STRATIGRAPHY OF THE INFRA-CAMBRIAN ROCK-UNITS IN EASTERN TAURIDES AND THEIR CORRELATION WITH SIMILAR UNITS IN SOUTHERN TURKEY.

Hüseyin KOZLU[1] and M. Cemal GÖNCÜOĞLU[2]

1Turkish Petroleum Corporation, Ankara, TURKEY
2METU Department of Geological Eng., Ankara, TURKEY

Kozlu, H. and Göncüoğlu, M.C., 1997, Stratigraphy of the Infracambrian Rock-units in the Eastern Taurides and Their Correlation With Similar Units in Southern Turkey: in: Göncüoğlu, M.C. and Derman, A.S. (Eds), Lower Paleozoic Evolution in northwest Gondwana, Turkish Assoc. Petrol. Geol., Spec. Publ., No:3, 50-61, Ankara.

ABSTRACT

Non-metamorphic or slightly metamorphic pre-Lower/Middle Cambrian successions are remarkably widespread in autochthonous, para-autochthonous and allochthonous units of the Central and Eastern Taurides. These successions are not yet paleontologically dated but unconformably overlain by Lower-Middle Cambrian quartzites (Feke and Hüdai quartzite) and platform-type carbonates (Çal Tepe and Değirmentaş limestone).

The Infra-Cambrian units known as Emirgazi formation in the Eastern Taurides, consist of two members. The lower member (Oruçlu M.) is represented by an alternation of red-green-gray colored arkoses and shales. Upwards follows varicolored stromatolitic and cherty limestones interlayered with sandstones and shales (İçme Tepe M.). The lower and middle part of the formation contain green and black colored basic-intermediate volcanics and highly altered tuffites. Where the volcanics dominate they are generally accompanied by bands and lenses of brecciated quartz-conglomerates and black shales.

The Emirgazi formation is unconformably overlain by the Feke quartzite that is characterized by specularite-bearing and purple colored quartz-arenites, intercalated with siltstones and conglomerates.

The lower member with well developed parallel lamination and cross-bedding is very probably deposited in a periodically subsiding shallow-marine environment. The stramatolitic dolomites and limestones of the middle member are interpreted as sabkha deposits. The cherty limestones of the same unit, are suggested to be the products of a silica-rich lagoon or shallow marine environment. The presence of cross-bedded sandstones between the barite-bearing limestone layers further suggest a shallow depositional environment. Depositonal features such as ripple marks, lamination, and large scale cross-stratification in the upper member indicates to a shallow marine depositional environment.

The lithologies as well as the depositional environment of the Infra-Cambrian units of the Eastern Taurides can be correlated with similar units of the Central Taurides and the Arabian Platform (Sadan and Zabuk formations) in Turkey. Equivalents of the Emirgazi formation have been described along the NW Gondwana-margin in the Albruz Mountains, (Soltanyeh formation of Stocklin et al.,1964), in Oman (Huqf Group of Gorin et al.,1982) and Kerman (Rizu Series of Huckriede et al., 1962) in Central Iran.

Regional correlations suggest that the Emirgazi formation in southern Turkey can be interpreted as the product of the Late Pre-Cambrian - Early Cambrian extension on the north Gondwanean Pericraton.

INTRODUCTION

Eastern Taurides is located in the northeastern Mediterranean, southern central Turkey.

Detailed geological mapping in this area, known as the "Eastern Tauride Para-autochthone" and is part of the "Geyikdağı Unit" of Özgül (1976), has shown the presence of an almost complete Paleozoic succession. The oldest paleontologically dated unit in this area is Middle Cambrian in age (Özgül et al., 1972, 1973). The Cambrian succession is underline by a very thick sequence of sedimentary rocks. This unit is named as the Emirgazi formation in the area around Kozan, Feke, Saimbeyli and Tufanbeyli and its stratigraphic and depositional features has been examined in detail (Kozlu, 1990; Özgül and Kozlu, 1992; Kozlu, 1994).

Similar sequences of the same stratigraphic order were studied in different para-autochthonous and allochtonous units of the Central Taurides in Ovacık, Alanya, Karacahisar and Sandıklı areas and in the Sultan Dağları region (Figure 1), to gain an general picture about the regional distribution and depositional features of this unit. The present paper is mainly focused on a detailed description of the lithostratigraphic sequence of the Infra-Cambrian "Emirgazi formation" in the Eastern Taurides and their brief regional correlation with similar units all along the Tauride Belt and also with the better known sequences in southeast Anatolia (Kellog, 1960; Dean et al., 1981; Bozdoğan et al., 1996).

Similar rocks with the same lithostratigraphic successions are also widespread in Iran and other parts of the Eastern Mediterranean. However, the lack of detailed paleontological data and the fact that earlier correlations (e.g. Demirtaşlı, 1975) were severely based on stratigraphic considerations, it is still problematic to suggest an over-regional interpretation for the Pre-Cambrian evolution of the northwest Gondwanean margin in this area.

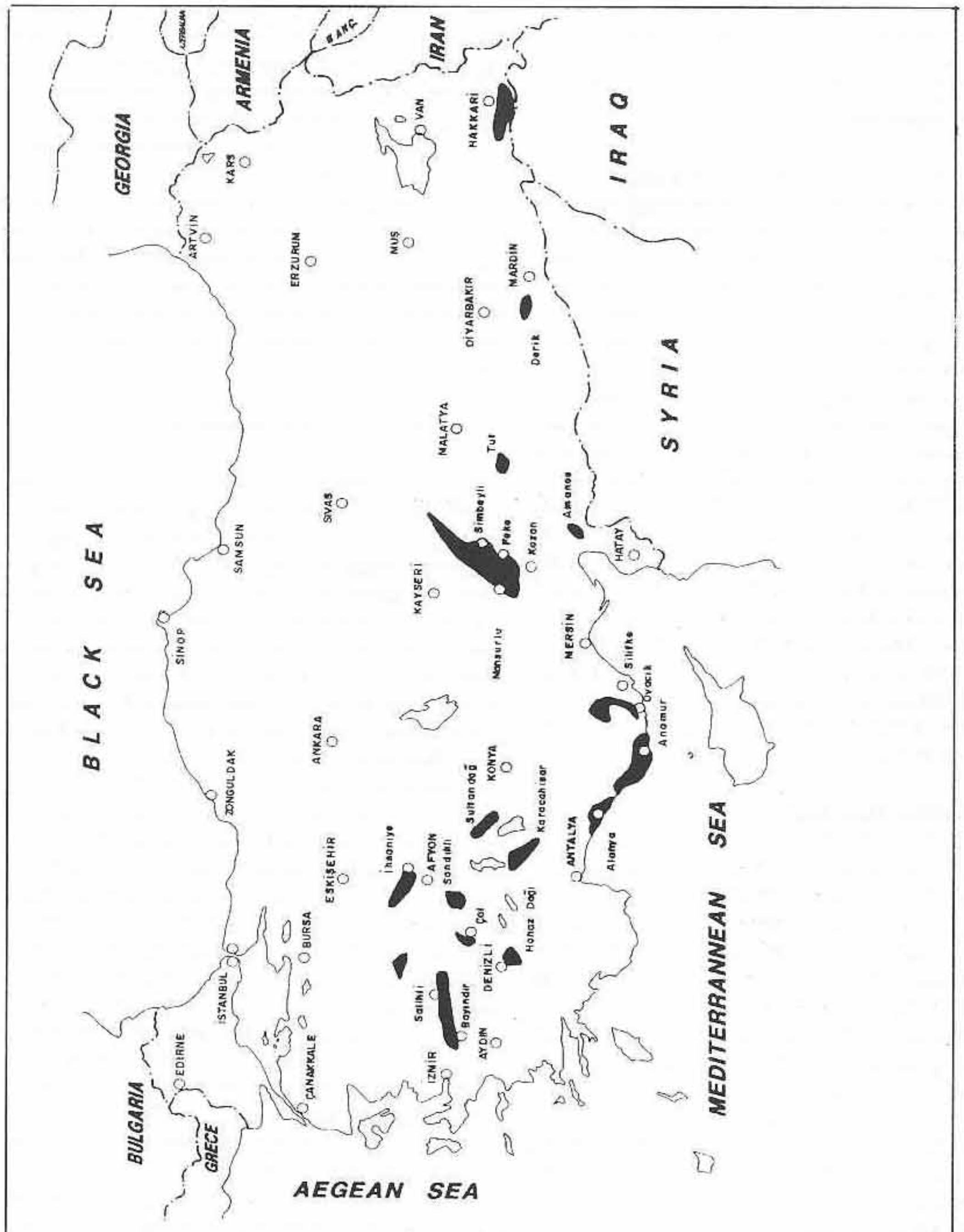

Figure-1: Distribution of Infra-Cambrian rocks in Turkey.

THE INFRA-CAMBRIAN EMİRGAZİ FORMATION AND ITS COVER IN THE EASTERN TAURIDES

In the Eastern Taurides the Infra-Cambrian rocks are represented by the Emirgazi formation, which is unconformably followed by the Feke/Hüdai quartzite and the Çal Tepe/Değirmentaş formation of Lower-Middle Cambrian age.

Emirgazi Formation

The lower part of the formation is dominated by shales with sandstone interlayers, followed by very typical stromatolitic and cherty limestones which alternate with sandstones and shales (Figure 2).

Emirgazi formation has been initially described by Özgül et al. (1972, 1973) in Tufanbeyli region in the Eastern Taurides. The type locality is in the Göksu Valley to the west of Feke.

From the Emirgazi formation no fossils have been dated yet. However, in the study area, the Değirmentaş limestone, equivalent of the Çal Tepe formation of Cambrian age (Dean and Monod, 1990) unconformably overlies the Emirgazi formation with an intervening quartzite unit (Feke quartzite), so that we assume an "Infra-Cambrian" age is for the deposition. Considering the rock-stratigraphical features of the Emirgazi formation two members have been differentiated. The thickness of the members changes laterally, but they are continuos in a regional scale and can be traced all along the Tauride Belt (Figure 1). Basic and intermediate tuffs and tuffites as well as dikes and sills are mainly concentrated in the lower part of the formation.

Oruçlu Member

The lower member of the Emirgazi formation is named after its type-locality around the Oruçlu Village in Mansurlu area in the Eastern Taurides. The outcrops of the member are widespread in Mansurlu region, in Göksu Valley to the west of Feke and around Kayhan, Gürümse and Bahçecik villages to the north of Feke.

The most typical rock-unit of this member is an alternation of red-green-pink to dark gray, mica-rich sandstones and slates. In the lower and middle part of the sequence, fine-grained sandstone, siltstone and mudstone displaying weakly developed cleavage is interlayered with sandstone bands. Towards the top the amount of sandy and shaly bands equalize.

The arkozic sandstones are reddish, medium to thick-bedded, silica cemented, cross-bedded and laminated. The gray-green colored, thin-medium-bedded sandstones of probable volcaniclastic origin have been diagenetically converted to quartzites. Red colored sandy mudstones and dark gray, mica-rich, and laminated shales which occur as bands exhibit well developed slaty cleavage. These rock-types are laterally and vertically transitional to each other and show changes in thickness along-strike. Lenses of olistostromal conglomerates are common in different levels of the member. The conglomerates are composed of angular fragments of different rock-units of the same member. The most frequent fragments are made up of quartzites and volcanic rocks. These fragments are weakly cemented by silica. Smaller clasts within the matrix are mainly from the underlying shaly levels. The intraformational conglomerates were very probably deposited during syn-sedimentary faulting which is accompanied by explosive volcanism.

Towards the top, Oruçlu member is transitional to the overlying İçme Tepe member.

No fossils could be obtained from the member. Considering the sedimentary features and rock-types it is assumed that the Oruçlu member has been deposited on a shallow-marine platformal basin, very probably in a coastal environment. Patchy distribution of sediments, together with the presence of volcanism suggest that the deposition is fault-controlled.

İçme Tepe Member

The unit is represented mainly by stramatolitic-cherty dolomitic carbonates, alternating with red and gray shales, arkozic sandstones, quartz-arenites and greenish siltstones (Figure 2). This carbonate-sequence crops out almost all along the Tauride Belt within the Infra-Cambrian units and can be considered as a marker horizon. İçme Tepe member is exposed in the Göksu Valley to the west of Feke and the type-section is located at İçme Tepe in this area. Further outcrops of the unit are located to the north of Salkım Mahallesi in the north of Kozan, at Kılcal Tepe to the north of Özbaşı Village and at the road-cuttings to the south of Kayhan Village.

At the type locality, the carbonates occur as numerous lenses, alternating with sandstones and shales. The thickness of the lenses varies laterally. In many outcrops the recrystallized limestone and dolomite bands are altered to ankerites. In the unaltered sequences, e.g. to the east of Salkım Mahallesi or at Kılcan Tepe to the north of Özbaşı Köyü, knoll-type algal structures and well developed stramatolitic lamination can be observed. The varicolored limestones in this area are medium to thick-bedded and contain thin layers of calkarenites, rich in quartz and volcaniclastics. Cherty bands and nodules are very common in these levels.

The levels, characterized by carbonate-clastic alternations are interpreted as siliciclastic and calcareous tidal sediments. The green-red colored and laminated quartz-arenites and quartzites between the carbonates display sedimentary features such as cross-bedding and ripple-marks, which would further indicate coastal deposition. The stramatolitic black dolomites, on the other hand may represent a transition to coastal sabkhas. The occurrence red to violet colors, cyclic sequences and alteration features in these carbonate layers is repre-

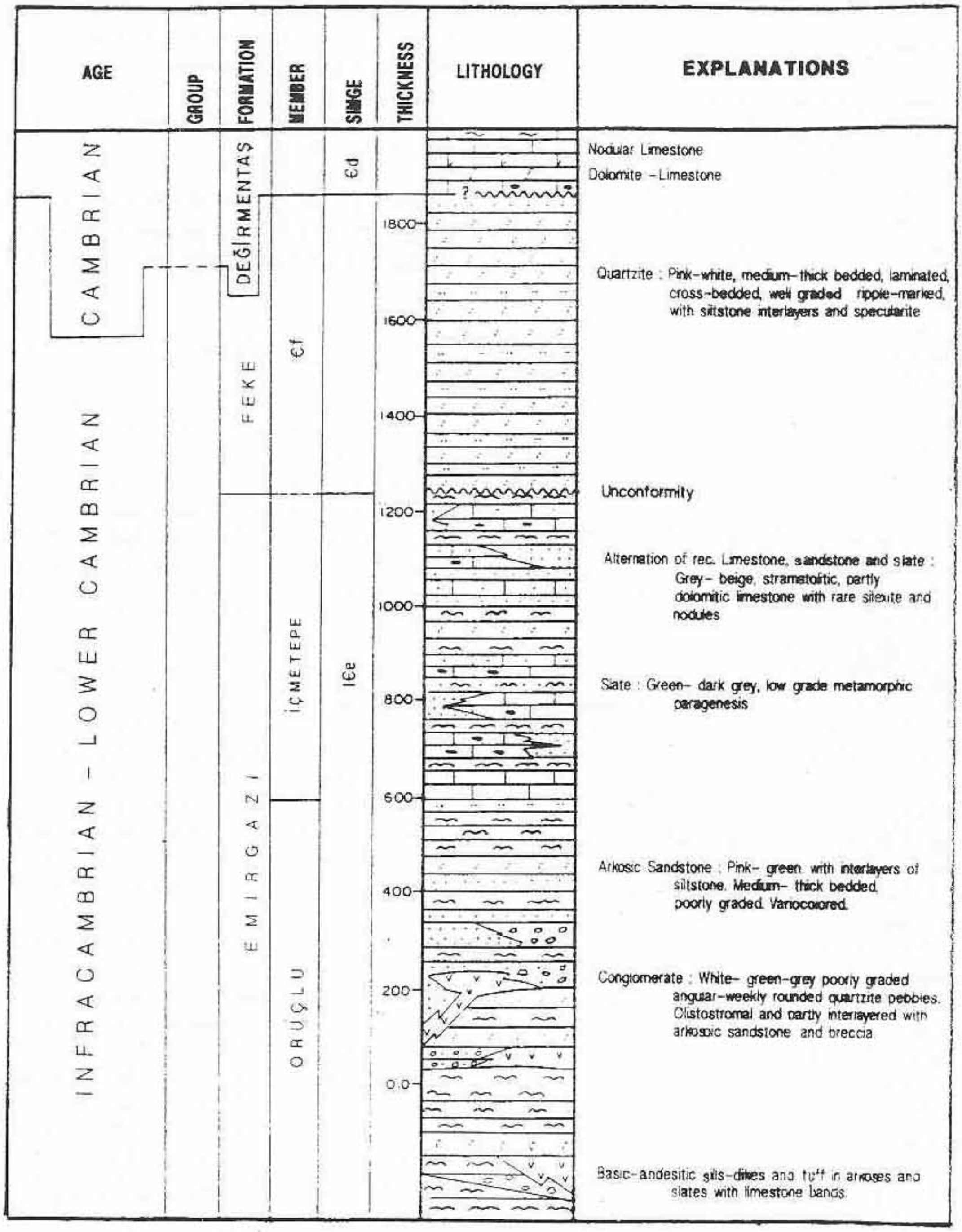

Fig - 2

Figure 2. Measured columnar section of the Emirgazi formation

sentative for sabkha evaporates and suggest arid climate conditions, comparable with modern coastal sabkhas of the Arabo-Persian Gulf (Purser, 1985).

Intraformational conglomerate bands and lenses, which are interpreted as intertidal channel fills and dykes and sills of intermediate volcanics are also common in the İçme Tepe member.

The İçme Tepe member is disconformably covered by the siliciclastics of the Feke quartzite. The measured thickness of the member in different sections varies between 450-600 meters.

Cover Units

Feke quartzite and Çal Tepe formation

The oldest unit unconformably overlying the Emirgazi formation is mainly characterized by yellow-green and tan colored quartzites with bands of purplish red colored shales.

The type-locality is located in Asmaca Dere and İçmeler area to the north of Feke. Further well-exposed outcrops can be studied in Göksu Valley, around Elmadağ, Özbaşı and Bahçecik villages.

In the type-locality, the measured thickness of the unit reaches up to 600 meters (Figure 2). Although the thickness may show lateral variations it can be followed all along the Eastern Tauride Belt.

Around the Özbaşı Village the formation starts with red mudstones containing bands and lenses of conglomerates on top of the carbonate-siliciclastic alternations of the İçme Tepe member of the Emirgazi formation. The conglomerates are mainly made up of quartzite and volcanic pebbles. This basal sequence is gradually followed by coarse conglomerates. The conglomerate bands and lenses at the basis of the member are interpreted as deltaic products, which would indicate a local unconformity between the Feke and the underlying İçme Tepe member.

Towards the top of the sequence in this area, silica cemented quartzites dominate. The quartzites are thin-thick bedded and display depositonal features such as cross-bedding and ripple marks. The bedding surfaces, and cracks are marked by specularite enrichment.

The contact-relationship between the quartzites of the Feke quartzite and the overlying Değirmentaş/Çal Tepe carbonates can be well studied in Karahasan Dere. In this location a 0.5-4 meters thick clastic unit is observed at the basis of the carbonates. This unit is represented by poorly cemented sandstones with pebbles of quartzites and schists. Towards the top the conglomeratic level is transitionally followed by layers of limy sandstones and sandy limestones which in turn are transitional to the yellow colored, thin-bedded, laminated and oxidized cherty limestones, constituting the basal part of the Çal Tepe formation. The middle and upper part of the Çal Tepe sequence in this outcrop is characterized by gray-black stomatolitic dolomites, white and gray recrystallized limestones and at the top by reddish-greenish nodular limestones. The thickness of the unit is about 138 meters. This very typical carbonate sequence is known in the Tauride Belt as the Çal Tepe formation and had been dated with trilobites as Middle Cambrian (Özgül et al., 1972).

The conglomeratic sandstone-sandy limestone level at the basis of the Çal Tepe limestones of Cambrian age is interpreted as basal clastics. It is, therefore, suggested that the carbonates are transgressive on the Feke quartzite. In almost all the other localities in the Eastern Taurides where the contact-relations can be clearly observed, there is a sharp contact between the clastics and the overlying limestones. Based on this observation it is suggested that the primary relation between the Feke quartzite and the Çal Tepe formation of Cambrian age is a parallel unconformity.

CORRELATION OF THE EMİRGAZİ FORMATION WITH FURTHER INFRA-CAMBRIAN SEQUENCES IN THE TAURIDE BELT

Stratigraphic equivalents of the Emirgazi formation of Infra-Cambrian age is unexpectedly widespread in the Central and Western Taurides. In almost all the locations re-studied and presented in Figure 3, similar lithologies have been noticed. It is interesting to note that all along the belt, not only the stratigraphic position but also the order of the sequences are almost identical.

Infra-Cambrian outcrops are mainly located in the Central Taurides (Karacahisar, Sandıklı and Sultandağı areas, Figure 1). The stratigraphy of the Infra-Cambrian sequences in northern Silifke (Ovacık and Gökbel areas, Figure 3, column 4), Anamur-Alanya area and Alanya (Figure 4) are very similar to the Emirgazi formation in the Eastern Taurides.

In Ovacık and Gökbel areas the Infra-Cambrian succession starts with mica-rich, slightly metamorphic shales and siltstones interlayered with quartzarenite. Sills and dykes of intermediate volcanics are widespread. The middle part of the succession is characterized by dolomites and stromatolitic cherty limestones alternating with siltstone, arkozic sandstone and shale. The thickness of the carbonate bands varies between 0.5 to 10 meters. This part of the sequence corresponds to the İçme Tepe member in the type-locality. Feke-type quartzites are transgessive on the carbonates. The following limestones of the Çal Tepe formation yielded middle Lower Cambrian trilobites (Dean et al., 1991).

In Anamur-Kalderan area between Anamur and Alanya the Emirgazi formation is ascribed to the Alanya Metamorphics and is the lower part of the Mahmutlar Nappe of Özgül (1985). The lowermost part of the Infra-Cambrian sequence is represented by an almost 2000 meters thick succession of low-grade metamorphic shales with sandstone bands. This member is followed by carbonates alternating with quartzites, brecciated quartz-conglomerates and schists. Sills of highly altered volcanic rocks are common. The thickness of this member varies between 200 to 400 meters. The carbonates are mainly represented by bands of laminated cherty limestone and lenses of barite, ankeritic carbonate and dolomite. This succession is very similar to the type-locality in the Eastern Taurides. The unit is unconformably covered by Feke-type quartzites and Çal Tepe-type recrystallized carbonates.

In the smaller outcrops within the Karacahisar anticline to the south of Eğirdir, westernmost Central

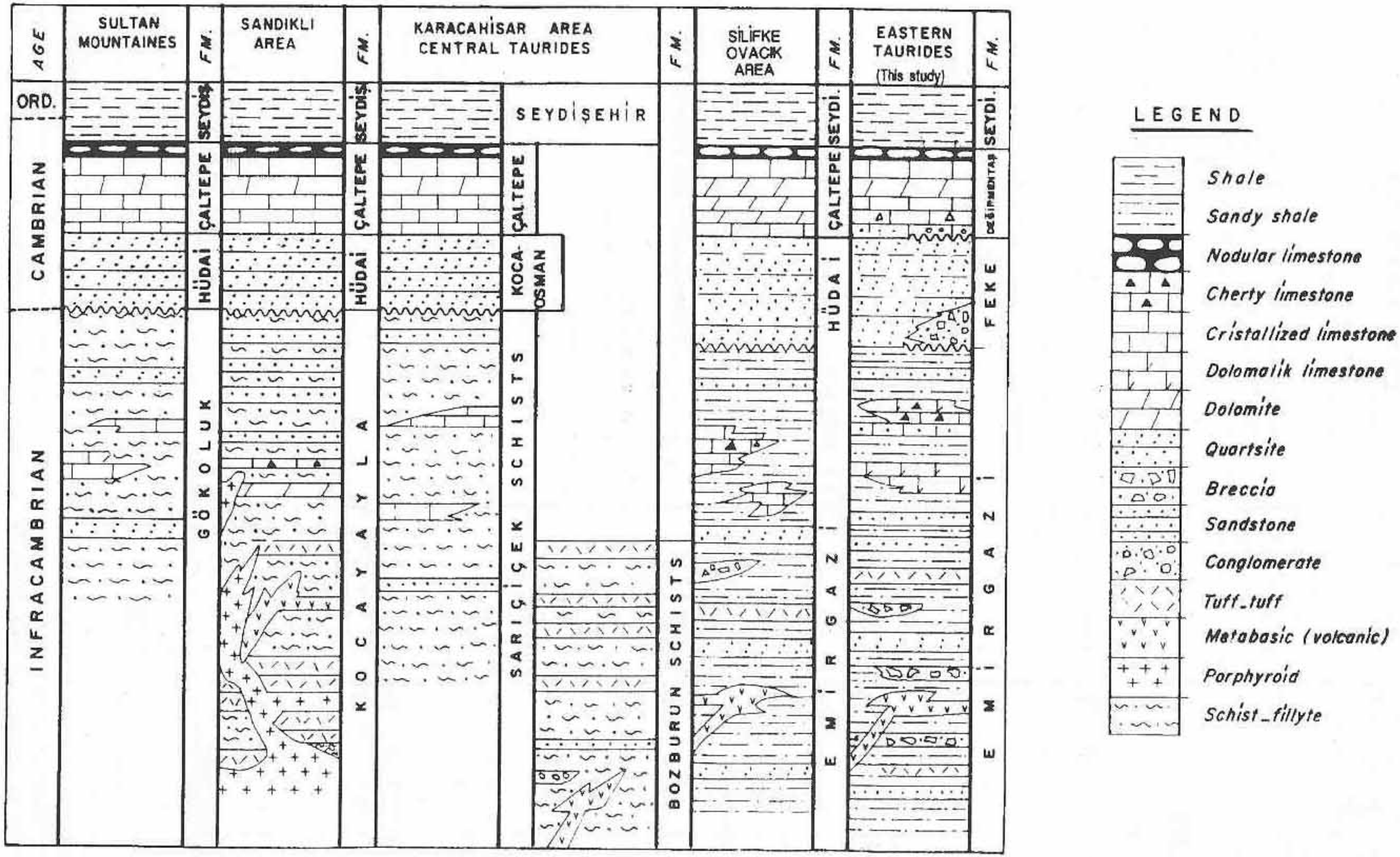

Figure 3. Correlation chart of the Infra-Cambrian rocks in the Tauride Belt.

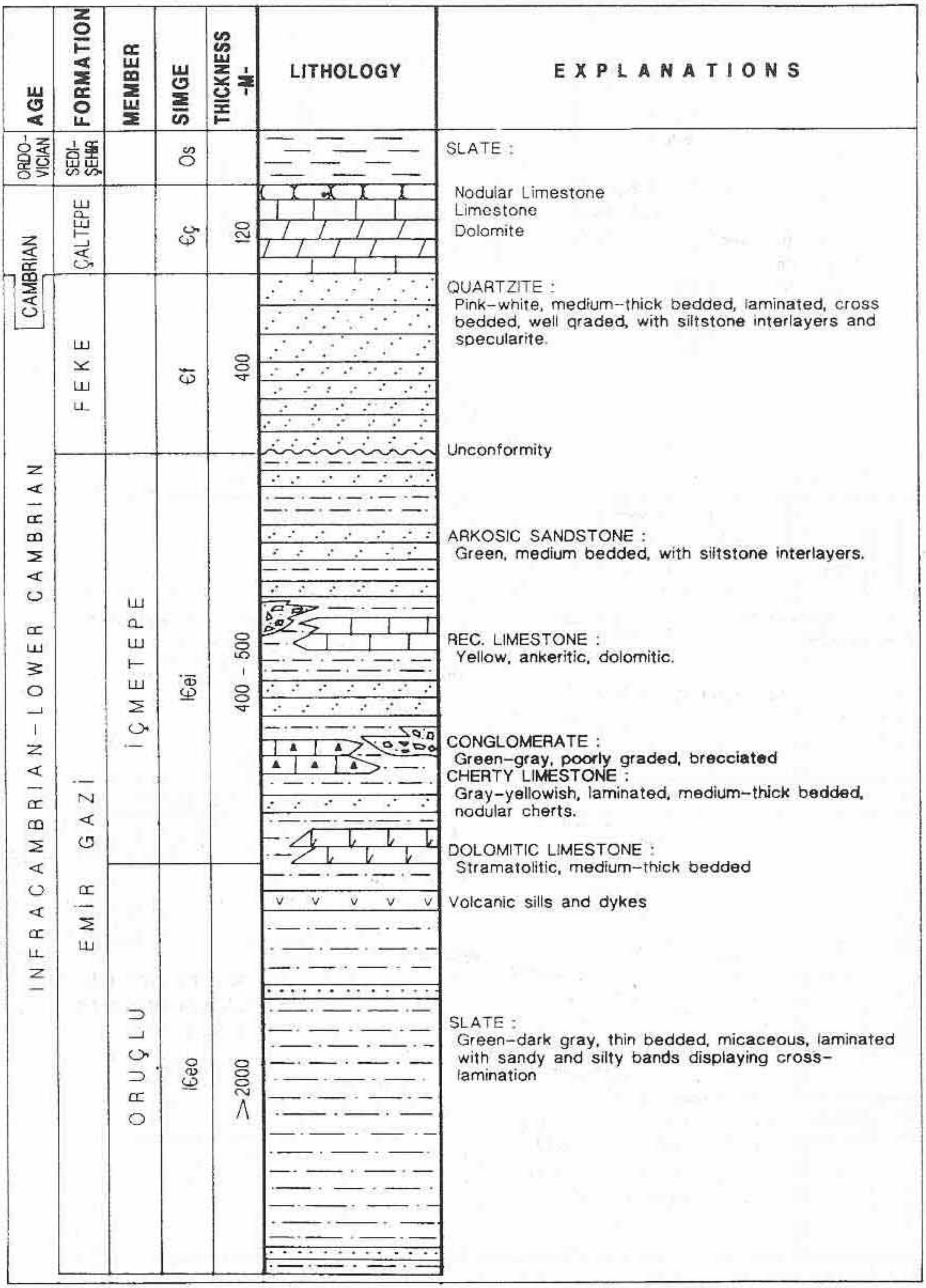

Figure 4. Generalized columnar section of Infra-Cambrian rocks in Anamur-Alanya area.

Taurides (Figure 3, column 3) two genetically distinct rock associations are noticed. Sarıçiçek Schists, located to the west of the anticline represents a thick sequence of strongly deformed pelitic rocks of probable turbiditic origin. Dumond (1972) reports that a sequence of clastics and black nodular limestones (Çal Tepe-type) with Middle

Cambrian trilobites conformably overlie the pelitic rocks. Sarıçiçek sequence differs from the type-section in the Eastern Taurides in the dominance of pelitic rocks. In the middle interval of the sequence, several bands and lenses of up to 5m. thick recrystallized limestone is observed. These limestones correspond to the İçme Tepe member of the Emirgazi formation. The almost 100 meter thick quartzites in the uppermost part of the sequence in this area (Kocaosman formation of Gutnic et al., 1979) correlate well with the Feke quartzite in the type-locality.

In the northeastern and relatively small outcrops of the Karacahisar anticline, the Bozburun Schists (Gutnic et al., 1979) are exposed. The unit is dominated by slates and slightly metamorphosed volcano-sedimentary rocks with basic volcanic sills and dikes. The dikes and sills reach up to 15 meters in thickness. This basal sequence is unconformably covered by clastics and conglomerates of Visean-Bashkirian age (Dumond and Lys, 1975). Based on geochemical considerations and single-zircon data Kröner and Şengör (1990) suggest that the medium- to fine-grained wacke to lithic arenites of both areas were derived from an Early Proterozoic volcanic source terrain. It is highly probable that the Bozburun schists in the Eğridir area correspond to the lower part of the Oruçlu member in the Eastern Taurides and can be further correlated with the clastics and pyroclastics in the Sandıklı area.

The Infra-Cambrian sequence in Afyon-Sandıklı area is characterized by a thick package of slightly metamorphic rocks (Kozlu and Göncüoğlu, 1995) beneath the Hüdai quartzite, equivalent of Feke quartzite and the Çal Tepe formation of Cambrian age. The unit is named as Kocayayla formation by Öztaş (1989), and Özgül et al. (1991). Kocayayla formation is mainly characterized by greywackes and pyroclastics, interlayered with pelitic rocks (Figure 3, column 2). The equivalent of the Oruçlu member in this area is represented by volcaniclastics and porphyroids. The clastics are followed by sandstones and shales with bands and lenses of cherty limestones and dolomites, which can be correlated with the İçme Tepe member of the Emirgazi formation. Towards top varicolored silicified mudstones with bands of conglomerates and sandstones are observed. This part of the sequence is signified by widespread diabase dykes and sills. The uppermost part of the Kocayayla formation constitutes an alternation of quartzites and slates succeeded disconformably by quartzites (Hüdai quartzite) which is the equivalent of the Feke quartzite of the Emirgazi formation. Çal Tepe formation conformably following the quartzites yielded Middle Cambrian trilobites in its uppermost part so that a Lower Cambrian age can be assigned for the quartzites (Dean and Özgül, 1994; Dean and Monod, 1995).

Further outcrops of Infra-Cambrian rocks in the Central Taurides are described by Özgül et al. (Gökoluk formation, Özgül et al., 1991) in the Doğanhisar Unit in Sultandağı area (Figure 3, column 1).

Low-medium grade metamorphic equivalents of the Emirgazi formation has been recently discovered in the Menderes Massif, in Honaz Dağı (Denizli), to the north of Afyon (Ihsaniye) and to the west of Çal area in the south of Uşak (Figure 1).

In the Central Menderes Massif between Bayındır and Salihli towns; in Karlık Dağ and Çal Dağ (Figure 1), intensively folded and recrystallized nodular limestones occur with a very thick sequence of quartzofeldsphatic schists, brown and dark pelitic schists and lenses of metaconglomerates alternating with fine laminated, gray discontinuous recrystallized limestones which resemble the Emirgazi formation.

In Honaz Dağı to the southwest of Denizli (Figure 1), felsic metatuffs (meta-ignimbrites) very similar to those in the Bozburun schists are unconformably covered by Triassic basal conglomerates.

In Çal area the units resembling Emirgazi formation is characterized by buff colored quartzites and arkosic sandstones, lenses of brecciated conglomerates alternating with İçme Tepe-type laminated recrystallized limestones.

The high grade metamorphic equivalents of the Emirgazi formation in southern Menderes Massif is recently confirmed by single zircon ages of 546±1.2 Ma from felsic augen gneisses intruding schists with minor amphibolites, metapsammites and marbles (Hetzel and Reischmann, 1996).

DISCUSSION AND CONCLUSIONS

In the "Eastern Tauride Para-Autochthone" an approximately 2500m thick succession of sedimentary and volcanic rocks of pre-Lower/Middle Cambrian age is described.

In its lower part, this formation consists of slates, meta-tuffs and arkosic arenites. Upwards follows variegated stromatolitic and cherty limestones interlayered with sandstones and shales, which are cut by basic and intermediate dikes and sills. Specularite-bearing and purple colored quartz-arenites, intercalated with siltstones and conglomerates unconformably cover the unit. Lower-Middle Cambrian carbonates (Çal Tepe formation) transgressively overlie this sequence.

Similar sequences are expansively exposed in different parts of the Tauride Belt is reported or re-evaluated in previous chapters of this work.

Pre-Lower Cambrian units were already known SE Turkey, in Iran and other parts of the Eastern Mediterranean. Ketin (1966) in one of his pioneering work correlated the volcanic-dominated Telbesmi formation in Derik area with the Meryemuşağı formation in Tut-Pembeğli (Adıyaman) and Çamlıpınar formation in Amanos Mountains and suggested an "Infra-Cambian" (Eocambrian to Lower Cambrian) age. This terminology from thereon was used by different authors. Demirtaşlı (1975) included the Taurus and the North Anatolian occurrences and the Lower Paleozoic units in Pakistan to this correlation. How-

ever, in all these earlier studies detailed paleontological data is lacking and the correlations were severely based on stratigraphic considerations.

The main problem related to the exact age of the Emirgazi formation is not only the absence of datable fossils in this unit but also the diachronous nature of the overlying fossiliferous Çal Tepe formation. Çal Tepe formation has been divided into several members. These are from bottom to top Dolomite, Dark limestone, Light limestone and Red Nodular limestone members (Dean and Monod, 1970). Most of these members are laterally quite continuous in the Taurus Belt. The trilobite (Dean et al., 1991) and conodont data (Gedik, 1977; Özgül and Gedik, 1973; Özgül, 1985) from the nodular limestone key horizon indicate that the depositional age of the Çal Tepe formation youngs considerably from northwest (earliest Middle Cambrian in Sandıklı area, Dean and Özgül, 1994) to south-southeast (Upper Cambrian in Alanya, Özgül, 1985; SE Anatolia, Dean and Monod, 1990). So that it is critical to use solely the lower age-limit of the transgressively overlying Çal Tepe formation as a justification for the upper age limit of the Emirgazi formation.

Another critical issue to discuss is the contact relations between the upper members of the Emirgazi formation and the covering units.

To the west of Çiloğlantepe in Sandıklı area, in one of the reference sections, the primary contact between the Hüdai quartzite and the "Emirgazi formation" is masked by a normal fault and the Neogene cover. A few kilometers to the SW of this locality, however, white-pink-gray colored, medium-thick bedded quartzites resembling Hüdai are in contact with very-low grade metamorphic rocks. Verrucano-type conglomerates of Jurassic age unconformably cover both units. The very-low grade metamorphic sequence constitute gray-red-black shales displaying crenulation cleavage and dark colored, medium-coarse grained semischists. The microscopic textural features of these weekly foliated pelitic rocks totally differ from the shales (Seydişehir formation) of the overlying sequence, thus indicating the presence of a deformational event predating the deposition of the Feke quartzite. This observation further support Özgül et al. (1991)'s suggestion that the contact between Hüdai quartzite and the underlying units is an unconformity.

The contact between the Feke quartzite and the overlying Çal Tepe formation in the Eastern Taurides is suggested to be a disconformity. In the Sandıklı area, however, Dean and Özgül (1994) assume a transitional contact between the corresponding Hüdai quartzite and the Çal Tepe formation. Derman and Günay (1995) proposed a prograding delta environment for the deposition of the Hüdai quartzite. It is followed by the lower dolomitic interval of the Çal Tepe formation representing tidal flat deposition.

Evidence from the lithological correlations indicates a continuity of Emirgazi-type deposition in Salt Range formation in NE Pakistan (Hasan, 1986), on both sides of the Zagros Suture in Iran (Soltanyeh formation of Stocklin et al.,1964 in the Albruz Mountains; Rizu Series of Huckriede et al., 1962 in Kerman), Huqf Group of Gorin et al. (1982) in Oman, the Ghabar Group in Yemen (Beydoun, 1964) and Saramuj Unit in Jordan (Beydoun, 1960). In the last two localities (Figure 5) , clastics with bands of stromatolitic limestones are intruded by acid and basic dikes. The dikes in Yemen and Jordan have been dated at 590 Ma and 600-640 Ma, respectively. In Jordan the units are unconformably overlain by sandstones followed by fossiliferous Middle Cambrian sediments. From these correlations it is evident that Emirgazi formation is a part of the same over-regional unit.

As a result of the preceding data, it appears that, Emirgazi formation represents the so far northernmost part of a very extensive NW Gondwanean Infra-Cambrian unit in Turkey. Its formation is very probably related to an extensional period at the Late Pre-Cambrian-Early Cambrian times, which is further inferred in neighboring areas (Cater and Turnbridge, 1992). The depositional environment in general terms suggest a rift-related sedimentation.

ACKNOWLEDGMENTS

This study is mainly based on long-lasting studies of the first two authors on the geology of the Taurus belt, which was supported by M.T.A and T.P.A.O. This paper is a contribution to IGCP Project 351 "Early Paleozoic Evolution of NW Gondwana".

REFERENCES

Beydoun, Z.R., 1964, The stratigraphy and structure of the Eastern Aden Procterate: Overseas Geology and Mineral Resources, 5, 1-107.

Bozdoğan, N., Göncüoğlu, M.C. and Kozlu, H., 1996, Lower Paleozoic stratigraphy of southeastern Turkey. In: Baldis, B. and Acenolaza, G. (Eds.), Early Paleozoic Evolution of NW Gondwana, Serie Corr. Geol., 12, 47-57, Univ. Tucuman, Argentina.

Cater, J.M.L. and Turnbridge, I.P., 1992, Paleozoic tectonic history of SE Turkey: Journal of Petroleum Geology, 15, 35-50.

Dean, W.T and Monod, O., 1970, The Lower Paleozoic stratigraphy and faunas of the Taurus Mountains near Beyşehir, Turkey, I Stratigraphy: Bull. British Museum, Geology, 19, 411-426.

Dean, W.T and Monod, O., 1990, Revised stratigraphy and relationships of Lower Paleozoic rocks, Eastern Taurus Mountains, south central Turkey: Geol. Mag., 127, 333-347.

Dean, W.T. and Özgül, N., 1994, Cambrian rocks and faunas, Hüdai area, Taurus Mountains, southwestern Turkey: Bull. Inst. Royal. Sci. Natur. Belgique, Sci. De la Terre, 64, 5-20.

Dean, W.T and Monod, O., 1995, Geological Excursion: Hüdai-Sandıklı area: Lower Paleozoic of Eastern

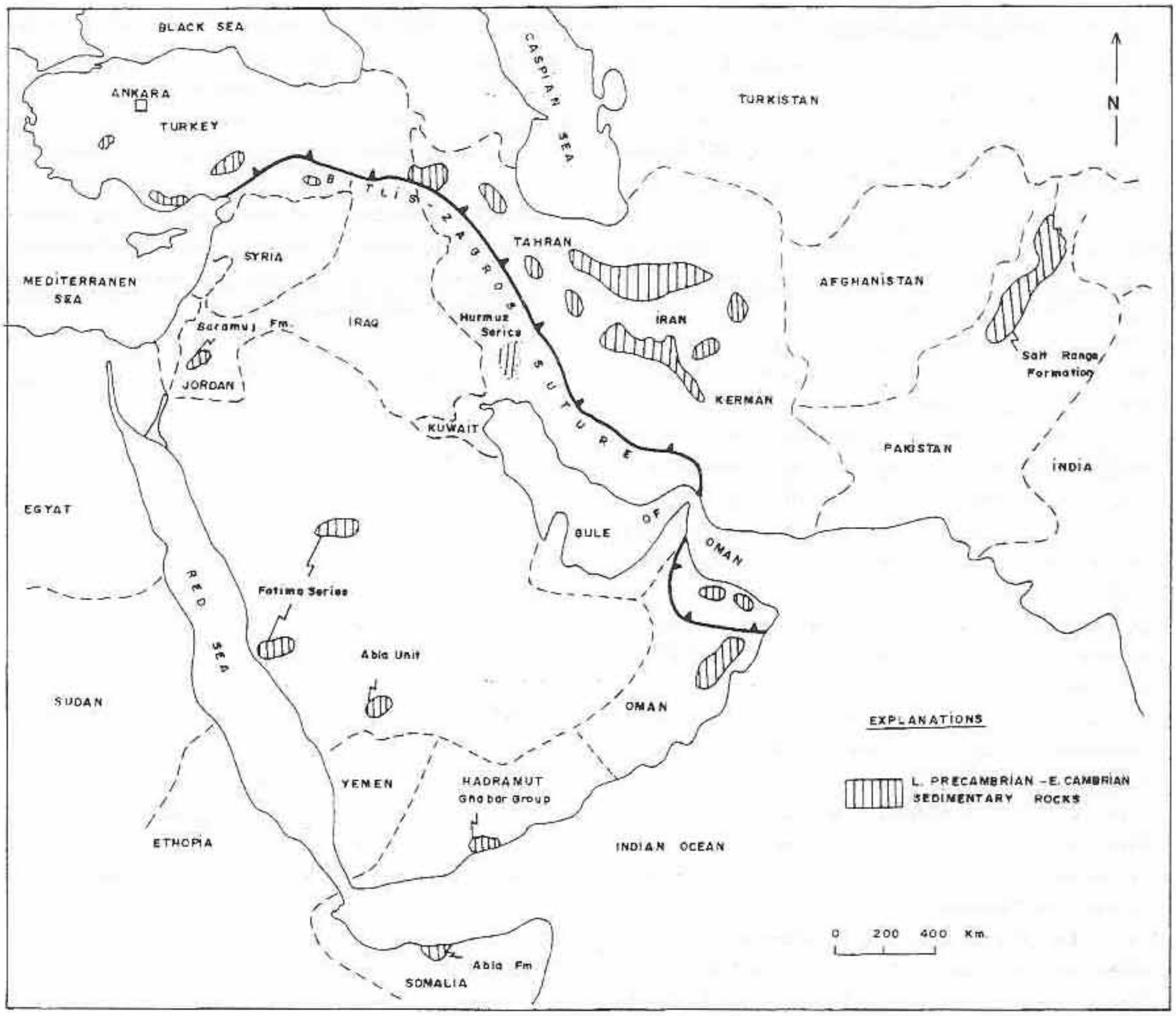

Figure 5. Distribution of Infra-Cambrian rocks in Middle East.

Turkey, Guide Book. In: Derman, A. S. and Günay, Y. (Eds.), 15-16, Turkish Assoc. Petrol. Geologists, Spec. Publ. No 2, Ankara.

Dean, W.T., Monod, O and Perincek, D., 1981, Correlation of Cambrian and Ordovician in SE Turkey: General. Dir. Petrol. Aff. Bull., 25, 269-291.

Dean, W.T., Martin, F., Monod, O., Gül, M. A., Bozdoğan, N. and Özgül, N., 1991, Early Paleozoic evolution of the Gondwanaland Margin in the western and Central Taurides. In: Turgut, S. (Ed.), O. Sungurlu Symposium Proceedings, O. Sungurlu Foundation, Ankara, 262-273.

Demirtaşlı, E., 1975, Iran, Pakistan ve Türkiye'deki Alt Paleozoyik yaşlı kayaların stratigrafik korrelasyonları. In: Doyuran, S. (Ed.), 50. Yıl Yerbilimleri Kongresi, M.T.A. Genel Müdürl., Ankara, 204-222.

Derman, A.S. and Günay, Y., 1995, Environmental consideration of Hüdai, Çal Tepe and Seydişehir formations in Hüdai area, Lower Paleozoic of Eastern Turkey. In: Derman, A.S. and Günay, Y. (Eds.), Guide Book, 14, Turkish Assoc. Petrol. Geologists, Spec. Publ. No 2, Ankara.

Dumond, J.F., 1972, Decouverte d'un horizon du Cambrian a trilobites dans l'autochton du Taurus de Psidie, region d'Egridir, Turquie: C. R. Ac. Sci., T 274, 2435-2438.

Dumond, JF and Lys, M., 1975, Pisidya Torosları Otoktonunda (Göller Bölgesi) bulunan Karbonifer serisinin tanımlanması (Viseen-Başkiriyen): Congress of Earth Sci., 50 Anniv. of the Turkish Rep., 192-203.

Gedik, I., 1977, Conodont biostratigraphy in the Middle Taurus: Türkiye Jeol. Kur. Bült., 20, 35-48.

Gorin, G.E., Racz, L.G. and Walter, M.R., 1982, Late Pre-Cambrian-Cambrian sediments of Huqf Group, Sultanate of Oman: AAPG Bull., 66, 2609-2627.

Gutnic, M., Monod, O., Poisson, A. and Dumond J.F., 1979, Geologie des Taurides occidentales (Turquie): Soc. Geol. France, Mem. 137, 112 p.

Hasan, M.T., 1986, Proterozoic and Cambrian phosphorites, Hazara, Pakistan. In: Cook, P.J. and Shergold, J.H. (Eds.), Phosphate Deposits of the

World, 190-201, Cambridge Univ. Press, Cambridge.

Hetzel, R. and Reischmann, T., 1996, Intrusion age of Pan-African augen gneisses in the southern Menderes Massif and the age of cooling after Alpine ductile extensional deformation: Geol. Mag., 133, 565-572.

Huckriede, R., Kürsten, M. and Venzlaff, H., 1962, Zur Geologie des Gebietes zwischen Kerman und Sagand (Iran): Beih. Geol. Jahrb., 51, 197p.

Kellog, H.E., 1960, Stratigraphic report, Bitlis-Siirt area, Petroleum District V: Report General. Dir. Petrol. Aff., Ankara (unpublished).

Ketin, I., 1966, Güneydoğu Anadolunun Kambriyen teşekkülleri ve bunların Doğu İran Kambriyeni ile mukayesesi: Mineral. Res. Expl. Bull., 66, 75-87.

Kozlu, H., 1990, Tufanbeyli-Sarız-Gürün dolayının jeolojisi ve hidrokarbon olanakları: T.P.A.O. Rep. No: 2851, 138 p. (unpublished).

Kozlu, H., 1994, Feke-Mansurlu dolaylarının jeolojisi ve petrol olanakları: T.P.A.O. Rep. No: 3465, 91 p (unpublished).

Kozlu and Göncüoğlu, 1995, Infra-Cambrian Units in Sandıklı area: Lower Paleozoic of Eastern Turkey. In: Derman, A.S. and Günay, Y. (Eds.), Guide Book , 15-16, Turkish Assoc. Petrol. Geologists, Spec. Publ. No 2, Ankara.

Özgül, N., 1976, Torosların bazı temel jeolojik özellikleri: Türkiye Jeol. Kur. Bült., 19, 65-78.

Özgül, N., 1985, Alanya Tectonic Window and geology of its western part. In: Ercan,T. and Çağlayan, A. (Eds.), Ketin Symposium, Geol. Soc. Turkey, 97-120, Ankara.

Özgül, N. and Gedik, I., 1973, New data on the stratigraphy and the conodont faunas of Çaltepe limestone and Seydisehir formation Lower Paleozoic of Central Taurus Range: Geol. Soc. Turkey Bull., 16, 39-52.

Özgül, N. and Kozlu, H., 1993, Kozan-Feke-Mansurlu arasının jeolojisi: T.P.A.O. Rep. No: 3380, 127 p (unpublished).

Özgül, N., Metin, S. and Dean, W.T., 1972, Lower Paleozoic stratigraphy and faunas of the eastern Taurus in the Tufanbeyli region, Southern Turkey, Mineral. Res. Expl. Bull., 79, 9-16.

Özgül, N., Metin, S., Göğer, E., Bingöl, İ., Baydar, O. and Erdoğan, B., 1973, Tufanbeyli dolaylarının Kambriyen ve Tersiyer kayaları: Türkiye Jeol. Kur. Bült., 16, 82-100.

Özgül, N., Bölükbaşı, S., Alkan, H. and Öztaş, Y. and Korucu, M., 1991, Tectonostratigraphic units of the Lake District, Western Taurides, Tectonics and hydrocarbon potential of Anatolia and surrounding regions. In: Turgut, S. (Ed.), O. Sungurlu Symposium Proceedings, O. Sungurlu Foundation, Ankara, 213-237.

Öztaş, Y., 1989, Homa-Akdağ yöresi, Sandıklı-Şuhut kuzeyinin jeolojisi ve petrol olanakları: T.P.A.O. Report No: 2584 (unpublished).

Purser, B.H., 1985, Coastal evaporite systems. In: Friedman, G.M. and Krumbein, W.E. (Eds.), Hypersaline Ecosystems. Springer Verl., 72-102, Berlin.

Stocklin, J., Ruttner, A. and Nabavi, M., 1964, New data on the Lower Paleozoic and Pre-Cambrian of North Iran: Geol. Survey Iran, Report No. 1, 13 p., Tahran (unpublished).