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PALEOCENE-EOCENE SEDIMENTS INTERBEDDED WITH VOLCANICS WITHIN THE LYCIAN NAPPES : FARALYA FORMATION

Mustafa ŞENEL*

ABSTRACT. - The presumably allochthonous structural units in the Southwestern Turkey between the Menderes massif and Beydağları autochthon are known as the Lycian nappes. Some of these units particularly beneath the ophiolite nappe end up with the Faralya formation of Paleocene-Lutetian age. The striking feature of this formation which includes micrile, clayey micrite, claystone, sandstone and conglomerate, is the presence of basic volcanite interbeds of Eocene age, This volcanite bearing formation exhibits a strong similarity to those of the other formations in Southwestern Turkey most of which include similar basic volcanites. Eocene basic volcaniles are also known in the Akseki autochthon to the south of Seydişehir (Geyikdağ unit in broad sense). Similar extensive lateral movements (Eocene mountain building processes) developed over the Faralya formation are seen over the volcanite bearing formations to the south of Menderes massif as well as to the north of Isparta angle and the Akseki autochthon. These features indicate that the area between the Menderes massif and Akseki autochthon (Geyikdağ unit) reflects common basinal characters in terms of depositional conditions, volcanism and the traces of Eocene mountain building process.

INTRODUCTION

The Lycian nappes are known as a NE-lrending allochthonous complex between the Menderes massif and Beydağları autochthon, SE Anatolia and made up of a great number of structural units related to the Lower Langhian overthrusting. Some structural units, particularly lying beneath the ophiolite nappe, as parts of the Lycian nappes widespreadly occurring in the southwest and becoming narrower towards north end with the Paleocene-Eocene flysch-like sediments (Fig. 1). These sediments, termed flysch by many investigators who have studied the Lycian nappes begin with the Datça flysch (Orombelli and others, 1967) and extend northeasterly as thin and narrow outcrops locally widening along the tectonic contacts in the uppermost levels of some structural units in the Teke Taurids. Some volcanic rocks are also known to be found within these sediments (Fig. 2) that exhibit various lithologies and successions within the region (Yılmaz, 1966; Bassaget, 1966; Richard, 1967) Graciansky, (1968, 1972) recognized the presence of some blocks (flysch with blocks) with varying ages and lithology within the Paleocene-Lower Eocene sediments overlying the cherty limestones of the Haticeana series. These sediments arc called the Alakaya formation by Erkman and others (1982), the Camialanı tectonic unit by Bölükbaşı (1987).

This paper dealing with part of a research carried out in Fethiye-Çameli-Elmalıarea summarizes the stratigraphic and structural features of the Paleocene-Eocene sediments described as the Faralya formation.

FARALYA FORMATION

Definition, name and distribution. - The Paleocene-Eocene flysch-like sediments that begin with red micritcs locally containing thin interbeds of basic volcanics are called the Faralya formation. This unit could be observed in the uppermost section of the structural units lying beneath the ophiolite nappe, west of Teke peninsula.

Type sections. - This unit exhibits type sections at the locality of Avian Pınarı, near Faralya village, and Küre Çeşme and Uzunca Yayla, east of Boyalı Mahallesi (Fig. 3).

Lithology. - The Faralya formation that exhibits various lilhologic sequences at different places, begins with planktonic foraminifera-bearing, red and pink colored micrites which are seen as thickly bedded from a distance, although they show, to medium lamination (Fig. 3, 4). These micrites locally containing nodule and bands of red chert arc overlain by alternating clayey limestone, marl, and claystone, all of which indicating the same characteristics of micritcs. The formation be-

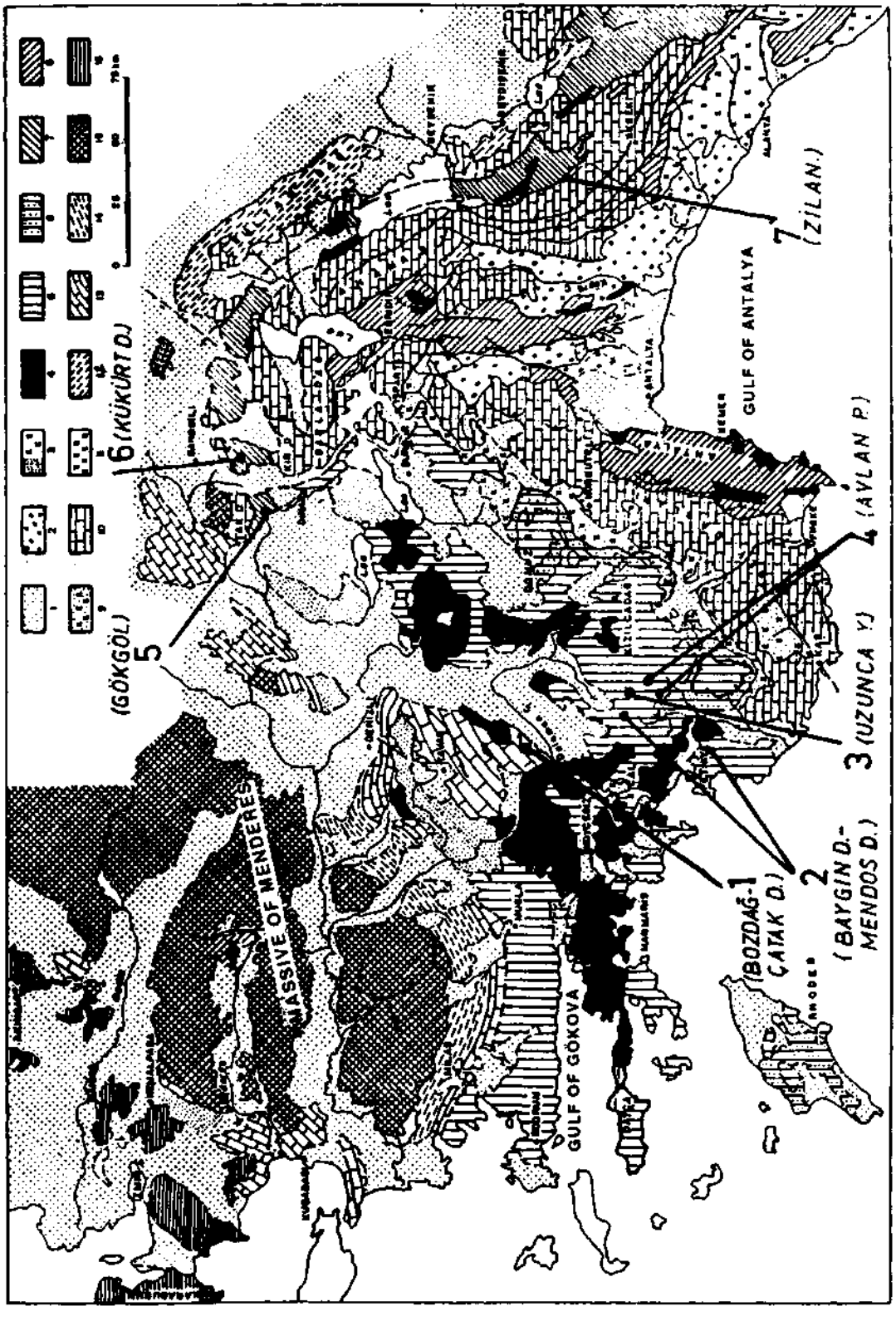

Fig. 1 - Structural scheme of the western Taurus. 1- Plio-Quaternary; 2- Antalya Miocene basin; 3- Tavas-Burdur and Fethiah-Kemalpaşa post-tectonic molasse basin (Oligocene-Burdigalian); 4- Ophiolite nappe; 5, 6- Lycian nappes (5: Radiolarite and carbonate units, 6: Yavuz unit); 7- Beyşehir-Hoyran-Hadim nappes; 8- Antalya nappes; 9- Beydağları Lower-Middle Miocene; 10- Carbonate platform (Mesozoic-Paleocene); 11- Alanya massif; 12- Series of Seydişehir Paleozoic and Sultan Dağları; 13- Mesozoic marbles; 14- Upper Paleozoic micaschists; 15a- Gneiss; 15b- Sandıklı porphyroids (Paleozoic); 16- Northern Menderes metamorphic series.

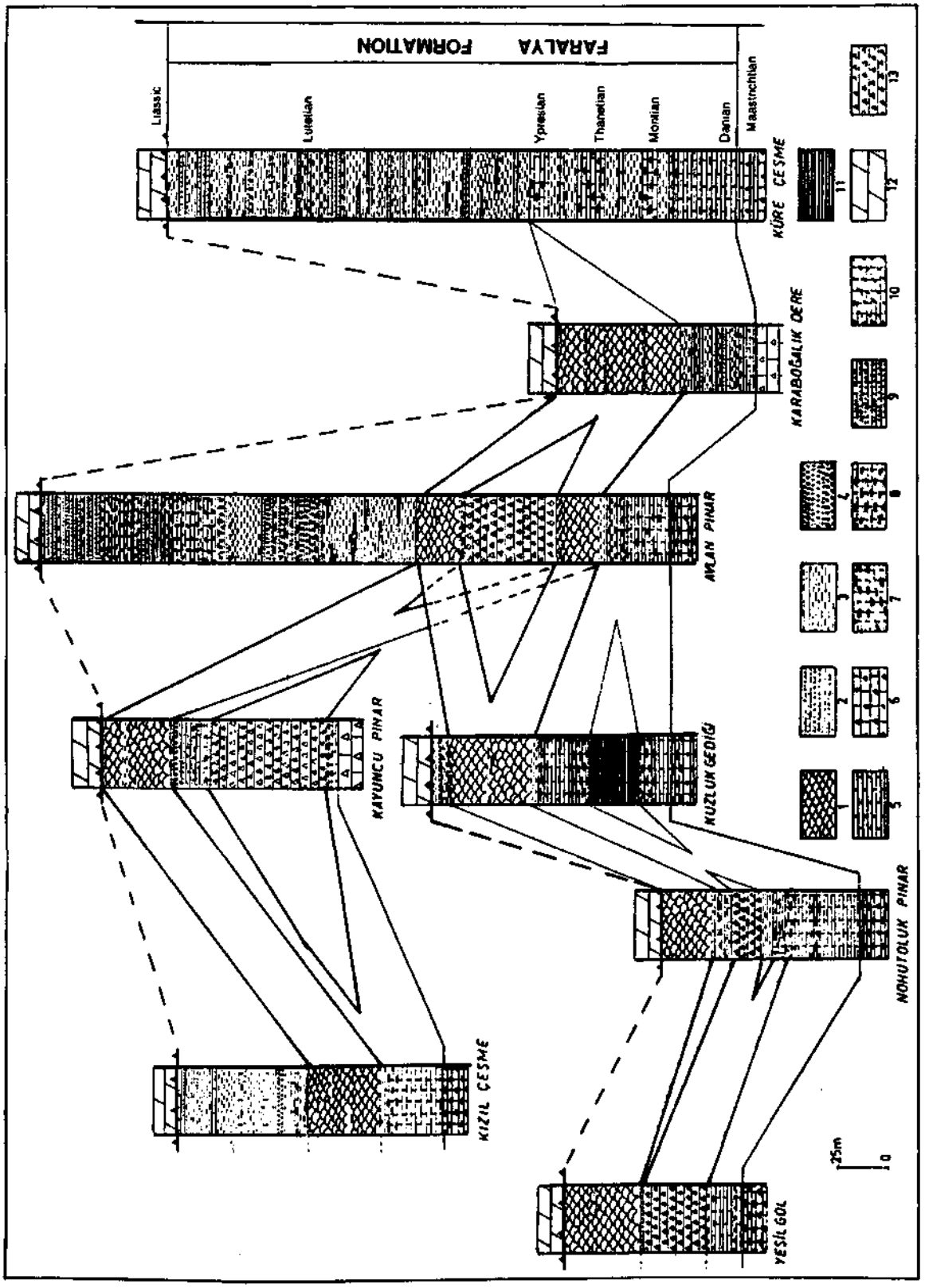

Fig. 2 - Stratigraphic columnar sections of the Faralya formation. 1- Pillow lava; 2- Sandstone; 3- Claystone and siltstone; 4- Conglomerate; 5- Pelagic limestone; 6- Brecciated limestone; 7- Cherty pelagic limestone; 8- Clayey limestone; 9- Sandy limestone; 10- Conglomeratic limestone; 11- Bedded chert; 12- Dolomite; 13- Breccia.

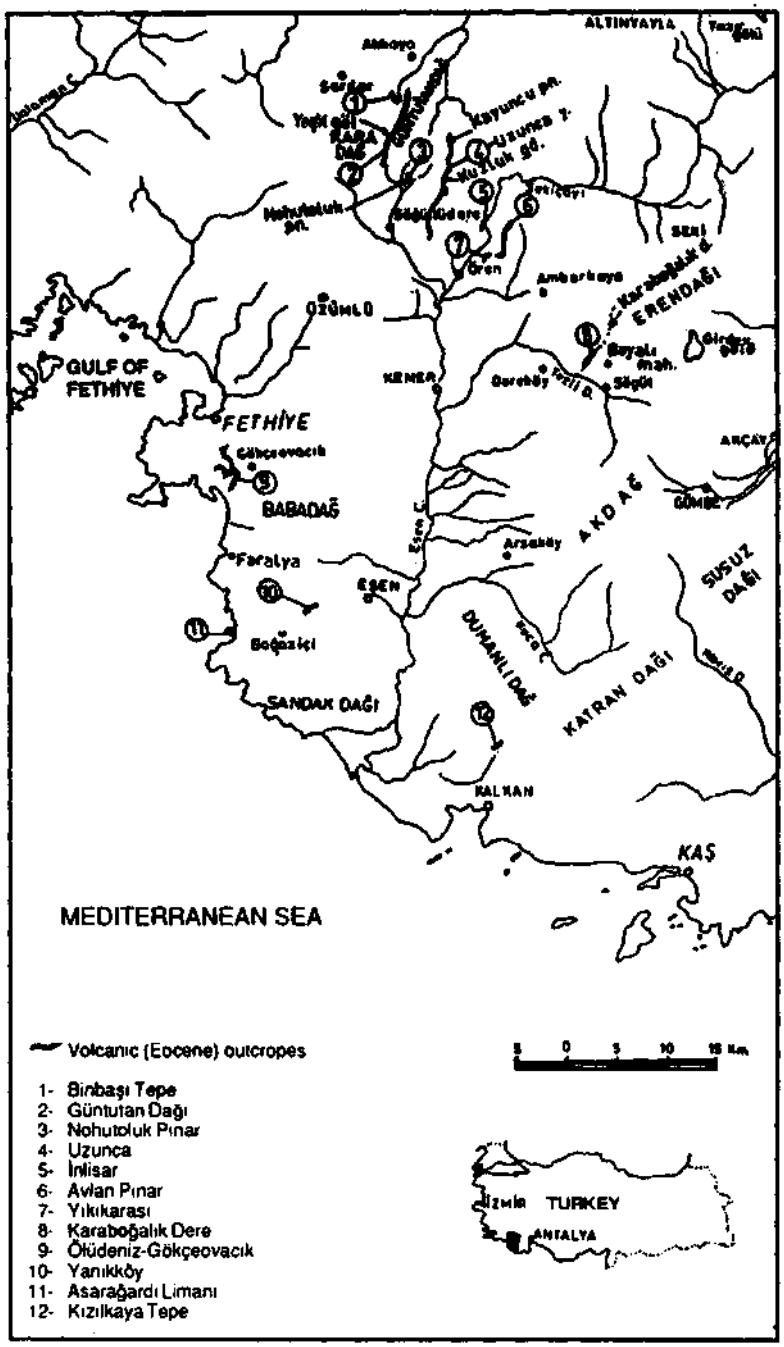

Fig. 3 - Cross-section illustrating basic volcanic outcrops within the Faralya formation.

ginning with brecciated, sandy, and clayey limestone and claystone, occurring rarely (Fig. 3, 5, 6 and 7), grades upward into conglomeratic limestone, breccia, sandy limestone, clayey limestone, marl, micritic limestone, sandstone, conglomerate, and siltstonc and claystone interbedded with basic pillow lavas. The siltstone and claystone, the most common lithologies of the formation, are thinly bedded and are reddish brown, wine, red, pink, dirty yellow, green and greenish gray colored at various horizons.

The breccias found as interbeds within the above lithologies are thick to medium bedded and greenish gray, dirty yellow, dirty white and light brown colored. This breccia unit which could be identified as a member locally show flow struc-

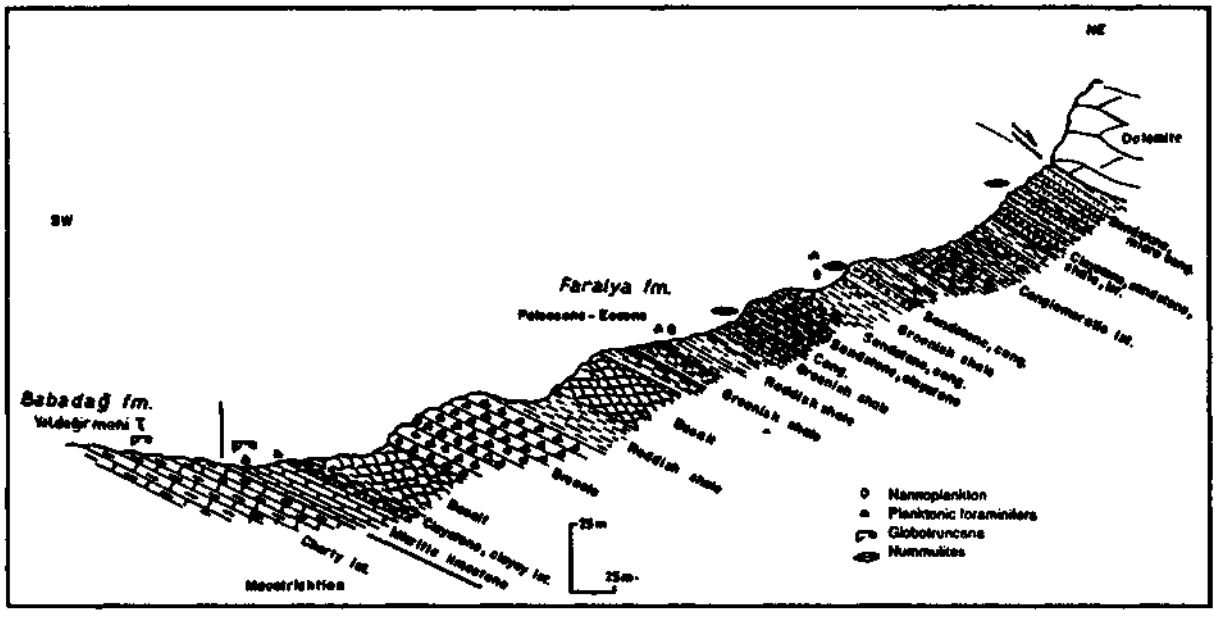

Fig. 4 - Cross-section illustrating outcrop of the Faralya formation from Avlan Pınarı.

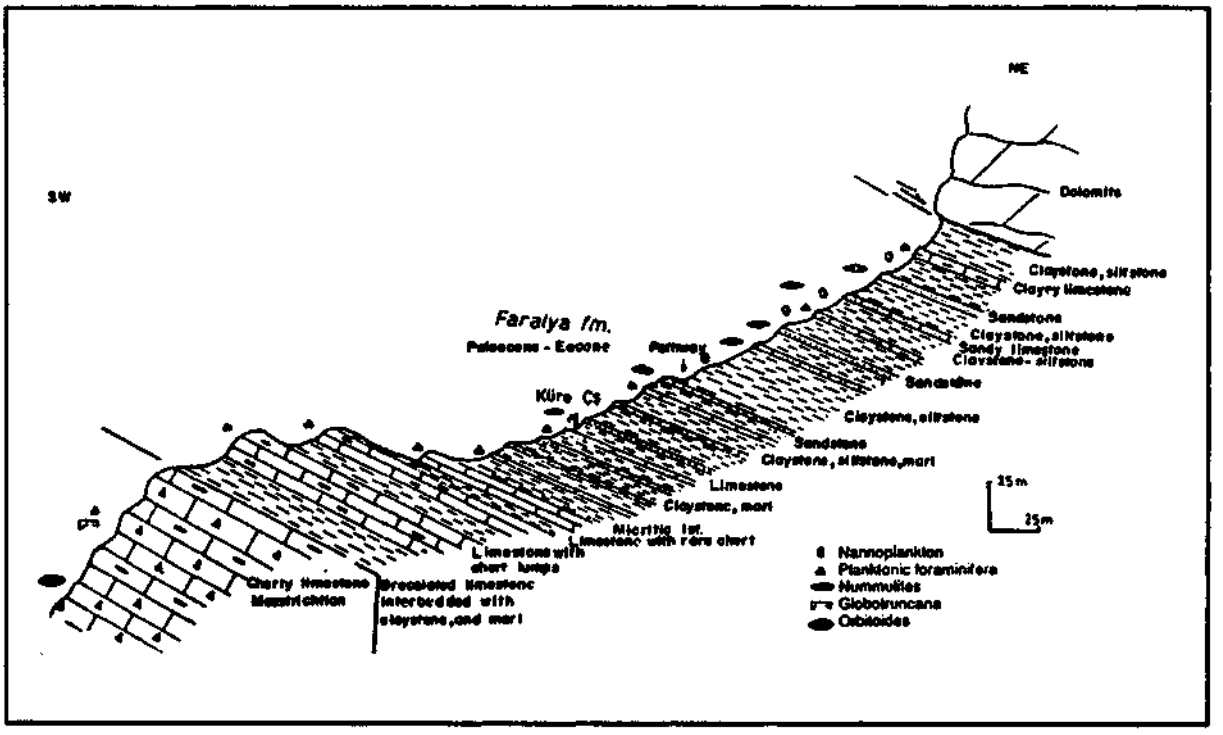

Fig. 5 - Cross-section illustrating outcrop of the Faralya formation from Küre Çeşme.

ture (flute casts) on the lower bedding planes and have angular fragments, displaying medium to poor sorting and local grading. The cherty limestone rarely contains fragments of some rock units such as diabase, gabbro and peridotite. It is locally as much as 50 m. thick and pinches out laterally as discontinuous outcrops for a long distance. As seen from the Avian Pınarı section, it is found between two basic volcanic flows, although it generally lies between the red micrites and basic volcanics (Fig. 4).

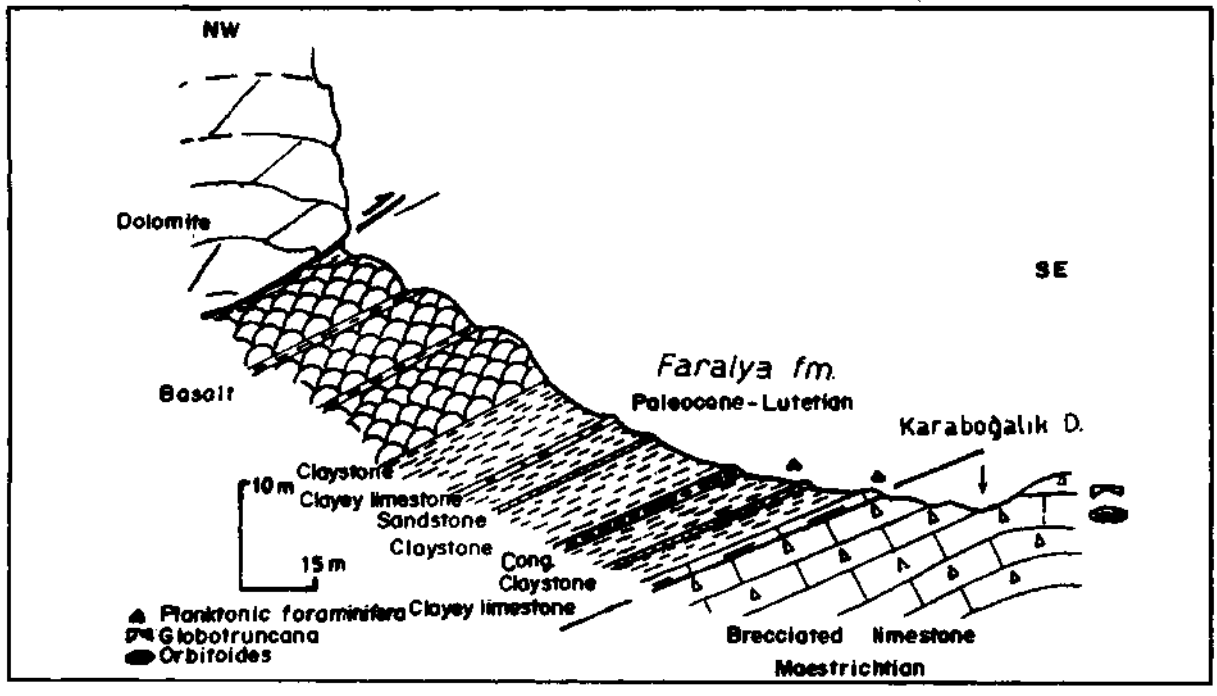

Fig. 6 - Cross-section illustrating outcrop of the Faralya formation from Karaboğalık Dere.

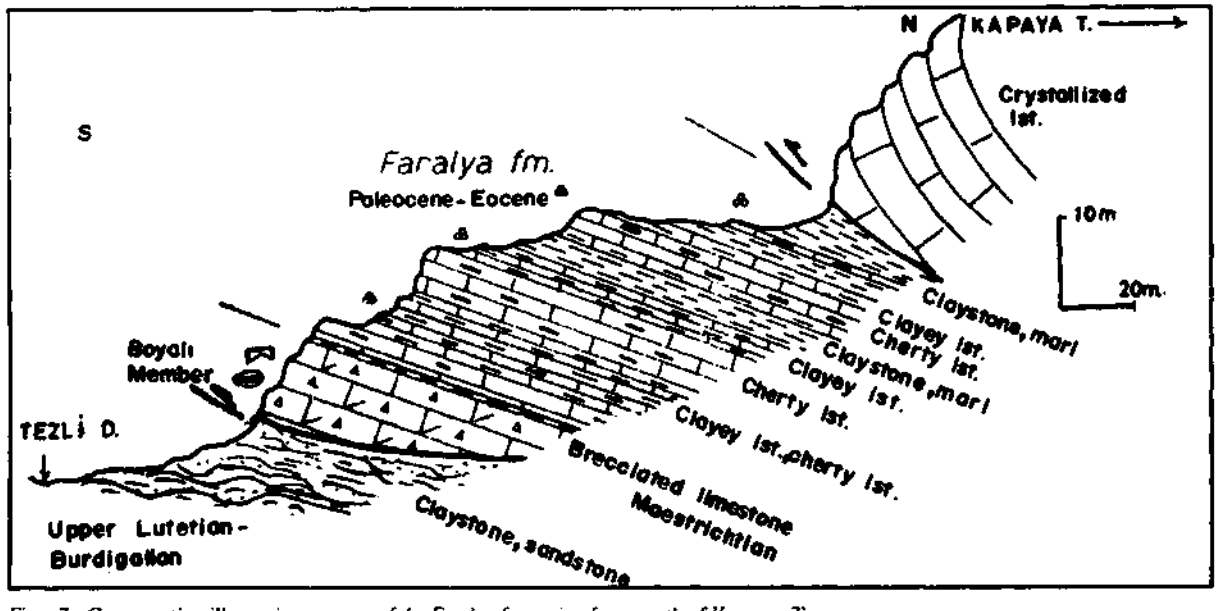

Fig. 7 - Cross-section illustrating outcrop of the Faralya formation from south of Kayaaya Tepe.

The interbeds of the brecciated limestone, sandy limestone, clayey limestone, and micritic limestone arc mostly seen as thin lenses, and bands at different levels of the siltstonc, and claystone. They are rarely up to 10 m. thick. The sandstone interbeds have the same features as those of the above mentioned lithologies. However, the uppermost section of the formation is composed of sandstone that is up to 30 m. thick near Avian Pınarı (Fig. 4). This greenish gray colored sandstone is thin to medium bedded. It contains thin lenses and bands of siltstone, and claystone. It has been intensively fractured and crushed, due to overthrusting of dolomite. It rarely contains thin horizons of conglomerate. The same section also displays alternating of clayslonc, and conglomeratic limestone, with a total thickness of more than 40 m. (Fig. 4). These lithologies formed boudinage structure arising from intense deformation.

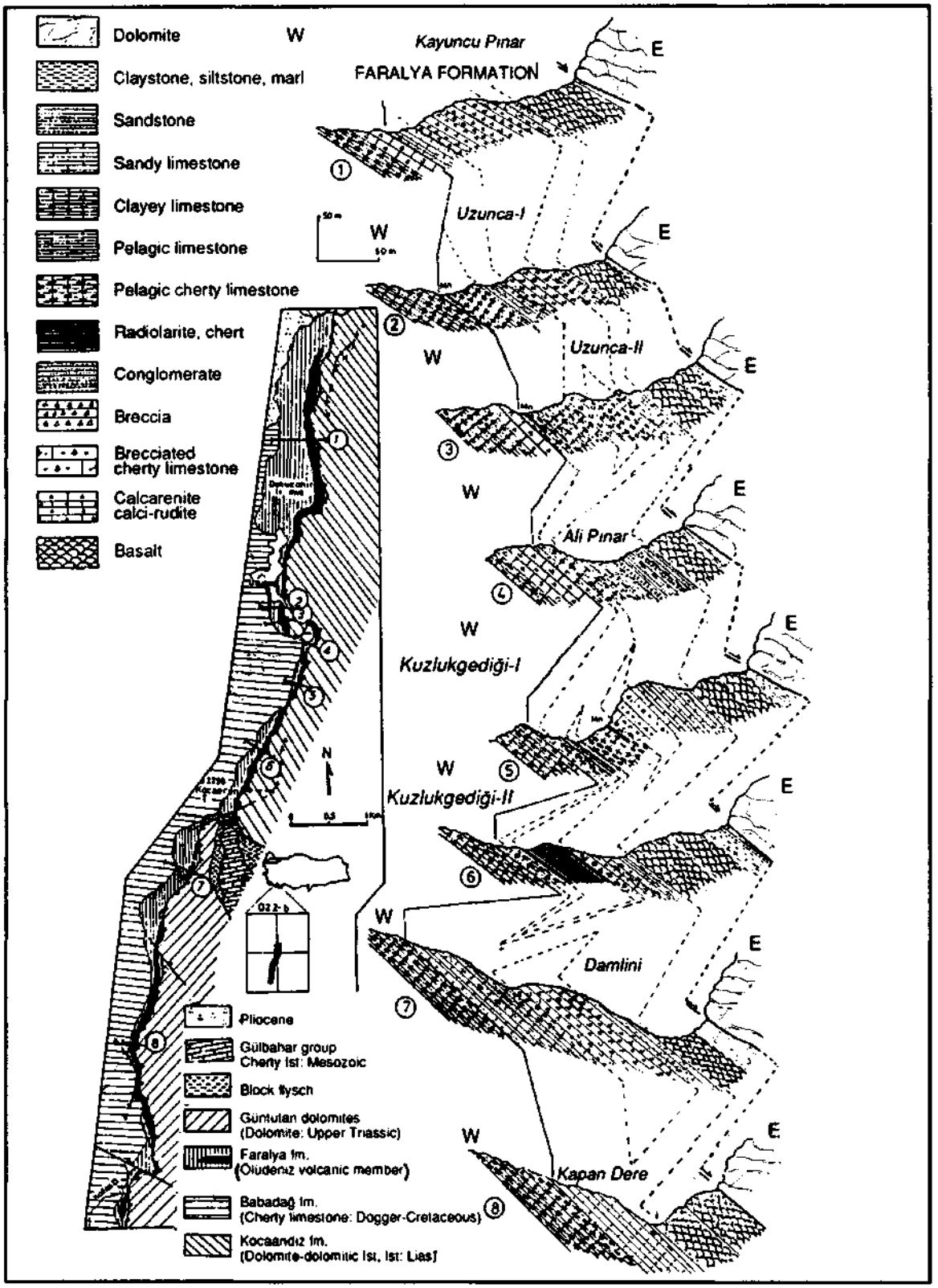

Fig. 8 - Geologic map showing the Faralya formation from Uzunca Yayla and, its southern part and cross-sections illustrating lateral lithologic variations throughout the unit.

The radiolarite and chert of the formation are observed only at the locality of Kuzluk Gediği, south of Uzunca Yayla (Fig. 8). These rocks overlying the red cherty micrites are thin to medium bedded; are reddish brown, and red colored. Cherts, about 25 m thick, grade laterally and vertically into the red cherty micrites.

The pillow lavas interslratified with the Faralya formation is named the Ölüdeniz volcanite member.

Ölüdeniz volcanite member

These basic volcanics named as "Ölüdeniz volcanile member" are best exposed along the road of Gökçeovacık-Oliidcniz, south of Fethiye and are seen as thin layers beneath the tectonic contacts where the Faralya formation is exposed (Fig. 3). They vary in thickness from 25 to 50 m. within the formation. These volcanics that commonly overlie the red micrites and breccias are pillow structured and reddish brown, brown and dark brown colored. The pillows range in length from 20 cm. to 1 m. They include thin lenses of green, and red colored claystone. Some red miqrites and clayey micrites can be found between the pillow lavas. Fractures and gas vesicles are filled with calcitc. The Ölüdeniz volcanics are fractured and crushed, due to the overlying dolomite overthrust, and as a result, they formed cataclastic texture.

These volcanics, namely spilite, spililized basalt, and olivine basalt display intersertal and ophilic textures. Plagioclascs found as phenoerysts are mostly albitized and locally sericitized. Augite (Ti-bearing) crystals are conspicuous between the laths of plagioclase. Olivine crystals occur mostly as carbonate and limonite pseudomorphs.

A total number of 13 rock samples collected from 3 different sections where the Ölüdeniz volcanics are exposed were analyzed for total rock chemistry (Table 1). When the analytical data is plotted using the diagrams of Zanettin (1984), and Peccerillo and Taylor (1976) (Fig. 9, and 10) in order to confirm the pctrographic descriptions, it is apparently shown

Table 1 - Major oxide compositions of the Ölüdeniz volcanite member within the Faralya formation

	K.1	*K.2*	*K.3*	*K.4*	*772A*	*772B*	*772C*	*803A*	*803B*	*803C*	*803E*	*803F*	*803G*
SiO_2	45.7	50.0	48.9	50.0	45.6	48.0	46.8	47.4	45.1	45.7	48.6	47.0	47.7
Al_2O_3	16.1	15.9	15.5	15.0	14.7	15.5	15.5	13.6	13.3	13.0	14.5	13.8	13.5
Fe_2O_3	8.7	5.7	8.0	5.8	7.9	5.7	5.9	6.4	7.7	8.2	6.2	6.5	6.7
FeO	1.65	3.75	3.00	2.75	3.54	3.50	4.64	3.26	3.62	3.10	4.40	4.58	3.90
MnO	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MgO	2.60	6.60	6.25	5.00	5.55	6.36	5.88	6.35	6.16	6.12	6.00	5.67	6.12
CaO	8.15	6.55	7.15	8.75	5.95	8.17	10.12	9.17	9.12	9.62	8.07	8.57	8.90
Na_2O	6.45	5.70	4.75	4.75	4.55	4.48	3.32	4.75	4.60	4.80	4.72	5.05	4.68
K_2O	0.80	0.50	1.10	1.10	2.00	0.85	1.30	0.60	0.70	0.80	0.90	0.80	0.70
TiO_2	1.8	1.8	2.0	1.3	2.2	1.2	1.1	1.4	1.4	1.4	1.5	1.5	1.4
P_2O_5	0.3	0.2	0.3	0.2	0.4	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.2
CO_2	2.90	0.28	0.41	1.78	0.50	1.00	1.25	1.52	1.77	1.77	0.75	0.75	1.52
H_2O	3.68	1.88	1.40	1.76	1.20	0.70	1.18	2.02	1.12	1.70	0.90	0.84	1.20

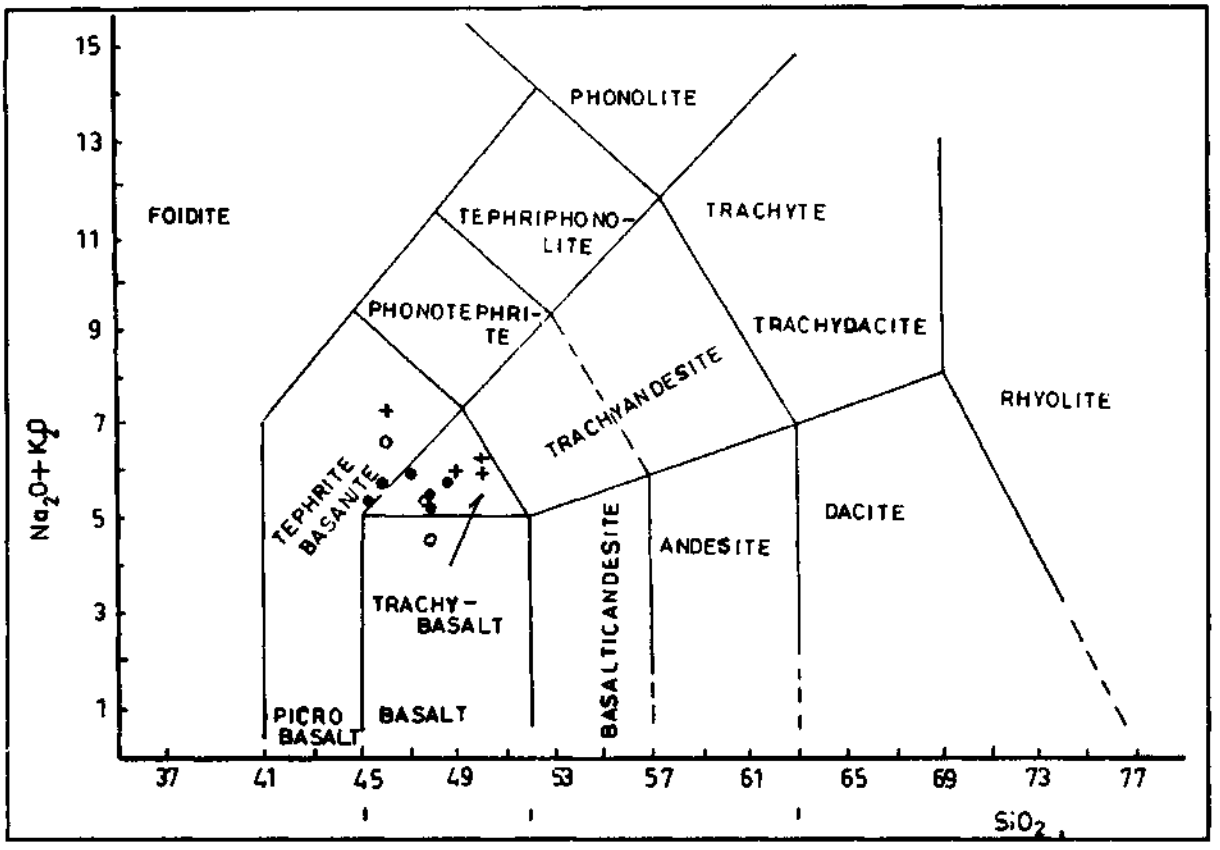

Fig. 9 - Nomenclature of volcanic rocks within the Faralya formation according to the diagram given by Zanettin (1984).

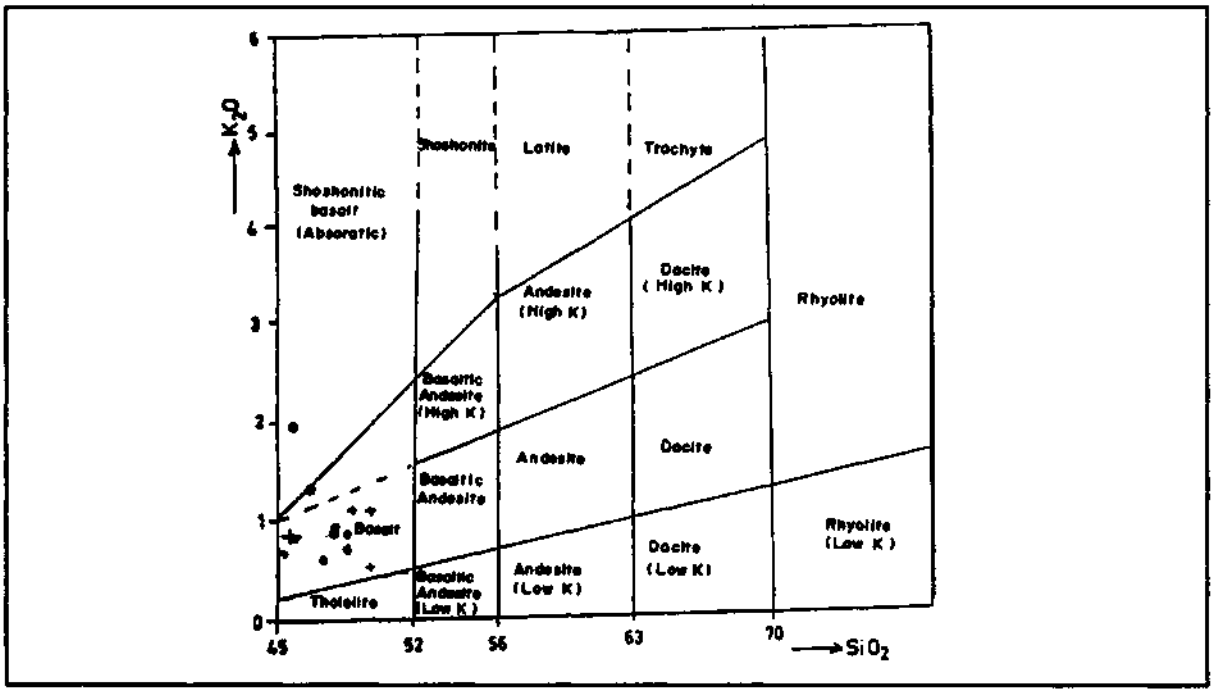

Fig. 10 - Nomenclature of basic volcanic rocks within the Faralya formation, according to the diagram given by Peccerillo and Taylor (1976).

that the total rock chemistry of the samples plots in trachybasalt field of the diagram given by Zanettin (1984), but in the basalt Held of Peccerillo and Taylor (1976). The concentration in the trachybasalt field in the diagram given by Zanettin (1984) may be attributed to the fact that the Ölüdeniz volcanics have been extensively spilitized. Having regard to the SiO_2 alkali (Na_2O+K_2O) contents of the discrimination lines given by McDonald and Katsuno (1964). and Kuna (1960), they show an alkaline character (Fig. 11).

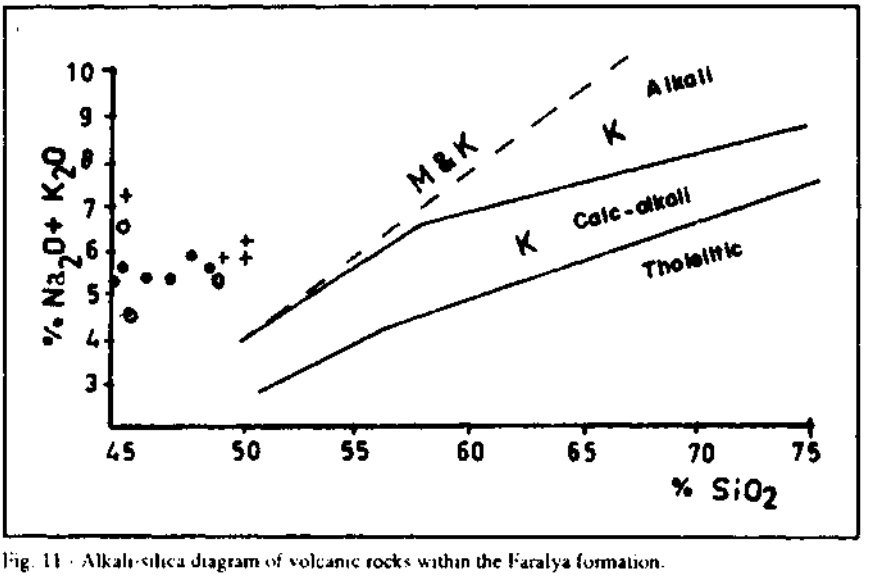

Fig. 11 - Alkali-silica diagram of volcanic rocks within the Faralya formation.

The observations reveal that no olistoliths arc found within the Faralya formation. However, a small block of serpentinized peridotite was observed immediately beneath the dolomite overthrust near Ali Pınar, south of Uzunca Yayla. Whether it is an olistolith or not, is debated. The presence of sonic exotic blocks is not uncommon, particularly in the uppermost levels of the formation, due to emplacement of nappes on to them.

The red micrites that make up the lowermost portion of the formation has some manganese occurrences. The common feature of all manganese occurrences is that they are overlain by a volcanic interbed. Locally, enrichments in F2O3 and MnO are found within the Ölüdeniz volcanics. A sample collected from such a level observed along the road of Gökçeovacık-Ölüdeniz yielded the following total-rock (major oxides) analytical results; 41.2 % SiO_2, 12.9 % Al_2O_3, 19 % Fe_2O_3 (total), 6.55 % = CaO. 4.07 % = MgO. 2.8 % = MnO, 3.15 % = Na_2O, 1.6 % = K_2O.1 % = TiO_2, 0.5 % = P_2O_5, 0.5 % = CO_2, 2.08 % = H_2O and FeO (trace amount). The contents of Fe_2O_3 and MnO(19 % and 2.8 %, respectively). The mangenese occurrences hosted by the Faralya formation were investigated in detail by Çelebi and others (1989).

Some pyrite chalcopyrite occurrences arc found particularly within the volcanics of the Faralya formation near Karaboğalık Dere, northwest of Boyalı Mahallesi and surrounding areas. These occurrences developed within the alteration zones parallel or subparallel to bedding planes.

Thickness and lateral changes. - The thickness of the Faralya formation was measured to be about 280 m. near Küre Çeşme (Fig. 5) and about 290 m. near Avian Pınarı (Fig. 4). It is considerably variable elsewhere in the area, due to emplacement of nappes. The lilhologics of the formation grade into one another, laterally and vertically. This variation is best documented near Uzunca Yayla and its southern part (Fig. 8).

Contact relations. - The formation conformably overlies the brecciated limestone, and cherty limestone of Maestrichlian age, where the structural units of the Lycian Nappes lie beneath the ophiolite nappe. However, it may be conspicuous by its thin skinned parts and abrasion surfaces on top of cherty limestones, and brecciated limestones. It differs markedly from the overlying formation in lilhology. The structural units that make up the Lycian Nappes are tecionically overlain particularly by dolomites.

Fossil content and age - Numerous samples were collected in order to determine the age span of the unit. Fossils identified in the samples taken from red micrites and adjacent horizons are as follows;

Globoratalia cf. *pusilla* Boli.
Globorotalia cf. *triloculinoide* Plummer,
Globorotalia cf. *aequa* Cush.-Renz.
Globoratalia cf. *angulala* (White).
Globarotalia cf. *nex.* Martin,
Globorotalia sp.,
Globigerina sp.,
Anomalina sp.,
Discocyclina sp.,
Hasligerina sp..
Quinqucloculina sp.,
Textularidae,
Rotaliidae,
Lithothamnium sp.,
Bryozoa,

Orbitoides and Globotruncuna (allocluhonous) fossils were also determined. Conversely, the uppermost levels that are made up of volcanics contain the following fossils;

Sphaerogypsina globus Rcuss,
Discocyelina sp..
Nu*nmulites* sp..
Alveolina sp.,
Lochartia sp.,
Eorupertia sp.,
Asterigerina sp.,
Operculina sp.,
Anomalina sp.,
Quinquelaculina sp.,
Cuvillerina sp.,
Lithothainnium sp.,
Globorotalia sp.,
Globigerina sp.,
Rotaliidae,
Textularidae and
Pelecypoda.

In addition to those, fossils identified in some claystone samples are as follows;

Sphenolithus radians Deflandre,
Discoaster lodensis Bramlette-Riedel,
Discoaster sublodoensis Bramlette-Sullivan,
Chiasmolithus grandis (Bramlette-Riedel),
Cyclococcolilhina gammalion (Bramlette-Sullivan),
Cyclococcolithinaformosa (Kamptner).
H*elicopotosphaena sp.*

Based on the above fossil assemblage, a Paleocene-Lutetian age is assigned to the Faralya formation.

Environmental interpretation. - On the basis of lithologic features and fossil content, it is suggested that the formation was deposited in a deep sea environment. The presence of turbidite beds, complete or parts missing indicate that turbiditic current were effective in the environment. On the other hand the presence of benthonse foraminifera, algac etc. show that shelf environment was not very for off also. Breccias found within the unit appear to represent submarine fan that developed along an active tectonic line. Basic volcanics are interbedded with Eocene sediments. Turbidity currents, volcanic activities, and the presence of breccias reflect that the depositional environment was tectonically active.

Correlation. - The Faralya formation shows similarity to the Datça flysch (Orombelli and others. 1967) to the west, with respect to lithologic features. The Palcocene-Lower Eocene rock units belonging to the southern cover of Mendcres massif are closely correctable with particularly the lower part of the Faralya formation (Bernoulli and others, 1974; Dün, 1975; Akat and others, 1975; Çağlayan and others, 1980; Konak and others, 1987). Akdeniz (1989, pers. comm.) reports that some basic volcanic rocks are found within this unit. Poisson (1977) reports another sequence equivalent to the Faralya formation from the Çatak Dere section measured within a structural unit named the Bozdağ massif. However, recent observations from the Çatak Dere section (Akdeniz, 1987, pers. comm.) indicated the presence of volcanics which have not been described by Poisson (1977) (Fig. 12-1). Some sediments and basic volcanics, that are identical to those found in the Faralya formation were observed within the structural unit named the Gökgöl unit (Gutnic, 1977), northwest of Dinar (Fig. 12-5). These volcanics were previously incorporated in the lowermost part of the Denizpınarı unit and considered to be Upper Triassic-Lias in age by Gutnic (1977). Various rock units similar to those of the Faralya formation and Eocene basic volcanic rocks are exposed within the Kükürtdağ group to the east of Dinar (Öztürk, 1989) and near Sultandağları (Öztürk, 1987, pers. comm.). The volcanics of the Eocene Zilan flysch (Table 2) described from the Akseki autochthon to the south of Seydişehir (Martin, 1969; Monod, 1977) show similarity to those found in the Faralya formation (Fig. 12-8).

Table 2 - Major oxide compositions of the volcanics within the Zilan flysch (Monod, 1977)

	Zi 02	*Zi 03*	*Zi 04*	*Zi 06*	*Zi 07*
SiO_2	43.50	40.10	44.80	47.20	45.80
Al_2O_3	15.80	16.10	17.90	16.00	17.55
Fe_2O_3	10.15	08.64	09.01	09.25	09.43
MnO	00.18	00.19	00.16	00.42	00.24
MgO	06.40	04.32	06.79	05.97	05.97
CaO	08.42	14.23	10.28	11.66	08.68
Na_2O	05.35	04.01	03.96	02.94	04.20
K_2O	00.32	00.76	00.47	00.38	00.37
TiO_2	01.31	00.95	01.33	01.03	01.54
P.F.	08.49	09.10	05.63	03.60	06.60

DISCUSSION AND CONCLUSION

It is put in evidence that at least a part of some units which had been defined as "intervening en echelon complex" and considered to be derived from the northern part of the Menderes massif by Graciansky (1968; 1972) should have been originally derived from an area between the Menderes massif and Beydağları autochthon (Poisson, 1977; Erkman and others, 1982). The structural and straligraphic features of the newly described Faralya formation provide a result that justifies this view.

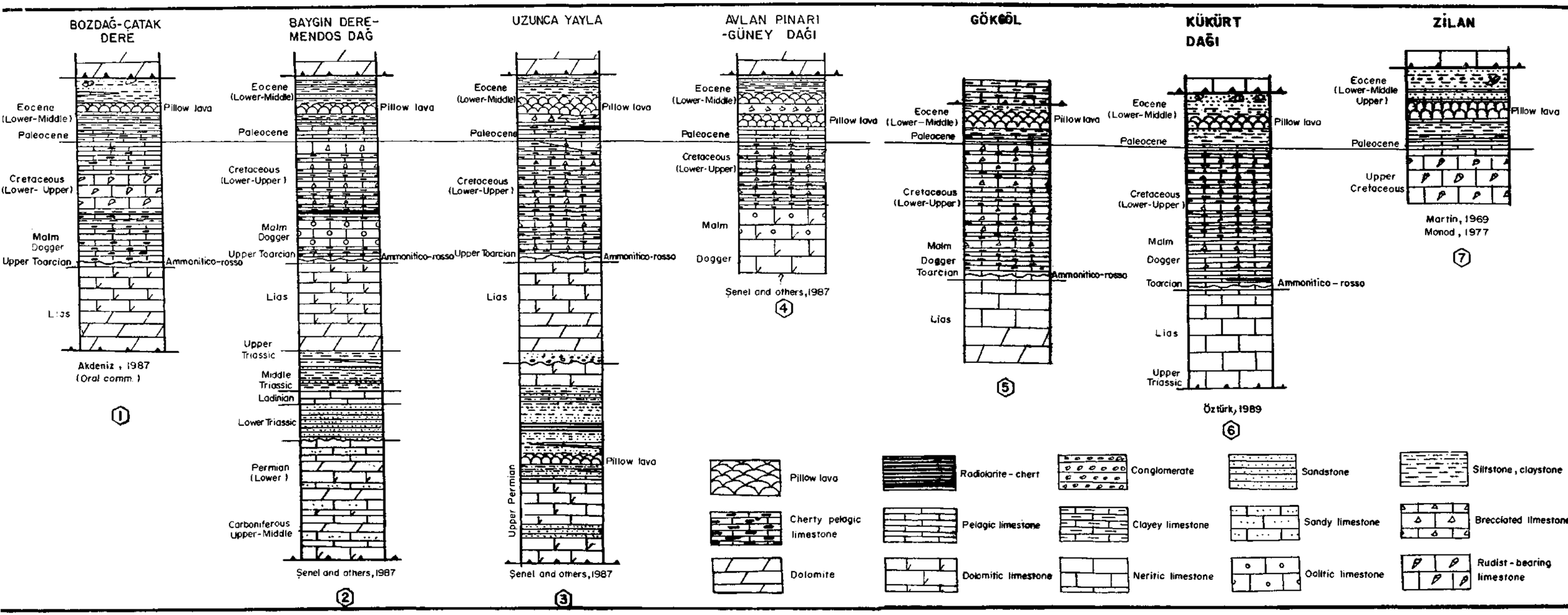

Fig. 12 - Stratigraphic columnar sections illustrating structural units that terminate with the Faralya formation from western Taurus.

The Faralya formation has the same environmental characteristics as flysch series that occurred more or less contemporaneously with it and constitute the uppermost portions of the southern cover, paraautochthons of the Menderes massif, and the structural units to the north of Isparta angle. The most striking similarity between the Faralya formation and closely correlatable formations which extend from Datça peninsula to Akseki autochthon (in broad sense, Geyikdağ unit, Özgül, 1976) to the south of Seydişehir is that large scale lateral movements (Eocene orogeny) occurred over all these formations.

These formations that have the same environmental characteristics include equivalent basic volcanics and bear traces of similar orogenic movements reflect the presence of a common basin which existed as extending from the southern part of the Menderes massif, through the north of Isparta angle to the north of Geyikdağ unit during the Paleocene-Eocene.

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