STRATIGRAPHY AND SEDIMENTATION OF THE LOWER TERTIARY AND MESOZOIC IN THE FOREDEEP BASIN OF S. E. TURKEY

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The purpose of this conference is to present a stratigraphie sedimentory schema of the Pre Middle Eocene sediments in the foredeep basin of S. E. Turkey.

This schema is the result of a detailed study of all available material from deep test wells and from typesections, during the last two years. It consists of the detailed stratigraphie, sedimentory and paleontologic study of the Raman No. 14, Kentalan No. 2, Gercüş No. 1 and Hermis No. 1 test-wells, and of a series of 12 sections sampled during last summer in the Derik, Mardin-Savur area. Our control points are thus still widely scattered over the region and information is still far from complete. We will need many more detailed typesections before it will be possible to present a more exact picture. Notwithstanding these drawbacks I will attempt to draw here a picture of the stratigraphy and sedimentation in this part of the foredeep basin of S. E. Turkey.

We must above all keep in mind that nearly all the evidence comes from the crestal areas of drilled or exposed anticlines and without information about the equivalent deposits in the synclines it is impossible to determine whether the sedimentory conditions represented were confined to the slowly rising anticlines or whether widespreal similar conditions prevailed also in the synclinal areas.

As foredeep basin of S. E. Turkey I consider the trough and belt of frontal folds and the hinge belt between the orogeosynclinal bordeland, the Bitlis massiy and its thrustzone, in the N and N. E., and the stable foreland shelf in the S. The stable shelf in this case is identical with the Arabian plateau of othey authors, So pur foredeep basin iş bordered in the N by the Bitlis massiv and the orogeosynclinal thrust zone and in the S by the Mardin uplift, though we should well remember that the Mardin uplift only represents a local basement swell separating the sedimentary foredeep basin in a Northern trough and a Southern trough. The Mardin swell is by no means part of the stable shelf or Arabian plateau, but only an intrabasinal swell. It would take us too long to go any deeper into this interesting feature, closely related with the whole tectonic framework of the basin.

I will first show you the main stratigraphie divisions of the Lower Tertiary and Mesozoic sediments and end with an evaluation of the sedimentory conditions expressed by these. Nowhere in the central part of the foredeep basin we observe basement rocks. It is only on the Derik-Mardin swell that folded and partly metamorph basement rocks are outcropping. Tolun and Ternek were the first to record diagnostic fossils establishing the age of the top of this basement Complex as Cambrian. As these basement rocks do not participate in the foredeep sedimentary history, I will not go into further details.

The oldest formation supposed to have participated in the sedimentory history of the foredeep basin is the Devonian, well established by Tolun by its fossils in the Hacertundağ outcrops. ît does not show an angular unconformity with the overlying Carboniferous of Permo-Carboniferous rocks, though the presence of a disconformity seems quite probable. SE of Siirt thick Devonian sediments were described by Altinli whereas Türkünal mentions Devonian E of Hakkari.

Detailed sections with complete evaluation of the fossils have not been made, so that it would seem to be premature to make any conclusions as yet. The same can be said for the Carboniferous and Permian. Its presence is known from the Hazru area by Tolun's work and by Tolun's, Altinli's and Türkünal's work also from the area E and ES of Siirt. Our knowledge of these formations as yet too scattered to consider them in relation with the stratigraphic - sedimentory history of the foredeep-basin. Its complete absence on the Derik-Mardin swell, however is significant.

No angular unconformities have been recorded by the various authors, but disconformities bewveen these formations are generally infered.

The Triassic is the first formation which has been hit by two deep test-wells in the more central part of the basin, while outcrops are known from

Hazru and from the area S and SE of Siirt. At Hazru it is composed of variecolored shales and claystones with phosphate nodules, underlayn by reddish colored limestones with: MYOPHORIA şnd CLARAIA CLARAI and with argillaceous limestones and marls at its base. The limestone streaks in the mainly variecolored shales in the deepest part of the Kentalan No. 2 well revealed a poor fauna with molds of CLARAIA CLARAI and some primitive FRONDICULARIA, thus prooving its Lower Triassic age. In Kentalan these beds are overlain by variecolored shales and some greyish marlstones, carrying locally MEGASPORES and phosphate nodules. I have correlated these beds with the variecolored shales of Hazru. They are in both sections overlain by Jurassic dolomites. The dark to black, occasionally dark reddish colored shales and claystones in the deepest part of the Raman No. 14 well showed only phospliate nodules and the same MEGASPORES as recorded from the Kentalan No. 2 well I therefore correlate the dark shales of the deepest part of the Raman No. 14 well with the variecolored shales of Kentalan No. 2 and Hazru, considering them all as Upper Triassic. It is possible that these beds will later proove to be of Rhaetian age, but no direct proof is available now.

Thickness of the Triassic is very much reduced in Hazru, where only 60 m is present, but thickening from Hazru to Kentalan seems evident as the variecolored shales underlain by beds with CLARAI CLARAI are already nearly 100 m thick E and SE of Siirt much thicker and more calcareous Triassic with fossils has been recorded by Altinli, who mentions thicknesses up to 500 m. Detailed sections have however not yet been measured, so that correlation with the Hazru, Kentalan and Raman Triassic is not yet justified. No Triassic at all was deposited on the Derik-Mardin swell.

There is no evidence of an angular unconformity between the Triassic and Jurassic in the forredeep basin, but the change from neritic, finely detritic reef-complex sedimntation in the Jurassic is so sudden that a disconformity must be accepted.

The Jurassic in the western part of the Foredeep basin is known from the Luçok and Hazru area's and from the Kentalan No. 2 and Raman No. 14 wells. It is thin in the Luçok are, were only 40 m of Jurassic limestone, with conglomeratic beds at its base was recorded by Tolun. Systematic study of the collected samples has still to be done, but Tolun has recorded Belenopsis in the upper part and Ammonites of the Egoceras bisipinatus group and Racophyllites from the basal Jurrassic. The Hazru are shows already a much thicker Jurassic, around 90 m, developed as mainly sterile dolomites and calcareous dolomites. Tolun accepted Jurassic age as it is overlain by typical Lower Cretaceous carbonates and underlain by Triassic. The Raman and Kentalan Jurassic, around 120 m thick and composed of calcareous dolomites, dolomites and dolomitic limestones, with towards the top some streaks of skeletal limestone, carrying a poor microfauna with TROCHOLINA FEIFFELI The Cretaceous-Jurassic boundaryin the Raman-Kentalan area is not yet quite well defined, though. I accepted untill further proof that the Jurassic begins at the first beds with TROCHOLINA FEIFFELL Additional fossil studies of samples from section more towards the E and SE might quite well help us to established a much more detailed subdivision. The Jurassic of the area E and SE of Siirt is generally included in the massive reef limestone complex of the Mesozoic, though Türkünal mentions an extremely thick Jurassic E of Hakkari. The relation of this Jurassic with our deposits in the fore-deep basin are however not yet clear.

The Lower Cretaceous, characterized generally by the presence of Orbitolina of discoidea, especially in a few skeletal limestone streaks near its top, has been recorded first by Tolun, from the Luçok and Hazru sections and by Tolun and Ternek from the Derik section, and was recently discovered in the Kentalan No.2 and Raman No. 14 sections. In the Luçok area it are 100 m of argillaceous limestones with Ammonites and CALPIONELLA, near Hazru again around 100 m of more or less dolomitized carbonates with limestone streaks carrying ORBITOLINA cf DISCOIDEA. The Kentalan and Raman wells show an almost entirely dolomitic series with ocasionally thin streaks with ORBITOLINA cf DISCOIDEA especially towards the top. The Cenomanian-Lower Cretaceous boundary here was traced Just at the first limestone streaks with ORBITOLINA cf DISCOIDEA, Total thickness is around 470 m in the Kentalan No. 2 and 402 m in the Raman No 14 well. Though no ORBITOLINA cf DISCOIDEA has been observed in the deeper parts of the Gercüş No. and Hermiş No. 1 wells it is believed that these wells reached the dolomitic Lower Cretaceous. Unfortunately most of the samples in the deepest part of these wells got lost. The Lower Cretaceous of Derik is only, thin, hardly 50 m, with locally basal conglomerates.

The rest of the section is composed of more or less dolomitized carbonates with ORBITOLINA cf DISCOIDEA near its top. ORBITOLINA cf DISCOIDEA-like fossils have been recorded from the Mesozoic carbonates E of Siirt and of Cizre, so that the presence of Lower Cretaceous seems to be established. Detailed sampling and measuring of type-sections would certainly reveal a well developed Lower Cretaceous there.

The Middle Cretaceous, Turonian and Cenomanian, in the foredeep basin is generally spoken represented by a series of more or less dolomitized carbonate rocks, with subordinate limestones and skeletal limestones. The definition of the Turonian unfortunately is still more or less vague, as only few diagnostic fossils have been found and its boundary with the Senonian is far from sharp. The Turonian is mainly strongly dolomitized and only in a few wells and section did we meet with a 50 m thick intercalation of thin - bedded, fetid smelling, often polybituminous limestones full of Globigerina cretacea and Oligostegina laevigata. These beds are overlain by Senonian with typical fossils and underlain by Cenomanian with typical fossils, so that its Turonian age can be infered. Thickness varies from 170 m in Kentalan No. 2,190 in Raman No. 14,220 in Gercüş No. 1,220 m in Hermiş No. 1 and 160 m at Derik.

The Cenomanian generally shows much less dolomitization than the Turonian and the Lower Cretaceous, and often carries quite a number of skeletal limestone streaks. It are again mainly limestones and more or less dolomitic limestones, at the top characterized by skeletal limestones with PRAEALVEOLINA IBERICA and PRAEALVEOLINA CRETACEA TENUIS. These PRAEALVEOLINAE are very characteristic for the top of the Cenomanian and have been observed in the Kentalan No. 2, Raman No. 14, Gercüş No. 1 and Hermiş No. 1 wells, as wells as in the Cenomanian of Derik. It is very remarkable that the Jurassic, Lower Cretaceous, Cenomanian and Turonian, and as we will see also the Senonian, all start at the bottom with more or less strongly dolomitized carbonates and only towards the top carry a certain number of fossiliferous limestone intercalations.

The series of Mesozoic carbonate cycles ends with the SENONIAN limestones. At the base they are still more or less dolomitized and carry a poor fauna, but dolomitization decreases rapidly and the bulk of the Senonian is formed by organic microbreccia's and skeletal limestones. It is generally difficult to separate the Senonian from the Maestrichtian, but a rapid decrease in the number of ORBITOIDES MEDIA in the lower part of the section would seem to indicate that Senonian is represented. The strongly skeletal upper part is characterized by the presence of ORBITOIDES MEDIA and OMPHALOCYCLUS MACROPORUS, and probably corresponds to the lowermost Maestrichtian, whereas the lower part is characte rized by DICYCLINA SCHLUMBERGERI and DICTYOCONELLA COMPLANATA, and a rapidly decreasing number of Orbitoids, thus representing the Senonian. Passage would seem to be gradual Numerous Rudists and Inoceramus together with Corals and Algae have been recorded from the strongly skeletal upper part of the Senonian and lower part of the Maestrichtian.

With the deposition of the Senonian - Maestrichtian limestones ends the shallow meritic reef - complex facies of the Mesozoic.

Generally without conglomerate or breccia, but occasionally with signs of subaerial erosion, these limestones are overlain by dense very finely detritic marlstones, calcareous shales and occasional argillaceous limestones of a quite different character. Maestrichtian age was established by the occasional rich micro-fossil content: GLOBOTRUNCANA STUARTI? GLOBOTRUNCANA CONICA, GLOBOTRUNCANA ARCA, GLOBIGERINELLA ASPERA, etc, a typical pelagic microfauna. These argillaceous more or less calcareous sediments are widespread in the foredeep basin and constitute the socalled Lower Germav formation. No angular unconformity separates them from the Maestrichtian-Senonian massive limestones, but there is evidence to accept a disconformity. Thickness varies from a few m over certain parts of the Mardin uplift to well over 300 m in the more pentral parts of the basin.

The Paleocene or Upper Germav formation, is generally developed as typical grey colored calcareous shales with marlstone, siltstone and occassional sandstone streaks and it is widespread in the foredeep basin. This well known unit is characterized by its microfauna with GLOBIGERINA PSEUDOBULLOIDES, Globigerina compressa, GLOBOROTALIA ACUTA. It varies from hardly 30 m on certain parts of the Mardin uplift to well over 600 m in the more central parts of the basin. No angular unconformity separates the Paleocene from the Maestrichtian, but the faunal break at the boundary is so sharp that I feel justified to accept a disconformity here. To confirm this conception I can , mention a very finely graind conglomeratic streak which was discvovered at the base of the Paleocene in the Ispandika section and which was composed of reworked Orbitoids, Omphalocyclus, Siderolites from the Maestrichtian, cemented by calcareous shale with Paleocene pelagic foraminifera, whereas the marlstones immediately below this bed contained the characteristic Globotruncana assemblage of the Maestrichtian, thus prooving the existence of pre-Paleocene and post - Maestrichtian erosion.

The last unit considered in my stratigraphie study is the Lower Eocene. This is the most variable unit, probably due to incipient movements of the northern and northeastern basin border. It shows us reddish and greyish colored conglomerater and greyish colored conglomerates and sandstones dominating near the N and NE basin border, passing into red and grey varieco-lored claystone and shale with sandy-silty streaks towards the central part of the trough and passing into light grey colored calcareous shales and marls with subordinated argillaceous limestones towards the SW, whereas the base, especially around and NE of the Mardin uplift is locally developed as reef and reef-complex limestones. The reddish colored part of the Lower Eocene has generally been known under the name of Gercüş ' red beds, whereas the limestones in the lower part have been recorded under the name of Becirman limestone. The light grey colored marly faciès of the Mardin uplift had hitherto not yet been recognized as Lower Eocene. Where skeletal limestones are developed at its base they are characterized by numerous MILIOLIDAE and by the presence of DISCOCYCLINA ARCHIACI, ORBITOLITES cf COMPLANATA, NUMMULITES PARVULUS and LOCKHARTIA CONDITI whereas Arni recorded from the Becirman limestone farther E. NUMMULITES PARTSCHI, N. PRAELUCASI, N. PARVULUS, N. BOLCENSIS and LOCKHARTIA CONDITI. The red claystones are generally very poor in organic remains, though occasionally RADIOLARIA, OSTRACODS and a few GLOBIGERINAE have been recorded. It is only in the Mardin area that a much better developed fauna was discovered in the Lower Eocene marlstones, calcareous shales and argillaceous limestones, with GLOBOROTALIA ARAGONENSIS and GLOBOROTALIA CRASSATA. Thickness varies from O m in the Mazidağı section to over 350-400 m in the central part of the basin. This mainly finely detritic Lower Eocene series is overlain all over the basin by the Massive Middle, Eocene Midyat limestones, which cover a tremendous surface in this area. We have positive evidence that there is a disconformity between the two as we observed very distinct transgression phenomena in the Mardin area and as the passage from pelagic basinal facies to the Middle Eocene reef complex facies is very sharp. As the Midyat limestone is exposed and more or less thoroughly eroded all over the area it covers, complete sections of this formation are very rare and no detailed stratigraphie analysis has yet been made.

After giving this brief summary of the stratigraphy of the pre-Middle Eocene sediments of the foredeep basin, let us consider the sedimentory conditions expressed in these sediments.

It is evident now that in the central part of the foredeep basin of S. E. Turkey, for example in Kentalan over 2600 m of Mesozoic and Lower Tertiary sediments were deposited, while farther to the SE still higher figures can be expected. This basin trough must have been in almost continuous subsidence throughout the entire Mesozoic and Lower Tertiary. The sediments depositied in this trough show evidence of being deposited in several well defined environments.

Information on the Premesozoic sediments of this trough is still to scattered to permit any serious reflections, though it might be that even Devonian participates already in the sedimentory history of this basin. A distinct period of widespread transgression however starts with the Permian, when full marine, mainly shallow neritic conditions prevailed over great surfaces along the N and NE border of the foredeep basin and far beyond the previously folded metamorphic massiv. While the Devonian and eventually Carboniferous might still suggest deposition on a marginal shelf area of the paleozoic geosyncline in the N, with chance that the sediments thin out rapidly towards the S, the Permian shows evidence of participating in the foredeep sedimentation for sure. It is known in the Hacertundağ, along the N basin border, from the area SE of Siirt, reaching thicknesses over 1000 m. Permian shales are known from N Syria to a thickness of 500m. No Permian however was deposited in the Mardin - Derik uplift. So there is evidence of intensive Permian shallow marine neritic sedimentation along the N border and in the SE of the foredeep - basin, whereas a swell divided it in a N and a Strough. So it would seem that from the Permian on the foredeep basin started to take its definite shape with a well pronounced Derik -Mardin swell. Subsidence and rate of sedimentation apparently increased considerably towards the SE in the N trough, Detrital apport was occasional and on a small scale in the N trough, on a larger scale, accounting for the bulk of the section in the N Syrian trough. In the foredeep basin of SE Turkey the Permian is represented by a detrital sandy transgression bed at its base, followed by calcareous, mostly chemical, partly organic sediments, with very little detrital apport, with occasionally a few intercalations of gypsiferous claystone and ferrugeneous sediments. Thius shallow neritic sedimentation, partly calcareous bank depositis with algal biostromes and bioherms, no or very little detrital apport, only occasionally slightly increasing finely detritic apport. If the detrital material has been derived from terrestrial erosion on the Mardin - Derik swell, which would seem very plausible, it might be expected to find some coarser detritics in the Permian sediments thinning out towards the S and S W. Towards the N of Hacertundağ and towards the NE even the strongly folded meta-morphic massiv was covered by a shallow neritic sea causing the deposition of limestones. Through later folding these Permian limestones on the metamorphic massiv have been highly marmorized. The main uplift of the metamorphic massiv came at the end of the Permian, with the Palatinate phase of the Hercynian orogeny. The more or less pronounced emersion of the metamorphic massiv with its cover of Permian carbonates has formed the N border of the foredeep basin.

No angular unconformity would seem to separate the Permian of the foredeep basin from the overlying Triassic, though the sudden change in the sedimentory character would seem to indicate a disconformity.

The Triassic along the N border of the Foredeep basin is only thin and suggests slow subsidence. It starts with shallow neritic marly - sandy calcareous sediments wirth a slight apport of finely detrital material, overlain by shallow neritic partly algal limestones and ending with very finely detrital variecolored shales with sandy streaks, indicating increasing apport of terrestrial material towards the end of the Triassic. It would seem that the argillaceous Upper Triassic of the Raman and Kentlan deep tetsts, already thicker tahn in the Hacertundağ indicates a greater subsi-dence, though especially the Raman Triassic shows evidence of near shore conditions. As a whole it would seem that no extensive area was covered by the Triassic sea in this part of the foredeep basin. The Kentalan and Raman Triassic are still mainly marine, but it may even interfinger with brackish or lagoonal finely detritic sediments as indicated by the frequent occurence of megaspores. This certainly suggests a nearby shore. From the scattered records it is still difficult to form an exact idea of the Triassic more towards the SE. Altinli described Triassic from the area NE of Harbol, where Permian is overlain by 100 m of bedded limestone, followed by 30 m of brownish reddish to purple colored thin bedded shale, ending with 25 m of bedded limestone. This is already much thicker fchan in the Hacertundağ and carbonate neritic sediments play a much larger role, finely detrital sedments only playing a minor rolen the Triassic sedimentation history there. Further N however becomes much more detritic, with the Triassic apparently starting with flysch-like sediments and continuing to be more detrital Further S and SE the Triassic seems to be thickening to 500 m, and starts to be mainly composed of carbonate rocks, though some finely detrital material seems to be present all the time. It would thus seem that subsidence was much greater in the SE part of the foerdeep basin where it passes into Iraq and Iran, than in the NW. I am inclined to believe that the Triassic sea came from the SE with shallow neritic marine carbonate sedimentation, passing towards the N and NW rapidly to mainly finely, occasionally coarser detrital, marine, occasionally brackish and lagoonal sediments. Landmasses furnishing the quite important amount of finer and coarser material will certainly have lain towards the N and NW, but with the Derik-Mardin swell quite well marked by the complete absence of Triassic, another landmass, furnishing detrital material might have lain S of Raman.

The Mardin-Derik uplift certainly devided the foredeep basin into a N and a S trough, as Traissic is known from N Syria, quite similar to that in the Harbol area.

The shallow neritic carbonate sedimentation, mainly of the reef - complex character, which started already in the deepest parts of the Triassic trough E of Harbol, though still with apport of finely detritic material, spreads rapidly over the entire foredeep basin with the beginning of the Jurassic. No angular unconformity between the Jurassic and the Triassic has been observed and continuous sedimentation in the most rapidly subsiding parts of the basin might have occured, but elsewhere evidence indicates that some sort of a disconformity exists, as for example conglomeratic limestones at the base of the Jurassic in the Kilise dağ and the sudden change of finely detrital basinal type sedimentation to very shallow marine reef - complex sedimentation would seem to suggest. As in the Permian and the Triassic again the Derik-Mardin uplift acted as a swell between a N and a S trough of the foredeep basin, and no sediments of Jurassic age were recorded from this swell. Subsidence in the foredeep basin in SE Turkey was continuous, but no great thicknesses of Jurassic sediments were deposided in the W part of it, though greater subsidence seems to have caused a greater thickness of carbonate rocks more towards the SE. Slightly detritic, clearly transgressive near the border the Jurassic rapidly passes into shallow neritic carbonate bank facies, with deposition of chemical backreef sediments, calcium carbonate sands, silts and occasionally muds, locally especially towards the top interfingering with purely skeletal and strongly fossiliferous limestones, marginal bank or forereef shoal deposits. The apport of shaly detrital material or sand is almost negligable, so that erosion of the surrounding landmasses only played a very minor role in contributing to the sedimentory history of the the basin during the Jurassic. A few thin streaks of sandstone in the Raman No. 14 well however might indicate that some apport of sandy material came from Mardin-Derik uplift, as the Kentalan No. 2 well does not show these streaks. This might indicate that S of Raman towards the Mardin-Derik swell a slight increase of sandy and shaly streaks could be expected. More SE in the foredeep trough Jurassic carbonates are thickening considerably. Near the border postdepositional dolomitization of the almost sterile bankreef sediments played only a minor role, whereas more towards the S and SE it becomes a major feature. Almost the totality of the calcium carbonate sands, silts and muds has been replaced by dolomite, apparently immediately after deposition and before complete consolidation and compaction. It is remarkable that the Jurassic reefcomplex carbonate cycle of the foredeep basin distinctly shows an almost sterile bankreef facies in its lower and an interfingering with fossiliferous forereef or marginal bank limestones towards the top, with only near the top the possibility to find really diagnostic fossils. The same cycle is repeated in the Lower Cretaceous, were sterile bankreef dolomites make up the entire lower and middle part of the section and only towards the top a few streams of fossiliferous limestone were observed. Also the Cenomanian, Turonian and Senonian repeate this same pattern, so that I am inclined to believe that small but distinct disconformities separate the Jurassic, Lower Cretaceous, Cenomanian, Turonian and Senonian reef-complex cycles. They probably represent temporary breaks in the sedimentation. This phenomenon has been recorded from all the well - sections, as well as from the fieldsections on the Derik - Mardin uplift.

The widespread bankreef sedimentation, which started with the beginning of the Jurassic, though already indicated in the SE part of the foredeep trough during the Triassic, shows a tremendous development during the following Lower Cretaceous. As already mentioned above, no angular unconformity separates the Lower Cretaceous from the Jurassic. A disconformity however must be accepted, because of the cyclic character of the series. Locolly even the transgressive character has been prooven, as for instance on the Derik - Mardin uplift, where the Lower Cretaceous with a basal conglomerate is overlying unconformibly the the Cambiran - Precambrian basement. It is remarkable that predominant pelagic deposits, possibly refelcting basinal conditions, with continuous apport of finely terrestrial detrital material, in rather reduced thickness, apparently representing the entire Lower Cretaceous, have been deposited in the Kilise - dağ area. These thin basinar pelagic deposits pass basirfward rapidly into an aver 500 m thick series of bankreef sediments, mainly dolomites and calcareous dolomites, replacement products of sediments originally deposited as calcium carbonate sands silts and muds. Only occasionally and then near its top do wo observe streaks of skeletal limestones, often real organic microbreccia's, marking the and of the Lower Cretaceous reefcomplex cycle. This continuously subsiding bankreef complex probably extended far towards the SE, though there is evidence for increasing interfingering with basinal type limestones in that direction. Whether the bankreef sedimention was confined to the certainly already slowly rising anticlines and a basinal equivalent filled the synclinal areas, or whether the bankreef sedimentation was general over the whole basin, cannot be said as all evidence on the situation in the synclinal areas is completely missing.

Without angular unconformity the Lower Cretaceous reef-complex cycle of the foredeep basin is followed by the Cenomanian cycle, starting again with more or less dolomitized bank-reef deposita, sediments originally deposited as chemictral back-reef Calcium carbonate sand, silts and muds, which pass towards the top into streaks of skeletal limestones, often organic microbreccia's of the marginal bank character or forereef deposits, Dolomitization is distinctly less than in previous or following reefcomplex cycles. The Cenomanian has generally the same characteristic all over the basin, in the deep test wells as well as in the Derik section on the Mardin-Derik swell, which distinctly participated in the general susidencen of the foredeep basin and shows thicknesses similar to those in the more central part of the basin. After acting as a swell between a N and a S trough there is all evidence that there was no such a swell from the Cenomanian on. In the known sections thickness does not exceed the 140 m.

Without angular unconformity the Cenomanian reefcomplex cycle is in its turn followed by the Turonian cycle, starting again with more or less but generally strongly dolomitized bankreef deposits, with only towards the top sometimes a few streaks of skeletal limestone. Thicknesse vary from 160 m at Derik to nearly 300 m in the Raman No. 14 well, thus showing a fairly uniform and gradual subsidence. The general sedimentory conditions were thus again similar to those in the Cenomanian and Lower Cretaceous. A remarkable feature however, possible even of importance for the petroleum geology, is the occurence of abaut 50 m of very finely and finely detriticr basinal type, fetid smelling, polybituminous Oligostegina limestones near the top of the Turanian of Raman, Gercüş. Hermiş and Mardin. They would seem to represent typical stagnant bottom conditions and show the characteristics generally accepted for petroleum source beds.

Extension of the Middle Cretaceous reef complex development towards the SE seems to be evident from field - observations, though it would seem from the descriptions by Tolun, Türkünal and Altinli that basinal limestones and calcareous shales are occasionally interfingering with these deposits. Detailed type - sections of the well exposed Mesozoic sequence in the area SE of Siirt are still lacking, but would be quite helpfull for a good understanding of the sedimentory conditions in the foredeep basin. As for the Jurassic and Lower Cretaceous, there is evidently very little apport of detrital material throughout the whole Middle Cretaceous, except for the finely angular calcareous detritus in the basinal Oligostegine limestones of the Turonian.

Without angular unconformity the Turonian reefcomplex eyelet with occasional interfingering basinal deposits near its top, is in its turn overlain by the Senonian-Maestrichtian cycle. It starts again with generally more or less, dolomitized bankreef of backreef deposits, originally deposited as calcium carbonate sands, silts and muds, but these sediments rapidly grade into organic microbreccia's, skeletal limestones, with Rudists, Corals, Algae and a teaming organic life, representing typical reef and fore shoal conditions. These shallow neritic forereef or open reef skeletal limestones, assiciated with the increasing development of real reefs, showing little dolomitization, account for a great part of the Senonian and for the lowermost part of the Maestrichtian. It possibly represents the increasing importance of patchy or massive reef developments on rising blocks or anticlines, Apport of very finely and finely detrital material still is very slight and it is only in the Lower Maestrichtian, with its numerous Orbitoids, that some finely argillaceous material starts to occur in the skeletat forereef breccia's. This starting apport of finely detrital terrestrial material certainly was caused by slowly rising bordelands and announces the sudden transgression of the Maestrichtian marlstone formation, which makes definitely an end to the Mesozoic reefcomplex sequence. There is some evidence that this Germav transgression started earlier in the Upper Cretaceous farther to the SE, but exact data are still lacking. There is even evidence that the flooding of argillaceous finely detritics started earlier in the synclinal area's, whereas reef-sedimentation continued on the anticlines. Locally also brecciated or conglomeratic beds at the top of the Reefcopmlex series indicate the transgfessive character of the Lower Maestrichtian Germav transgression. Locally on the crests of the rising anticlines there my have been some short emersion, but generally subaerial erosion did not play any role of importance, though a break in the sedimentation might have occureä over large areas. Thickness of the Senonian-Lower

Maestrichtian reef complex varies from 90 m on the Derik-Mardin uplift to over 200 m in the more central parts of the basin.

With the Lower Maestrichtian "Germav" transgression starts a long period of subsidence for the foredeep basin in SE Turkey together with a deepening of the seabottom. The increase of detrital material, already observed in the upper part of the reefcomplex limestones of the Lower Maestrichtian is more or less gradual. At first marlstones and argillaceous very finely detritic limestones were deposited, later grading intomarlstones with calcareous shales. The fauna of these finely detritic argillaceous and calcareous sediments indicate deep neritic, basinal types of sedimentation, generally with a well developed plancton, but occasionally with almost total absence of benthos, showing the existence of stagnant bottoms, locally silled basins, with euxinic bottom conditions. Evidence on the Mardin-Derik uplift would seem to indicate that movements started here in the Maestrichtlian, so that only a very thin cover of Maestrichtian basinal sediments was deposited here. Thickness increases rapidly towards the NE fromMardin and towards the central part of the basin, reaching far over 300 m E of Siirt. We thus witness a sudden deepening of the sea, together with continuing subsidence. N of Hacertundag along the border of the metamorphic massiv the Maestrichtian is represented by a special facies, resulting from the incipient movements of the massiv. It are neritic to deep neritic red and brownish colored marly limestones, with a considerable amount of detrital limonite and argillaceous material. They are deposited on peneplenized metamorphic and Permian rocks of the massiv. This is a typical neritic to deep neritic, basinal, border facies. There is an overall increase of coarseness in the argillaceous basinal sediments towards the top of the Maestrichtian, indicating a further uplift of the borderland. Simalr sedimentory conditions as described here for the area W of Siirt, must have existed farther towards the SE though there is clear evidence that detrital apport there is even more important and that even flysch like'series were deposited. The available sections in that area have however not yet been detailed. Thicknesses would certainly seem to increase considerably towards the SE. With its very thin cover of Maestrichtian basinal the Mardin uplift must again have acted as a swell, though probably mainly submarine.

As already mentioned above, the sharp faunal break at the Cretaceous-Tertiary boundary, with continuing basinal sedimentation, forces us to accept a disconformity between the Maestrichtian and the Paleocene. Additional evidence was found in the Ispandika section where a fine basal conglomerate was discovered separating the Maestrichtian basinal series from the Paleoceen basinal series. It would thus seem that this disconformity causes the apparent absence of Danian in the examined sections throughout the basin, though we should realize that all our evidence is from anticlinal areas and that it is a priori not excluded that there was continuity in the synclinalareas.

During the Paleocene the foredeep basin continues its subsidence, receiving mostly finely to very finely silty-argillaceous detritic material from the N and NE, however with a gradually increasing amount of medium to coarsely grained detritic material. It are typical deep neritic, basinal, silty-shaly sediments with silty sandy streaks, near the N and NE border often even passing into a typical flysch facies. The fauna is often mainly pelagic, indicating the existence of euxinic bottom conditions. The calcium carbonate content is on the average much lower than in the shaly Maestrichtian beds. Over 600 m of these Paleocene basinal sediments kaye been deposited in the central parts of the basin of Siirt, apparently even showing greater thicknesses towards the E and SE. The Mardin uplift shows this formation reduced to hardly 100 m or less, thus showing a rapid decrease in the subsidence of the foredeep basin SW of Gercüş.

The increasing amount of coarser detrial material in the argillaceous, finely detrital basinal Paleocene, suggested already increasing of the upward movement in the metamorphic massiv towards the N and resulting in a more widespread erosion. This tendency kept on increasing in the Lower Eocene, where large parts of the subsiding basin were rapidly filled with reddish colored shales, silts and sandstones, along the border grading into conglomerates. There certainly is a disconformity separating the Lower Eocene and the Paleocene with supporting evidence on the Mardin uplift and in many other places in the basin, though in the deepest part of the basin continuity of sedimentation is not to be excluded. There is very clear evidence that the red colored detritic came from the N and NE as the Lower Eocene on the Mardin uplift shows an entirely different development. It starts there with a thin streak of shallow neritic occasionally biostromal limestone passing rapidly into marly and shaly, occasionally even argillaceous calcareous, generally grey colored basinal deposits of a typical deep neritic character, occasionally even showing the existence of euxinic bottom conditions. Towards the NE near Savur these grey basinal deposits start interfingering with the red colored detritic series. Thicknesses are slightly over 100 m on the Mardin uplift near Mardin, disappearing completely, possible due to the Middle Eocene transgression, in the direction of Mazidaği. Greatest thickness is reached more towards the N border of the basin, where thicknesses over 500 m have been recorded, whereas thinning is very rapid N of Hazru, Siirt and Şirnak. Towards the S and SE, away from the N border the red detrital sediments of the Lower Eocene are interfingering with, especially in its lower part, with pinkish to greyish colored shallow neritic limestones, partly decidedly showing a bankreef-complex character. S of Siirt and W of Gercüş up to 30 % and more of the Lower Eocene section can be made up by these reefcomplex sediments. The marine character even of the marginal conglomerates is emphasized by the presence of Nummulites in the cement. These conglomerates thus probably represent submarine deltafans, whereas the thick shaly series in the central part of the basin shows evidence of being deposited on shallow mud flats, with occasionally a teeming lif of Ostracoda and Radiolaria, whereas elsewhere silled off lagoons or basins provided the environment for the gypsiferous streaks occuring locally in this formation. Its is only at the beginning of the Lower Eocene in the S that shallow fullmarma conditions were reached, as demonstrated by the Lo-wer Eocene reef-complex, whereas only towards the SW, in the Mardin- Savur area full marine, deep neritic conditions prevailed. Thus rapid subsiding along the N border and in the central part of the basin, with formations of submarine delta-fans and extensive mud flats, reef- shoaling in the lower part of the Lower Eocene in the S part of the basin trough and slow subsidence with formation of basinal, deepneritic sediments on the Mardin uplift. The basinal deposits of the Mardin area would seem to correspond with similar deposits in N. Syria.

This clastic phase in the sedimentory history of the foredeep basin, resulting from the increased movements of the bordering massiv, is followed by a much quieter phase.

The Middle Eocene sea transgressed far over the peneplenized metamorphic massiv and established a very quiet marine environment over very wide areas. No. detritic apport of any importance has been recorded during the Middle Eocene. It is represented by a great thickness of shallow neritic limestones, which show evidence of being deposited mainly on large bankreefs, with partly chemical backreef, partly forereef and open reef shoal conditions. No detailed study has yet been made of the sedimentory conditions represented, so that it cannot be said if basinal limestones or chalks are interfingering with these reefcomplex limestones, though some evidence would seem to be contained in the literature. The transgressive character is evident on the metamorphic massiv and in the Mardin area and a disconformity se-parating the Lower Eocene from the Middle Eocene must be assumed.

The Importance of an accurate picture of the sedimentory history of this foredeep basin connot be too mcuh emphasized, as it is one of Turkey's most promising petroleum provinces. The presence of commercial oil has been prooven on two structures, where oil is produced from the skeletal limestones of the Senonian-Lower Maestriçhtian reef-complex, It is not yet clear zed calcium carbonate sands, silts and muds can ever constitute a good primary reservoir rock. There certainly was originally a good porosity in the calcium carbonate sands and silts, permitting the postdepositional circulation of magnesium rich waters, but just this subsequent dolomitization, showing all evidence of having taken place immediately after deposition, before complete consolidation and compaction of the rocks, when free circulation of magnesium rich waters saill was possible, would seem to result in rather tight dolomitic rocks with very litle primary porosity and permeability. As a matter of fact fracturing can have resulted in secondary porosity and permeability, whereas eventual exposure of these dolomites to subaerial wheathering during emersion, might account for secondary porosity. Good primary porosity and permeability would seem to be represented mainly in the ill sorted fossil microbreccia's of the real reef and forereef shoals, such as is the case in Raman and Garzan. What the source of this Raman and Garzan oil actually is, but there is evidence in the Raman No. 14 well that the polybituminous Oligostegina basinal limestones of the Upper Turonian, representing apparently euxynic bottom conditions, might have constituted a source rock for the Raman oil.

These polybituminous limestones have appanently the cha-racteristics generally accepted for source beds. It is however quite well possible that basinal euxynic type of deposits in the synclinal areas, deposited during the Senonian and Lower Maest richtian, acted as source rocks for the Raman and Garzan oil, but as already mentioned above, all information on the situation in these synclinal areas is lacking. A further possibility is the migration of oil generated in the basinal Maestrichtian deposits, over lying the reef-complex. In any case am I convinced that this oil accumulation did come from a contemporeneous or penecontemporarieous source or from an overlapping source.

Nevertheless the entire Mesozoic reef complex series, as we have seen composed of various cycles, show continuously some small traces of oil and asphalt, also in wells, where no polybituminous Oligostegina limestones have been observed, so that it would seem that some oil was generated occasionally in the calcareous bank deposits, making up the bulk of the section, unless they were generated in basinal euxinic deposits in the synclines. There seems to be little hope that the massive series of dolomiti.

Though the hitherto drilled test wells did not reveal the presence of important thicknesses of porous skeletal limestones lower in the Mesozoic section, and these limestones are typically concentrated in the upper part of the formations, it would seem that elsewhere in the basin Middle Cretaceous, Lower Cretaceous and Jurassic forereef or reef deposits can be encountered, which have sufficient thiskness and primary porosity to constitute a reasonable reservoir rock. If really basinal limestones or chalks should be the main source of the oil in the carbonate section of the foredeep basin, as has been put forward by HENSON, there is plenty of chance that basinal deposits elsewhere in the basin throughout the Mesozoic section, can locally account for concentration of petroleum. A carefull study of all available fieldsections in the Mesozoic formations of SE Turkey would therefore seem of the utmost importance and urgency, as every detailed mapping of lithofacies can be a clue to other petroleum occurencies in the foredeep basin. The Ain Zalah oil in N. Iraq, coming partly from highly fractured, extremely tight marly limestones and marls of basinal type, this type of petroleum accumulation might a priori not be excluded in SE Turkey.

The occurence of very thin sandy streaks in the Lower Cretaceous and the Jurassic of Raman No. 14, typically quarzose sands with calcite cement, togehher with the emersion of the Mardin-Derik uplift during the Jurassic, suggests that this uplift might have been the source of detrital material during the Jurassic, so that thicker sandstone beds might be found in the Jurrassic in approaching the Mardin-Derik uplift, S of Raman. With the oil shows observed in the Jurassic of Kentalan, it would seem not excluded that locally such sandstones even in stratig-raphie traps, might act as good reservoir rocks. As no Jurassic is exposed on the surface in this area, only drilling can proove this theory.

The great thickness of Maestrichtian and Paleocene finely detritic sediments, reflecting basinal, locally possible euxinic environmental conditions, do not a priori give the impression of a very favorable source rock, but too little is yet known about the regional sedimentory character of these rocks and a detailed regional sedimentory study of the Germav formation seems also to be indicated, especially as oil and asphalt traces have been recorded from them, at several localities.

The stratigraphie sedimentory pattern of the pre Middle Eocene sediments of foredeep basin of SE Turkey, drawn in the previous pages can only be considered as preliminary, as our control points are still too scattered over the area and to little detailed data are available especially along the N border of the basin and in the part of the basin situated E and SE of Siirt. The recent papers by Tolun, Altinli and Türkünal undoubtedly give many indications where to sample and measure comprehensive sections, and at the hand of their maps it will be possible to choose a number of very usefull typesections.

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