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NEOGENE - QUATERNARY STRATIGRAPHY OF KİRAZ - BEYDAĞ VICINITY, KÜÇÜK MENDERES GRABEN, WEST ANATOLIA

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ABSTRACT.- The study area constitutes the eastern end of the Küçük Menderes Graben and is underlain by the Ödemiş-Kiraz Submassif of the Menderes Masif. The Middle Miocene Başova andezite, cut the metamorphic basement and they are calc-alkaline in nature. Basalts and andesites are considered to be the products of the common igneous activity because their trace element compositions. During the Late Middle Miocene time the Kiraz basin way stated to form. In this extensional basin small lakes were formed with algae and ostracoda populations. At the beginning the basin was connected to an open sea but later it was controlled by rivers with alluvial fan deposits. The Suludere formation consist of lacustrine and fluvial sedimentary rocks and yield ostracoda fossils of the Middle to Late Miocene. This formation overlaps the metamorphic basement and the volcanic rocks and unconformably covered by the Aydoğdu formation. This unit consists of alluvial fan deposits which were formed along high angle faults. The Aydoğdu formation includes semiconsolidated poorly sorted and laterally digitated sedimentary rocks. The alluvium covers the youngest depresion. The faults controlled the extensional basin and the geometry of the sediment in fill. These faults are a few kilometers in length and bring the various Neogene units in contact with the older units. The high angle active faults control the present morphology of the area.

Key words: West Anatolia, Küçük Menderes Graben, Neogene- Quaternary continental sedimentary rocks, Neogene volcanism.

INTRODUCTION

There are several studies on the structure of the Küçük Menderes graben (Philippson 1910-1915, 1918, Erinç 1955, Ketin 1968, McKenzie 1978, Dewey and Şengör 1979, Dumont et al. 1979, Angelier et al. 1981, Şengör 1982, 1987, Jackson and McKenzie 1984, Şengör et al. 1984, 1985, Rojay et al. 2001, Emre et al. 2003, Bozkurt and Rojay 2005, Rojay et al. 2005, Emre and Sözbilir 2006 *b*) and Neogene rocks of the region (Ozansoy 1960, Nakoman 1971, United Nations 1974, Kaya 1987, Gemici et al. 1992, Ercan et al. 1996, Emre et al. 2005, Emre and Sözbilir 2006 *a*) which the geological studies have been started many years ago in Western Anatolia (Hamilton and Strickland 1840, Tchihatcheff 1869, Phillipson 1911-1918).

There are different models on the origin and age of extensional tectonic regime dominated Western Anatolia and related graben formation. a- Some investigators suggest that a N-S tension forces originated from westward escape ("tectonic escape") of the Anatolian platelet between the North and East Anatolian Faults during Late Serravallian initiated the formation of the grabens (Dewey and Şengör 1979, Şengör 1979, 1982, 1987, Şengör et al. 1985, Görür et al. 1995). b- Another model suggests that the extensional regime in Western Anatolia started in Early Miocene (McKenzie 1978, Le Pichon and Angelier 1979, 1981, Jackson and McKenzie 1988, Okay and Satır 2000). The "Back arc spreading model" explains that the formation of the grabens are due to back arc spreading of the region caused by the southward N-S tension forces formed as migration of the Aegean Arc. c- According to the "orogenic collapse" model, N-S trended extension dominated Western Anatolia commenced by Late Oligocene-Early Miocene (Seyitoğlu and Scott 1992, Seyitoğlu et al. 1992). d- In the fourth

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model, it is proposed that the extension affected Western Anatolia by two different mechanisms. This model claims that orogenic collapse controlled by low-angle normal faults in Early Miocene is followed by a rifting stage formed under the effect of high-angle faults. The second stage also maintains its development under the effect of North Anatolian fault (Sözbilir and Emre 1996 *b*, Koçyiğit et al. 1999, Bozkurt 2000, 2001 *a-b*, 2003, Bozkurt and Sözbilir 2004). Similarly, the relationship between geochemical features of Late Cenozoic volcanism in Western Anatolia controlled by regional tectonic evolution and time is controversial. Geochemical character of the volcanism being active from Late Eocene period (Ercan et al., 1995) up to the recent times (Richardson-Bunbury, 1996) in Western Anatolia, varies from acidic to basic (Ercan et al., 1985, Yılmaz, 1990). This volcanism is considered to be a product of thickened continental crust in the region due to the orogenic activities (Şengör 1980, Şengör and Dewey 1980, Şengör and Yılmaz 1981, Şengör et al. 1984, Fytikas et al. 1984, Pe-Piper and Piper 1989, Gülen 1990, Aldanmaz et al. 2000). According to some researchers, Western Anatolia was under the effect of N-S trend compression during Late Oligocene-Middle Miocene and magmatism commenced when thickened upper continental crust fractionally melted (anatexis) at depths, compressional tectonic regime ended in the presence of WNW-ESE trended extensional regime and NE-SW trended weakness zones, there were generally calcalkaline, continental crust volcanics and some hybrid intracontinental volcanics in these zones. Lithospheric thickness decreases owing to the fact that N-S trend extensional regime commenced in Middle-Late Miocene, and alkaline magmatism of mantle together with E-W trend graben structures existed from the latest Late Miocene-Pliocene to recent (Keller 1969, Borsi et al. 1972, Keller and Villari 1972, Dewey and Şengör 1979, Sunder 1979, Ercan 1981, 1982, 1987, Şengör and Yılmaz 1981, Ercan and Öztunalı 1982, Ercan et al. 1984, Ercan et al. 1985, 1996, Yılmaz 1989, 1990, 1997, 2000, Savaşçın 1990, Savaşçın and Güleç 1990, Güleç 1991, Yılmaz et al. 1994, 2000, 2001). According to some researchers, N-S trending extensional regime has been active since Late Oligocene in West Anatolia and compositional change in associated volcanism is due to the asthenospheric contribution (Seyitoğlu and Scott 1991, 1992, Seyitoğlu et al. 1992, 1997).

It is considered that E-W trending Küçük Menderes valley is one of numerous E-W and WNW-ESE trending grabens like Gediz and Büyük Menderes developed under the effect of approximately N-S tension forces based on the conducted studies (Philipson 1910-1915, 1918, Ketin 1968, McKenzie 1978, Jackson and Mc Kenzie 1984, Şengör 1987, Şengör et al. 1984). It is reported that a significant, northward dipping fault is traced at western half of the south rim on Küçük Menderes valley (Erinç 1955, Şengör et al. 1985) and through just southeast of Ephesus ancient city (Dumont et al. 1979, Angelier et al. 1981) to Aegean Sea. Rojay et al. (2001 and 2005) state that Küçük Menderes Graben develops on an E-W trended syncline among Beydağ-Gökçen-Tire-Belevi. There are three stages of the deformation and a counterclockwise rotation movement in the region after Miocene period. Strike-slip regime in the first stage, caused by N-S compression, is followed by WSW-ENE trending extensional regime with a strike slip component, and in the last stage seismically active at the present in which NW-SE and NE-SW extensional regime is dominant. To Bozkurt and Rojay (2005), a short-ranged N-S trending compressional stage is present between the extensional phases forming low- and high-angled normal faults in the region, respectively.

Only few of the previous studies are related with the Neogene rocks at the eastern part of Küçük Menderes Graben which is a subject of this article (United Nations 1974, Ercan et al. 1996, Rojay et al. 2001, Emre et al. 2003, Bozkurt and Rojay 2005, Emre et al. 2005, Rojay et al. 2005, Emre and Sözbilir 2006 *a*).

Rojay et al. 2001 and 2005 suggest that secondary basins, on which Neogene-Quaternary clastics deposited and developed at various directions, exist on the Küçük Menderes Graben. Of these, Miocene-Quaternary aged sediments have deposited in Kiraz, Dağkızılca-Torbalı and Selçuk regions and Quaternary sediments have deposited in Ödemiş and Bayındır areas. Bozkurt and Rojay (2005) and Rojay et al. (2005) have no paleontological and radiometric evidences for the age determination of the sedimentary and volcanic rock units in Kiraz basin.

In this study, with using paleontological and radiometric age determinations Neogene-Quaternary rock units were discerned (Figure 1). Firstly determined micropaleontological evidences and the radiometric age data of the volcanics in the region confirm eachother. In this article, stratigraphy of the sediment filling, the facies properties and findings related the age of Kiraz basin will be given in details (Emre ve Sözbilir 2006 *a*), and the Neogene aged volcanics which is a subject to another paperwill be shortly discussed.

STRATIGRAPHY

Precambrian-Mesozoic aged schists, marbles, orthogneisses, paragneisses and metagabbros of Ödemiş-Kiraz Submassif in Menderes Masif constitute the basement rocks (Candan et

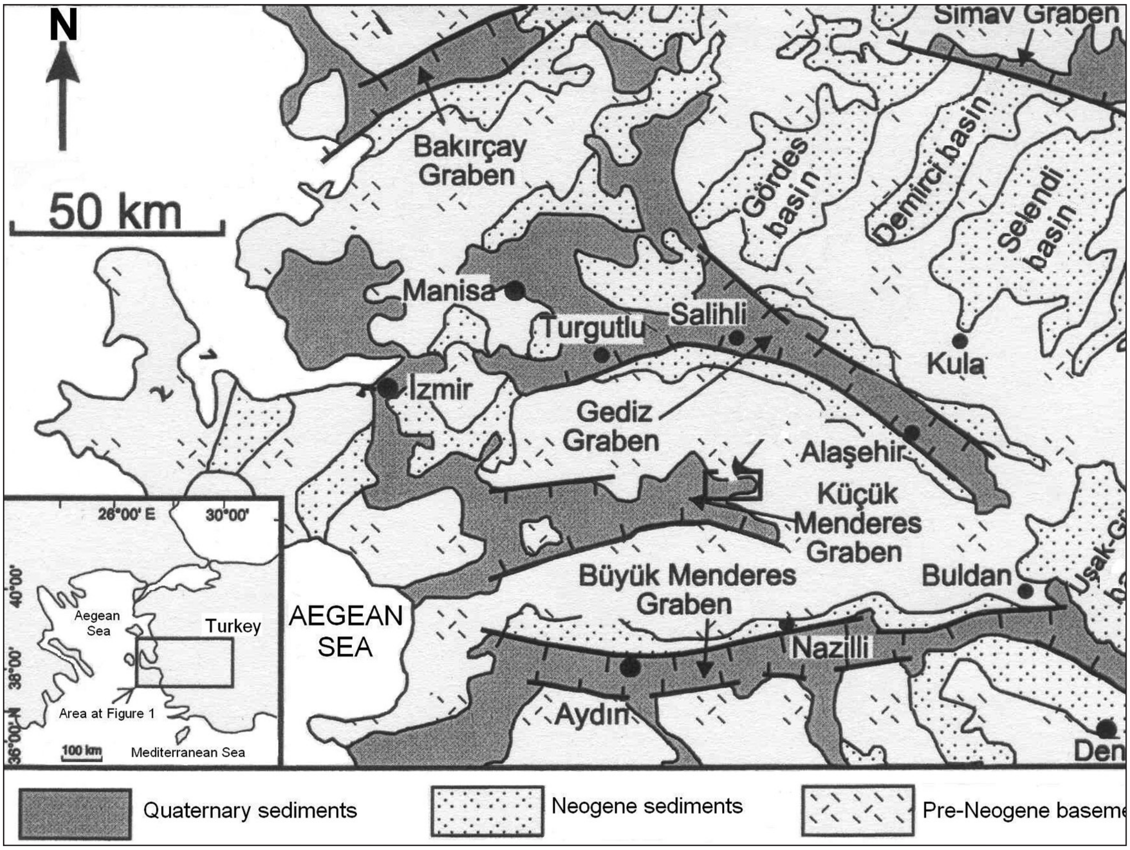


Figure 1- Location of the Study Area (modified from Bozkurt, 2000).

al., 2001). Başova andesites, Suludere formation, Aydoğdu formation and alluvium overlay this basement unconformably (Figure 2).

BAŞOVA ANDESITES

Başova andesites which exposed at three localities (Figure 3) are composed of dykes,

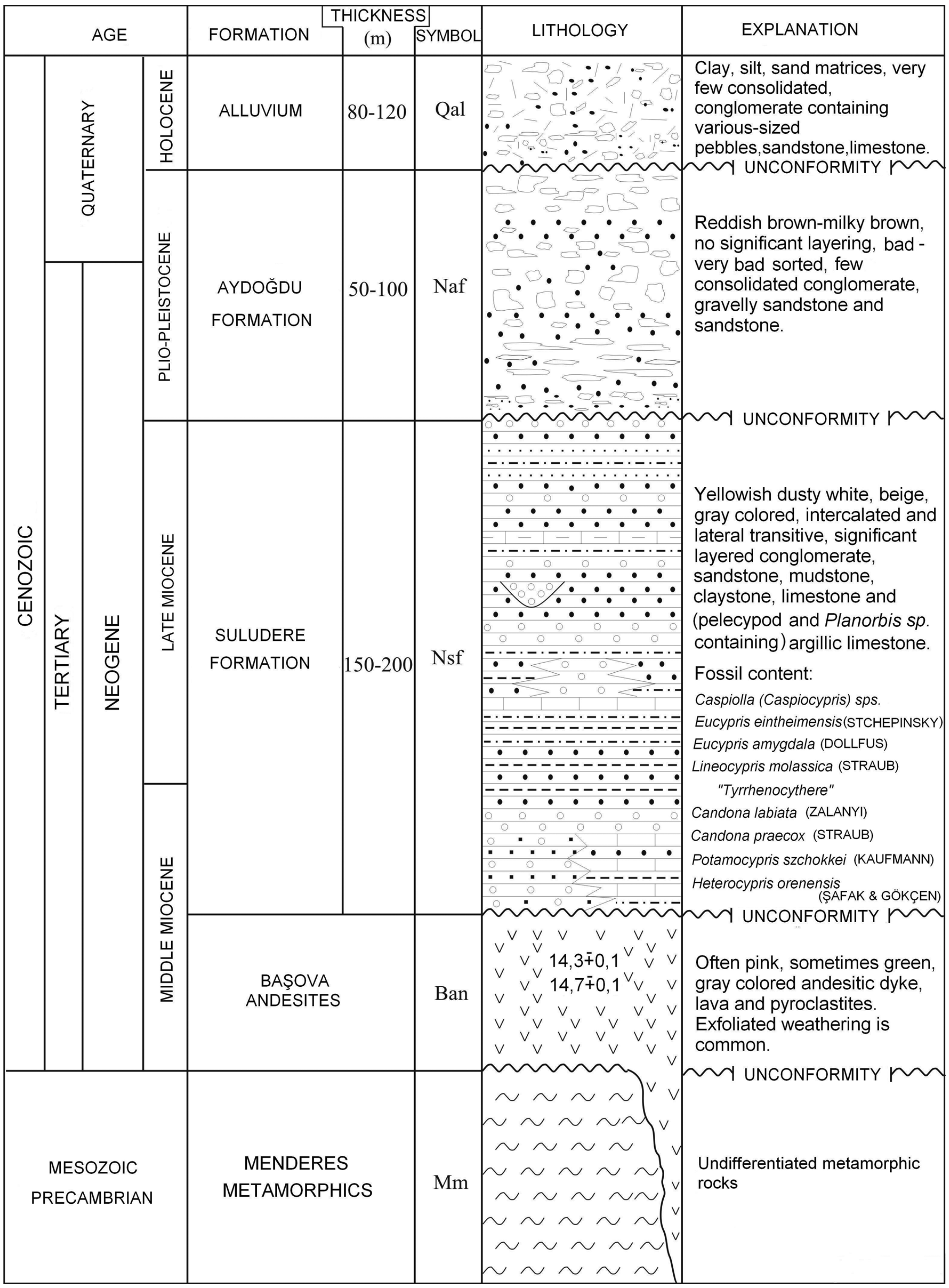


Figure 2- Generalized Stratigraphic Column of the Study Area.

lavas, volcanic breccias and pyroclastites. Volcanics mainly composed of andesites and basaltic andesites, are generally pink, gray and greenish gray in color. These volcanic rocks owning hypocrystalline porphyritic and some hyalopilitic textures contain phenocrysts of plagioclase, biotite, amphibole and pyroxene minerals. The matrix is composed of glass-microlites. Microlites have no obvious orientation, but some are observed as to circle some of the phenocrysts. The various-sized xenoliths of schist and gneiss including andesites, where intrude metamorphic rocks, commonly tend to display limonitisation and kaolinitisation. Radiometric age ($^{40}Ar/^{39}Ar$) of the weathered parts of which are yellowish, orange and red colored, of the volcanic rocks is among 14,3±0,1 and 14,7±0,1 million years (Emre and Sözbilir 2006 *a*). Trace element distributions of these calcalkaline andesitic rocks which there is a small difference of age between them, point out that those are derived from probably a similar source. Trace element and rare earth element variation diagrams of volcanic rocks generally resemble the pattern of calc-alkaline arc volcanic rocks or orogenic volcanic rocks (Emre and Sözbilir 2006 *a*).

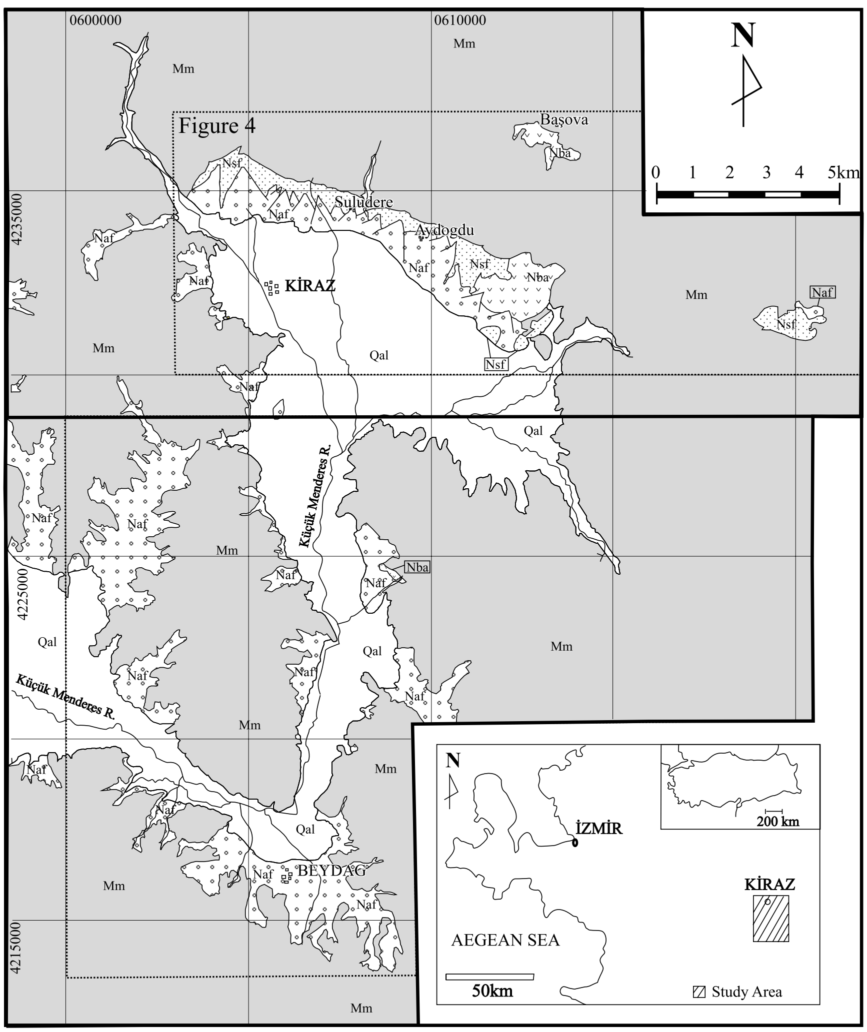


Figure 3- Simplified Geological Map of Kiraz - Beydağ Vicinity.

SULUDERE FORMATION

Definition

The unit exposed around Kürlüorman Hill, 8 km east of Taşlı Hill in the north and northeast of Kiraz covers a total area of 7 km², in addition, it is exposed in small areas on N and S rims of the Küçük Menderes River valley in the North of Beydağ and around Avunduruk area, 8 km southeast of Kiraz (Figure 4 and 5). Because the best observed outcrops are around Suludere, the formation is called as "Suludere formation". Generally yellowish, dusty white, beige and some gray and greenish gray colored unit consists of lacustrine and fluvial sediments.

Lithology

The unit presents a succession including varies in composition, color, texture and thickness of conglomerates, gravelly sandstones, sandstones, mudstones, clayey limestones and limestones displaying vertical and horizontal transitions, intercalations, interfingering and interlayerings. Thickness of lacustrine carbonate deposits, often found at bottom levels of the sequence, is less than 12 meters.

Conglomerates are of yellow-orange, milky white, gray-dusty white colored, bad-medium (some well) consolidated, and medium-thick-very thick layered. These sediments, generally half-matured and some unmatured or matured, have a range of very bad to well sortings. Sometimes normal or reverse gradings are seen from bottom to the top. Conglomerate occasionally pass to gravelly sandstones and the latters also pass to sandstones. Often angular, jagged edged, round or platy gravels have a low sphericity. Gravels have a ratio of between 20 % - 80 %, and a varying sizes between few millimeters to large boul-

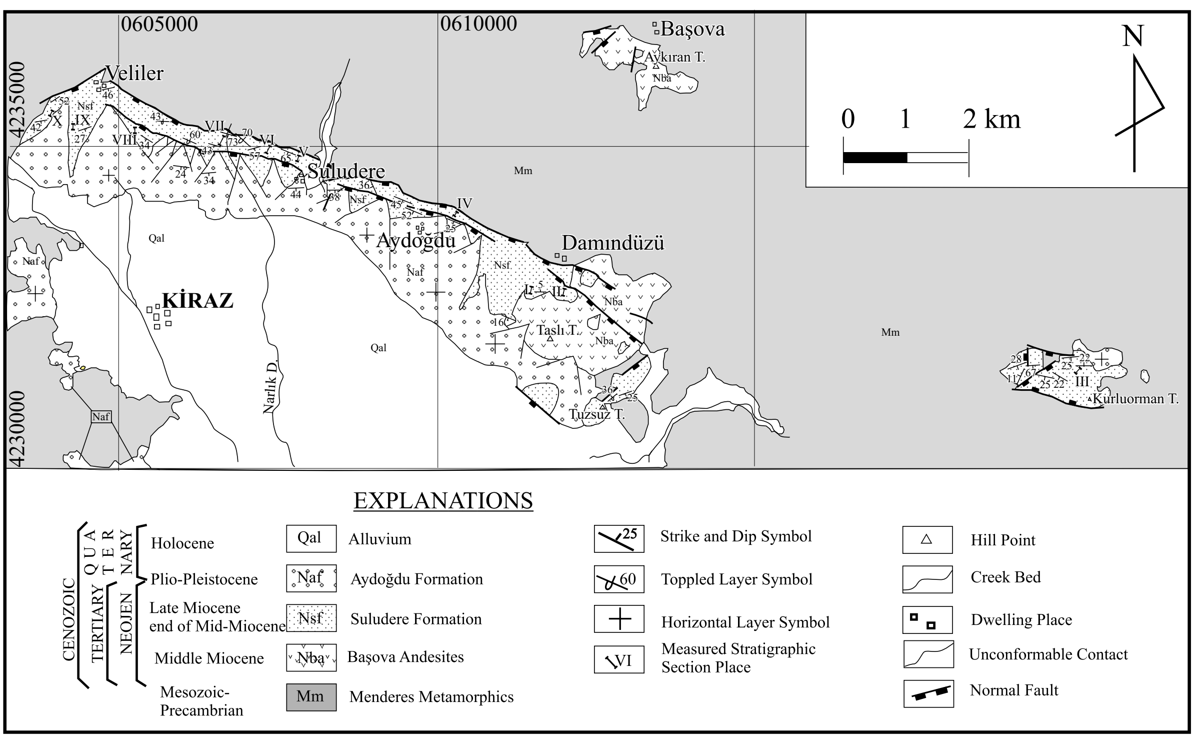


Figure 4- Geological Map of Kiraz Region.

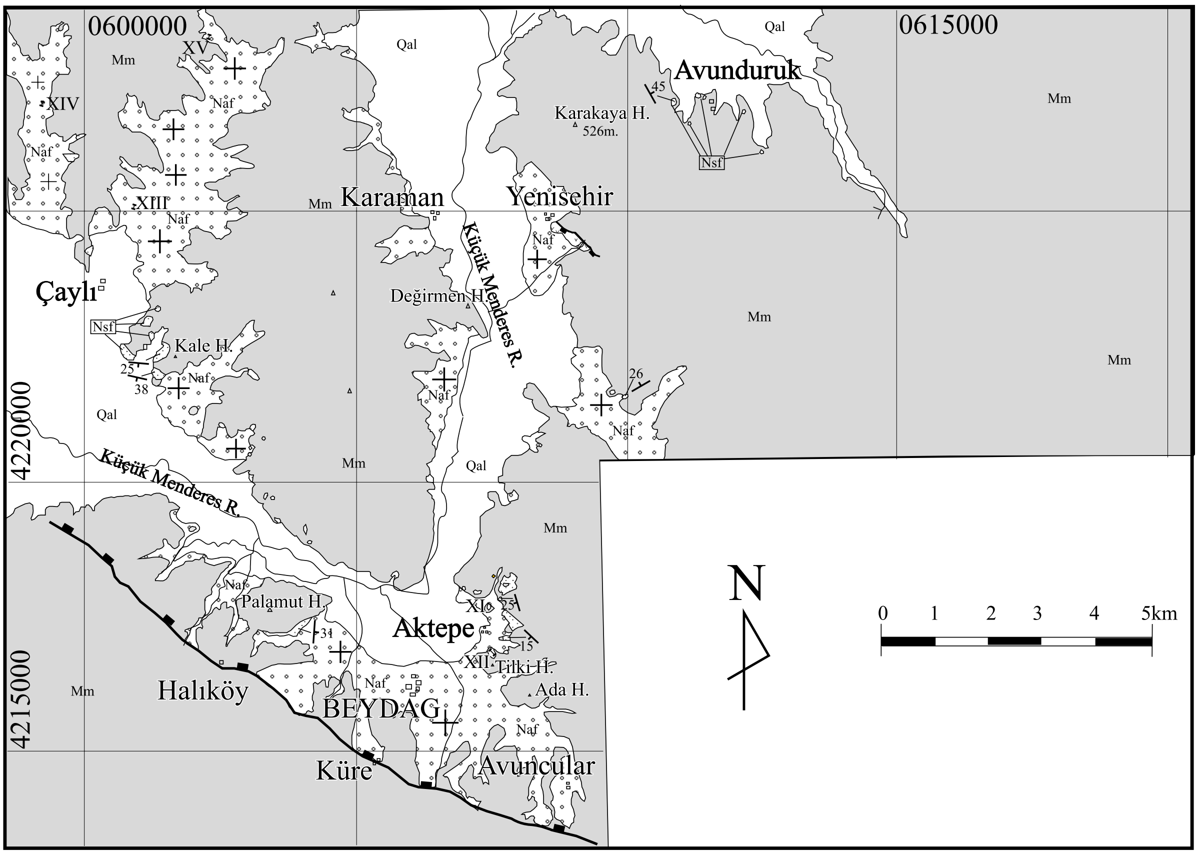


Figure 5- Geological Map of Beydağ Region (see Figure 4 for the Explanation).

ders (rarely 80-90 x 60 cm). Nearly all grains were derived from metamorphics. The ratio of andesitic pebbles seen occassionally seems to be up to 1 %. The ratio of metamorphic derived gravels changes: Dominant grain type depends on the supply area. In some parts, they may contain 60 % of marble, 20 - 30 % of schist and of minor quartzite or 60 % of schist, 20 - 30 % of marble, in some places 60 - 90 % of gneiss and remaining schist and metaquartzite, sometimes 45 % of schist and 50 % of gneiss. Conglomerates with matrix- or grain-supported texture have generally fine-coarse sand, fine gravel-coarse sand and some clay-sand matrices. At the lower parts of the succession, the cement is composed of algal limestone or of clayey-silty-sandy carbonates. Conglomerates have some interfingers and lenses of sandstone and gravelly sandstone with varying thicknesses. Conglomerate levels, displaying different packing and sorting properties are intercalated or well sorted conglomerates include badly sorted conglomerate lenses. Long axis of gravels or large surfaces of platey gravels are generally parallel to stratification.

Sandstones are dusty white, gray, milky white-beige, greenish, yellowish, milky brown colored, often few-medium, some well and some very few consolidated, and generally fine, some very fine or medium-coarse grained, and often medium-thick, rarely laminated, thin or very thick layered. They rarely display cross-stratification. The regular layers generally have some fining upward. Occasionally gravelly, coarse grained sandstones at the base change upward to fine grained sandstones and some claystones or clayey-sandy limestones. Sandstones contain bird's eye voids, fine angular andesitic gravels and oval carbonate nodules in some parts, and have a black-gray dotted appearance thanks to abundant mica flakes. Sandstones are sometimes intercalated with conglomerates or mudstones, and they have some lenses or interfingers of gravelly sandstone and conglomerate, rarely claystone, milky white clayey limestone or limestone.

Gravely sandstones are greenish-light gray, light brick red, light brown colored, and medium-well consolidated, and well-medium sorted, and medium-thick layered. These levels changing to conglomerate and sandstone or display succession with them may include some interfingers of mudstones. Grain size of scattered gravels within medium-coarse grained sandstones range from 3 mm to 5-10 cm, but dominant grain size is between 2-3 cm and 5-6 cm. They also include scarce small andesite gravels smaller than 5 cm or 8-10 cm long platy schist gravels. Long axis of the gravels or wide surfaces of platy gravels seem to be parallel to the stratification in general.

Claystones and mudstones are gray, beige, reddish, light brown, light gray, greenish gray colored, and generally bad-medium packed, some well packed, poorly compacted, and medium-thick, some fine layered or laminated. These levels, which are intercalated with each other, may be lenses or interfingers of another level. Mudstones intercalated with clayey limestones or sandstones sometime, may include some lenses or interfingers of sandstones, conglomerates, gravelly sandstones, gravelly mudstones, clayey limestone and limestones. Claystones and mudstones have rare *Planorbis* sp. fossils, calcareous nodules or scattered pebbles.

Limestones are dusty white, beige, milky white, light gray, milky brown colored, and fine-medium and thick layered, and compacted (Plate 1-a). Limestones contain algal-wrapped reed spikes, intraformational gravels, small oval limestone nodules, spherical algal bioherms with varying diameter between 3-5 cm and 25 cm (Figure 6), oncoidal stromatolites, and pelecypod and Planorbis sp. fossils (Plate 1-d). Some of the voids caused by rotting algal-wrapped reeds or other plant fragments have calcite-crystalled walls. Limestones, which are of a spotted appearance, silicified and manganous dendrites in some parts, are considerably tough. Algal limestones comprising superposed algal bioherms or semi-spherical stromatolites (Plate 1-b) laterally pass to sandy or clayey limestones. Sandy limestone levels are less observed than clayey limestone levels.

Algal limestones are intercalated with sandy and clayey limestones (Plate 1-c), laterally and

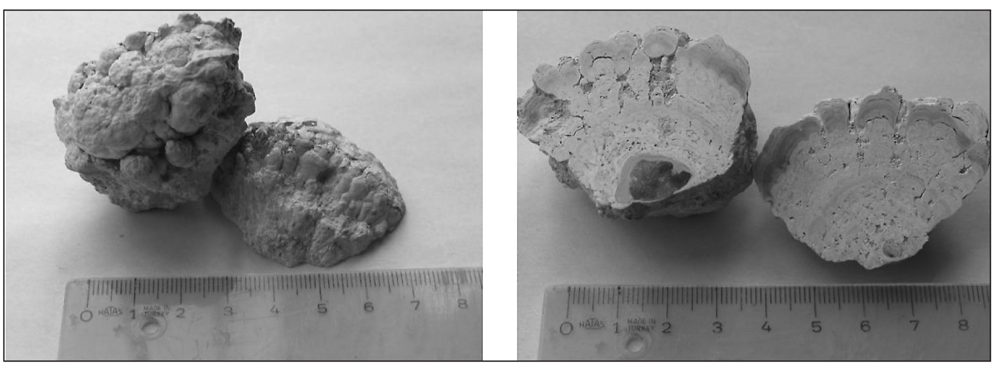


Figure 6- (a) Exterior and (b) Polished Surface Views of Spherical-Subspherical Algal Bioherms.

vertically passing to sandstones and mudstones in some places, and mudstones in some places. Light gray-beige clayey limestones are composed of layers between 2 and 30 cm thick, and include some 1-2 mm wide bird's eye voids, plant spikes or angular-jagged schist or andesite gravels with varying size between 2 mm and 3-4 cm.

The sequence I, seen at 700 m north-northwest of Taşlı Hill, has a thin basal conglomerate level at the top followed by limestone-mudstone intercalation. Sandstones are dominant. There are limestone (Plate I-e), claystone and mudstone levels between sandstones (Figure 7, see Table 1a- for fossil content of the samples).

The sequence II observed at 600 m north of Taşlı Hill, is composed of sandstones with thin clayey limestone and conglomerate levels, underlain by andesites and conglomerates (Figure 8, see table 1b- for fossil content of the samples). Clayey limestones, which have varying thickness between 3 and 8 cm (Plate I-f), contain plant spikes and small angular-sub-angular andesite gravels.

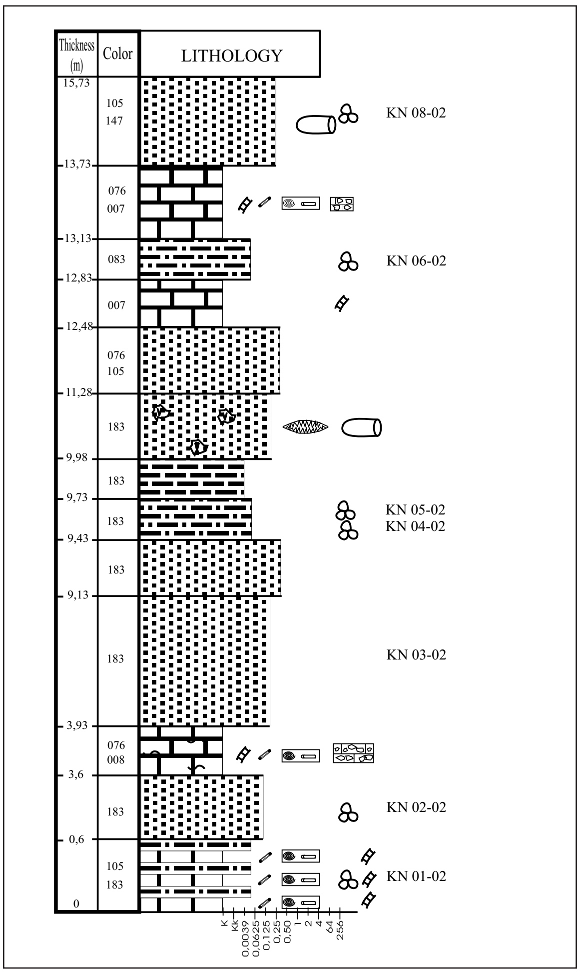


Figure 7- Part of Measured Stratigraphic Section from Suludere formation (11555/32670) Section I (N of Taşlı Hill). (see Figure 30 for the Explanation).

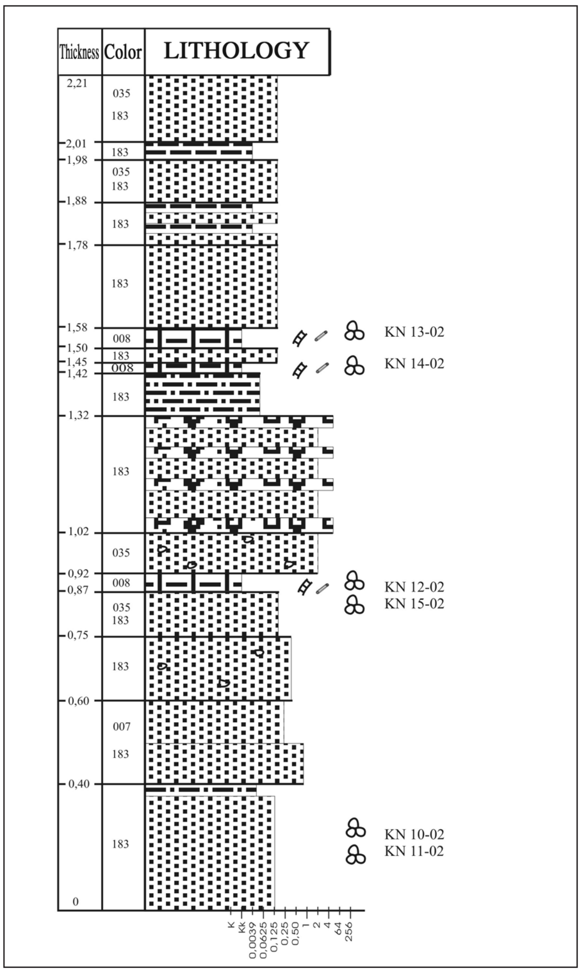


Figure 8- Part of Measured Stratigraphic Section from Suludere formation (11860/32890) Section II (N of Taşlı Hill). (see Figure 30 for the Explanation).

Table 1- Fossil Content of Measured Section Localites

Sample No	Fossil content (SECTION I)
KN 01-02	*Globigerinoides trilobus* (REUSS) *Globoquadrina dehiscens* (CHAPMAN PARR COLLİNS) *Globorotalia obesa* BOLLI *Globorotalia* cf. *menardii* (d'ORBIGNY)
KN 02-02	*Globorotalia* cf. *menardii* (d'ORBIGNY) *Globorotalia obesa* BOLLI
KN 03-02	*Orbulina universa* d'ORBIGNY *Globoquadrina dehiscens* (CHAPMAN PARR COLLINS) *Globigerinoides trilobus* (REUSS) *Globorotalia* cf. *menardii* (d'ORBIGNY) *Globorotalia obesa* BOLLI *Hastigerina* cf. *siphonifera* (d'ORBIGNY)
KN 04-02	*Globorotalia* cf *obesa BOLLI* *Orbulina universa* d'ORBIGNY *Hastigerina* cf. *siphonifera* (d'ORBIGNY) *Globoquadrina* cf *altispira* (CUSHMAN ve JARVIS) *Globorotalia* cf. *menardii* (d'ORBIGNY) *Globigerinoides trilobus* (REUSS) *Globigerinoides obliquus* BOLLI
KN 05-02	*Globorotalia* cf *obesa* BOLLI *Globigerinoides obliquus* BOLLI *Globigerinoides trilobus* (REUSS)
KN 06-02	*Globigerinoides trilobus* (REUSS) *Globigerinoides* cf. *obliquus* BOLLI *Globorotalia* cf. *menardii* (d'ORBIGNY) *Globorotalia obesa* BOLLI
KN 08-02	*Globorotalia obesa* BOLLI Undetermined, badly preserved Foraminifera like *Globigerina, Globigerinoides.*

a

Sample No	Fossil Content (SECTION II)
KN 10-02	*Globigerinoides trilobus* (REUSS) *Orbulina universa* d'ORBIGNY *Globoquadrina dehiscens* (CHAPMAN PARR COLLINS) *Hastigerina* cf. *siphonifera* (d'ORBIGNY) *Globorotalia* cf. *menardii* (d'ORBIGNY)
KN 11-02	*Globorotalia obesa* BOLLI *Globigerinoides* cf. *obliquus* BOLLI *Globorotalia* cf. *menardii* (d'ORBIGNY)
KN 12-02	*Globorotalia* cf. *menardii* (d'ORBIGNY) *Globigerinoides* cf. *obliquus* BOLLI *Globigerinoides trilobus* (REUSS) *Globorotalia obesa* BOLLI *Orbulina universa* d'ORBIGNY
KN 13-02	*Globorotalia obesa* BOLLI Undetermined Foraminifera like *Globigerina, Globigerinoides*.
KN 14-02	*Globorotalia obesa* BOLLI *Globigerinoides trilobus* (REUSS) *Globigerinoides* cf. *obliquus* BOLLI
KN 15-02	*Globorotalia* cf. *obesa* BOLLI *Hastigerina* cf. *siphonifera* (d'ORBIGNY) *Globorotalia* cf. *mayeri* CUSHMAN ve ELLISOR *Globigerinoides* cf. *obliquus* BOLLI *Globiquadrina dehiscens* (CHAPMAN PARR COLLINS) *Orbulina universa* d'ORBIGNY

b

The sequence III, seen in the north of Kürlüorman Hill starting with a mudstone-claystone intercalation has sandstones as dominant unit (Figure 9, see table 2 for fossil content of the samples). Lenses and interfingers of gravelly sandstone, conglomerate and mudstone within the sandstones are less than 15 cm thickness. Lateral extention of mudstone and claystone lenses is about 1-2 m. Lenses and interfingers of clayey-sandy limestone have thicknesses up to 25 cm. Conglomerates have carbonate and sandy cements with lateral and vertical transitions. At algal limestone-clayey limestone cemented levels, various-sized grains between 4-5 mm and 50-60 cm are wrapped and encrusted by algal limestones. Dusty white-beige colored limestones are composed of superposed algal bioherms and few gravels (Plate 2-a). Gravels, often marble, are less than 15 cm size with medium-coarse grained sand matrix.

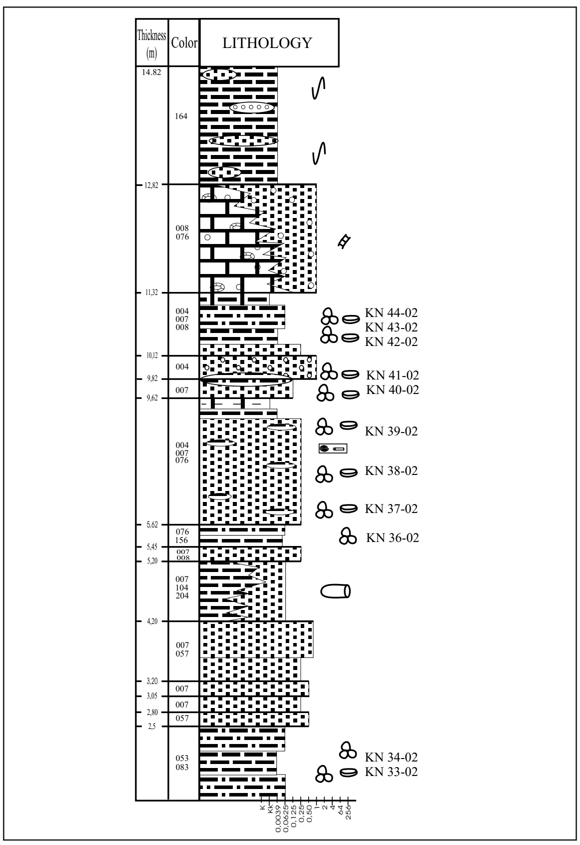


Figure 9- Part of Measured Stratigraphic Section from Suludere formation (19935/31540) Section III (N of Kürlüorman Hill). (see Figure 30 for the Explanation).

The sequence IV, seen at Çömlekçi vicinity, contains sandstone mudstone intercalations, limestone-clayey limestones, clayey limestones with mudstone interfingers and sandstone-mudstone levels, all underlain by conglomerates with thin sandstone levels (Figure 10, see table 3a for fossil content of the samples). Various-sized constituents between 3 mm and 20 cm are often 2-6 cm. Rarely observed lime cemented levels of the conglomerates pass laterally to gravelly-clayey limestones.

The sequence V observed at 250 m north of Suludere Village, is mainly composed of sandstones, mudstones and conglomerates. The sequence begins by sandstones and mudstones, and lasts by conglomerates, gravelly sandstones and sandstones, and ends by conglomerates (Figure 11). Lens-shaped interfingers are between 15 and 28 cm thick. Gravels have various sized between 2-3 mm and 50cm. Dominant grain size is between 2-3 cm and 5-6 cm in conglomerates, and between 2-3 cm and 5-6 cm in gravelly sandstones.

The sequence VI seen at NW of Suludere Village, begins by conglomerates and sandstones, lasts by mudstones, gravelly sandstones and sandstones, and ends by conglomerates (Figure 12, see table 3b for fossil content of the samples). Gravelly sandstones have gravel sizes between 4 and 5 cm, conglomerates have between 1 and 15 cm, but dominant grain size is between 3 and 8 cm.

The sequence VII observed at 150 m northwest of Suludere Village, is mainly composed of conglomerates, sandstones and mudstones. The sequence begins by gravelly sandstone-conglomerate and lasts by conglomerates, gravelly sandstones, sandstones and mudstones. Rarely

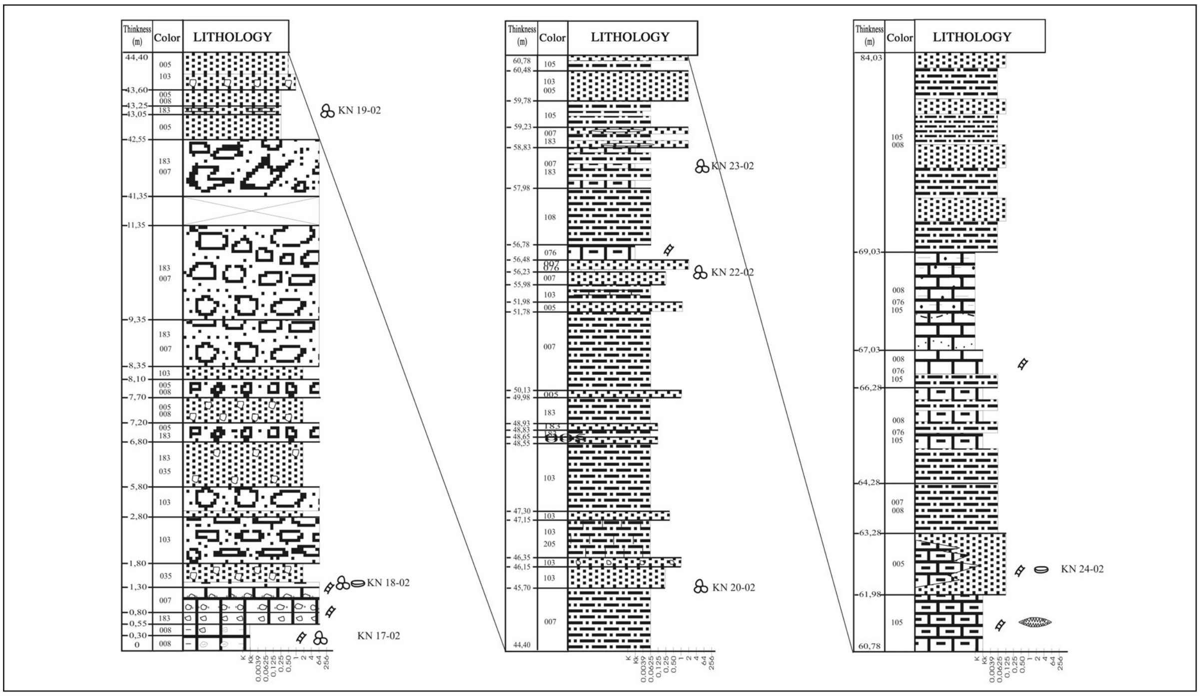


Figure 10- Part of Measured Stratigraphic Section from Suludere formation (10390/33970) Section IV (NW of Aydoğdu Village). (see Figure 30 for the Explanation).

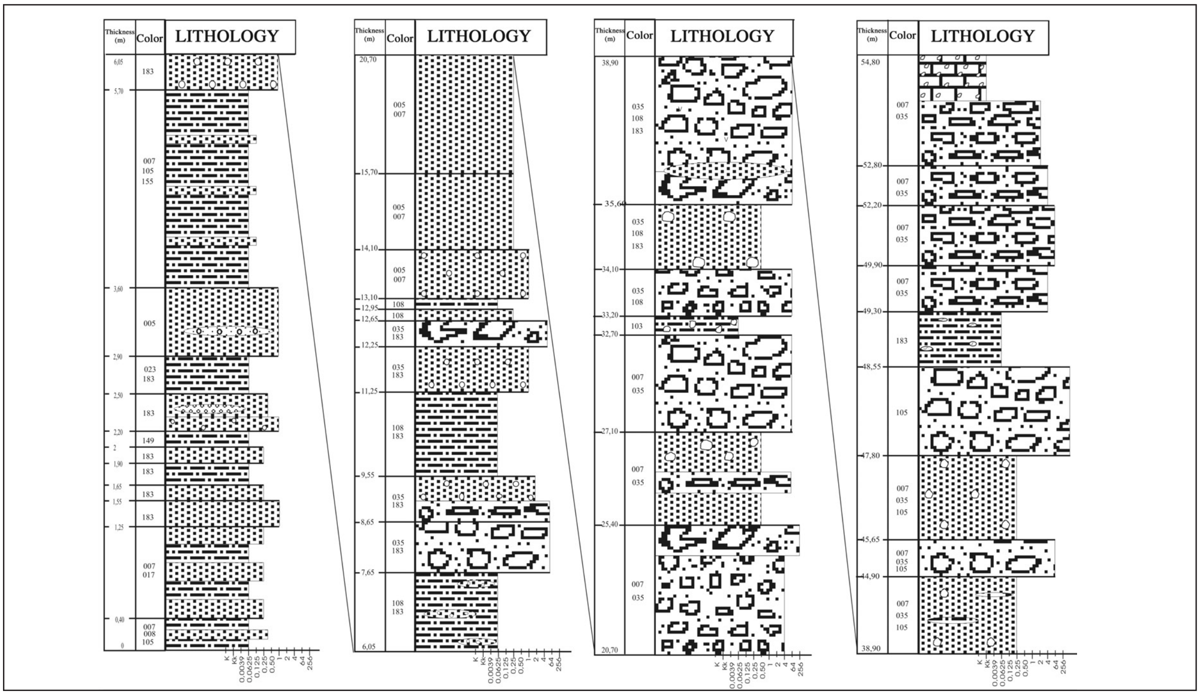


Figure 11-Part of Measured Stratigraphic Section from Suludere formation (07695/34985) Section V (N of Suludere Village). (see Figure 30 for the Explanation).

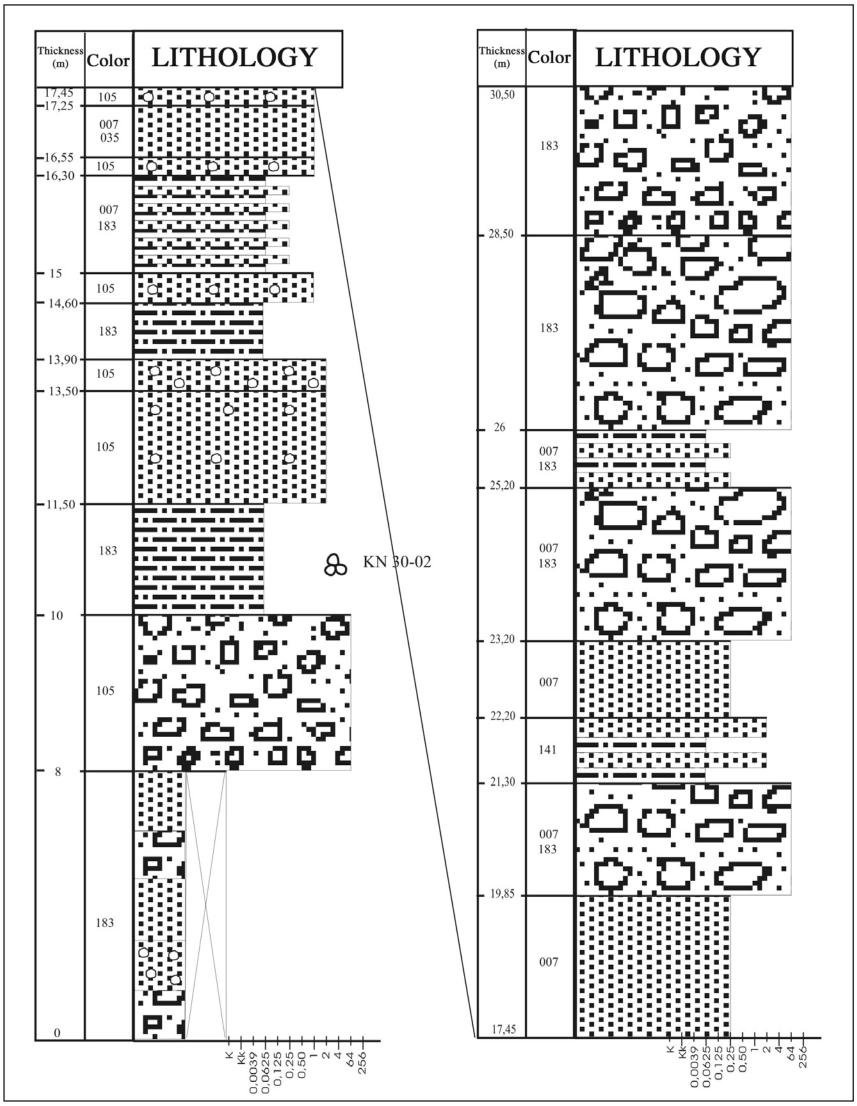


Figure 12- Part of Measured Stratigraphic Section from Suludere formation (07300/35050) Section VI (NW of Suludere Village). (see Figure 30 for the Explanation).

including claystone and clayey limestone interfingers, the sequence ends by mudstones (Figure 13, see table 2c for fossil content of the samples). Various-sized constituents between 3 mm and 40 cm are often between 3 mm and 5 cm.

The sequence VIII, seen at 650 m. to the southeast of Veliler village, is mainly composed of conglomerates, sandstones and gravelly sandstones. The sequence begins with sandstones containing of scattered gravels and conglomerates, and lasts by intercalated and interfingered successions of conglomerates, gravelly sandstones and sandstones with passing laterally and vertically each other (Figure 14). Various-sized constituents between 3-4 mm and 15 cm are often between 2 and 5 cm. 60 - 70 % of the constituents are derived from gneiss.

Table 2- Fossil Content of Measured Section Localites

Sample No	Fossil Content (SECTION III)
KN 33-02	**Ostracod:** *Candona sps.* **Foraminiferid**:*Globigerinoides* cf. *obliquus* BOLLI
KN 34-02	*Hastigerina* cf. *siphonifera* (d'ORBIGNY) *Globigerinoides* cf. *obliquus* BOLLI
KN 36-02	*Globigerinoides* cf. *obliquus* BOLLI *Globiquadrina dehiscens* (CHAPMAN PARR COLLINS)
KN 37-02	**Ostracod (Freshwater):***Eucypris amygdala* (DOLLFUS) *Candona (Caspiocypris) labiata* (ZALANYI) *Candona (Candona) kirchbergensis* (STRAUB) *Paracypris bouldnorensis* KEEN *Ilyocypris* sp. *Orbulina universa* d'ORBIGNY *Globigerinoides* cf. *obliquus* BOLLI *Globorotalia* cf. *menardii* (d'ORBIGNY)
KN 38-02	*Globigerinoides* cf. *obliquus* BOLLI *Hastigerina* cf. *siphonifera* (d'ORBIGNY) *Orbulina universa* d'ORBIGNY *Candona labiata* (ZALANYI) (Freshwater ostracod)
KN 39-02	*Globigerinoides* cf. *obliquus* BOLLI *Hastigerina* cf. *siphonifera* (d'ORBIGNY) *Globorotalia obesa* BOLLI *Globorotalia* cf. *scitula scitula* (BRADY) *Candona labiata* (ZALANYI) (Freshwater ostracod)
KN 40-02	*Orbulina universa* d'ORBIGNY *Candona labiata* (ZALANYI)
KN 41-02	*Orbulina universa* d'ORBIGNY *Globigerinoides trilobus* (REUSS) **Ostracod:***Candona labiata* (ZALANYI) *Candona praecox* (STRAUB) *Potamocypris szchokkei* (KAUFMANN) *Heterocypris orenensis* ŞAFAK&GÖKÇEN *Eucypris eintheimensis* STCHEPINSKY
KN 42-02	*Globorotalia* cf. *mayeri* CUSHMAN ve ELLISOR *Orbulina universa* d'ORBIGNY *Globigerinoides trilobus* (REUSS) *Globigerinoides* cf. *obliquus* BOLLI *Globiquadrina dehiscens* (CHAPMAN PARR COLLINS) *Globorotalia obesa* BOLLI *Hastigerina* cf. *siphonifera* (d'ORBIGNY) **Ostracod:***Candona praecox* (STRAUB) *Eucypris eintheimensis* STCHEPINSKY
KN 43-02	*Globoquadrina* cf *altispira* (CUSHMAN ve JARVIS) *Globorotalia* cf. *menardii* (d'ORBIGNY) *Globorotalia obesa* BOLLI *Globigerinoides trilobus* (REUSS) *Globigerinoides* cf. *obliquus* BOLLI **Ostracod:***Caspiolla (Caspiocypris) sps.* *Candona praecox* (STRAUB) *Eucypris eintheimensis* STCHEPINSKY *Eucypris amygdala* (DOLLFUS) *Lineocypris molassica* (STRAUB) *"Tyrrhenocythere"*
KN 44-02	*Globigerinoides obliquus* BOLLI *Globigerinoides* cf. *trilobus* (REUSS) *Globiquadrina dehiscens* (CHAPMAN PARR COLLINS) *Globorotalia* cf. *menardii* (d'ORBIGNY) *Globorotalia obesa* BOLLI *Lineocypris* cf. *molassica* (STRAUB) *Eucpris* sp. *Candona lycica* FREELS

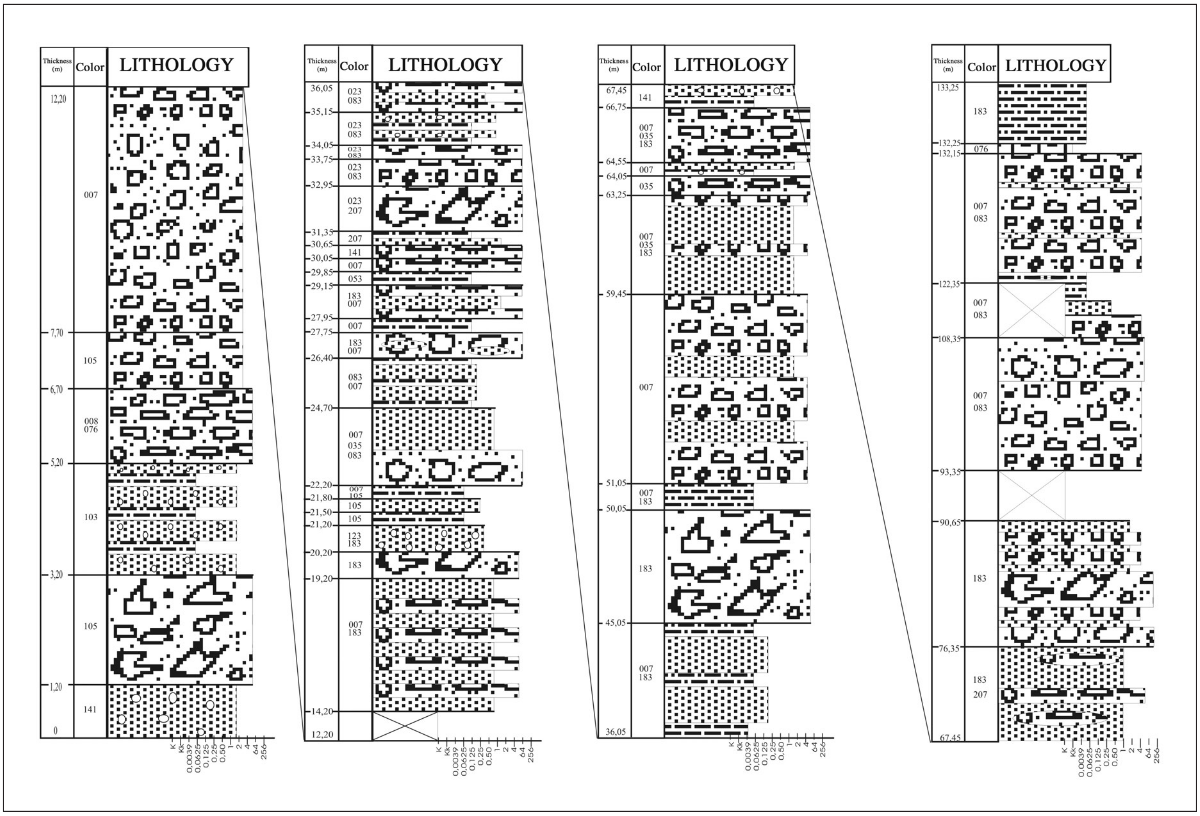


Figure13- Part of Measured Stratigraphic Section from Suludere formation (06760/35165)Section VII (NW of Suludere Village). (see Figure 30 for the Explanation).

The sequence IX located in southwest of Veliler is mainly composed of conglomerates and sandstones. The sequence begins by well-sorted conglomerates and lasts by gravelly sandstones and sandstones. Dominant lithology is conglomerate (Figure 15). Various-sized clastics between 2-3 mm and 45 cm are abundant between 3-4 mm and 8-10 cm. There are very rare blocks up to 90x60x35 cm in size.

The sequence X located in southwest of Veliler Village, is composed of poor-medium consolidated conglomerates and sandstones. The sequence begins with conglomerates containing of sandstone and gravelly sandstone levels, and lasts by sandstone-conglomerate intercalations, conglomerates and sandstone-gravelly sandstone-mudstone levels, and ends up with sandstone-conglomerate intercalation (Figure 16). Various-sized constituents between 3-4 mm and 60 cm are abundant between 3-4 mm and 2 cm. The constituents are often derived from gneisses.

The sequence XI, located at 1,5 km to northeast of Beydağ, is composed of medium-consolidated mudstones and sandstones. The sequence begins with mudstones, and lasts by conglomerates, conglomerate-sandstone and sandstone-conglomerate intercalations. At some places conglomerates change upwardly to sandstones and sandstones to conglomerates (Figure 17). Often few rounded - subangular and less than 1 cm size, gravels have a low sphericity.

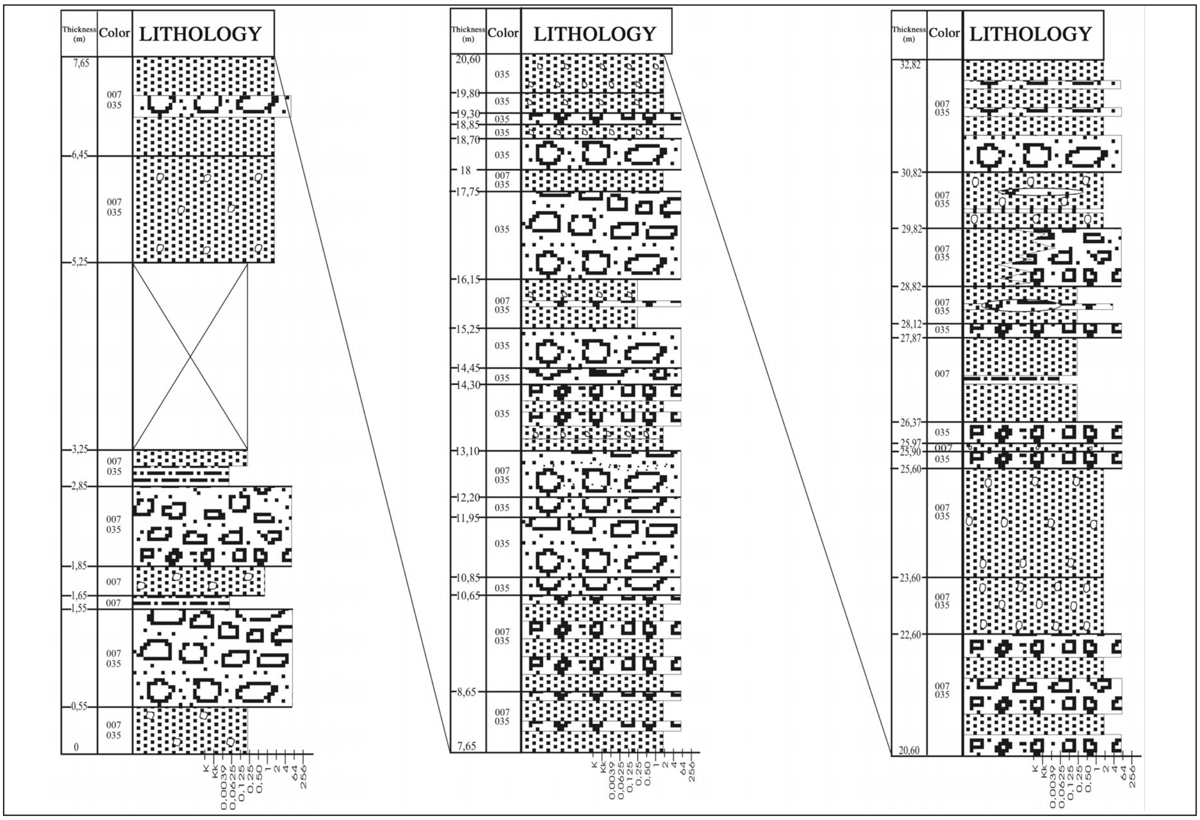


Figure 14- Part of Measured Stratigraphic Section from Suludere formation (05207/35207) Section VIII (SE of Veliler Village). (see Figure 30 for the Explanation).

The sequence XII observed at south of Beydağ-Aktepe Village, is mainly composed of sandstones and conglomerates. The sequence, beginning with conglomerates, continues with sandstones, interfingered with mudstone and limestone, conglomerates containing of sandstone lenses, sandstones and conglomerates (Figure 18). Various-sized gravels, changing between 2-3 mm and 20 cm, but mostly between 5 mm-2 cm and 6-7 cm, are generally derived from gneisses.

The Contact

Suludere formation, unconformably underlain by Menderes Massif Metamorphics and Başova andesites, begins with basal conglomerates including some badly sorted, clay-sand matrices and some carbonate cements (Figures 19 and 20). These conglomerates have no significant stratification and has bad sortings. At 600 m north of Taşlı Hill, conglomerate constituents underlain by andesites are generally angular, various-sized andesite gravels between 2-3 mm and 50 cm (Figure 20). The contact between Suludere formation and metamorphic rocks on Damındüzü-Veliler is faulted along a NW-SE trended line. Suludere formation is overlain by Aydoğdu formation and alluvium with an angular unconformity.

Age

Palynological samples from clayey levels of Suludere formation have not yielded an age. Freshwater ostracods at clayey - carbonate lev-

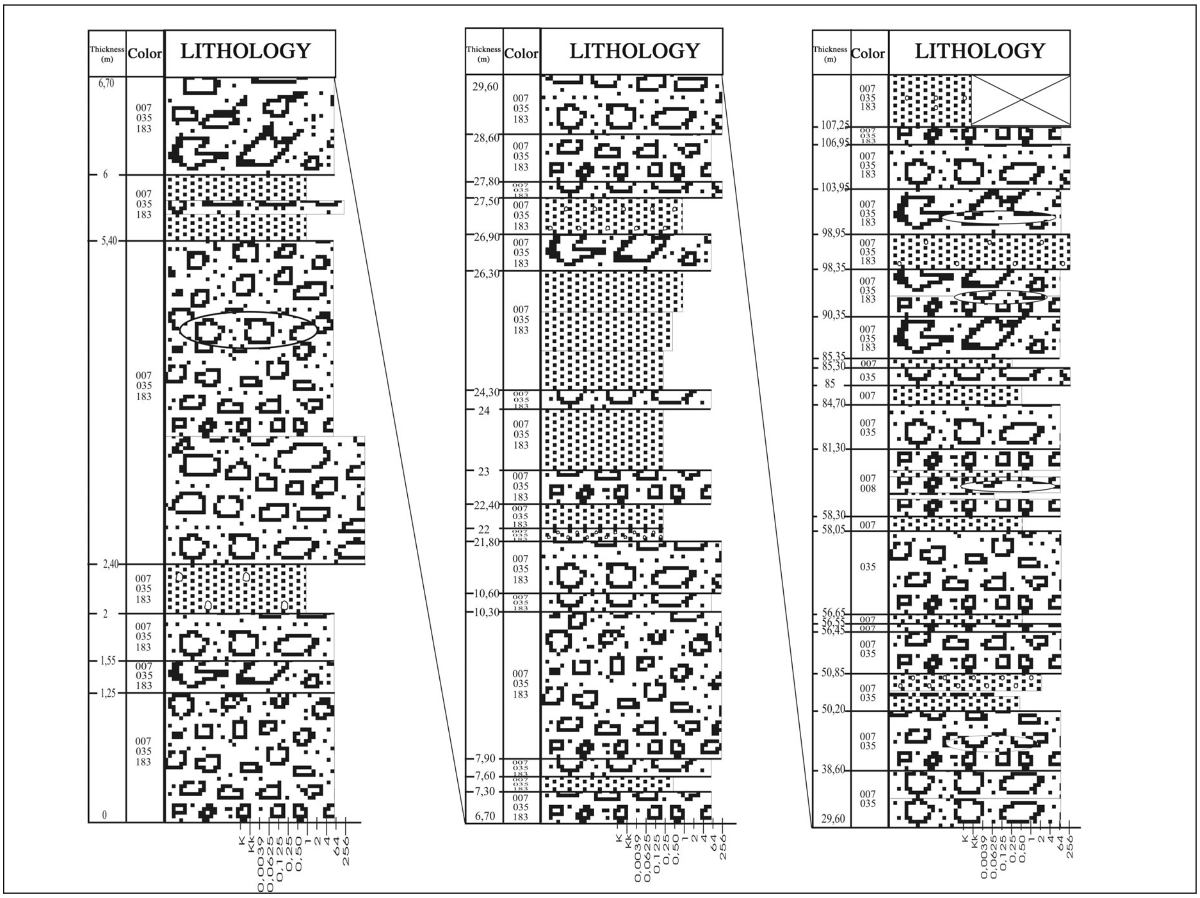


Figure 15- Part of Measured Stratigraphic Section from Suludere formation (04370/35295) Section IX (SW of Veliler Village). (see Figure 30 for the Explanation).

els of the formation (Table 3-2a) give an age of the latest Middle Miocene-Late Miocene. Taking into consideration of Suludere formation overlying Başova andesites (14,7±1- 14,3±1 My) with an unconformity, the radiometric and paleontological age data seem to be consistent.

Comment

Beginning of the Suludere formation with a basal conglomerate, having a limestone and clayey limestone cement and continuing with limestone-clayey limestone and mudstone levels with planktonic and benthonic foraminifers and freshwater fossils on the basement at many places, indicate the formation to start to deposit on a low energy, shallow lacustrine environment connected to an open sea. The lithological composition in the lakes depends on input of clay and silt amounts.

Very bad preserved foraminifers might have been washed in by surface currents which have connections to open sea and probably carried to the depositional environments by them. That lacustrine ostracods increase at upper levels of the formation and only freshwater ostracods are found which attributed to open sea contribution to these coastal lakes ended when basin floor uplifted/filled as clastic supply increased due to tectonic activity and/or climatic conditions.

Table 3- Fossil Content of Measured Section Localites

Sample No	Fossil Content (SECTION IV)
KN 17-02	*Orbulina universa* d'ORBIGNY *Globorotalia* cf. *menardii* (d'ORBIGNY) *Globorotalia obesa* BOLLI
KN 18-02	**Ostracod:***Ilyocypris bradyi* SARS *Candona paralela pannonica* (ZALANYI) **Foraminiferid:***Globigerinoides trilobus* (REUSS) *Globorotalia* cf. *menardii* (d'ORBIGNY)
KN 19-02	*Globigerinoides* cf. *obliquus* BOLLI *Globiquadrina dehiscens* (CHAPMAN PARR COLLINS)
KN 20-02	*Globigerinoides trilobus* (REUSS) *Globigerinoides* cf. *obliquus* BOLLI *Globorotalia* cf. *menardii* (d'ORBIGNY) *Globorotalia obesa* BOLLI
KN 22-02	*Globigerinoides* cf. *obliquus* BOLLI
KN 23-02	*Globorotalia obesa* BOLLI
KN 24-02	**Ostracod:***Candona(Candona)* cf. *devexa* (KAUFMANN) *Potamocypris szchokkei* (KAUFMANN)

a

Sample No	Fossil Content (SECTION VI)
KN 30-02	*Globigerinoides* cf. *obliquus* BOLLI *Globigerinoides trilobus* (REUSS) *Globiquadrina dehiscens* (CHAPMAN PARR COLLINS)

b

Sample No	Fossil Content (SECTION VII)
KN 31-02	*Globorotalia obesa* BOLLI *Globigerinoides obliquus* BOLLI *Globorotalia scitula scitula* (BRADY) *Globigerinoides trilobus* (REUSS)
KN 32-02	*Globorotalia obesa* BOLLI *Globorotalia* cf. *menardii* (d'ORBIGNY) *Globiquadrina dehiscens* (CHAPMAN PARR COLLINS)

c

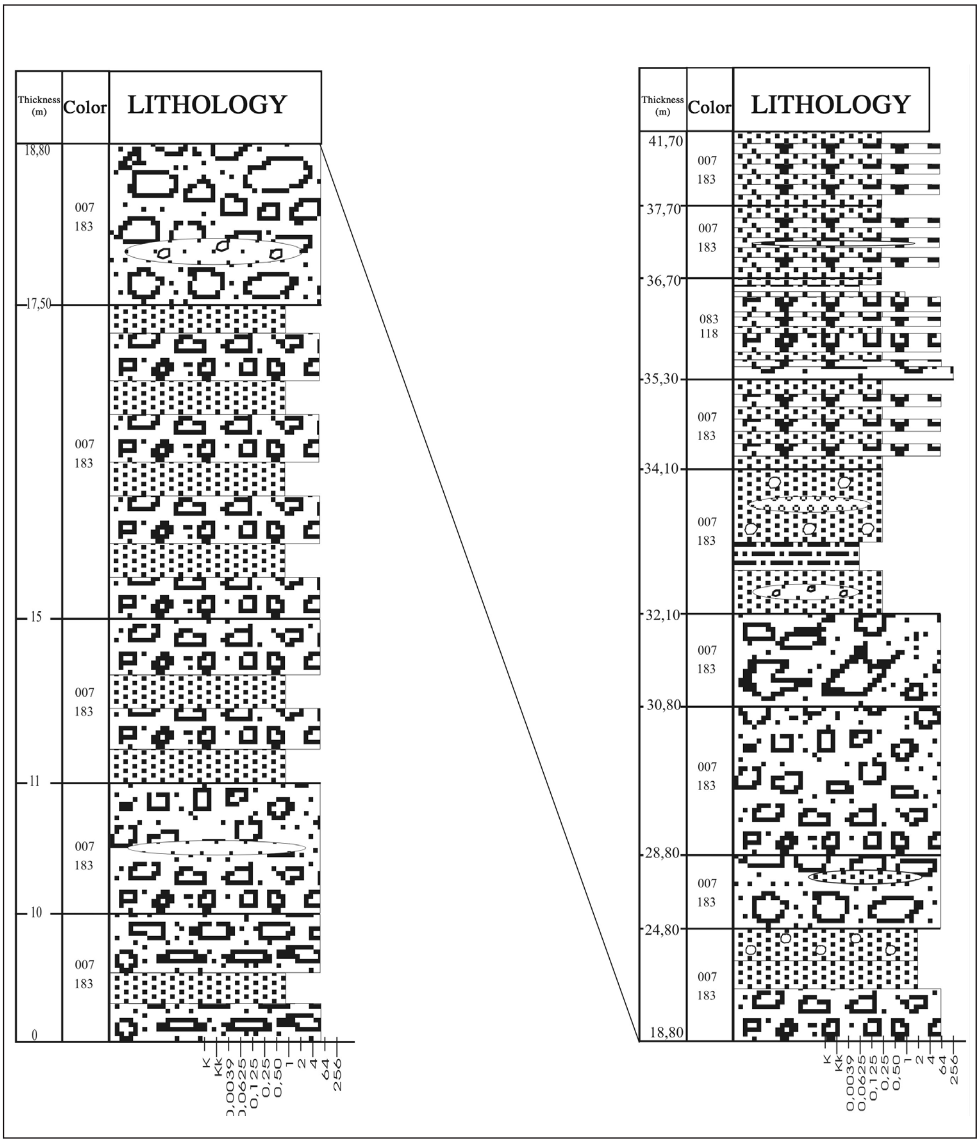


Figure 16- Part of Measured Stratigraphic Section from Suludere formation (03980/35435) Section X (SW of Veliler Village). (see Figure 30 for the Explanation).

It is considered that sediments on the limestones are composed of superposed channel and flood plain sediments of low curved rivers on a gentle topography in a humid climate. In this period, topographic gradient is favorable to develop flood plains, and water energy flowed on this low inclined topography is suitable to lay down the suspended material.

Mudstones overlying sandstones and conglomerates overlap channel fills owing to lateral migration and bed displacement.

Limestone and clayey limestone levels among clastic materials indicate the flood plains to be stagnent for limestone deposition but clastic inputs to alleviate in this process.

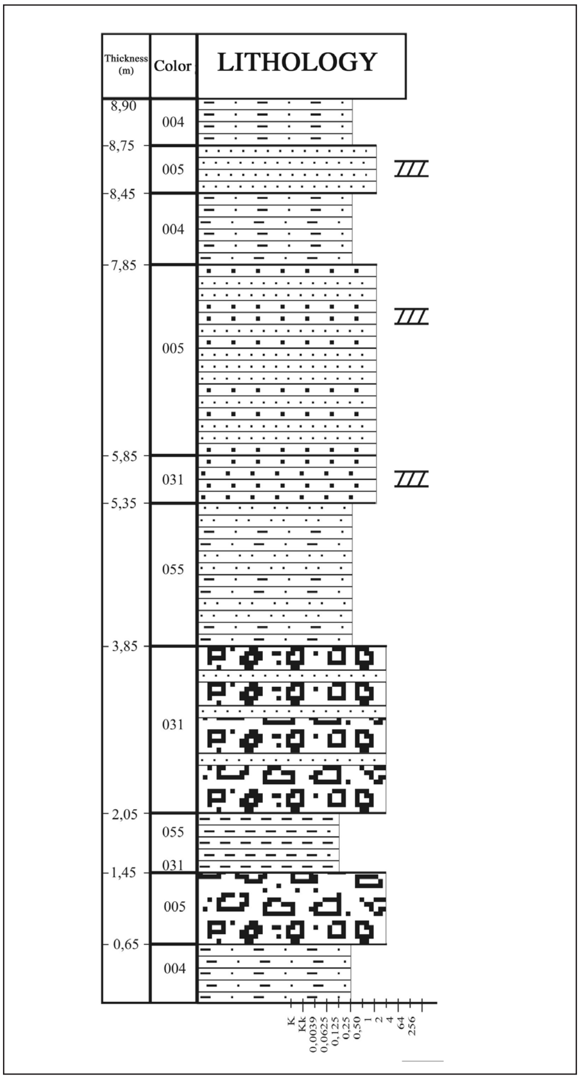


Figure 17- Part of Measured Stratigraphic Section from Suludere formation (07500/ 17650) Section XI (N of Aktepe Village). (see Figure 30 for the Explanation).

Decrease of mudtones and claystones, and increase of conglomerates and gravelly sandstones imply the increase of topographic gradient and strong river energy. These sediments were deposited on a high inclined topography in more humid climate by controlling high energy waters. Succession of the well- and bad-sorted conglomerates emphasize the stream energy to have sudden changes.

Based on textural and geometrical features of conglomerates, we can say that sediment transport was not by debris flow, developed on a river-dominated alluvial fan environment.

Sandstone overlying conglomerate reflect the current energy decreased to be in time. Sand-

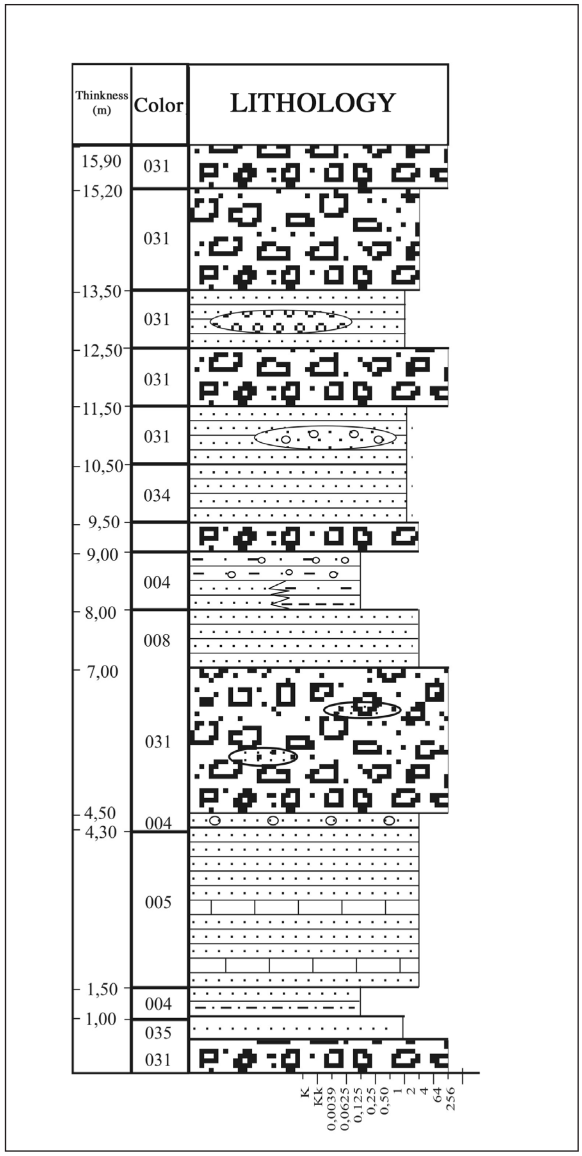


Figure 18- Part of Measured Stratigraphic Section from Suludere formation (07495/16930) Section XII (S of Aktepe Village). (see Figure 30 for the Explanation).

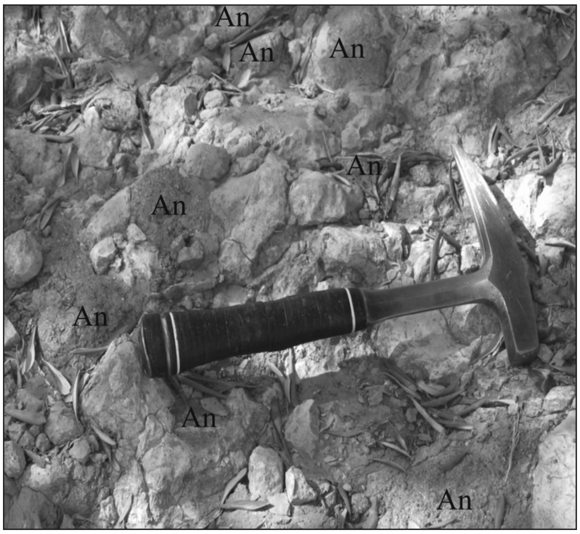


Figure 19- Carbonate-cemented basal conglomerates of Suludere Formation (An: Gravels derived from andesite).

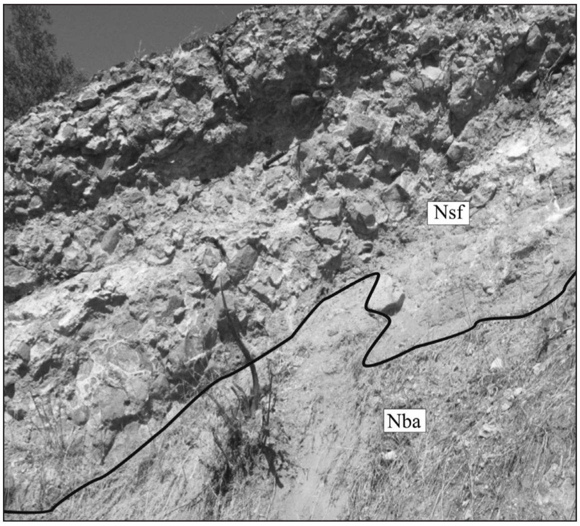


Figure 20- Conglomerates overlaying andesites unconformably.

stones with lenses of mudstone or coarse-grained conglomerate may be explained by development of barriers and/or by local energy change in the channel. Variously observed reverse/normal gradings on sandstones and conglomerates imply the water energy gradually to rise/fall.

The clayey levels having no spores and pollens are consistent with the implied depositional environments.

AYDOĞDU FORMASYONU

Definition

The formation observed around Beydağı, Uzundere, Çaylı, Aydoğdu, Gedik and Ceritler covers a total area of 35 km² (Figures 4 and 5), and outcrops best at around Aydoğdu. It is generally of reddish brown-milky brown, rarely yellowish brown-gray colored, and few consolidated, and composed of conglomerates, gravelly sandstones as well as sandstones, changing laterally and vertically to each other. These levels may be lenses, wedgings or interfingerings of eachother. Conglomerates are more abundant than sandstones. The formation with unmatured-half matured texture displays sharp slopes and fairy chimneylike morphologies due to rapid erosions (Figure 21).

Figure 21- Views from Aydoğdu Formation.

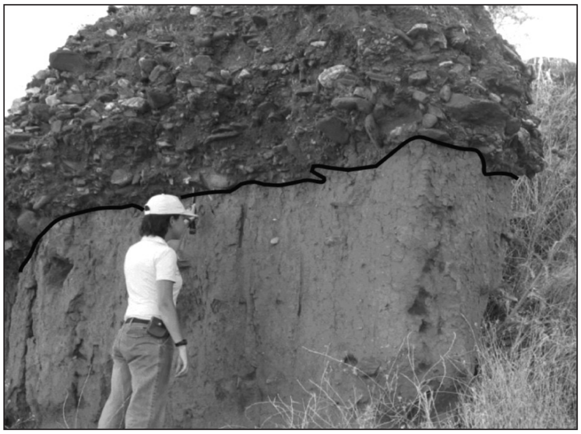
Lithology

Ranging from light brown to red dark brown colors, conglomerates are medium-bad consolidated, and medium-thick and very thick layered. Layer thickness varies from 20 cm to 500 cm, but often among 25-50 cm, 100-170 cm and 300-500 cm. These sediments, usually unmatured-half mature textured and very bad-badly sorted, some matured and medium-well sorted, have angular, sub-angular and some bladed or platy constituents with a low sphericity. Majority of the constituents are derived from metamorphic rocks (70 % schist, 20 % gneiss and 5 % marble) and the remains are andesite gravels. Occasionally gneiss gravels may compose of it, up to 80 - 95 % amount, and schist derived gravels may be up to 90 %. Andesite derived gravels may be up to 5 % and 30x20 cm in size. Various-sized constituents are between 3-4 mm and 60 cm. Gravels rarely reaches 1-3 m. Conglomerates with matrix-supported, matrix or grain-supported textures and a generally irregular internal structure have clay-sand or coarse sand-fine gravel matrices. Coarsening upward is common. Longitudinal axis of gravels with a bricklike arrangement at some places are sometimes parallel to the stratification. Conglomerates including some coarse sand grained, medium-thick sandstone lenses have rare cross stratifications (Figure 22), channel fill, erosional surfaces (Figure 23) and faults coeval with sedimentation (Figure 24).

Sandstones, are often light brown, some red brown, and medium consolidated, and usually coarse grained, and medium-thick layered. They tend to exhibit regular stratifications. Layer thickness varies from 20 cm to 200 cm, but often between 30-60 cm and 80-100 cm. At lower parts, sometimes, scattered gravelly rough sandstones tend to display fining upwards.

Gravelly sandstones are light brown-reddish brown, and medium consolidated, and thick-very thick layered. Scattered gravels within coarse

Figure 22- Cross-stratified conglomerate-sandstone observed on Aydoğdu Formation.



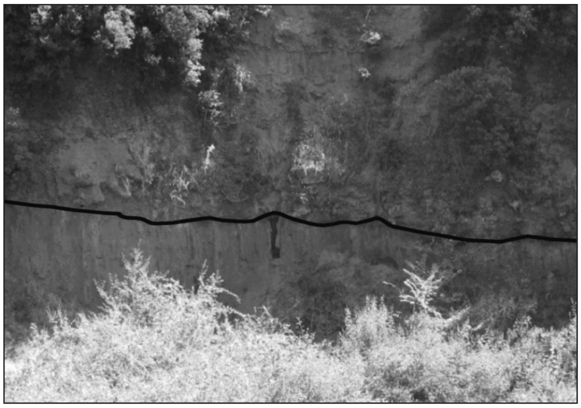


Figure 23- Conglomerates deposited to form an erosional surface within Aydoğdu Formation.

grained sands are less than 5 %. At some levels grain size do not exceed 3-5 cm, some are between 30 and 40 cm.

Aydoğdu formation is often horizontal layered (Figure 25).

At northwest of Eselli, the sequence is mainly composed of sandstones and conglomerates. The sequence begins with conglomerates, and lasts with medium-thick layered sandstone levels and finally thick-very thick layered gravelly sand

Figure 24- Fault coeval with sedimentation observed on Aydoğdu Formation (Fault slip: 130 cm).

Figure 25- Horizontal layered conglomerate-sandstone included in Aydoğdu Formation.

stones. Conglomerates usually have grain sizes varied between 5 and 20 cm (Figure 26).

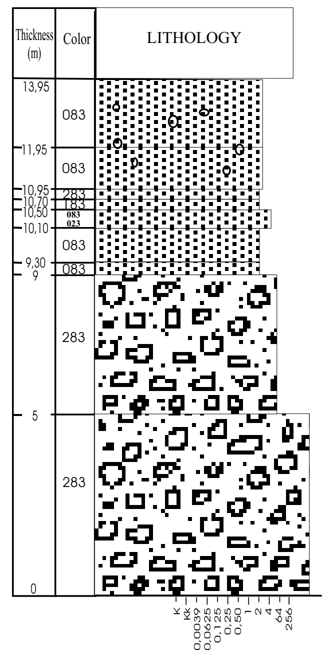


Figure 26- Part of Measured Stratigraphic Section from Aydoğdu Formation (99125/27300) Section XIV (NW of Eselli). (see Figure 30 for the Explanation).

The sequence, measured at Köfündere, is composed of conglomerates, gravelly sandstones and sandstones. It begins with conglomerates at the base and continues with an intercalation of 1-2 m thick sandstones and 40 cm thick gravelly sandstone (Figure 27).

The sequence, measured at Çaylı, is composed of conglomerates and sandstones in general: It begins with coarse grained sandstones containing rare gravels, and continues with a conglomerate-sandstone intercalation (Figure 28).

The Contact

Menderes Massif metamorphics constituting the basement rocks and Aydoğdu formation, which underlain Başova andesites cutting these units, and Suludere formation with an angular unconformity, are all covered by an alluvium with an angular disconformity (Figure 29). Basal conglomerates on lower contact of Aydoğdu formation are badly sorted. These conglomerates, owning no significant layering and owning coarse sand-fine gravel matrices, seem to contain generally angular, variously sized constituents changing from several cm to 2-3 m.

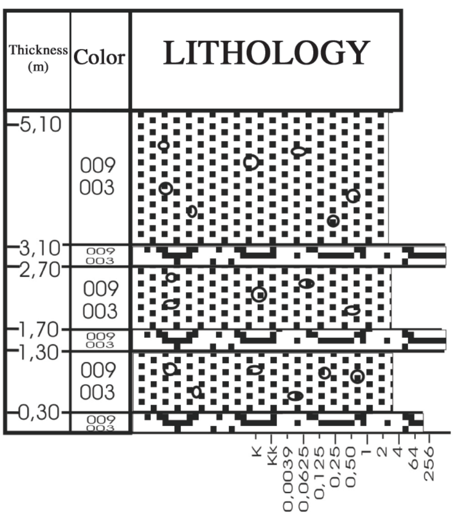


Figure 27- Part of Measured Stratigraphic Section from Aydoğdu Formation (02025/28850) Section XV (Köfündere). (see Figure 30 for the Explanation).

Age

Since Aydoğdu formation displays no paleontological evidences except for overlying Suludere formation of the latest Middle Miocene-Late Miocene, the age of Aydoğdu formation is assumed to be Plio-Pleistocene.

Comment

Conglomerates' containing both of sand-sized clastics and of very large boulders, as well as

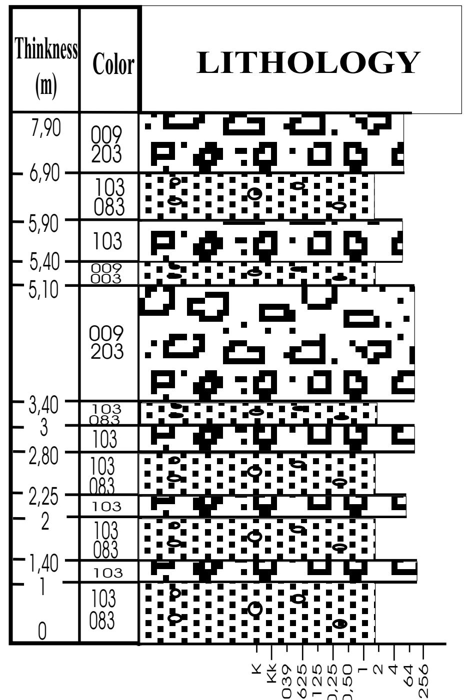


Figure 28- Part of Measured Stratigraphic Section from Aydoğdu Formation (00800/25025) Section XIII (Çaylı). (see Figure 30 for the Explanation).

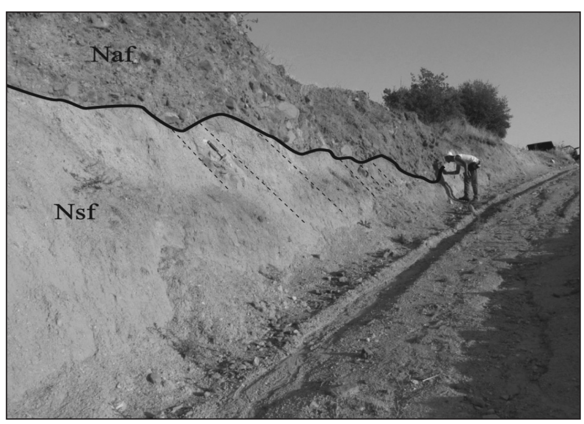


Figure 29- Angular Unconformity Surface between Suludere Formation (Nsf) and Aydoğdu Formation (Naf). (Axe edge is parallel to stratification of lower Suludere formation).

large gravels together, accumulation of small size gravel and sand size material in the bottom of its front part with respect to current direction, seem to be the indicators of the unit to deposit on a slope with a considerbly high speedand with a flow to cause a sudden material accumulation. Displaying normal gradings in some parts implies a reflection of a drop of current velocity in time.

Sandstones' having scattered gravels, various thick layers and also no sedimentary structures often related to currents indicate that they were formed with materials brought by high energy waters. Rarely observed sedimentary structures created by paleocurrents formed when current velocity slightly decreased and regular current regime occurred

Formation is composed of alluvial fan sediments developed by high-angle normal faults controlling the Kiraz basin.

Alluvium

The unit constitute vast plains which are topographically low parts of the study area. These gray-beige unconsolidated sediments, deposited by recent streams and composed of various-sized clastics, overlay all units unconformably.

GEOLOGICAL EVOLUTION AND PALEOGEOGRAPHY

Kiraz basin began to form at the end of Middle Miocene following active andesitic volcanism dominated in the region. During this period, the region was under the effect of an extensional tectonic regime. Small lakes were formed to host algaes and ostracoda populations. At the beginning these shallow, coastal fresh lakes were connected to open sea and hence were subjected to have surface currents. Coastal carbonates formed on these lakes are located at the bottom of Suludere formation and overlap volcanic rocks unconformably.

Water-borne planktonic and benthonic foraminifers by surface currents from open sea to lakes are found at lower parts of the Suludere formation. Increase of the lacustrine ostracods at upper levels of the formation and meeting only freshwater ostracods at the area is an evidence of the ending open sea contribution. This may be explained in three ways: a- a local sea level fall provided regression of the sea, b- basin floor uplifted/filled and the sea regrade as clastic supply increased due to tectonic activity and/or climatic conditions, and c- the region may be more uplifted than the sea level because of a compression after a tension. Our findings seem to support the second opinion. Grain size and amount of the clastic materials brought to the basin seem to be controlled by regional tectonic activity, various morphology owing to climatic conditions, and stream energy. The increased clastic supply and filled/uplifted basin by tectonic activity are not affected by surface currents from open sea. Thus, channel and flood plain sediments of low curved streams are deposited on the carbonate sediments. In this period, water energy flowing over gentle slope topography was low enough the suspended materials lay down on flood plains. Flood plains having low amount of clastic materials have been stagnant for a period that the limestones get deposited. Occasionally, relatively coarse clastic sediments carried by high-energy waters on an inclined topography were deposited on a river-dominated alluvial fan environment. All of these lacustrine, braided river and alluvial fan sediments form Suludere formation.

It is implied that an angular unconformity between Suludere and Aydoğdu formations reflects a sedimentation break, during the latest Late Miocene. In this period, dominant compressional tectonic regime resulted from thrusting of Menderes Masif rocks onto Suludere formation (Emre and Sözbilir 2006*b*). After this break, sediments began to deposit on an inclined surface on a fault-controlled basin, by a current with very high energy and rapid deposition rate. During this period, the alluvial fan sediments have

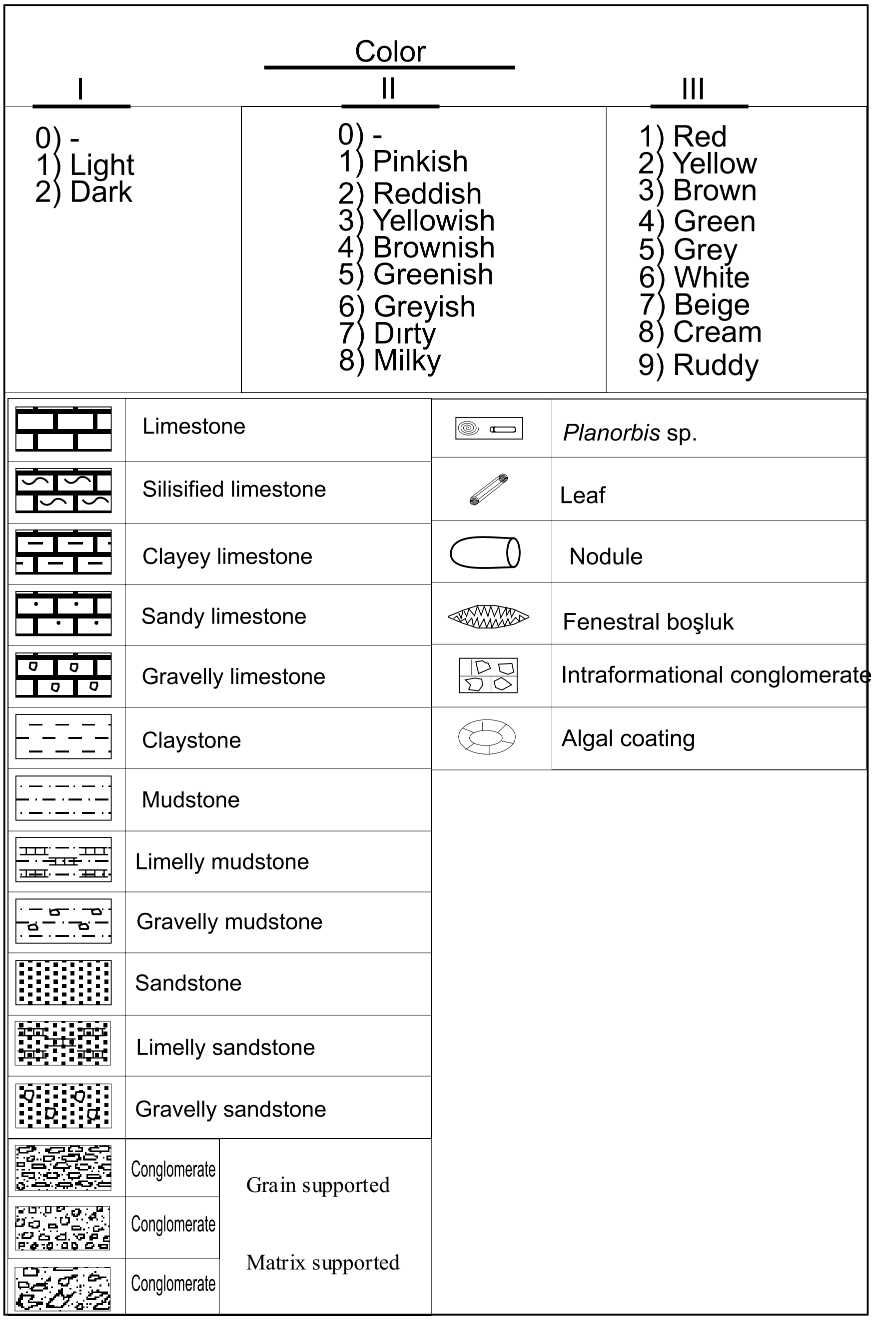


Figure 30- Explanation for Measured Stratigraphic Sections.

developed due to high-angle normal faults and also current velocity has sometimes fallen. Filling of the new basins, formed after Pleistocene period, by alluvium still continues.

Extensional tectonic regime not only began to form Kiraz basin but also was active during the sedimentation which can be deduced from the coeval faults of the sedimentation (Figure 24). Faults cutting and inclining the sediments are the indicators of the effect of the post-sedimentary N-S, NE-SW and NNE-SSW trended tension forces in the basin (Emre and Sözbilir 2006*b*). As evidenced by Kiraz earthquakes (www.koeri.boun.edu.tr), today still active faults work together and thus provide recent morphology to the study area.

CONCLUSIONS

1- In the study area, Precambrian-Mesozoic schists, marbles, orthogneisses, paragneisses and metagabbros of Ödemiş-Kiraz Submassif belonging to the Menderes Masif form the basement rocks (Candan et al., 2001).

2- Başova andesites of Middle Miocene (14,7±0,1My-14,3±0,1My), intruding metamorphic rocks, are composed of calc-alkaline andesites and basaltic andesites derived from similar sources. Trace element and rare earth element variation graphics of the volcanics resemble the pattern of calc-alkaline arc volcanics or orogenic volcanics. Because Başova volcanics have a similar enrichment of trace elements to that of the continental volcanics, negative Ta-Nb anomalies are probably attributed to have an association with the crustal assimilation (Emre and Sözbilir 2006 *a*).

3- At the end of Middle Miocene, Kiraz basin started to form just after active volcanism in the region. Small freshwater lakes were formed with algae and osracoda populations on this extensional basin. Coastal carbonates formed on these lakes overlap volcanic rocks unconformably. Lacustrine carbonate sediments at the bottom contain very bad preserved planktonic and benthonic foraminifers as well as freshwater fossils. These deposits, started to form on a low energy, in small shallow lakes and continued with superposed channel and flood plain deposits of low curved rivers and river-dominated alluvial fan sediments. At the beginning, the basin was connected to open sea and was subjected to surface currents of the sea. In further periods, clastic supply increased due to tectonic activity and climatic conditions, and therefore the basin floor filled/uplifted, open sea contribution ended and river-dominated alluvial fan sediments deposited.

4- Suludere formation composing the oldest sediments of Kiraz basin overlays metamorphic and volcanic rocks unconformably. This formation has intercalated, lateral and vertical transitive, significant bedded lacustrine and fluvial sediments with ostracod fossils. These fossils give an age of the latest Middle Miocene-Late Miocene.

5- There is a sedimentation break after Late Miocene period. During this break, the active compressional tectonic regime in the region, conclude with a thrusting of Menderes Massif metamorphics onto the Suludere formation (Emre and Sözbilir 2006 *b*). Following this break, Aydoğdu formation of Plio-Pleistocene overlay Suludere formation unconformably. The sequence containing alluvial fan sediments are composed of texturally unmature, few consolidated of lateral and vertical transitions among each other, and of sharp-contacted levels.

6- Alluvium filling basins due to tectonic activities from Pleistocene to Recent overlay the other units unconformably. Alluvium have clay, silt and sand matrices, and is composed of very few consolidated conglomerates, sandstones and siltstones with various-sized gravels.

7- Tectonic regime, formed Kiraz basin, controls the basin evolution and geometry of the sedimentary basin, in addition to the post-sedimentation environment. Products of the tension forces and several kilometer traceable faults, brought different Neogene facies and the younger units together with the older units (Figures 4 and 5). Near these faults, Suludere formation layers reach up to 80° and Aydoğdu formation layers up to 44° slopes (Figure 4). Finally, Kiraz Basin achieved as an asymmetric graben, bordered by these active NW-SE trended faults (Emre and Sözbilir 2006*b*).

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PLATES

PLATE- I

Microscopic Features of Carbonate Levels based on Compositional (Folk, 1959) and Textural (Dunham, 1962) Nomenclatures

a) Recrystallized Limestone

b) Algal Micritic Limestone with Fenestral Voids/ Algal Carbonate Mudstone with Fenestral Voids:
Fenestral voids are discontinuous, irregular, and filled with sparry calcite and/or not.
Voids are probably vesicules.
Carbonate mud changed to microsparry.

c) Sandy Silty Micritic Limestone/ Sandy Silty Clayey Carbonate Mudstone:
Sands are composed of abundant micas and few quartz grains.
Micrite mud commonly changed to fine sparry calcite.

d) Intraclastic Peloidal Biosparite/ Intraclastic Peloidal Grainstone:
Pellets are faecal pellets.
Bioclasts include ostracods and shell fragments of ostracod.
Cement is composed of pseudosparry calcite.

e) Allochemical Recrystallized Limestone:
Identifiable allochems, fine pelecypod (possibly ostracod) shells.
Texture contains local micrite and patches of local sparry calcite. Perhaps primary packstone.

f) Silty Sandy Micritic Limestone/ Silty Sandy Carbonate Mudstone:
Sands and silts are composed of angular quartz and mica grains.
Carbonate muds partially changed to micro-sparry calcite.

PLATE - I

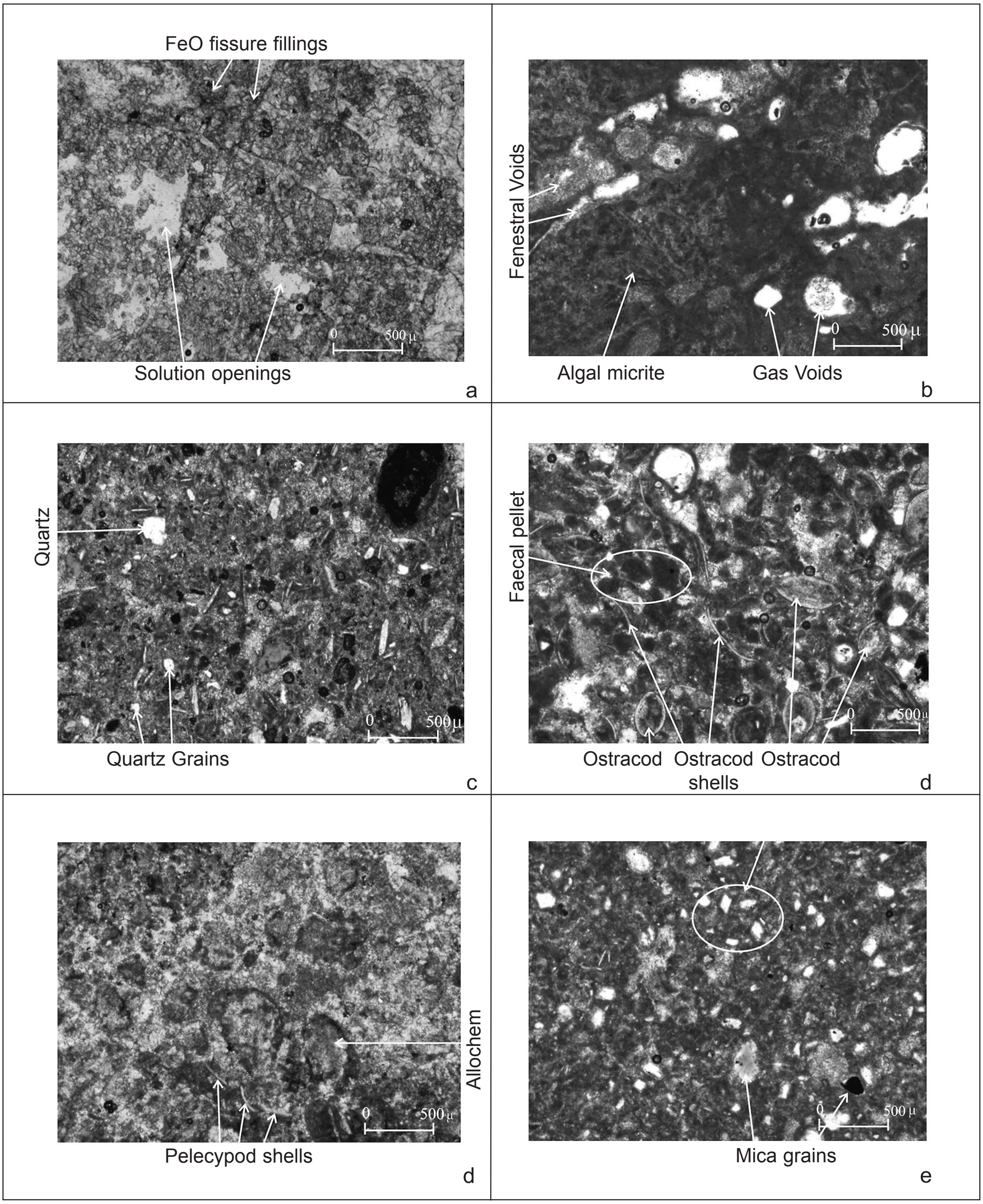

FeO fissure fillings
0 500 µ
Solution openings
a
Fenestral Voids
0 500 µ
Algal micrite
Gas Voids
b
Quartz
0 500 µ
Quartz Grains
c
Faecal pellet
0 500 µ
Ostracod
Ostracod shells
Ostracod
d
Allochem
0 500 µ
Pelecypod shells
d
0 500 µ
Mica grains
e

PLATE- II

Microscopic Features of Carbonate Levels based on Compositional (Folk, 1959) and Textural (Dunham, 1962) Nomenclatures

a) Bioclastic Peloidal Algal Micritic Limestone/Bioclastic Peloidal Algal Carbonate Mudstone:
Contains bioturbation traces and faecal pellets. Rare bioclasts are ostracods.
Bioturbation cavities are filled with sparry calcite.

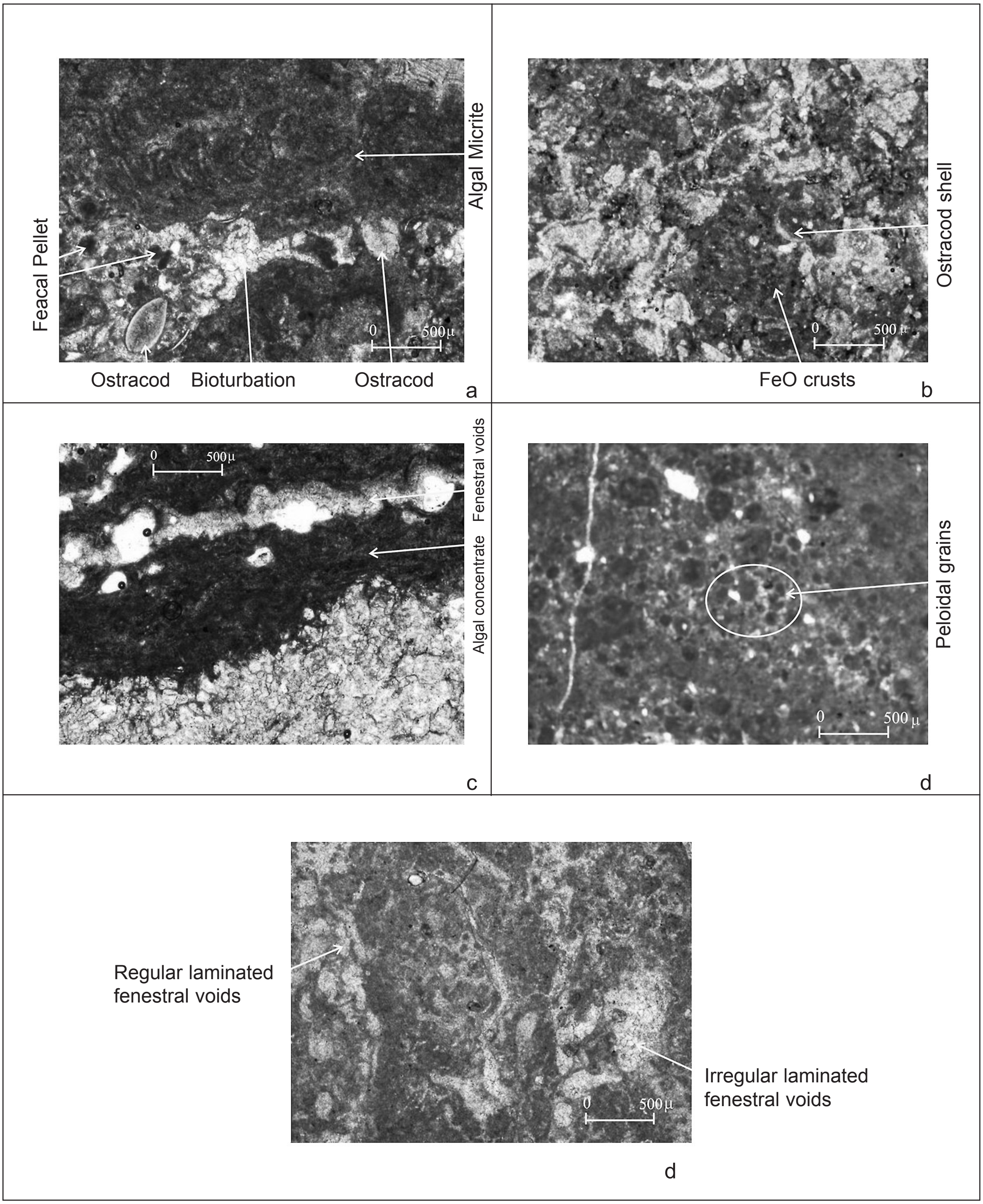
b) Intra-Biomicrite/Intraclastic Bioclastic Wackestone:
Bioclasts: Ostracod shells,
Intraclasts: Fragmented carbonate crust and/or fragments of pore filling.
FeO crusts common.

c) Algal Micritic Limestone with Fenestral Voids/ Algal Carbonate Mudstone and/or Boundstone with Fenestral Voids:
Fenestral voids are continuous and regular laminated, and filled with sparry calcite.

d) Peloidal Intramicrite Intrasparite/ Peloidal Intraclastic Packstone

e) Peloidal Algal Micritic Limestone with Fenestral Voids/Algal Carbonate Mudstone with Fenestral Voids:
Fenestral voids are regular laminated and irregular fenestral, and filled with sparry calcite.

PLATE - II


Algal Micrite
Feacal Pellet
0 500μ
Ostracod
Bioturbation
Ostracod
a
Ostracod shell
0 500 μ
FeO crusts
b
0 500μ
Fenestral voids
Algal concentrate
c
Peloidal grains
0 500 μ
d
Regular laminated
fenestral voids
Irregular laminated
fenestral voids
0 500μ
d

BOŞ SAYFA