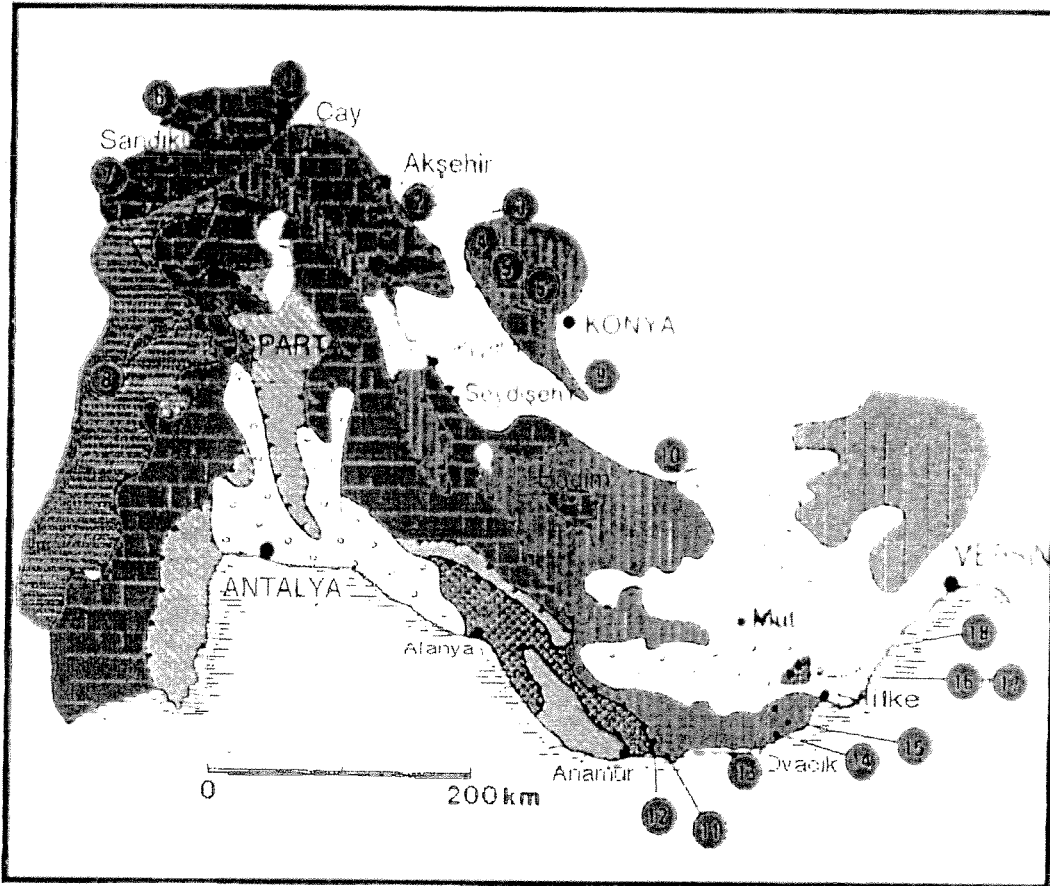


IGCP PROJECT 351 EARLY PALEOZOIC EVOLUTION IN NW GONDWANA



LOWER PALEOZOIC OF SOUTHERN TURKEY EXCURSION GUIDE BOOK

NOVEMBER 7-11, 1995

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**EXCURSION GUIDE BOOK
FOR
LOWER PALEOZOIC
OF
SOUTHERN TURKEY**

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LOWER PALEOZOIC OF SOUTHERN TURKEY

INTRODUCTION

Some of the best exposures of Early Paleozoic sequence is present in Sandıklı (Afyon), Seydişehir (Konya) and Ovacık (İçel) areas in Central Taurus Mountain. In two of these areas, Infracambrian rocks are exposed (Sandıklı and Ovacık areas).

Sedimentary characteristics of the Lower Paleozoic sediments have common features in Turkey. Events recorded in type locality can be correlated between regions. Still some controversial view exists among workers about the relationship between some units.

Although there have been many studies dealing with paleontological and stratigraphical aspects of Lower Paleozoic in Southern Turkey, unfortunately studies concerning the sedimentological and environmental aspect of the same units are not many. We hope that this symposium and field trip will initiate this kind of studies and get attention of many scientists to these aspects.

The aim of this field trip is to share and exchange ideas and examine the Lower Paleozoic exposures in their type localities together with the scientist from different countries who have experience on the Lower Paleozoic in their respective countries. We hope that this will built a common background and contributes new information and data needed to interpret the Evolution of Lower Paleozoic in NW Gondwana.

ACKNOWLEDGMENT

We would like to thank to Turkish Association of Petroleum Geologists, Geological Engineering Department of Middle East Technical University and Turkish Petroleum Corporation and ETİBANK for their support. We would also like to thank to individuals Dr. N. Özgül and Mr. H. Alkan who have giving support in various phases of the organization.

STRATIGRAPHY OF LOWER PALEOZOIC IN SOUTHERN TURKEY

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INFRACAMBRIAN UNITS

The thick packages of low-grade metamorphic rocks beneath the Hüdai Quartzites are mapped and described as Kocayayla Formation (Öztaş, 1989, and Özgül et al. 1991). This Formation constitutes from bottom to top Güvercinoluk Member (Öztaş, 1989), Koçgazi Phyllite Member (Öngür, 1973) or Göğebakan Member (Özgül et al., 1991), Sarıyar Member (Öztaş, 1989) or Celilioğlu Member (Özgül et al., 1991). Kestelçayı Porphyroides (Özgül et al., 1991) intrudes Koçgazi Phyllite member or Göğebakan member.

CAMBRIAN

Hüdai Formation

First sediments overlying Precambrian consist of shales and quartz arenites and known as Hüdai formation. The shales are gray colored, brittle, laminated and contain very thin siltstone laminae. Quartz arenites are yellowish gray, pink and gray colored, medium bedded, cross laminated (Photo-1) and show lensoid geometry (Photo-2). Intensity and lateral extension of quartz arenites increase upward in the section. This implies that clastic part represents a coarsening upward sequence (Phot-3). Due to the soil cover, it is difficult to define whether the quartz arenites have scouring at the bottom. Thickness of the unit is more than 100 meters. It unconformably overlies underlying Precambrian rocks, but considered gradational with the overlying Çaltepe Formation. Possible environment of deposition is related to a delta. Hüdai formation does not contain any age diagnostic fossil, therefore age of the unit is given correlatively. Since underlying unit is Precambrian and overlying Çaltepe formation is Upper part of Lower Cambrian-Lower part of the Middle Cambrian, Lower Cambrian age is given to this formation.

Çal Tepe Formation

Type section of the formation is at Çaltepe which is about 2 km to the NW of Seydişehir city. The formation is first named after Çaltepe by Monod in 1974. The bottom of the unit is not observed in the type locality. Çaltepe formation has been divided into three subunits by Monod (1974). Lower part contains black colored massive dolomite (Photo-4). This part is 50 meters thick. Middle part contains black to dark gray limestone, mostly in carbonate mudstone microfacies, and trilobite, sponge spicules, crinoid spines. Upper part is described as pink colored, fine to medium bedded nodular limestone (Photo-5) containing trilobite fragments and greenish gray colored shale interbedding. Trilobites in the type section gives Early-Middle Cambrian.



Photo-1: Well developed cross lamination is common sedimentological feature in the quartz arenites of Hüdai Formation at lower levels. In the upper levels, cross beddings are common.

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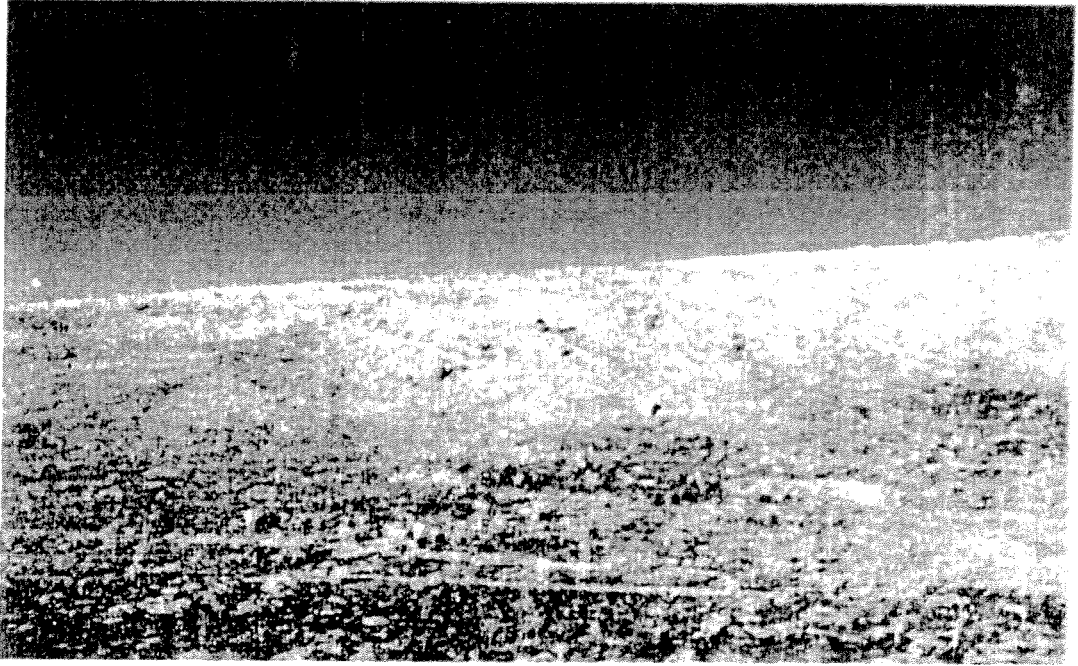


Photo-2: Lower part of Hüdai Formation at Çiloğlan Tepe. Grass covered areas are gray shales which dominates in the lower part of Hüdai Formation and barren areas are shale-sandstone interbedding. Note that sandstones show lenticular geometry at where geologists are standing.



Photo-3: Upper part of Hüdai Formation to the east of Çiloğlantarla Tepe. Note that the amount of sand increase upward. Lateral extension of the sand is also increasing

Çal Tepe formation begins with algally laminated carbonate in Sandıklı area. This character is also observed in Ovacık area which is about 400 kms away. This lower part is mostly dolomitized (Photo-4). Black, dark brown colored dolomites are medium bedded and contains lensoid quartz arenites at the lower part, massit and coarse crystalline dolomites at the upper part. Considering coarsening upward character and overlying algally laminated limestone implies that an unconformity may be present between Hüdai Formation and Çaltepe Formation. Upwards it grades into Seydişehir formation. Toward the contact, the amount of clay increases and red coloration appears, so does decrease the thickness of the bedding. Due to bioturbation, limestone shows nodular appearance (Photo-5).

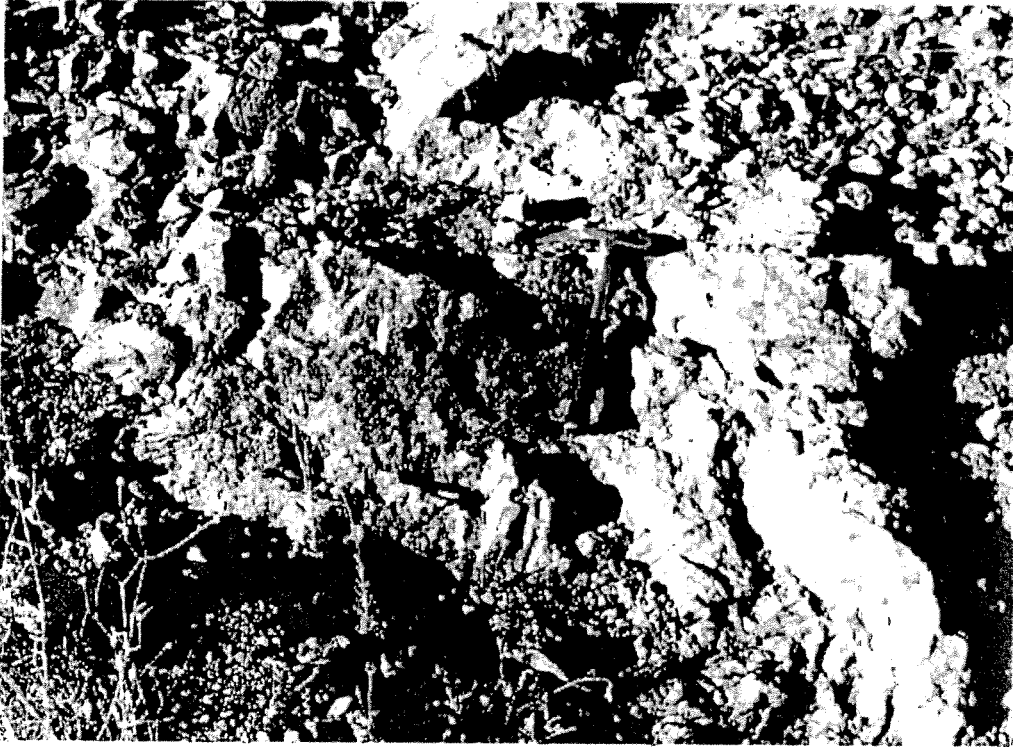


Photo-4: Most of the limestone are dolomitized at the lower part of Çal Tepe Formation. Some algal lamination can still be recognized.

There are trilobites and *Hadimoporella özgülü*, *Acrotretida* sp., *Poliutus* sp. type conodonts. Therefore Upper Early Cambrian-Lower Middle Cambrian age is given to Çal Tepe Formation (Dean and Monod, 1970). From bottom to top the unit shows a fining and deepening upward character. The thickness of Çaltepe formation changes between 15 and 40 meters.

From the observational data, Çal Tepe formation begins with algal staromatolitic boundstone which implies deposition in a tidal flat. This is the beginning of a new depositional period overlying a deltaic succession. Therefore we interpret it to be unconformable. Upward there is a deepening in the environment from tidal flat to shallow shelf where there is abundant bioturbation. Deepening probably accompanied an input from a clastic source which terminated the



Photo-5: Red nodular limestone occupies upper part of Çal Tepe Formation. Nodular appearance is probably caused by bioturbation.

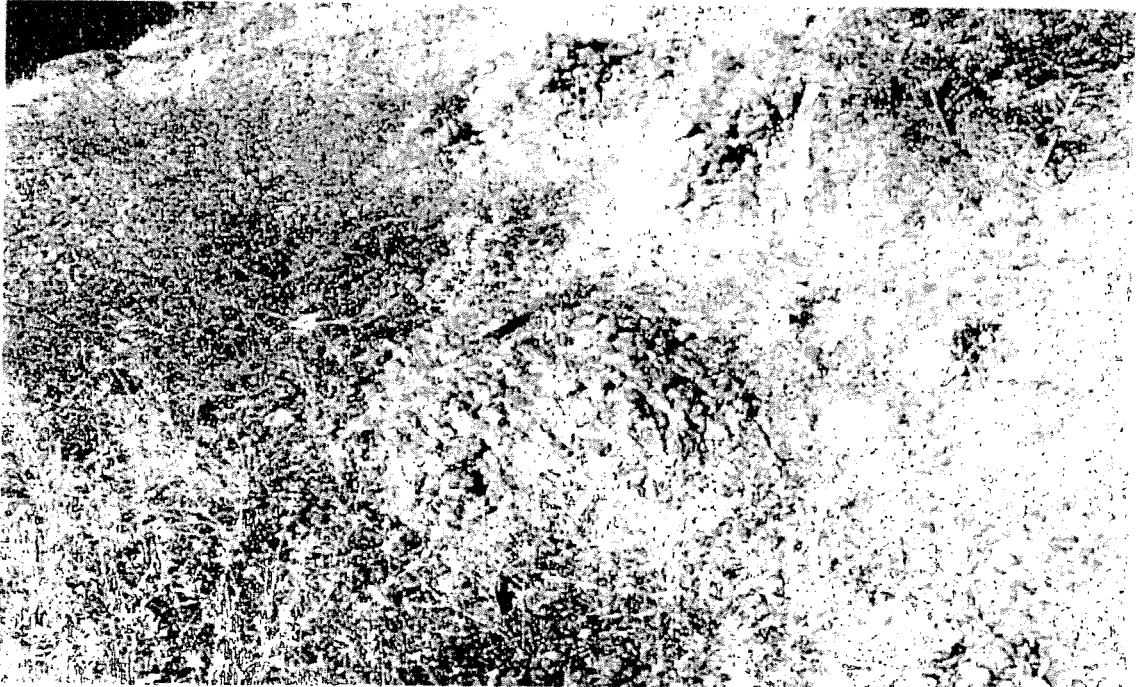


Photo-6: Seydişehir Formation is overlain by Verrucano facies of Triassic which is represented by red colored, unsorted, non-graded coarse conglomerate.



Photo-7: Looking at Çiloğlan Tepe from the NW. At this locality, Seydişehir Formation (at the left hand side of the bottom of the creek with gray color) is overlain by Verrucano facies of Triassic (at the right hand side with red color).

deposition of carbonate in the environment. The clastic source must have been a far source or the availability of coarse grained clastics were limited. Therefore only clay and silt size material are supplied to the environment.

Seydişehir Formation

The type section of Seydişehir formation is in Seydişehir area. It is named after Seydişehir city in 1977 by Monod. The formation overlies Çal Tepe formation with a gradational contact. At the lower part it consist of laminated shale and thin bedded argillaceous limestone. A color change occurs from pink to yellowish gray color at the type locality. Up in the section at Hüdai area, shale and minor siltstone constitute the unit. This lower part is followed by shale-sandstone interbedding. Upward greenish-yellowish gray shales, fucoides bearing quartz arenite, brachiopod, gastropod, orthoceras and trilobite bearing calcarenite interbedding constitute the unit. The thickness of the unit is more than 100 meters. Late Cambrian-Ordovician age is given to the Seydişehir formation (Dean and Monod, 1970). It is overlain by Triassic Verrucano Facies with an angular unconformity (Photo-6 and 7).

Seydişehir formation is overlain by Sobova formation in Seydişehir area and is overlain by Triassic age Verrucano facies with an angular unconformity in Hüdai Area.

This unit has been interpreted as being deposited in deeper water or in basinal areas.

Sobova Formation

Type section of the Sobova formation is Sobova valley, 7 km south of Beyşehir. It is made up of 10 m pink and gray limestone and following 20 m. of gray shales. The unit provided a conformable upper limit for Seydişehir.

GEOLOGICAL EXCURSION: HÜDAİ-SANDIKLI AREA

By W. T. DEAN and O. MONOD

In the Western Taurides (Fig. 1), ?Precambrian and Lower Paleozoic rocks from an elongated inlier that extends south for several kilometers from Had Hamamı (Fig. 1B). The oldest rocks comprise >1000 m. of low-grade schists and metavolcanics, the Kocayayla formation of "Sandıklı metaporphyroid", which are assigned a ?Precambrian age and lie outside the limits of the present excursion. They are succeeded disconformably by the Hüdai Quartzite formation, >500 m. of quartz arenite, supposed beach deposits which pass conformably upward into carbonates of the Çal Tepe formation, here almost 170 m. thick and made up mostly of thick bedded, coarse dolomites (Fig. 1C). No macro or microfossils were found in either the quartzites or dolomites, which together form the higher part of Çiloğlantarla Tepe, where they dip to the southeast (Fig. 1E). The highest Çal Tepe formation, a conspicuous unit about 16 m thick, crops out along the eastern side of Çiloğlantarla Tepe, where a NW-SE traverse will cover most of the succession. Carbonates are mostly pink and gray limestone beds, but most significant portion is a 3.25 m. level of red limestone and pink nodular limestone (Fig. 1D). This is the only part of the succession to yield determinable fossils near Hüdai. No microfossils were found but trilobites include, especially, *Acadoparadoxides mureroensis*, first described from Spain, where it is used as index species for the basal zone of the middle Cambrian, and *Corynexochella? venusta*. The only other area in southern Turkey where both these species have been found is at the stratotype of the Çal Tepe formation, near Seydişehir; there they occur together in the lower part of the light gray limestone member, that is to say, at a level about 10 m. below the appearance of the red limestone facies. The assemblage of Çiloğlan Tepe includes also the trilobite genus *Protolenus*, often considered a zonal index for the lower Cambrian in the so-called "Atlantic Province", but here clearly of middle Cambrian age, as it is in Morocco.

On the east side of Çiloğlantarla Tepe the Çal Tepe formation is followed by brown-weathering green-gray shale and fine-grained quartz sandstone of the Seydişehir formation, 200 m. of which are visible up to the marked angular unconformity below so-called "Verrucano Conglomerates" of the İlyaslı formation (Mesozoic) which form the nearby hill of Maymunkayası Tepe (Fig. 1B, E). No macrofossils or microfossils were found in the Seydişehir formation and it was not possible to demonstrate whether a stratigraphic break occurs at the contact with Çal Tepe formation.

STOP-2 : Continuation of Stop-1 on the same location. At this stop, we will observe Çal Tepe and Seydişehir Formations.

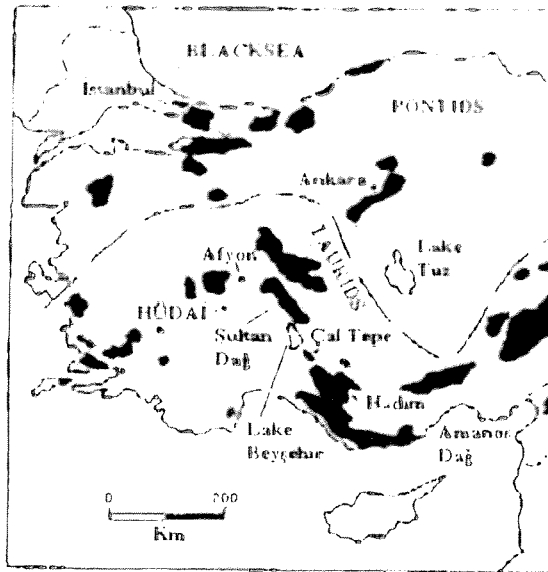


Fig. 1A

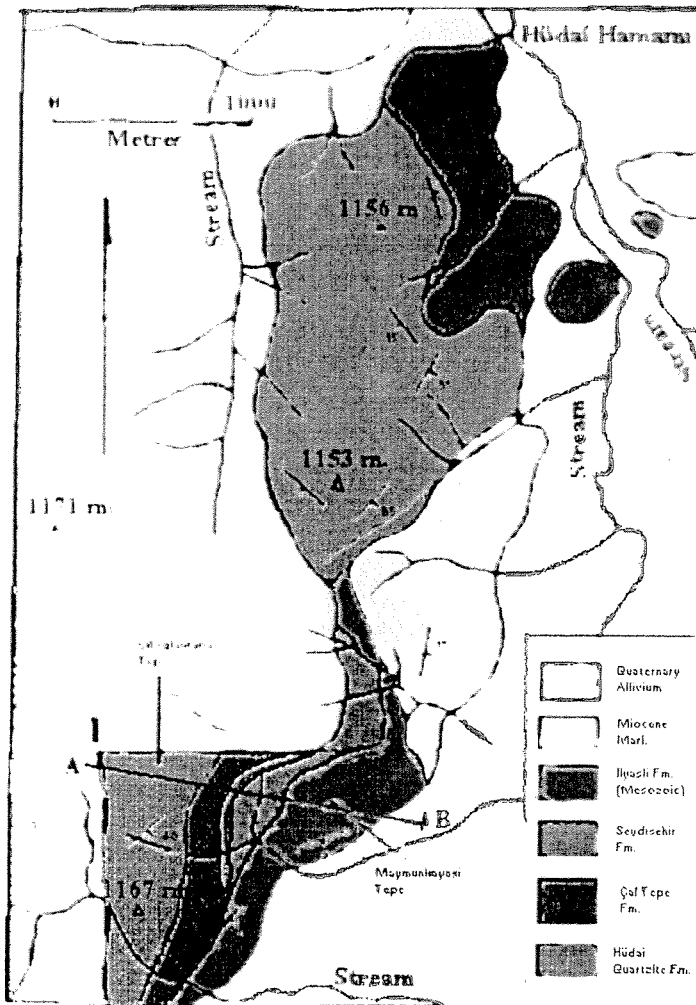


Fig. 1B

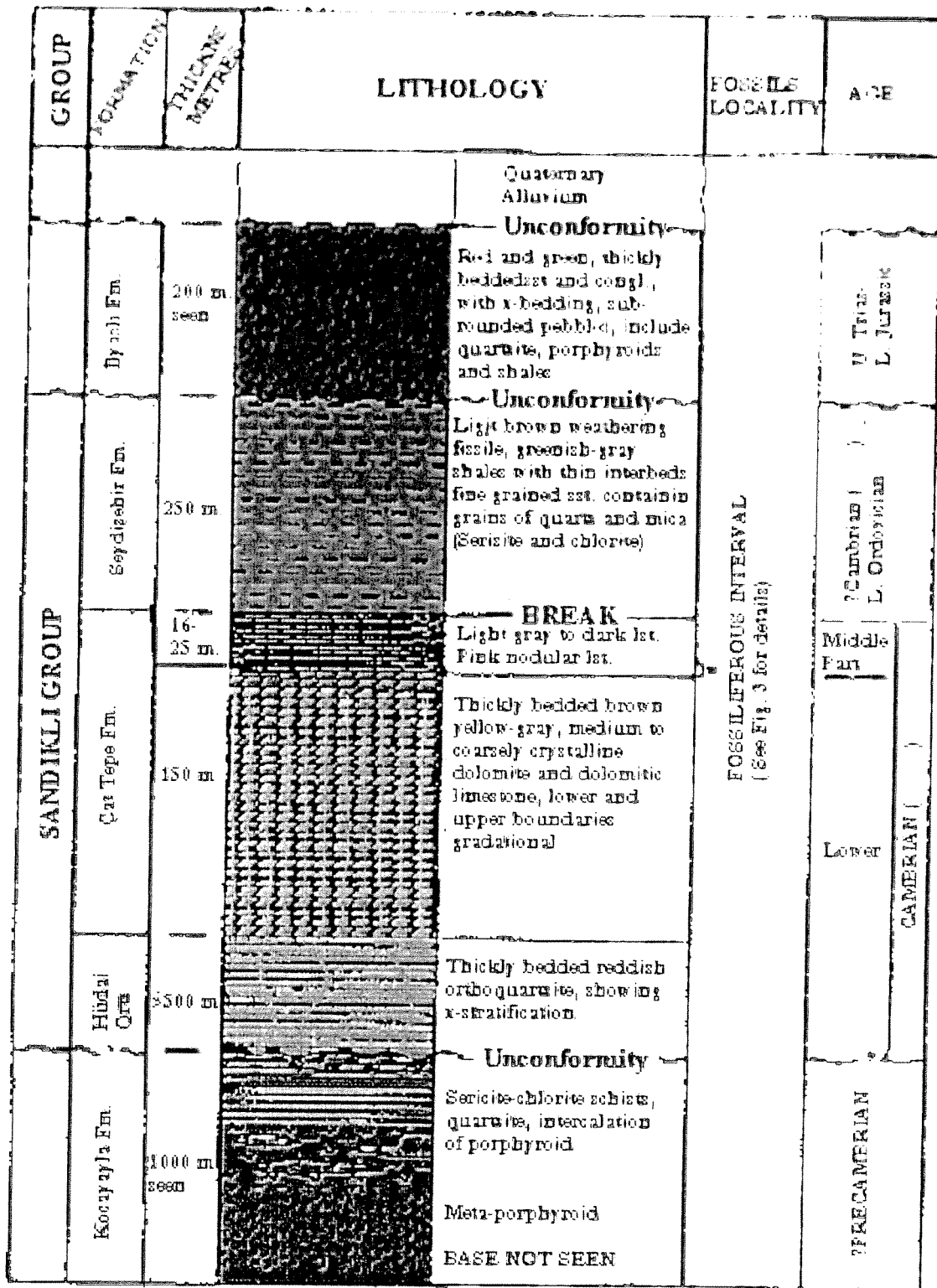


Fig. 1C

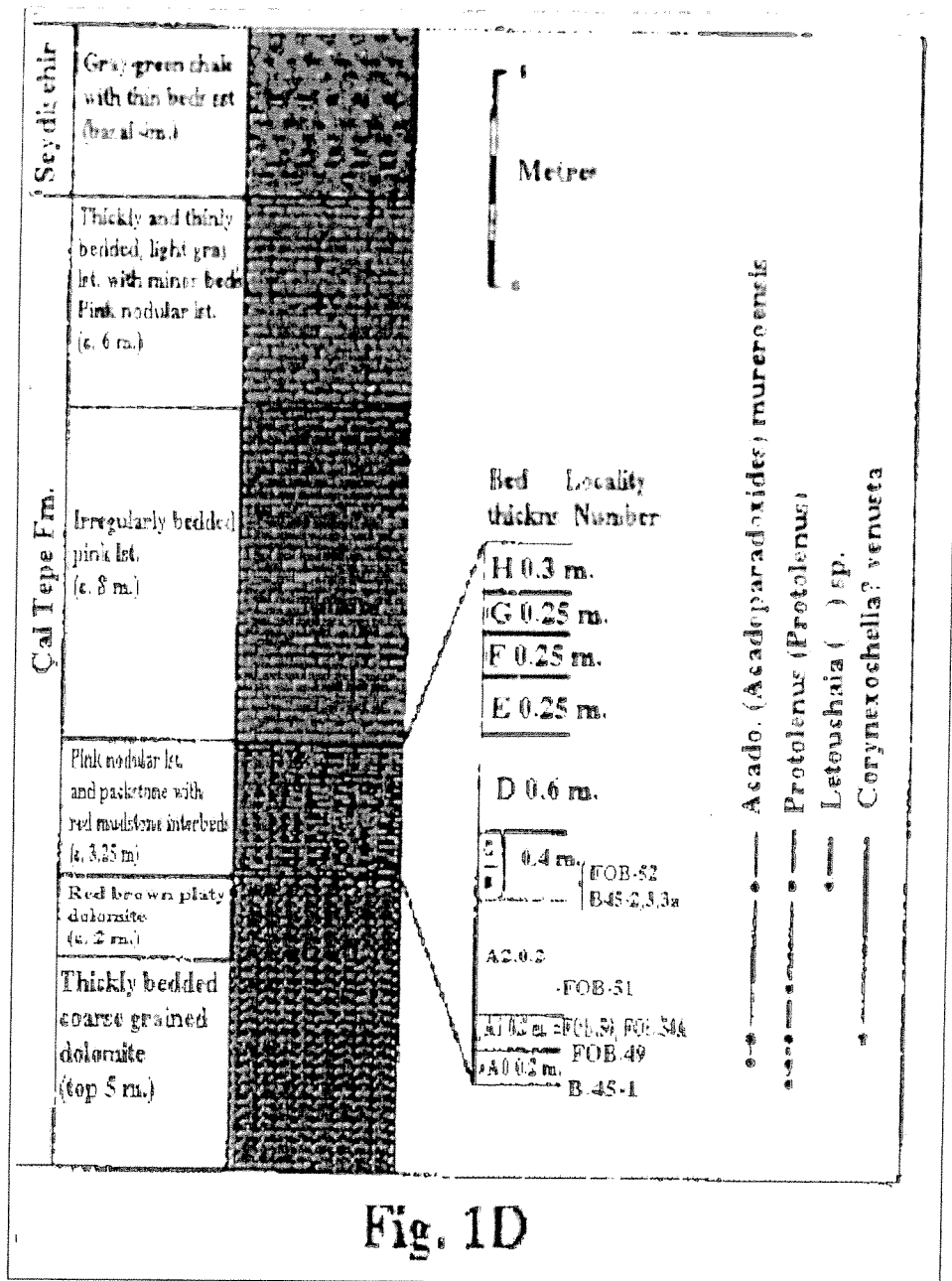


Fig. 1D

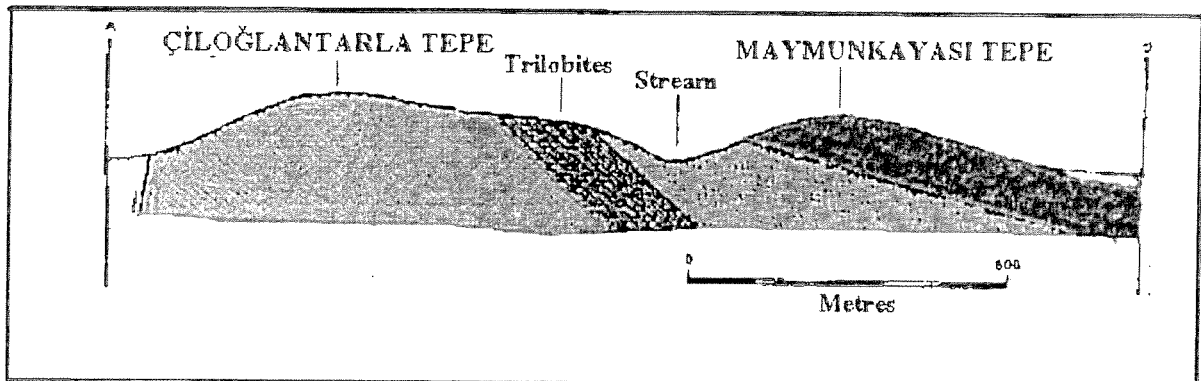


Fig.-1E

ENVIRONMENTAL CONSIDERATION OF HUDAI, ÇALTEPE AND SEYDİŞEHİR FORMATIONS in HÜDAİ AREA

By A. Sami DERMAN and Y. GÜNAY

Hüdai Formation

Hüdai Formation shows a coarsening and shallowing upward sequence along the section exposed at Çiloğlantarla Tepe Locality. Lower part of Hüdai formation is made up of gray shales very thin laminae of silt and very fine sand can be observed. Upward in the section grain size increases from fine sand size to coarse sand. Lensoid body of quartz sandstones can be observed (Photo-1). Cross lamination and beddings are well developed. At the uppermost part, size of cross bedding, frequency of lensoid sandstones (Photo-2) and thickness of individual sand body increase and large scale cross bedding can be observed. Due to the soil cover and limited fresh exposure, no further observation is made. From the limited data and observation, it seems that Hüdai formation is deposited in a prograding delta environment. Each channeled body of sandstone probably represents fluvial channel or mouth bar deposits. Large cross bedding and lensoid geometry indicate deposition in a channel. Uppermost part of the unit might have been deposited in delta plain environment. To distinguish channel deposits from mouth bar deposit, and to define the type of delta, additional study is needed.

Çal Tepe Formation

Overlying Hüdai Formation, a carbonate sequence is present (Çal Tepe Formation). This carbonate sequence shows intense dolomitization and locally preserved algal laminations. In this lower part, local lensoid quartz sandstone is present. Upward in the sequence, it grades into red nodular limestone and then the shales of to Seydişehir formation. Algally laminated limestone at the lower part of the unit probably indicate deposition on a tidal flat. Intense dolomitization may be related to deposition on the tidal flat. Nodular appearance of the limestone may be the result of bioturbation. Upward change from algally laminated limestone to nodular limestone indicate a deepening condition in the environment. The change at the contact between Çal Tepe and Seydişehir formation from limestone to shale indicates a clastic input, suggesting a disturbance in source area. Çal Tepe Formation began as carbonate on a deltaic sequence and deepens upward toward Seydişehir formation.

STOP-1: Çiloğlan Tepe, 2 km NE of Örenkaya village, along Eğrek Dere, Hüdai section will be made and some of the sedimentary characteristics will be observed.

INFRACAMBRIAN HÜDAİ AREA IN SANDIKLI

By H. KOZLU and M. C. GÖNCÜOĞLU

Güvercinoluk Member

This unit consists of slates with carbonate lenses and is interlayered with quartzitic sandstone. In its lowermost part, the sequence starts with dark slates with bands and lenses of dolomites. These are followed by and an intercalation of reddish sandstones and recrystallized limestone. The upper part is characterized by slates, recrystallized limestones and sandstones. The uppermost part of the sequence is made up of dark colored brecciated, cherty and laminated limestones and is interlayered with sandstones. The dominating lithologies in the Güvercinoluk Tepe area are dark colored slates and carbonates. The unit is cut by felsic intrusives and is observed locally as mega-enclaves within porphyroides. The metaclastics display the metamorphic paragenesis: quartz+albite+muscovite+calcite indicating a low-grade metamorphism. The depositional environment is interpreted as shallow marine or lagoon where carbonates and clastics were deposited. The thickness of the unit reaches up to 250 meters and lateral as well as vertical facies changes are commonly observed. No fossils have yet been determined from this Member.

Göğebakan Member

This member consists of dark gray-black-pink and green colored, highly deformed slates and phyllites. Quartzitic sandstones, tuffs, volcanic breccias and basic lava flow are observed as interlayers. The volcanoclastic rocks are andesitic-dasitic and rhyolitic in composition. Similar to Güvercinoluk Member, the unit is intruded by porphyroides. Upwards the unit is transitional to Celiloğlu Member. The metatuffs are well foliated and contain the metamorphic assemblage: white mica+albite+quartz. Relict textures are commonly observed. The sedimentary features are widely removed by deformation so that an exact interpretation of the depositional environment is not possible. The litho-facies, however indicate a low-energy neritic environment with volcanic activity and continental influx. The thickness is not exactly known but estimated as 600 meters. No fossils have been determined yet.

Kestelçayı Porphyroides

Felsic intrusives and their pyroclastic equivalents that consist of lithic and crystal tuffs, ignimbrites as well as epiclastics intercalated with the sediments of Gūvercinoluk and Gōğebakan Members are named as Kocayayla Porphyroid Member by Öngür (1973). Dome-shaped bodies of felsic intrusives are disrupted and highly deformed. The “porphyroids” are typically mylonitic rocks with relict volcanic textures. Corroded quartz and micropertitic feldspar porphyroclasts are embedded in a glassy matrix consisting of recrystallized fine-grained quartz and white mica along foliation planes. The pyroclastics are also well foliated and range from dacite to rhyolite in composition.

These rocks are described as “Sandıklı Granite” by Kröner and Şengör (1990). Typical plutonic zircons from two samples yielded single zircon ages that vary between 543 ± 7 Ma and 2448 ± 3 Ma. The lower age is interpreted by the authors as the intrusion age, which is incompatible with the geological data.

Celilioğlu Member

An alternation of medium-thick bedded and laminated greenish-reddish-brown and gray slates and quartzitic sandstones make up the main lithology of this member. The sandstones are dominantly cross-laminated and sometimes graded bedded and contain sole marks. Lateral and vertical changes in the depositional features are common. No porphyroids cutting this Member are observed in the field. The unit shows graded transition to the overlying Hūdai Quartzite. The sedimentological features suggest a rhythmically deepening and shallowing marine deposition. Due to the rapid lateral changes in the depositional facies and the intense deformation the original thickness cannot be given but estimated as > 2000 meters. No fossils have been yet determined from this Member.

Hūdai Quartzite and Lower-Middle Cambrian Çaltepe Formation conformably cover the Celilioğlu Member, so that the members of the Kocayayla Formation, described above, should be of pre-Lower Cambrian age.

STOP-3 : Varicolored slates and sandstones of Gōğebakan member intruded by basic dikes will be observed.

Stop-4: Felsic volcanics and volcanoclastics of Kestelçayı Porphyroids will be observed.

TÜRKİYE PETROL JEOLUJLARI DERNEĞİ
KÜTÜPHANESİ

GEOLOGICAL EXCURSION: SEYDİŞEHİR-ÇAL TEPE AREA

By W. T. DEAN and O. MONOD

The area of the western Taurides (Fig. 1A) extending 21 km. northwest from Seydişehir to the Sobova valley, 7 km. south of Beyşehir (Fig. 2A) is one of the most important in Turkey for Lower Paleozoic stratigraphy as it includes stratotypes of three major formations (Photo-8): a. Çal Tepe, b. Seydişehir and c. Sobova.



Photo-8: General view of the type section of Çal Tepe Formation. Highest point represents Çal Tepe itself.

a. Çal Tepe Formation

This predominantly carbonate unit forms both the Çal Tepe itself (Fig. 2A) and a number of smaller hills which are essentially inliers within a plain underlain by Ordovician and Neogene-Recent deposits (Fig. 2F, Units 1-3). The apparent dip at the Çal Tepe is to the Northeast, but the succession there is inverted and an ascending sequence will be examined during a NE-SW traverse that crosses the hill about 400 m southeast of the summit (Fig. 2E, F). The formation is divided into four members: Dolomite, Black Limestone, Light-gray Limestone, and red nodular limestone, in ascending order. A unit of Middle Cambrian yellow shales (50 m) follows the carbonate succession at the Çal Tepe and is considered to be Lowest Seydişehir formation. The dolomite member (>50 m.; Fig. 2f, Unit 6) comprises thickly bedded, coarsely-crystalline, dark-gray dolomite. No macro or microfossils have yet been found, and a lower Cambrian age is inferred from that of the succession member. The formation base is not exposed at the Çal Tepe, but in the Göksu valley near Hadim 70 km. southeast of Seydişehir. The dolomite member is underlain by non-fossiliferous dark shales (base not seen). The thickly-bedded carbonates of the black limestone members (24 m; Fig 2F, lower part of unit 5) yielded the first Lower Cambrian fossils recorded from Turkey. These include

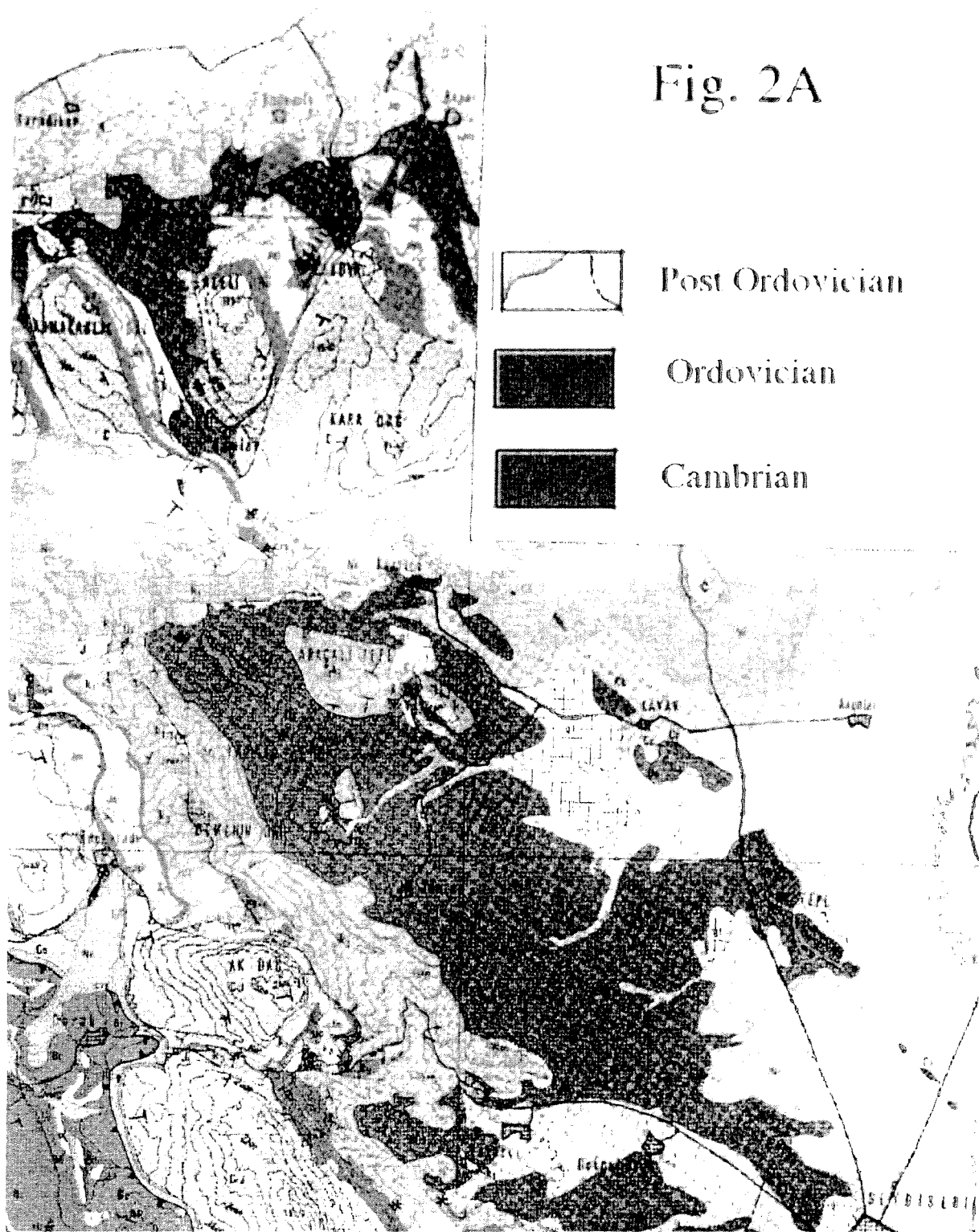
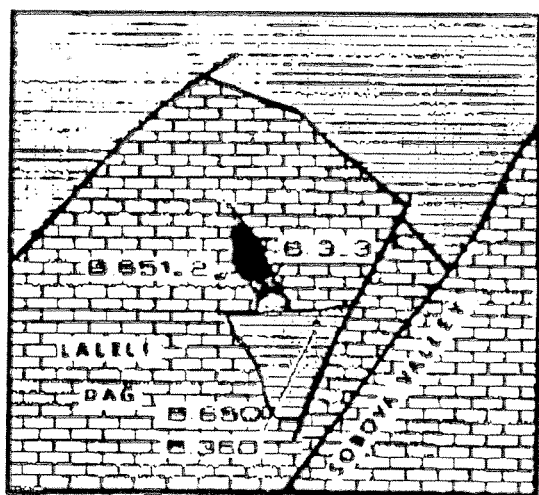


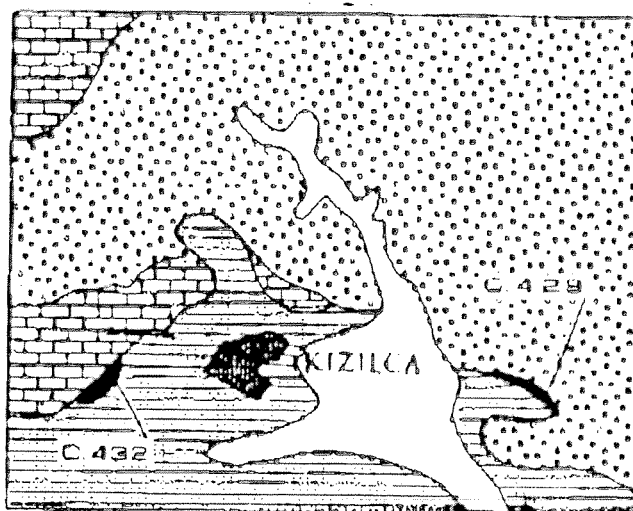
Fig. 2A

uncommon late Lower Cambrian trilobites (*Antatlasia*, *Kingaspis*) whose affinities are with assemblages in the north African, Near Eastern and Eastern European parts of Gondwana. The Light-gray Limestone member (Fig. 2F, upper part of unit 5) comprises 11 m. of well bedded limestone, mostly light-gray but occasionally pink. It is more fossiliferous than the underlying member, and the contact of the two is

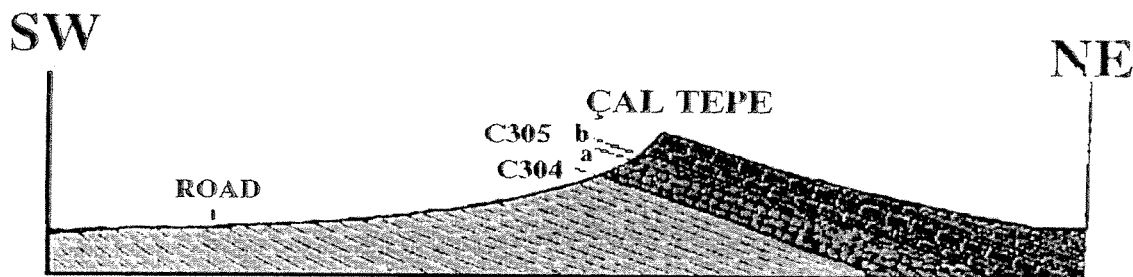
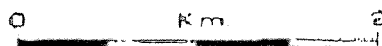
apparently conformable; *Acadoparadoxides mureroensis*, index trilobite of the lowest Middle Cambrian biozone, was found 1 m. above the base. The most conspicuous part of the formation, the Red Nodular Limestone member (Fig. 2F, Unit 4), is about 47 m. thick at the Çal Tepe, where it comprises thinly to medium bedded gray and pink limestone, with interbeds of red, nodular öcrite and red to yellow shale. No microfossils were found, and the locally abundant macrofossils, found especially in lenses of white sparate, are often difficult to extract. They are mostly trilobites and those in the upper half of the member indicate the Pardailhania Biozone of the middle Middle Cambrian. The overlying yellow shale unit at the Çal Tepe contains thin beds of gray micrite with fragments of Paradoxides, indicating a general Middle Cambrian age; but corresponding strata near Hadım, 75 km to the southeast, belong to the Pardailhania Biozone and Çal Tepe/Seydişehir formational contact is conformable.



2B



2C

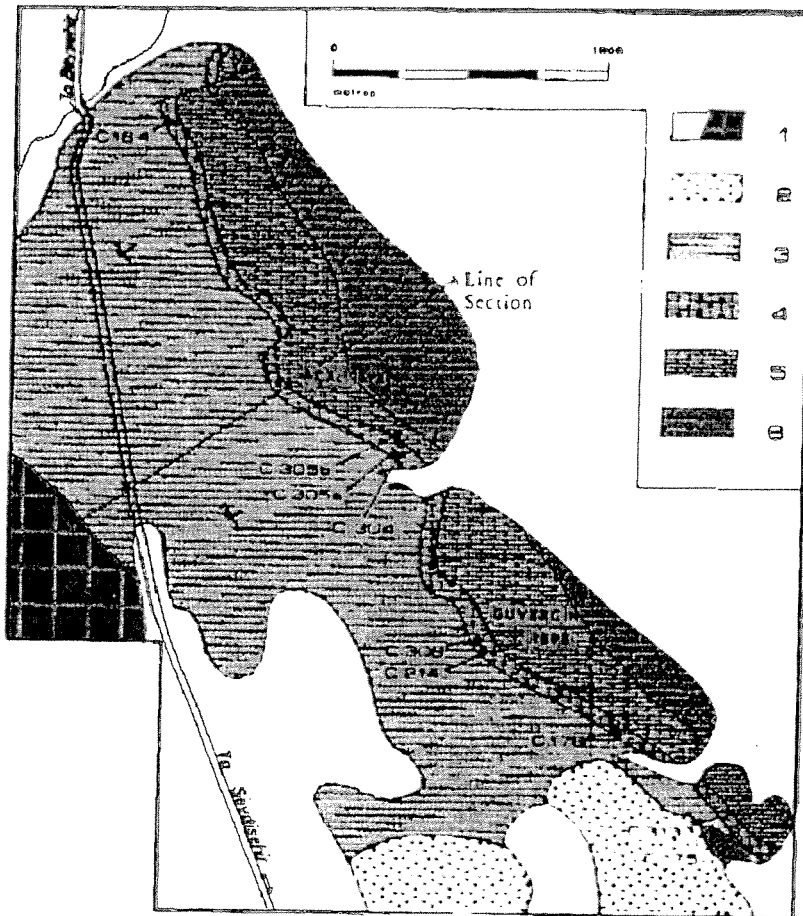


2E

Members of the Çal Tepe fm. represent remarkably uniform lithofacies which may be traced along the western and central Taurides and, to a lesser degree, still further east, in the Amanos Mountains and Border Folds. Dating of the lowest three members is difficult outside the type area, but diachronism of the red nodular limestone facies can be demonstrated. In terms of present day geography it becomes generally younger from west to east, ranging from basal Middle Cambrian at Hüdai to the highest biozone of the middle Middle Cambrian in the Border Folds. But in terms of Cambrian Paleogeography the diachronism is interpreted as being due to progressive foundering of the Gondwana margin from north to south during some 10 million years.

b. Seydişehir Formation:

West of Çal Tepe, the formation is more than 1000 m. thick and ranges in age from middle Middle Cambrian to Lower Ordovician (probably upper Arenig). The rocks comprise a monotonous succession of quartzites and alternating micaceous shale,



shale, part of a considerable development of clastic sediments that covered an enormous area of Gondwana platforms from eastern Canada, through the Mediterranean Region to southwestern China. Most of the succession lacks carbonate, and occasional thin beds of limestone occur only in the lowest and highest parts, where they have yielded macrofossils of stratigraphic value; much of the remainder of the formation is dated by means of micro-fossils (acritarchs) but trace fossils (*Cruziana*) may be locally useful. As noted earlier, the lowest 50 m. of the sequence is of middle Cambrian age

and is seen on the Southwest slope of Çal Tepe, topographically below the top of the Red Nodular Limestone Member. Upper Cambrian strata are unconfirmed west of Çal Tepe, and the lowest shales with Tremadoc acritarchs occur close to the Middle Cambrian yellow shales (Fig. 2G). From there to Tavşanlı village thin (c. 10 cm.)

lenses of pink gray limestone contain Lower Tremadoc trilobites, including *Proteuloma*, and resemble similar strata recorded from the Sultan Dağ, Western Taurides. The macrofossil affinities are with southern and western Europe, and the microfossil are of peri-Gondwana type.

Most of the remaining Seydişehir formation lacks macrofossils, but isolated occurrences of graptolites suggests lower Arenigian. The highest bed exposed in the Sobova valley, 24 km. northwest of Seydişehir (Fig. 2B), contain probably upper Arenig cephalopods, with other mollusks and trilobites of peri-Gondwana type.

c. Sobova formation:

The unit provided a conformable upper limit for Seydişehir formation, and its the type section, 7 km. south of Beyşehir (Figs. 2A, B), includes 10 m. of pink and gray limestone, followed by 20 m. of gray shales. Trilobites from the limestone exhibit both Gondwana and Baltic affinities; they and associated conodonts indicate and upper Arenig age. Small outcrops of white and gray limestone at Kızılca (Fig. 2C), are unlike those at Sobova, 8 km. to the north, but only slightly older, based on fossil evidence. No post Arenig Lower Paleozoic rocks are known in the region.

ENVIRONMENTAL CONSIDERATION OF THE UNITS IN THE SEYDİŞEHİR AREA

By Y. GÜNAY and A. S. DERMAN

Hüdaî Formation is not exposed in Çal Tepe Location in Seydişehir. Lower contact of Çal Tepe Formation is not exposed either. Lower part of the Çaltepe Formation is dolomitized. At the middle part, beside dolomites, algal laminated limestones are observed (Photo-9)



Photo-9: Although intensely dolomitized, algal laminations are locally preserved in Çal Tepe area.

Upward in the section, dolomitized limestone grades into red nodular limestone (Photo-10). Red nodular limestone grades upward into shales of Seydişehir Formation (Photo-11). Both units have common characteristics in both Sandıklı and Seydişehir area. Therefore environmental conditions must be the same in the both areas.

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Photo-10: Red nodular limestone in Çal Tepe. Highest point is Çal Tepe locality.



Photo-11: Gradational contact between Çal Tepe Formation and Seydişehir Formation at Çal Tepe Locality.

GEOLOGICAL EXCURSION: SİLİFKE-OVACIK AREA

By M. Ali GÜL

Dibekli Formation (€d)

The unit is made up of dark gray, greenish gray siltstone and sandstone interbedding with volcanogenic constituents. Probably deposited in outer shelf environment. Due to its stratigraphic position, it has been assigned to Lower Cambrian. Lower contact of the units is not observed.

Hacıışaklı Formation (€h)

The unit is made of red to white colored, very thick bedded, quartz arenites with well developed cross bedding. It is 100 m. thick, and it is probably deposited in fluvial environment. It is considered as Lower Cambrian due to its stratigraphic position. It is overlain by Çal Tepe Formation with a conformable contact.

Çal Tepe Formation (€ç)

The unit has three partite lithological division; dark colored dolomite at the lower, gray colored trilobite bearing micritic limestone at the middle, and pink colored, nodular trilobite fragments bearing limestone with sandy, silty and shaly interbedding at the upper part. The thickness is 250 meters. Lower part was deposited on a platform and upper part was deposited in outer shelf environment. Fossil content indicates that the unit is Lower-early Middle Cambrian age.

Seydişehir Formation (€Os)

Seydişehir Formation conformably overlies Çal Tepe Formation. It is made of olive green, gray colored silty shales and khaki-gray colored sandstone-siltstone interbedding with fucoides, worm traces and ripple marks. 400-1000 meters thick. Acritarcs listed below, indicating Middle Cambrian-Ordovician has been identified.

Cymatiogalea sp.

Late Cambrian-Ordovician

Rhopaliophora palmata

Acanthodiacrodium costatum

Cristallinium dentatum,

Arenig-Llanvirn.

Coryphidium bohemicum

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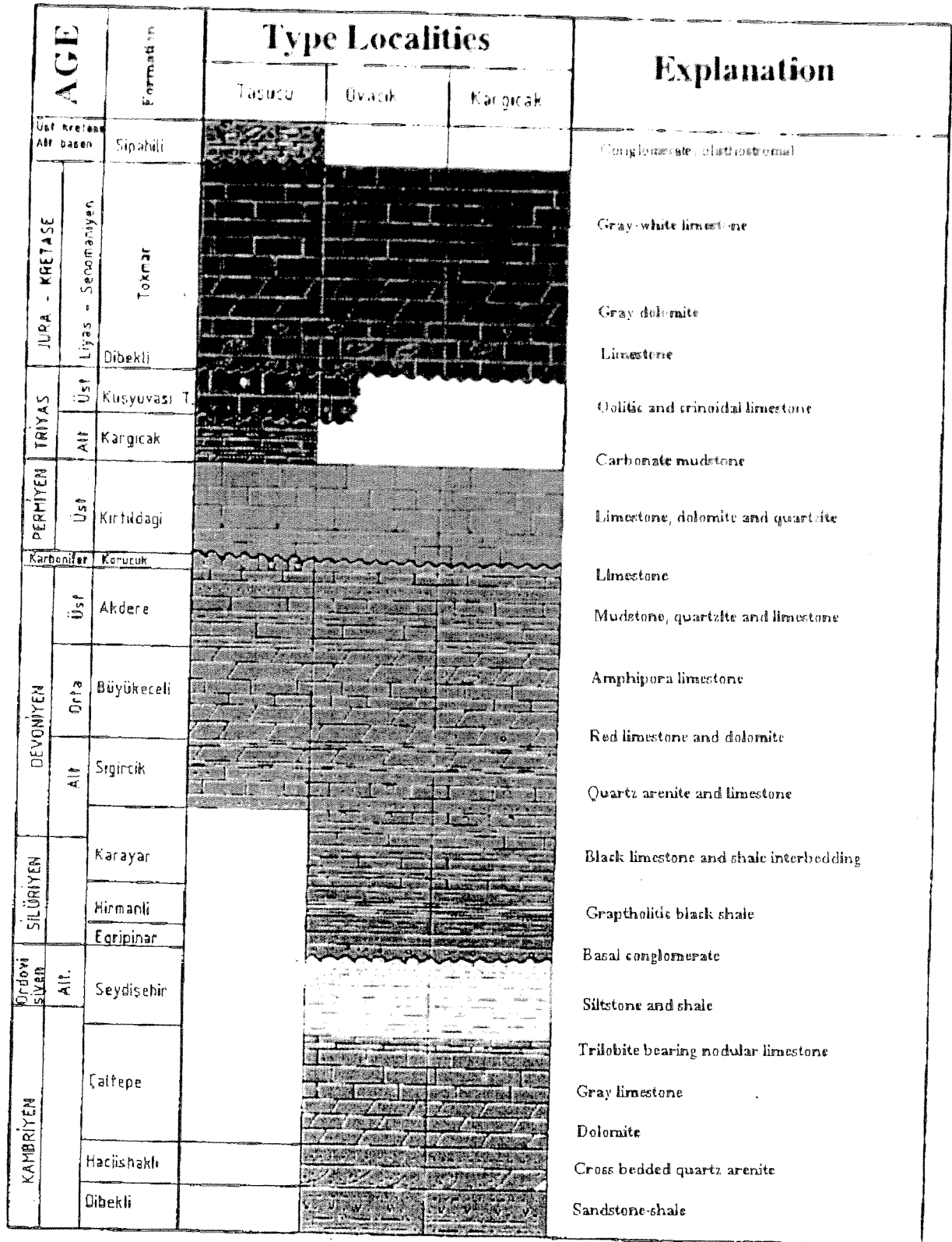


Fig. 1: Generalized stratigraphic columnar section of Ovacık-and neighbourin areas.

Eđripınar Formation (Se)

The unit unconformably overlies Ordovician age rocks. It consists of red colored, cross bedded conglomerate and sandstone that contains granitic pebbles derived from basement at the lower part. Upward it continues as greenish gray colored shales and siltstone interbedding which contains conglomerate and sandstone lenses. It is overlain conformably by Hirmanlı Formation. It is 125 meters thick. The unit contains miyospores and grapholites indicating Early Silurian age and was deposited in shore-lagoonal environment.

Hirmanlı Formation (Sh)

This unit comprises black colored, well laminated and bedded siliceous and grapholite bearing shales at the lower part, followed by 10 meters thick dark gray colored, medium bedded limestone containing Orthoceras. This is in turn overlain by dark gray, greenish gray colored siltstone-shale interbedding. It is 100 meters thick. It was deposited in deep and closed basin (restricted basin) and contains Silurian age fossils.

Karayar Formation (SDk)

The unit grades upward into shales of Hirmanlı Formation and begins with dark gray-black colored, medium bedded shale-limestone interbedding. Limestones are in turbiditic character. It shallows upward into medium-thick bedded, bluish gray nodular limestone and this in turn grades into brown colored, thick bedded, partly laminated silty, sandy limestone containing brachiopods and crinoids. This is conformably overlain by Sığircık Formation of shallow character. It is 350 meters thick. It was deposited in a slope environment. It contains Late Silurian Miospores and Early Devonian Brachiopods.

Sığircık Formation (Ds)

This unit begins with dark gray-gray colored, medium-thick bedded limestone containing crinoid, coral and brachiopod, white-yellowish colored, cross bedded quartzite and dark greenish gray colored shale interbedding. Upward it grades into whitish colored, cross bedded quartzite. This is in turn overlain by gray colored, medium-thick bedded dolomites and red colored silty mudstone, sandstone and conglomerate interbedding. It is 250 meters thick. It was deposited in a very shallow environment above wave base (shore environment). It contains Favosites type corals and brachiopods like Strophamena and Lower Devonian age is given to this unit. Sığircık Formation conformably overlies Karayar Formation and is overlain by Büyükeceli Formation.

Büyükeceli Formation (Db)

Büyükeceli Formation consists of, from bottom to top, 5-10 meters thick brechoidal conglomerate, bluish gray colored, thick bedded 40 meters thick carbonate containing corals like *Disphyllum goldfussi* and *Calceola Sardalina* and megabreccia beds, dark gray colored medium thick bedded dolomitic wackestone, yellowish gray colored shale interbedding, white colored, cross bedded, 1 meter thick quartz arenite, dark gray colored, thin-medium bedded, laminated limestone, dark gray colored medium-thick bedded, laminated, partly dolomitized brechoidal stramatoporoid wackestone containing *Amphipora ranoza*, light gray colored, partly dolomitized limestone and 25 meters thick blocky megabreccia interbedding, white-pink colored, medium-thick bedded quartz arenite, dark bluish gray colored, medium bedded, bituminous wackestone, dark gray colored, thick bedded dolomitic wackestone containing coral, gastropod, brachiopod and dolomites. Thickness of the unit varies from 630 meters to 40 meters. It contains Middle-Upper Devonian fossils.

Akdere Formation (Da)

The unit is made up of dark gray, partly sandy, dolomitic limestone containing coral, bryozoa and brachiopods, red-white colored, medium-thick bedded, occasionally cross bedded quartz arenite and reddish-greenish colored shale interbedding. It is 250 meters thick. It was deposited in a shallow (supratidal-intertidal) environments. It contains Upper Devonian age coral (*Disphyllum gaespitosum*), brachiopod (*Cyphoterrorhynchus gr. arpaensis*).

Korucuk Formation (Ck)

This unit consists of dark gray colored, medium bedded grain and packstones interbedding containing forms and large shell fragments. It contains fossils of Lower Carboniferous.

ENVIRONMENTAL CONSIDERATION OF LOWER PALEOZOIC UNITS IN OVACIK AREA

By A. S. DERMAN and Y. GÜNAY

We have already described and interpreted environment of deposition of Hüdai, Çal Tepe and Seydişehir Formations in Sandıklı and Seydişehir areas. In Ovacık area, we will describe general characteristics of the Silurian and younger rocks in order to avoid conflict with the formation boundaries.

Silurian age sediments begin with sandstone and conglomerate which contains pebble to cobble size granitic material and show well developed cross bedding. These sandstones grade upward into gray, greenish-gray shale and sandstone interbedding (Gül, 1991) (Photo-1).

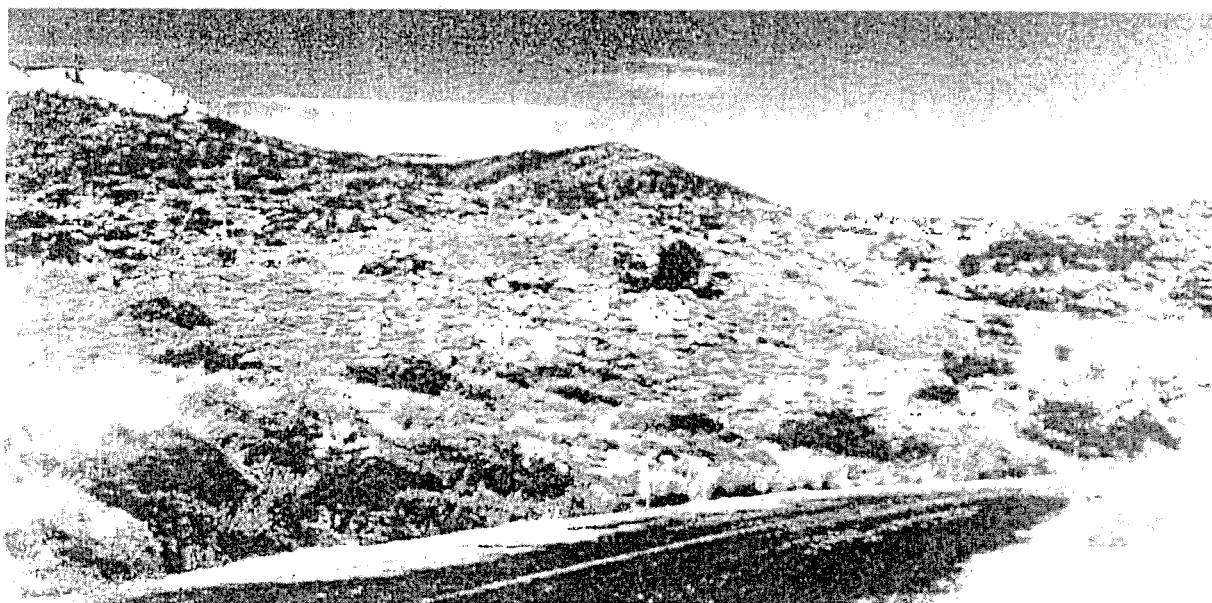


Photo-1: A Sandstone-conglomerate level which contain granitic material probably derived from the basement marks the boundary between Ordovician and Silurian. Picture is from along Ovacık road.

This sandstone-shale interbedding is followed by black colored, laminated and graptolite bearing shales followed by Orthoceras bearing argillaceous limestone (Photo-2). This is in turn overlain by shale-siltstone interbedding (Photo-3). This part, due to the sand content, has a resistant topographic expression (Photo-4).

Following section has rather uniform character, mostly bioturbated shales containing brachiopods and crinoids as fossils up to the top of Silurian section (Photo-5).