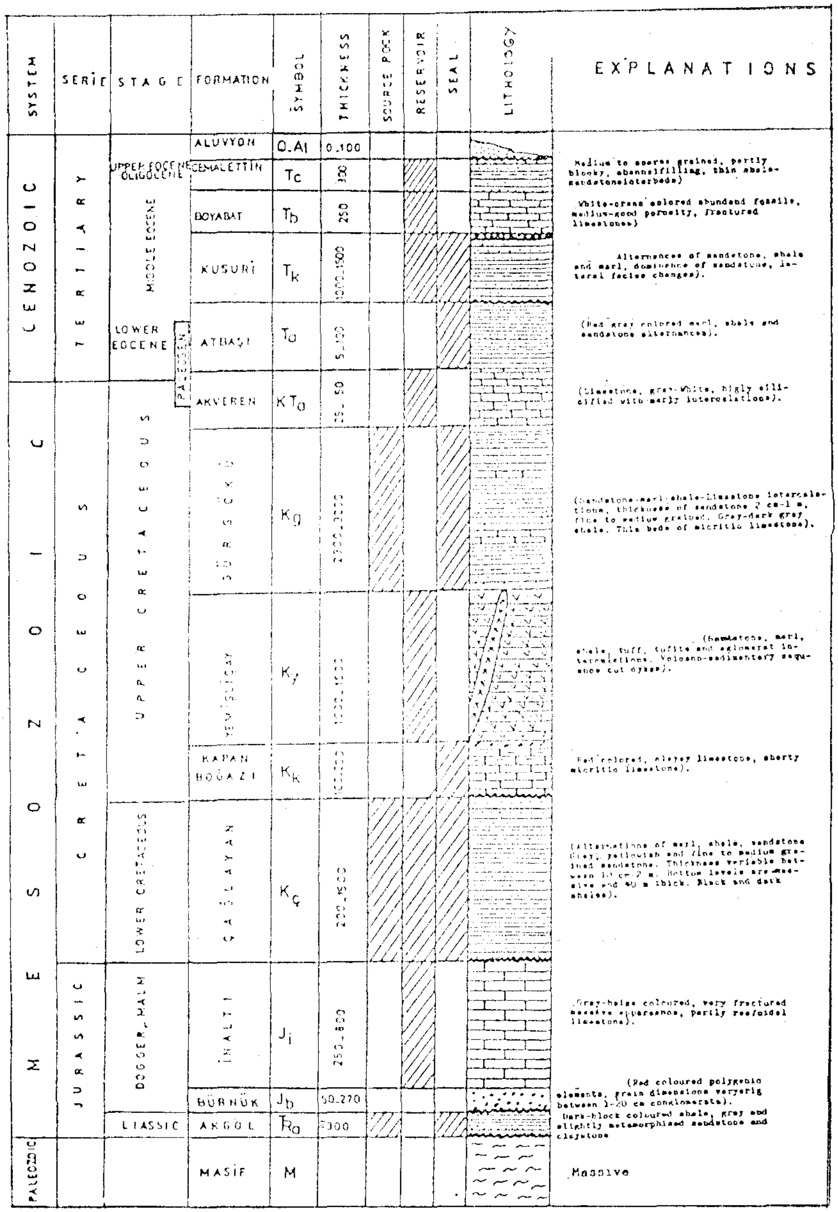


Figure-3:Generalized stratigraphic columnar section of the Boyabat area

2. DETERMINATION OF PETROLEUM SOURCE ROCK

Petroleum source rocks are described as fine grained sedimantery rocks which produce economic amount petroleum and /or gas and sent into reservoir rocks and have black shales including kerogen matters, pyrites (Guillemont, 1964; Dow., 1978). Especially, black shales have good source rock properties. Besides, in a lesser extend, clayish limestone and marls are accepted as source rocks (Leverson, 1967; Momper, 1978; Kirklend and Evans, 1981). Lots of researchs have been performed on petroleum source rock determinations (Hunt and Jemiesen, 1956; Gehman, 1962; Baker, 1962; Erdman, 1962; Dunton and Hunt, 1962; Tissot and Welte, 1978; Espitalie and etc., 1977).

In order to get accurate petroleum source rock determinations, different kinds of analyses are performed.

2.1. Rock Evaluating Analyses

These analyses are used in determinations of kinds and evolutions of organic matters (Espitalie and etc., 1977). In these analayses, Samples are exposed to pyrolise with a special temperature program in an environment without oxygen (Tissot and Welte, 1978). During the pyrolise period, S. S2, Tmax, TOC, P1 and HI data of samples having organic matters are found. By means of determining the data, source rock potantials of the samples are determinated. Genetic potantial of a petroleum source rock is also determinated. Genetic potantial is described as amount of hydrocarbon in kg. out of 1 ton source rock (Tissot and Welte, 1978). Calculation procedure is as follows.

If $S1 + S2 < 2$ kg /ton it can't be petroleum source rock, it seldom produces natural gas.

If 2 kg. /ton $< S1 + S2 <$ 6 kg. / ton it has medium graded source rock potantial

If $S1+S2 >$ 6 kg. / ton it is a source rock with a good potantial. It is possible to determine kerogen type by relations of TOC amount, get from pyrolise results, with Tmax. Pyrolise analyses results of 7 samples are given in figure–7.

2.2 Vitrinite Reflection Values (Ro)

By using these analyses which are applied to the deposites having rich organic matters maturity degree of the organic matters can be determinated (Tissot and Welte, 1978).

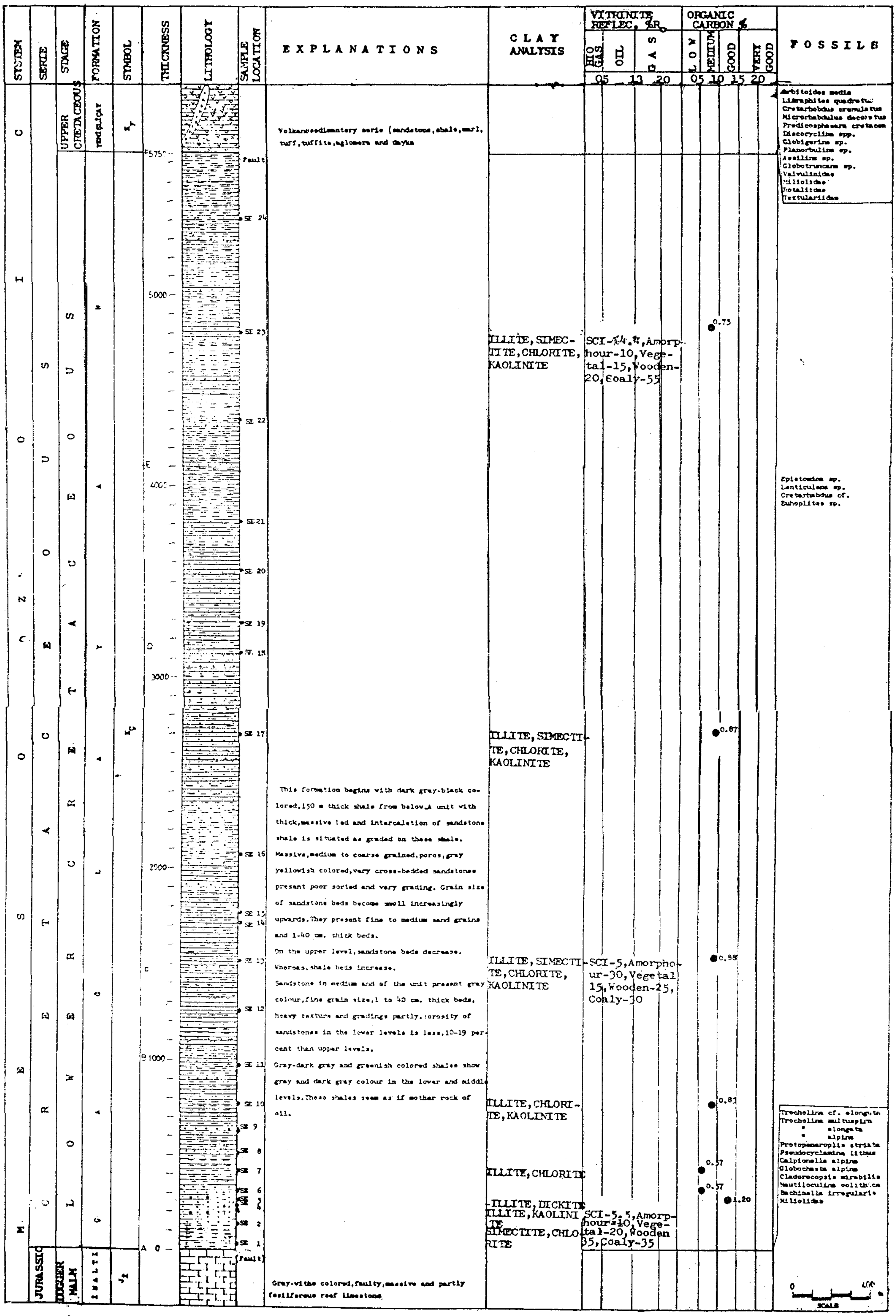


Figure-4: Semeköy measured section

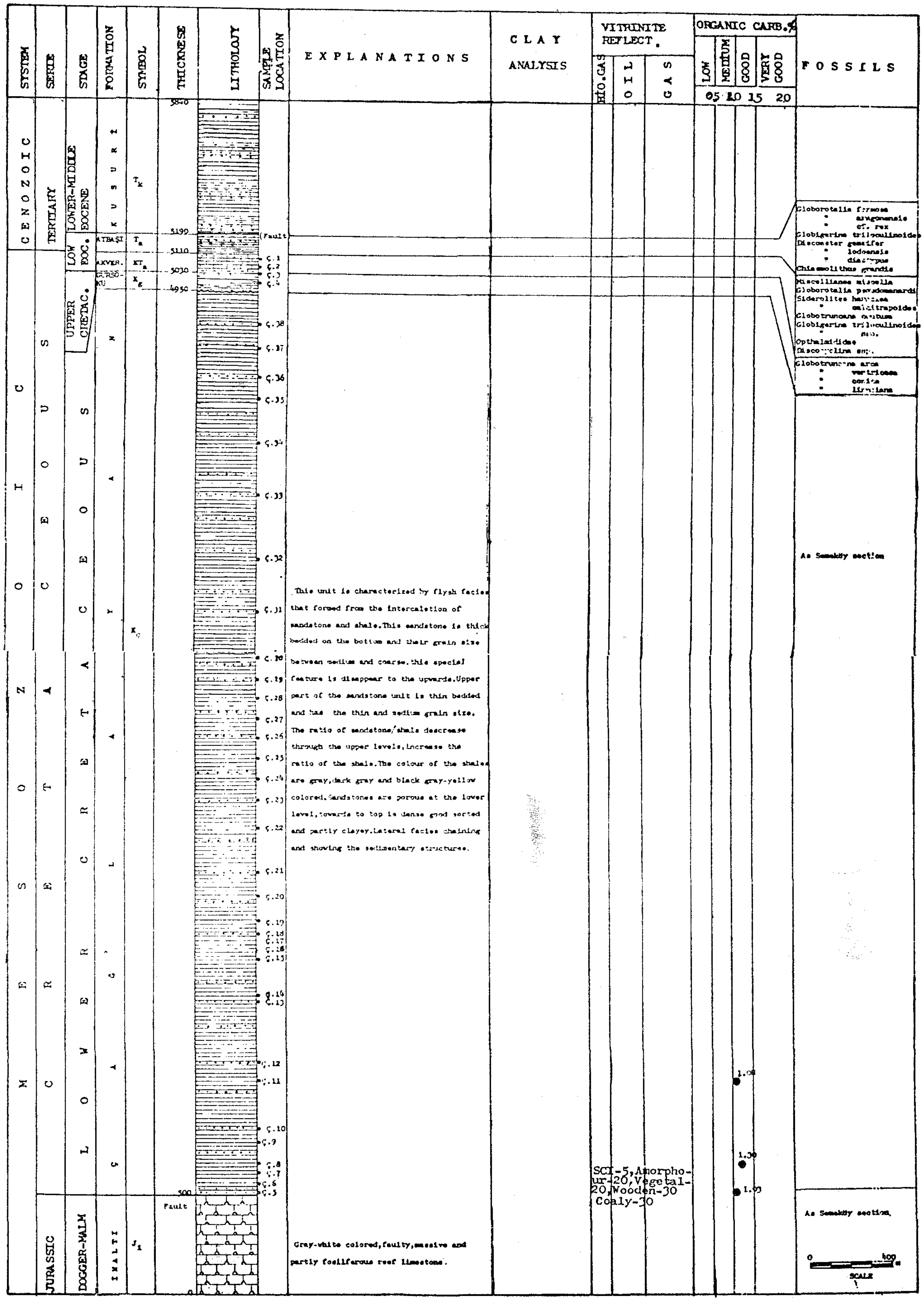


Figure-5:Çaltu measured section

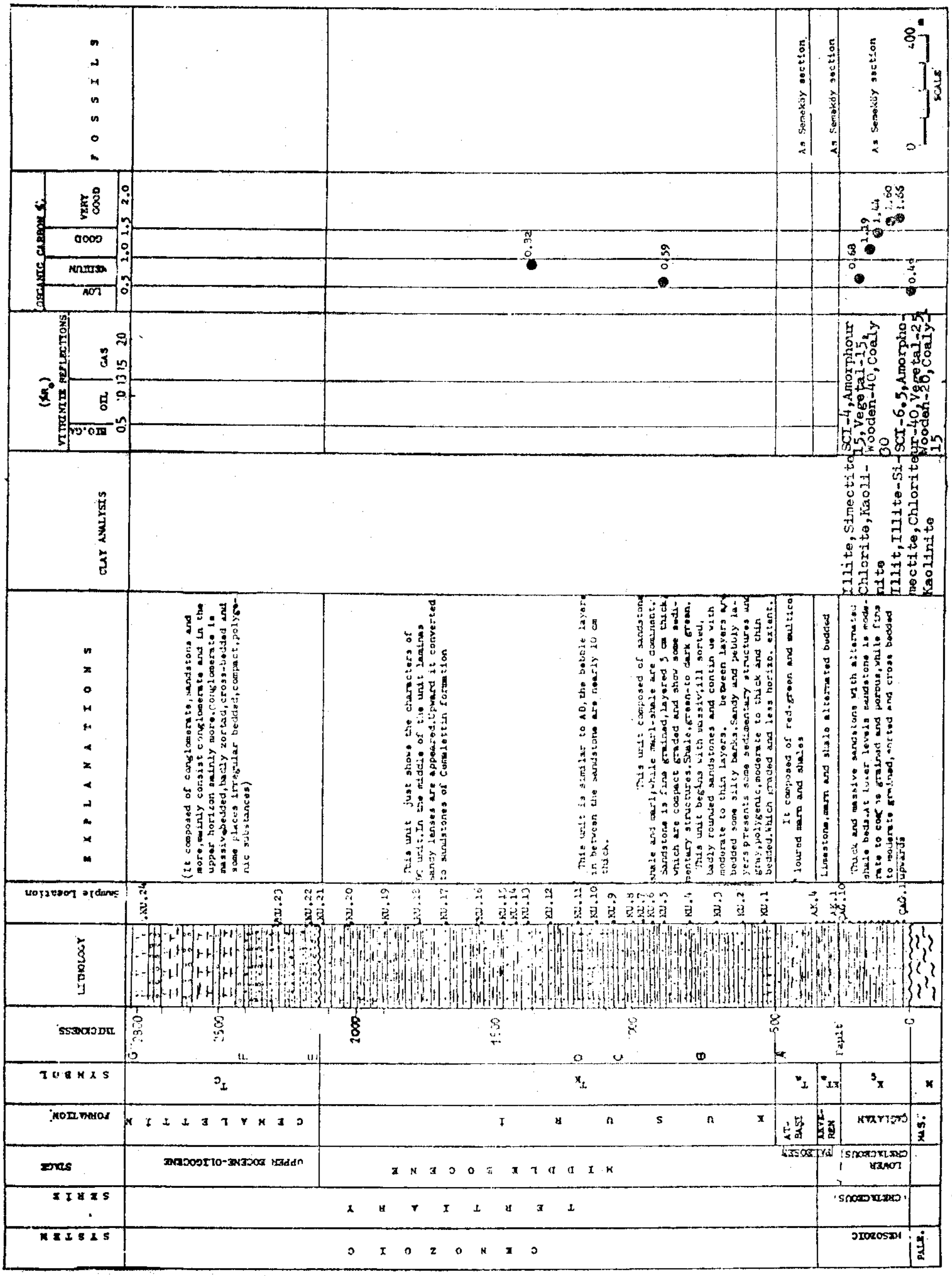


Figure-6:Ekinveren-Vartli section

Figure 7. Pyrolyse results of shale samples

Sample Nr.	Formation	S1	S2	Tmax	P1	TOC	HI	Kerogen Type
ÇAĞ. 3,4	Çağlayan	0.02	3.35	434	0.02	1.66	193	TİP II
ÇAĞ. 5	Çağlayan	0.22	2.33	444	0.09	1.60	146	TİP II
ÇAĞ. 6	Çağlayan	0.09	2.00	442	0.04	1.44	140	TİP II
ÇAĞ. 8	Çağlayan	0.02	1.16	434	0.02	1.19	88	TİP III
Ç. 5	Çağlayan	0.00	0.65	438	0.00	1.03	56	TİP III
Ç. 8	Çağlayan	0.01	0.68	444	0.01	1.30	45	TİP III
Ç. 11	Çağlayan	0.01	0.59	440	0.02	1.09	51	TİP III

S1– Genetic potantial amount transforming into hydrocarbon, S2–Hydrocarbon formed by thermal cracking of kerogene Tmax. –Maximal temperature (C°) of S2, TOC–Total organic carbon, HI–Hydrogene index

2.3. Amount of Total Organic Carbon (TOC)

This analyses is composed of amount of carbon related to kerogen and carbon which is produced from kerogen but not discharged from the rock (Durant and etc., 1972; Jonathan and etc, 1976; Hunt, 1983).

According to total organic carbon amount of the samples, petroleum source rock determinations can be made. Generally 0.5 % is accepted as a lower limit of organic matters for a normal source rock (Dow, 1978; Mamper, 1978; Tissot and Welte, 1978; Hunt, 1983; Welte , 1965; Melver, 1967; Ala and etc., 1980). Analyses results of our 18 samples are shown in figure 8.

Figure 8. Total Organic Carbon (TOC) results of shale samples

Sample Nr.	Formation	TOC (%)
ÇAĞ. 1	Çağlayan	0.43
ÇAĞ. 3,4	Çağlayan	1.66
ÇaAĞ. 5	Çağlayan	1.60
ÇAĞ. 6	Çağlayan	1.44
ÇAĞ. 8	Çağlayan	1.19
ÇAĞ. 10	Çağlayan	0.68
KU. 5	Kusuri	0.59
KU. 13	Kusuri	0.82
Ç. 5	Çağlayan	1.03
Ç. 8	Çağlayan	1.30
Ç. 11	Çağlayan	1.08
K. 8	Çağlayan	0.76
SE. 4	Çağlayan	1.21
SE. 5, 7	Çağlayan	0.57
SE. 10	Çağlayan	0.83
SE. 13	Çağlayan	0.88
SE. 17	Çağlayan	0.87
SE. 23	Çağlayan	0.75

2.4. Clay Mineral Analyses

In order to determine geochemistrial evulation of deposits and potantial of rocks of petroleum source, these analyses are being used for a long time. A number of researchers have determined that hydrocarbon production and water loss are happend during the smectite conversion to illite (Weaver, 1960; Perry and Hower, 1972; Foscolos and Kodama, 1974). Water with 150 degrees temperature being in the deposits which sunk deep provides dissolution of hydrocarbon. Conversion of montmorillonite to illite is concludet with a big amount of water in sufficent temperature (Perry and Hower, 1972).

Degree of metamorphism is also determinated by means of crystallinity index. While crystallinity index is getting smaller with sinking, incresement propational to sharpness are observered (Foskolas and Kodama, 1974).

Making use of illite crystallinite degree, diagensis, antimetamorphism of a rock can be determined (Weaver, 1960; Foscolas and Kodema, 1974.).

Clay mineral XRD results and crystallinity indexes of our 12 samples are shown in figures–9, 10, 11 and 12 respectively.

2.5 Spore colour Indexes (SCI)

Because of temperature increasements related to sinking, colours of spores changed. These colours are as follows: Yellow (in kow diagenesis period, index 2), Yellowwish–brown (In katagenesis, index 3–3.5) and black (in metagenesis, index 4 and more) (Staplin, 1969; Gunther, 1976).

Organic matter kinds and spore coloure index of our 6 samples are shown in figure–13

3. LABORATORY ANALYSES

Measures stratigraphical cross–sections were made and systematially samples were taken from the units which have petroleum source rock specifications in Boyabat basin (Fig. 4,5 and 6). Rock evaluation (Fig. 7)., total organic carbon amount (Fig. 8), organic matter kinds and maturity X ray difractometrics analyses (fig, 9, 10 and 11) were applied to the samples and crystallinity indexes were determined (fig. 12).

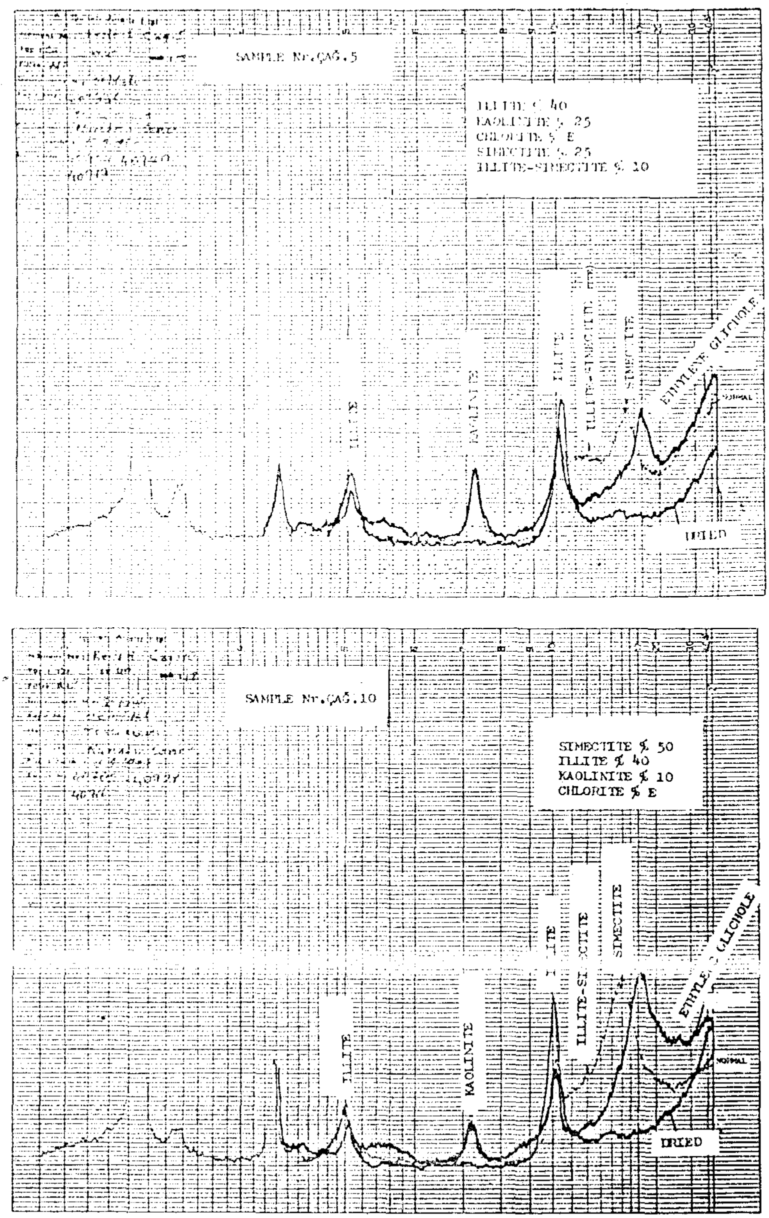
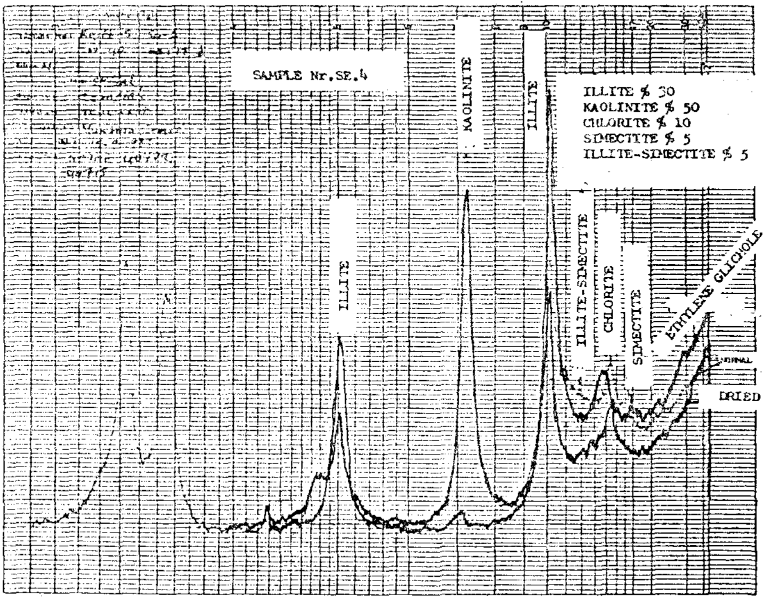


Figure-9: The x-ray difrackometric analysis results of clay mineral sample for ÇAĞ.5 and 10 of Çağlayan formation.



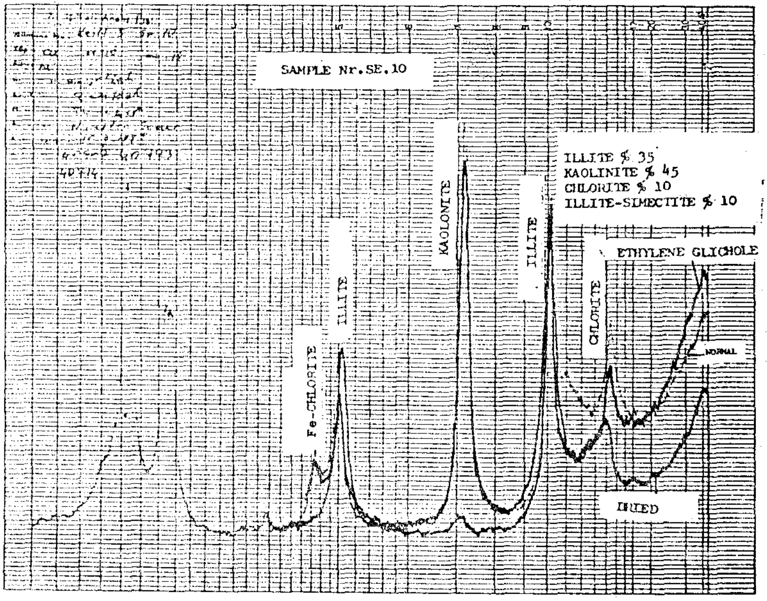


Figure-10: The x-ray difractometric analysis results of clay mineral sample for SE.4 and 10 of Çağlayan formation.

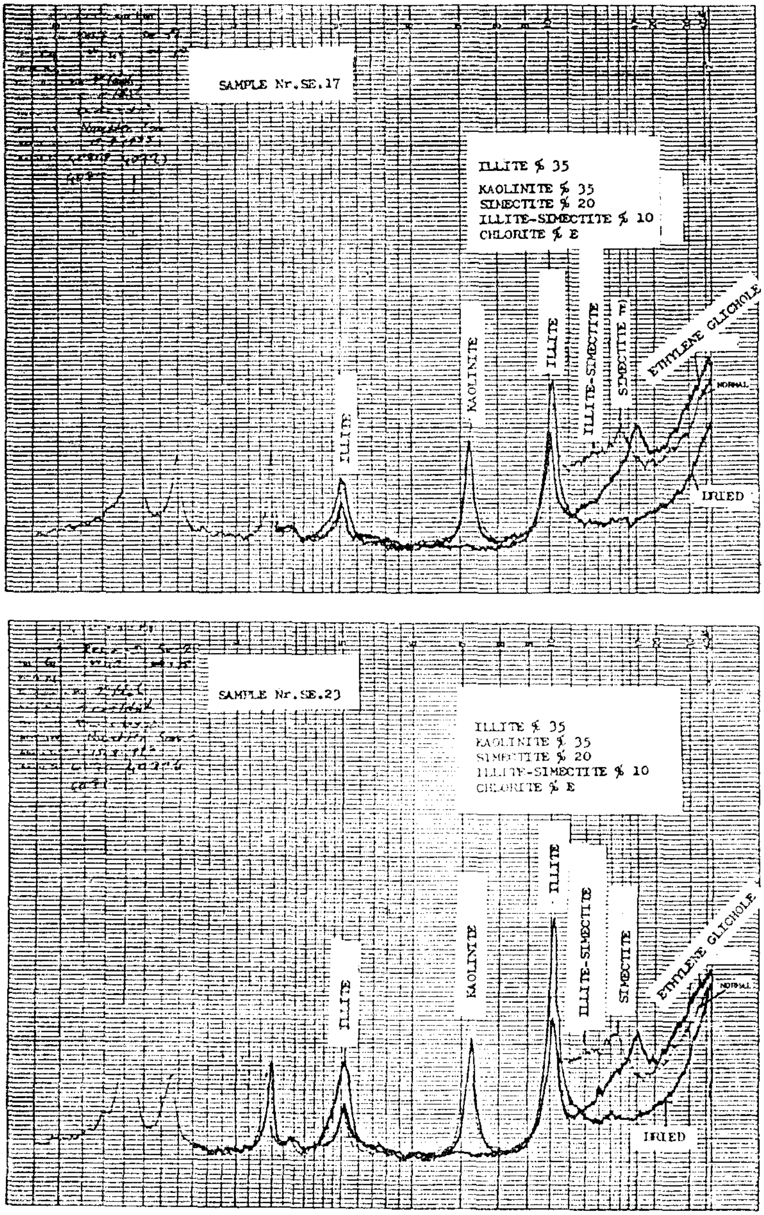


Figure-11:The x-ray difractometric analysis results of clay mineral sample for SE.17 and 23 of Çağlayan formation.

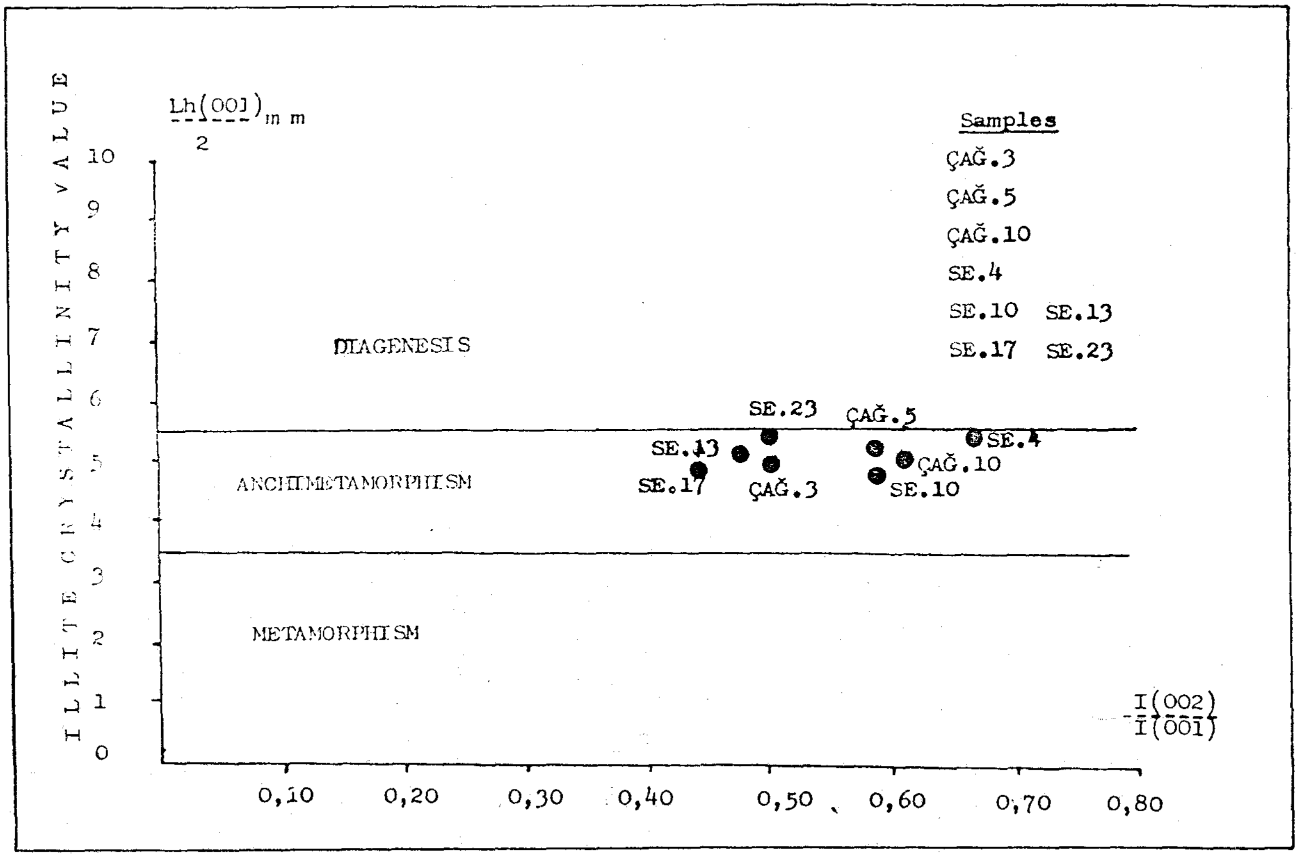


Figure-12:The illite crystallinity values of the samples of Çağlayan formation

Figure 13. Maturation and different organic matters of shale samples

Sample Nr.	Formation	SCI	Amcrphour	Vegetal	Wooden	Coaly
ÇAĞ. 5	Çağlayan	6.5	40	25	20	15
ÇAĞ. 10	Çağlayan	4.0	15	40	15	30
Ç. 8	Çağlayan	5.0	20	20	30	30
SE. 4	Çağlayan	5.5	10	20	35	35
SE. 13	Çağlayan	5.0	30	15	25	30
SE. 23	Çağlayan	4.5	10	15	20	55

SCI–spor color index

Amoung these analyses, organic geochemistrial analyses and maturity experiments were accomplished in research laboratories of petroleum company of Turkey and clay mineral difractometric analyses were completed in research center of Hacettepe Universicity and Union Turkey Cement Producers.

3.1. Determination of Laboratory Data

Most of 18 samples, on which total organic carbon analyses were carried out, belong to Çaglayan formation (Fig. 8). According to data of the samples, the formation has petroleum source rock specifications. The samples with the numbers of ÇAG. 3,4,5,6,8, C.8 and C. 11, which were taken from the lower part of the formation, have rich organic matter contents.

From this point' it is said, Çağlayan formation can be a good petroleum source rock and can produce petroleum and naturel gas.

Two samples of Kusuri formation exhibit the values on limit level. According to these data this unit can not be accepted as a petroleum source rock.

Genetic potantial values calculated from pyrolise results of 7 samples were found between 0.65 and 2.55 (fig 7). Although, ÇAG. 3, 4 and ÇAG. 5 marked samples exhibit medium degree source rock potantial, genetical potantials of other samples are less than 2. that means, this unit can not be petroleum source rock and rarely produce gas.

Relations between total organic carbon and T max of 7 samples, on which pyrolise experiment carried out, were established (Fig. 14). According to these relations; space which is shown by the data, point out type II and III of kerogen types. These results provide good connections with genetic potantial data.

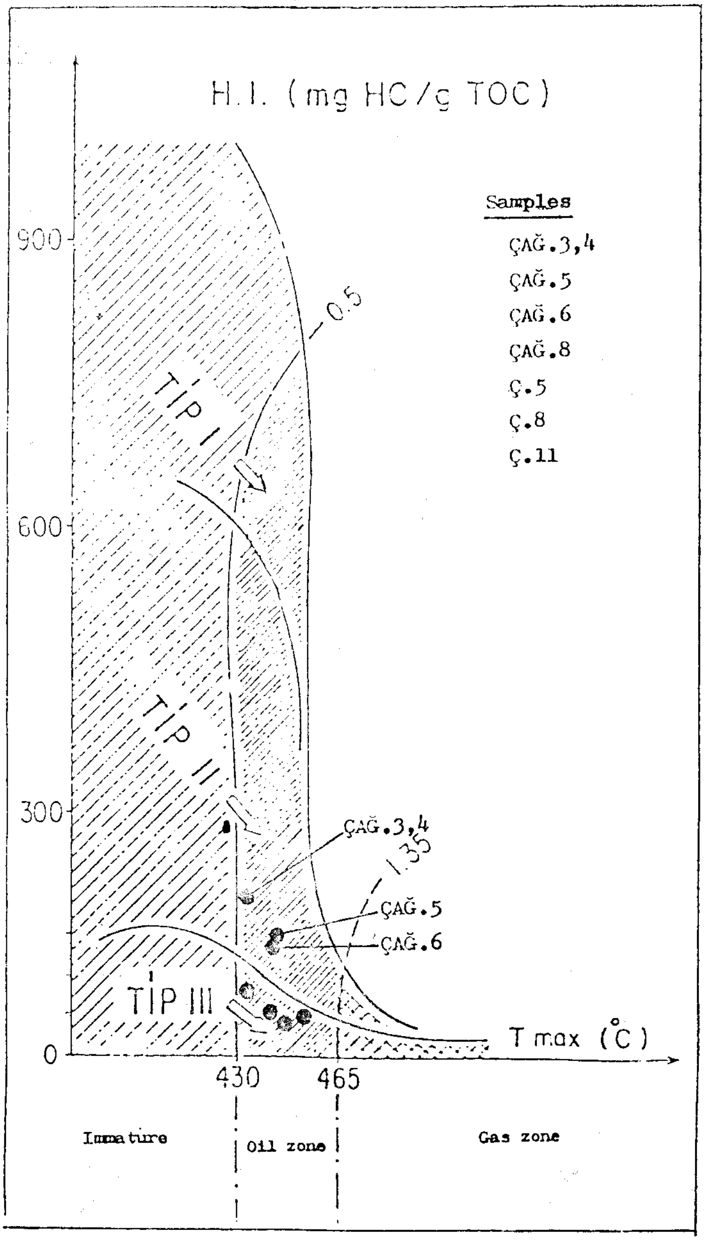


Figure-14:Organic material type and maturity of shale samples

Kerogen types of the samples taken from Çağlayan formation point out that units may give petroleum at lower parts and gas upper parts. These specifications may also shown that Çağlayan formation has deposits in an environment which has been getting shallower.

According to the matter types and maturity analyses, organic matters in Çağlayan formation matured enough and reached metagenes period (Fig. 14). Spore colour indexes shows that the formation reachs a petroleum and gas giving level. Different types of matters are found into organic matters types. It is know that these types of matters may produce petroleum and gas.

Spore coloure indexes have a little high values. These show that samples may not be taken from lower part of the formation.

X–ray difractometric analyses of 12 samples, taken from Çaglayan formation which exhibits petroleum source rock appearance were carried out. Amoung these samples for 8 samples only clay mineral x–ray analyses performed.

Analyses results are follows; illite 25–35 %, Kaolinite 10–50 %, smectite 20–50 %, illite–smectite 10–20 % and chloride 10 %. During clay–mineral paragenesis, smectites are getting reduced with increasing depths and complex layered illites$_+$smectites and chlorides replace with smectites (Fig. 9, 20 and 11). Generally, big amount of complex structure clay minerals are seen in the samples, besides, this amount is getting bigger by increasing depths. From this point, Çaglayan formation is mature enough to give petroleum and gas. This conclusion agrees with pyrolise and maturity analyses results.

Besides occurrence periods of clay minerals also agree with occurence and maturity periods of petroleum. Illite crystallinite indexes, calculated from x-ray diagrams of illite minerals, show that the formation sank enough to produce petroleum and may give petroleum.

4. CONCLUSION

According to geochemistrial and x-ray difractometric analyses of the samples belonging to Caglayan formation, followings are found.

1. Amount of total organic matters of 16 samples taken from Caglayan formation are around 0.43–1.66 %. These data indicated that the formation could be a petroleum source rock.

2. Amount of total organic matters of 2 samples taken from Kusuri formation are around 0.59–0.82 %. From the wiev point of petroleum source rock, these data show that the formation is in a limited area.

3. Genetic potantial values calculated using pyrolise data of 7 samples taken from Caglayan formation, are between 0.65 and 2.55. If it is though that genetic potential value of a petroleum source rock is more than 2, in this case, it is though that lower part of the formation may be a medium degree petroleum producing source rock.

4. According to the matter types and maturity analyses, kerogene types are tip II and tip III and the formation may give petroleum and natural gas.

5. Spore colour indexes of the samples show that formation reach enough maturity to give petroleum and natural gas.

6. By applying x-ray difractometer analyses on 12 shale samples, Clay mineral paragenesis of illite, illite-smectite and kaolinite were determineted. Occurency of illite and illite crystalinity index agree with petroleum occurency zones. These data indicate that Caglayan formation could be a petroleum source rock and organic matter reach a mature level.

7. In order to determine petrolem potantial of the units reflecting source rock appearance, systematic geochemistrial and clay-mineral analyses must be done

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