

# BULLETIN OF THE MINERAL RESEARCH AND EXPLORATION INSTITUTE OF TURKEY

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Foreign Edition

October 1967

Number : 69

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# EOCENE - OLIGOCENE SEDIMENTATION IN THE KEŞAN AREA, SW TURKISH THRACE

(Preliminary Results)

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**ABSTRACT.** — Petrological and sedimentological characteristics of the Keşan formation (Eocene-Oligocene) are described. The formation is recognised as a sandy turbidite facies comprised of the Çınarlı Dere (lower) and Şaplı Dere (upper) members. The mean palaeocurrent direction for the Çınarlı Dere member is to 305°, that for the Şaplı Dere member is to 95°. Volcanic rock fragments are significantly more abundant in the Şaplı Dere member than in the Çınarlı Dere member. Metamorphic rock fragments, however, are significantly more abundant in the Çınarlı Dere member. Consideration of palaeocurrent data and petrological character suggest a regionally metamorphosed source area in the south or southeast (? Troy massif) for the Çınarlı Dere member and a volcanic source area in the west or northwest (? volcanic association of Rhodope massif) for the Şaplı Dere member.

## INTRODUCTION

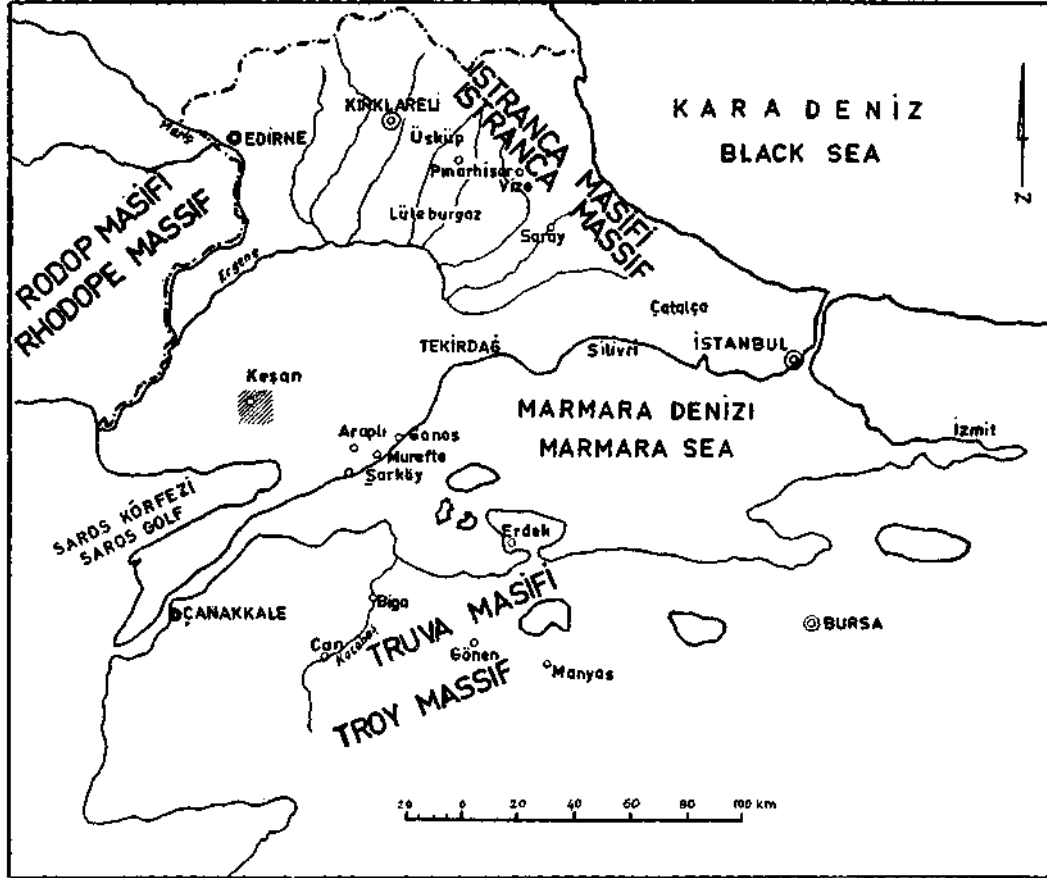
Turkish Thrace is composed mainly of sediments of Tertiary and Quaternary age with minor occurrences of igneous rocks. It is bordered in the northeast by the crystalline rocks of the Istranca massif, in the west by those of the Rhodope massif, and in the south, across the Marmara Sea, by the pre-Mesozoic basement of the Troy massif (Pamir, 1967).

The regional geology of SW Turkish Thrace has been studied by various workers (Ternek, 1949; Boer, 1954; Kopp, 1955, 1964, 1965; Andrews, 1960; Schindler, 1958, 1959, 1963). Recently, various oil companies have made detailed studies and geological maps. A recent stratigraphic investigation has been made by Beer and Wright (1960).

The Keşan area is located in the SSW part of Turkish Thrace (Fig. 1) and consists mainly of Tertiary sediments (interbedded sandstone, siltstone, mudstone and shale) and associated igneous rocks. In the past it has been customary to refer to part of these sediments as «flysch». In the southern part of the area coarse «brackish-water» deposits of Plio-Pleistocene age are found.

The author made a short visit to Turkish Thrace in August, 1965, with Mr. J.E. Thomas, and the Keşan area was chosen for detailed investigation. The research project now in progress, involves investigation of the geological history and palaeogeography of the area; special attention is being given to the relationship between the sediments and volcanics and the sedimentary features associated with them.

The present paper reports preliminary results of field and laboratory work carried out during 1966-67, with special emphasis on the two members of the Keşan formation (Table 1). A more complete interpretation will be published in the future.



**Fig. 1 - Location map of Keşan area and massifs.**

#### STRATIGRAPHY AND SEDIMENTATION

Beer and Wright (*op. cit.*) have proposed group, formation and member names for the Tertiary strata of Turkish Thrace. The present writer has adopted the same terminology for groups and formations, but has modified the terminology for those members represented in the research area. A litho-stratigraphic comparison of the two classifications is given in Table 1.

In the area under discussion only the Keşan, Yenimuhacir and Çelebi formations are present. All transitions in the sequence are concordant except for the fault contact between the Keşan and Çelebi formations (Fig. 2). Further discussion will be confined to the Keşan formation.

#### Field investigation

An almost continuous section through part of the formation is compiled from exposures in Çınarlı Dere and Şaplı Dere, giving a stratigraphic thickness of 1423 m. The formation covers a wide area in Southwest Turkish Thrace and persists as a predominantly «sandy facies».

Table -1

Comparison of litho-stratigraphic units as proposed by Beer and Wright (1960)  
and present author

BEER & WRIGHT - 1960			GÖKÇEN - 1967		
Group	Formation	Member and mapping unit	Gr up	Formation	Member and mapping unit
ERGENE GROUP	ÇELEBI	—	ERGENE GROUP	ÇELEBI	—
MALKARA CLASTIC GROUP	DANIŞMEN	Meriç member	MALKARA CLASTIC GROUP	DANIŞMEN	Meriç member (not exposed)
		Sandstone member			Sandstone member (partly exposed)
	YENİMU-HACIR	— (2)		YENİMU-HACIR	—
KORUDAĞ CLASTIC GROUP	KEŞAN	Karanlık Dere member (1)	KORUDAĞ CLASTIC GROUP	KEŞAN	(2) Şaph Dere member (1)
		Lower clastic member			Çınarlı Dere member
		Pebble marl member			(not seen)

(1) = Sarıkızdere tuff. (2) = Keşan tuff (agglomerates).

The lower limit of the Keşan formation is not seen in the Keşan area. In the south the formation is faulted against the Çelebi formation of the Ergene group, the contact being interpreted on field evidence as a low - angle reverse fault. There are also some fault zones in Çınarlı dere member, therefore the complete thickness of the Keşan formation cannot be determined. Further east, however, in the northern part of the Korudağlar, an additional member has been recorded, the pebbly marl (Beer & Wright, 1960).

The upper limit of the formation is taken at a different horizon from that chosen by previous workers. Oil companies have regarded the Keşan tuffs (Table 1), forming the crest of the Keşan hills, as the topmost member of the Keşan formation. However, the dominantly sandy facies of the formation with the characteristic sedimentary and structural features continues above the Keşan tuff for a further thickness of 78 m. The Keşan - Yenimuhacir formation boundary is taken, therefore, at the top of these sandy beds. Above this horizon the muddy facies of the Yenimuhacir formation begins.

In the area studied the Keşan formation has been divided into two members: Çınarlı Dere and Şaplı Dere. They are separated by a conformable tuffaceous unit, the Sarkızdere tuff (Beer & Wright, 1960), which can be traced throughout the area. Field and laboratory examination of the tuff has revealed certain characteristics suggestive of «turbiditic» deposition viz. internal structures, sole markings, such as well-preserved flute marks, interbedding with non-tuffaceous elastics, a large uniform lateral extent and the presence of unwelded glass shards with pumice in a fine-grained siliceous matrix, etc. The current direction deduced for the tuff corresponds with that of the Şaplı Dere member.

Igneous rocks occur within the Çınarlı Dere member. Amphibole-andesite (Bukdankaya), rhyodacite (Kaletepe), and rhyolite (Karabayırtepe) being represented (Moorhouse, 1964). The rhyodacite of Kaletepe is probably intrusive, but the igneous rocks of Bukdankaya and Karabayırtepe are extrusive.

In respect of their lithologies and sedimentary features, the Çınarlı Dere and Şaplı Dere members are in many ways similar. The sequences of both members are characterized by thick marine sections of sandstone, siltstone and mudstone/shale alternations. Sole markings, which are represented by a variety of scour and tool marks, internal structures (Bouma's T a-e units, 1962) and surface structures, such as ripple marks with large-scale wash-out channels, are associated with the sandstone beds. The fossil content of both members is very poor. Lithological units and cycles in the formation are characterized by lateral continuity and absence of wedging.

If the criteria of Kuenen (1950, 1958, 1959, 1960) and those of Bouma (1962) are accepted, the above lithological and sedimentological features warrant the use of the term «sandy turbidite facies» for the Keşan formation.

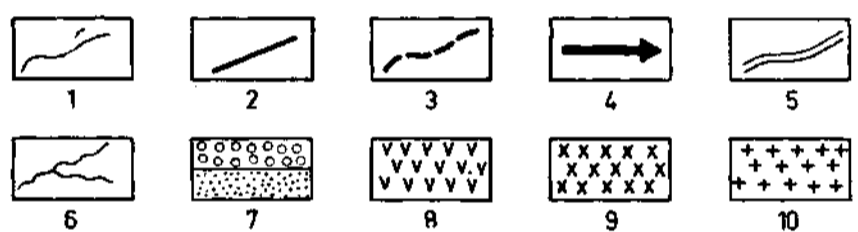
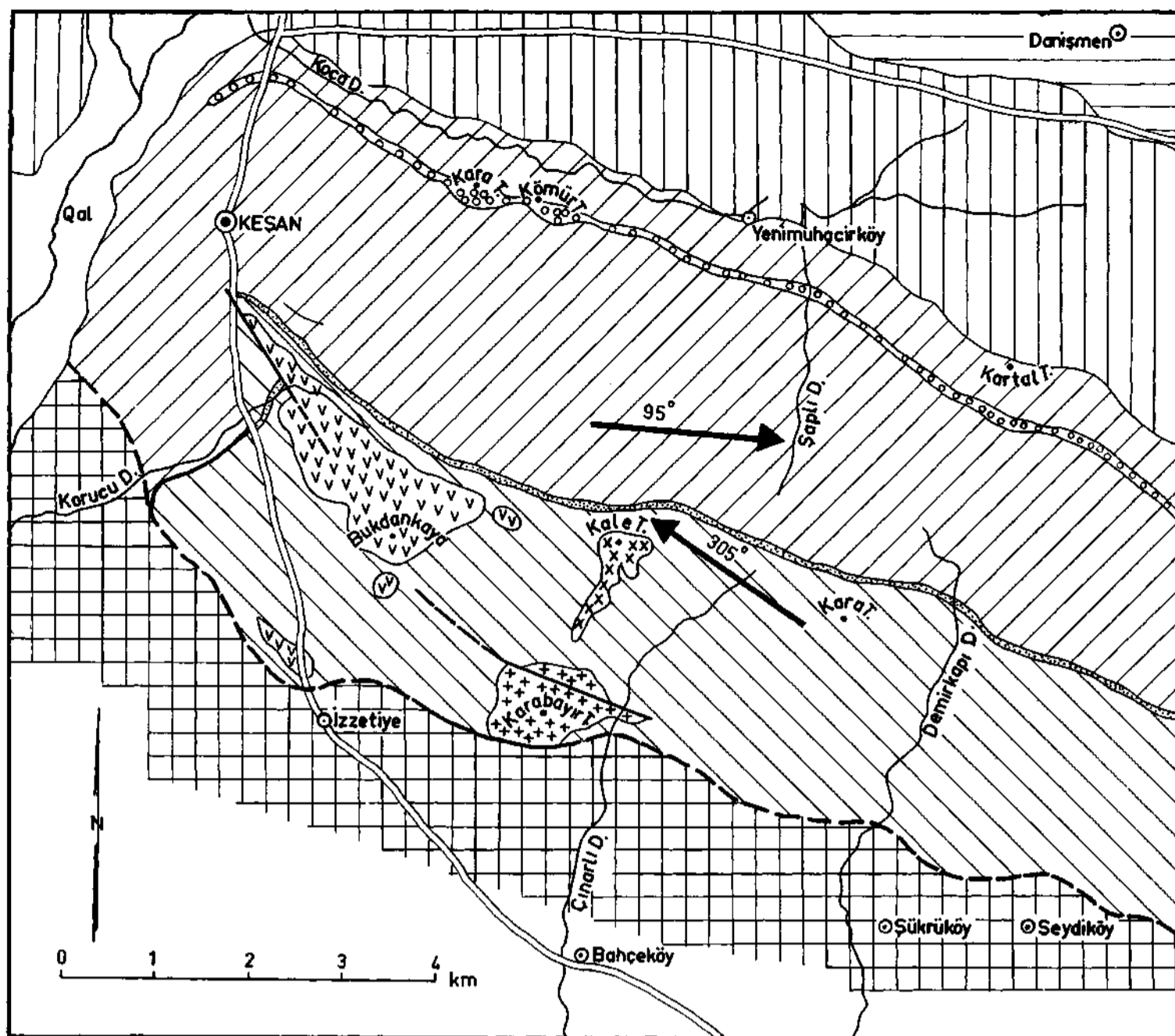
There are, however, marked sedimentological differences between the two members. Firstly, distinctly different current directions may be deduced for each of them. The mean direction (60 readings) for the Çınarlı Dere member being to 305° and that for the Şaplı Dere member to 95° (90 readings). Secondly, the Şaplı Dere member, with its many and varied types of sole markings (specially small-scale scour marks with rare tool marks), graded bedding, convolute laminations and commonly occurring linguoid ripple marks, presents a typical turbidite sequence.

The Çınarlı Dere member, in contrast, although exhibiting many but less varied types of sole markings (especially large-scale V-shape flutes), has fewer representatives of graded units and internal structures. However, unlike the Şaplı Dere member, there are well-preserved slump structures around the volcanic centres, transverse ripple marks, burrow-bearing beds and, furthermore, the proportion of sandstone beds are greater.

#### Structure

In general, the strike of the beds throughout the area is E-W with a gentle dip to the north. However, within the Çınarlı Dere member some variations from the norm have been observed, e. g., in the Demirkapı Dere section. The cause of these swings in strike is uncertain as yet, but may perhaps be due to emplacement of igneous intrusive bodies.

Along the southern margin of the area investigated, complete reversal of dip is characteristic and is attributed to a low-angle reverse fault which brings the Keşan formation into contact with Ergene group.



Stratigraphic column

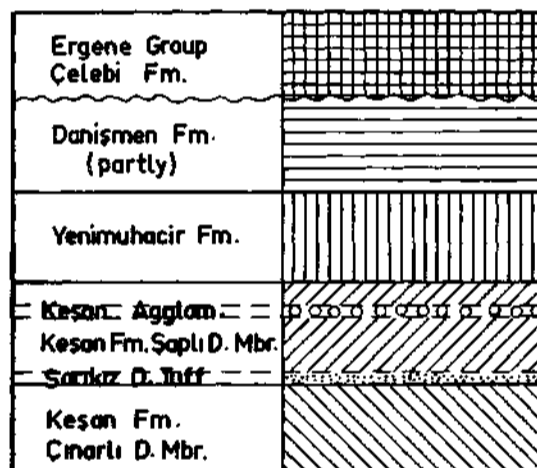


Fig. 2 - Geological sketch-map of Keşan area

1 - Formation contact; 2 - Fault (observed); 3 - Fault (inferred); 4 - Mean paleocurrent; 5 - Road; 6 - Stream-substream; 7 - Agglomerate (circles), tuff (points); 8 - Andesite; 9 - Rhyodacite; 10 - Rhyolite.

Two other fault zones have been recorded. One, striking NW-SE, in the river sections, cutting the Çınarlı Dere member. Another, striking N 43°W towards Keşan, was found in the SSW part of the Çınarlı Dere member, separating sediments from the Bukdankaya extrusives. A fault breccia was found in a small side stream of Sarıkızdere. Both of the fault zones are composed of normal faults.

There is a «zone of tectonic disturbance» in the Keşan hills which may be interpreted as a mixture of contorted beds, folds and minor faults (?) in the south contact of the Keşan agglomerates with the sediments; this complex zone is clearly exposed at the eastern side of the hills in the Yenimuhacir-Kartal Tepe region.

#### COMPLEMENTARY LABORATORY WORK

The remarkable difference in palco-current directions of the two members in spite of their conformable relation, suggested that further petrologic work on composition was necessary. Specimens were collected from the Şaplı Dere and Çınarlı Dere members spaced evenly through the stratigraphic sequence.

Thin sections of 14 samples from each member were prepared for petrological examinations, eight thin sections (clastic sediment) from each member were point-counted. The results of detailed petrological and statistical examinations are summarised as follows :

#### **Petrological**

##### 1. Çınarlı Dere member

a. The clastic sediments of this member are generally carbonate cemented medium to fine-grained lithic sandstones.

b. Predominant constituents of the clastic sediments are single to semicomposite quartz grains, Photo 6 (Folk, 1965), angular to subrounded with common inclusions and contact (pressure) solutions, Photo 2 (Carozzi, 1960).

c. Lithic fragments are dominantly metamorphic rock fragments, Photo 4, 5 and 8, with over 21 % by volume and some volcanic rock fragments are associated with less than 6 %.

d. Minor constituents are muscovite, chlorite flakes with some epidote, garnet and iron-oxide minerals which provide staining.

e. The feldspars comprise less than 9 % by volume. Generally twinned and altered plagioclase is the dominant feldspar.

##### 2. Şaplı Dere members

a. The clastic sediments of this, member are fine-grained carbonate cemented lithic sandstones.

b. The predominant constituents are single quartz grains with very angular, elongated to rounded shapes, with euhedral mineral inclusions and rare contact (pressure) solutions, especially with biotite, Photo 1.

c. Lithic fragments are dominantly small rounded pieces of volcanic rock fragments, Photo 3 and 7 (over 21 % by volume) and some of metamorphic rock fragments (less than 5 % by volume).



d. The minor constituents are large elongated flakes of biotite, Photo 1, and chlorite with few epidotes, garnet and devitrified glass.

e. Plagioclase comprises over 12 % by volume. The grains are usually twinned and fresh and larger in size than those of Çınarlı Dere member.

### **Statistical**

The petrological work was followed by point-counting of 16 selected thin sections. Approximately 550 grains were counted in each section by means of volume. The results of total counting, which shows their marked compositional differences, are tabulated in Table 2.

### **Relation between the mean-current directions and laboratory work**

The petrological and statistical results and the mean-current directions in both members complement each other and provide strong evidence for two different sources for the Keşan formation.

## **CONCLUSIONS**

Within the area studied, the Keşan formation comprises two members which have been named the «Çınarlı Dere» and «Şaplı Dere» members. The following observations and conclusions have been made concerning the formation and members :

1. The members are concordant and are separated by a conformable turbiditic tuffaceous unit, the Sarkız Dere tuff.

2. On the basis of field and laboratory work, and application of the criteria of Kuenen and Bouma, the formation is recognized as a sandy turbidite facies.

3. The marked difference in the mean-paleocurrent direction for each of the members indicates, locally, two opposed directions of initial dip or paleo-slope for the Keşan formation.

4. The high content of metamorphic rock fragments, semicomposite quartz grains, muscovite and the epidote content of the minor constituents in the Çınarlı Dere specimens provides strong indications of a source area composed of regionally metamorphosed rocks.

5. In contrast, samples from the Şaplı Dere member are characterized by a high content of volcanic rock fragments, rare semicomposite quartz grains and occurrence of biotite. A source area composed of igneous rocks is indicated for the Şaplı Dere member.

6. Consideration of mean-current directions and mineralogical composition lead to the proposal of two possible source areas for the Keşan formation :

a. A regional metamorphic source in the south or southeast for the Çınarlı Dere member —(?) Troy massif.

b. An igneous source in the west or northwest for the Şaplı Dere member —(?) Volcanic association of the Rhodope massif.

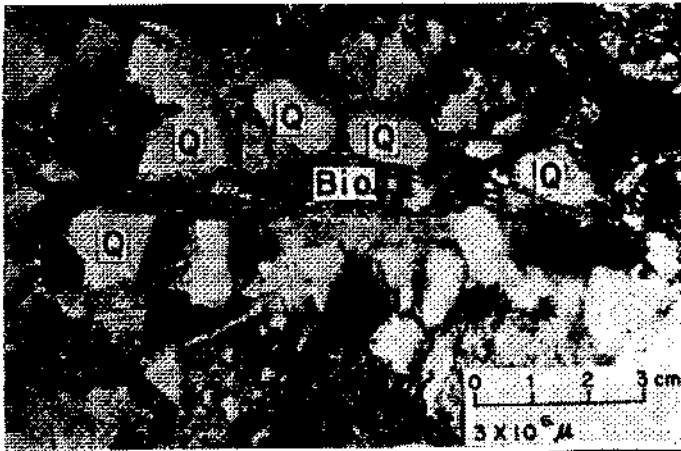


Photo 1 - Sandstone, Şaplı Dere

Note large biotite (Bio.) flake and contact solution (Con. Sol.) with small subrounded to rounded single quartz (Q.) grains ( $\times$  nichols).

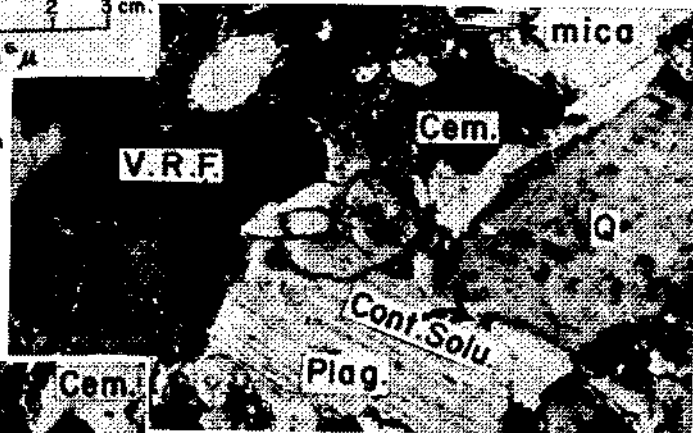


Photo 2 - Sandstone, Şaplı Dere

Contact solution of single quartz grain with twinned and altered plagioclase (Plag.). Note dark volcanic rock fragment (V.R.F.) and adjacent mica flakes ( $\times$  nichols).

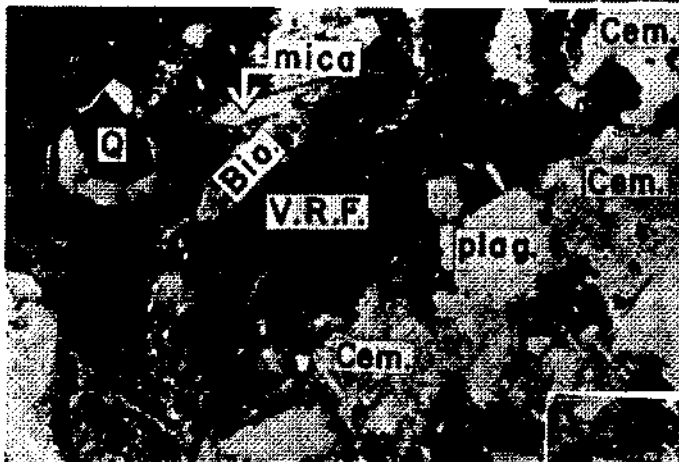


Photo 3 - Sandstone, Şaplı Dere.

A dark volcanic rock fragment surrounded by quartz grains, carbonate cement and biotite ( $\times$  nichols).



Photo 4 - Sandstone, Çınarlı Dere

A large rounded metamorphic rock fragment (M.R.F.), schist, in a carbonate cement and associated with rounded single quartz grains ( $\times$  nichols).

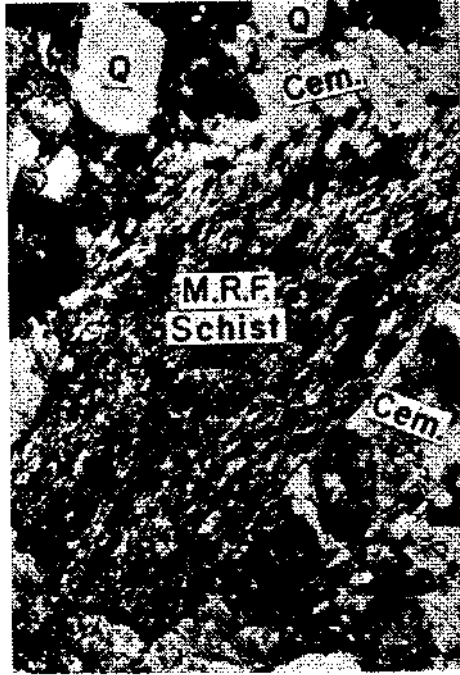


Photo 5 - Sandstone, Çınarlı Dere  
Metamorphic rock fragment, schist,  
surrounded by quartz grains and  
carbonate cement ( $\times$  nichols).

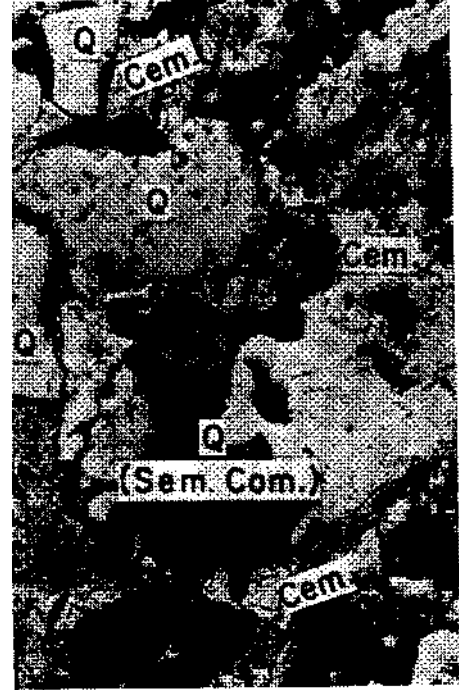


Photo 6 - Sandstone, Çınarlı Dere  
A rounded semi-composite (Sem. Com.)  
quartz grain in a carbonate cement.  
Note the peripheral corrosion of the  
grain by secondary cement  
( $\times$  nichols).



Photo 7 - Sandstone, Şaplı Dere  
A rounded volcanic rock fragment in a  
carbonate cement. Note adjacent single  
and angular quartz grains ( $\times$  nichols).

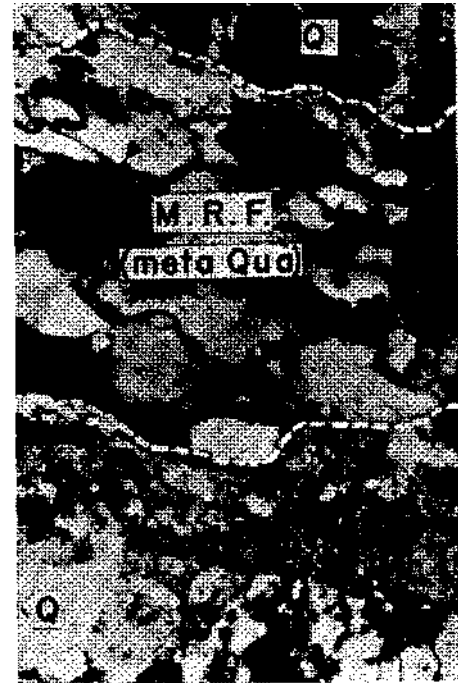


Photo 8 - Sandstone, Demirkapı Dere  
Fragments of metamorphic rock (Meta  
Qua.) and fossil material in a carbonate  
cement ( $\times$  nichols).

Table - 2  
Comparison of the mean and mineral composition (by volume) of carbonate cemented sandstones from the Çınarlı Dere and Şaplı Dere members

Slide no.	Quartz (%) <sup>1</sup>	Feldspar (%)	Minor <sup>2</sup> constituents (%)	Metamorphic rock fragm. (%)	Volcanic rock fragm. (%)	Sedimentary rock fragm. (%)	Unknown (%)	Cement	Total counting
1	38 (168) <sup>3</sup>	13 (60)	15 (66)	5 (21)	18 (80)	5 (21)	6 (29)	97	542
2	38 (176)	12 (58)	15 (70)	5 (23)	21 (97)	4 (19)	5 (23)	99	565
3	40 (179)	10 (44)	11 (50)	5 (22)	24 (109)	3 (12)	6 (25)	86	527
4	40 (186)	13 (61)	13 (63)	5 (21)	19 (91)	3 (15)	6 (27)	92	556
5	43 (191)	11 (48)	11 (47)	5 (23)	21 (92)	3 (13)	6 (28)	79	521
6	41 (181)	11 (51)	16 (71)	4 (19)	18 (82)	3 (14)	6 (26)	101	545
7	43 (194)	12 (53)	12 (54)	5 (23)	20 (88)	1 (7)	6 (28)	82	529
8	44 (201)	10 (45)	11 (51)	5 (22)	21 (96)	2 (8)	6 (29)	91	543
Mean (X)	41 (185)	12 (53)	13 (59)	5 (22)	20 (92)	3 (14)	6 (27)	91	541
1	43 (198)	8 (38)	11 (50)	20 (92)	5 (25)	5 (24)	7 (31)	81	538
2	54 (225)	9 (38)	9 (38)	20 (86)	3 (13)	2 (8)	3 (12)	76	496
3	38 (165)	10 (43)	12 (53)	22 (94)	5 (21)	6 (28)	7 (32)	98	534
4	45 (191)	7 (32)	12 (51)	20 (86)	4 (16)	5 (21)	7 (32)	93	522
5	42 (191)	9 (41)	10 (48)	17 (78)	9 (41)	5 (24)	8 (36)	92	551
6	38 (162)	12 (50)	12 (51)	21 (91)	5 (22)	5 (22)	7 (32)	90	520
7	29 (140)	7 (32)	13 (62)	30 (141)	11 (53)	3 (14)	7 (35)	71	548
8	52 (231)	7 (29)	9 (41)	19 (83)	4 (19)	4 (16)	5 (22)	69	510
Mean (X)	42 (188)	9 (39)	11 (49)	21 (94)	6 (26)	4 (20)	6 (29)	93	538

<sup>1</sup> Percentages are calculated on a cement free basis.

<sup>2</sup> Figures in brackets are number of counts (by volume).

<sup>3</sup> Minor constituents of Şaplı Dere member are predominantly biotite larger flakes and secondary chlorite with some muscovite, epidote and iron-oxide minerals.

Minor constituents of Çınarlı Dere member are predominantly muscovite-chlorite and epidote-zoisite with some garnet and iron-oxide minerals.

## ACKNOWLEDGEMENTS

The author wishes to express his sincere thanks to Professor P. Allen for his encouragement throughout the work, to Dr. D.T. Hopkins for his invaluable guidance both in the field and the laboratory, and to Mr. J.E. Thomas for suggesting the research area and topic originally. Thanks are further due to Dr. D.T. Hopkins and Mr. J.E. Thomas for their constructive criticism of the manuscript of this paper.

The author has also benefited from discussions with his colleagues in the Sedimentology Research Laboratory and from the assistance of the technical and clerical staff.

Thanks are also due to the Scientific and Technical Research Council of Turkey for grants provided during the course of this work and to M.T.A. Institute of Turkey for support during the summer field work in 1965-1967.

*Manuscript received October 17, 1967*

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