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THE ISOPACHYTE MAP OF THE OLIGOCENE OF NORTH HUNGARY

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INTRODUCTION

The Hungarian occurrences of the Oligocene are confined to three geological units: *1.* the Paleogene Basin of North Hungary—South Slovakia; *2.* the Karád—Buzsák Region; *3.* the so-called "Great Plain Flysch Belt" *(Fig. 1)*. The last-mentioned two have been explored only by wildcatting and are not yet known satisfactorily. Therefore only the North Hungarian Oligocene is discussed here.

The North Hungarian Paleogene has been the subject of detailed geological—paleontological investigations for a century. Such an interest was initially stimulated mainly by the presence of Eocene, Lower and Upper Oligocene brown coal deposits

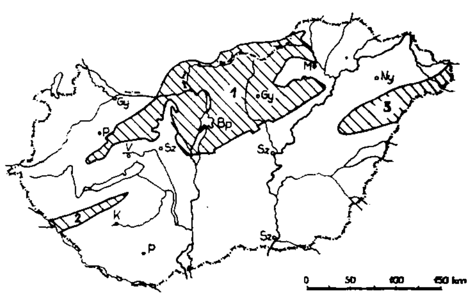

Fig. 1. The occurrences of the Oligocene sediments in North Hungary. *1.* The North Hungarian — South Slovakian Paleogene Basin. *2.* The Karád—Buzsák Region. *3.* The so called Great Plain Flysch Belt.

and since the 1930's by the prospective exploitation of oil and gas fields supposed and then really discovered in the Middle Oligocene of the eastern basin portions. Because of the block-faulted tectonics; the close similarity between the Upper Oligocene and Lower Miocene lithofacies; the extreme disproportions in the distribution of entirely core-drilled boreholes and the slow progress observable throughout Europe in the improvement of stratigraphical-paleontological methods, it was not until now that the geologists have arrived at gaining a clear knowledge of the virtual stratigraphic range of the Paleogene units under consideration. However, the road leading to this knowledge has been paved by the continually reviving "boundary discussions" aimed at both defining the Eocene—Oligocene and Oligocene—Miocene boundaries and correlating the Eocene subbasin fillings.

Out of the problems arisen in this connection it is the Chattian—Aquitanian problem that seems to be most significant owing to the great thickness of the sequences involved. As a result of coordinated efforts of Hungarian, Slovak and Austrian specialists [I. Csepreghy-Meznerics, T. Báldi, J. Seneš, M. Vaňová, A. Papp] the Conference on neogene stratigraphy, Budapest 1969, provided evidence confirming the following conclusions [T. Báldi, 1969, T. Báldi, Gy. Radócz, 1969]:

— the deposition of the undoubtedly Middle Oligocene ("Rupelian") *Kiscell Clay* ("Kiscellian") and the beginning of the Miocene are separated just by one depositional unit;

— this unit is the "*Eger Formation*" ("Egerian") corresponding to the Upper Oligocene ("Chattian") and recommendable as its stratotype for the central Paratethys;

— synchronous with the Eger Formation, but of different facies, are the "*Törökbálint*" ("Kováčov"), "*Mány*" and "*Mór*" *Formations;*

— the sediments which overlie the Upper Oligocene thus determined and which used to be named "Chattian—Aquitanian", already belong to the Lower Miocene;

— the "Chattian—Aquitanian" formations under consideration, united under name of "*Salgótarján Formation*" by T. Báldi and comprising the intertonguing "*Amussium Schlier*" and "*Glauconitic Sandstone*" sequences, form a depositional unit closely linked with the "*Budafok Formation with Anomia and larger Pectinids*" dated as Burdigalian already earlier and are to be referred to the newly established *Eggenburgian* (= Aquitanian + Burdigalian) *Stage;*

— the establishing of the Eggenburgian is justified not only by the fossil content of the strata belonging to it, but by the intensive post-Oligocene to pre-Miocene erosion as well.

The establishment of the Eggenburgian has led in Hungary to the logical solution of two problems:

(1) It has eliminated the controversy between the Hungarian (*i.e.* Upper Oligocene) and Slovak (*i. e.* Lower Miocene) interpretations of the "Chattian—Aquitanian" beds [*cf.* K. Balogh et al. 1966. p. 26].

(2) It helped "find the coat that goes to the button to be sewed on": in other words, instead of knowning just the comparatively thin, *littoral* "Budafok Formation", now geologists have managed to recognize the respective *pelagic*, sublittoral sediments — the Amussium Schlier and the Glauconitic Sandstone.

CONSTRUCTIONAL PRINCIPLES

Most important of the above conclusions is for us to know that, as a result of the heavy denudation due to the Sava movements, the "Salgótarján Formation" lies for the most part immediately on the Rupelian "Kiscell Clay" or yet older formations [see *Fig. 2* in T. Báldi, 1969] rather than on the Upper Oligocene ("Egerian"). Between Šahy (Czechoslovakia), Balassagyarmat (Hungary) and Lučenec (Czechoslovakia) the basal members of the "Salgótarján Fomation" rest really on the crystalline schists of the Veporides; between Rimavská Sobota and Bretka (Czechoslovakia) and even at Alsószuha (Hungary) they lie on the Trias of the Southern Gemerides, while at Bušince (Czechoslovakia) they rest surely on the Kiscell Clay *(Fig. 2)*. The "Salgótarján Formation" is limited to the Cserhát, the northern foreland of the

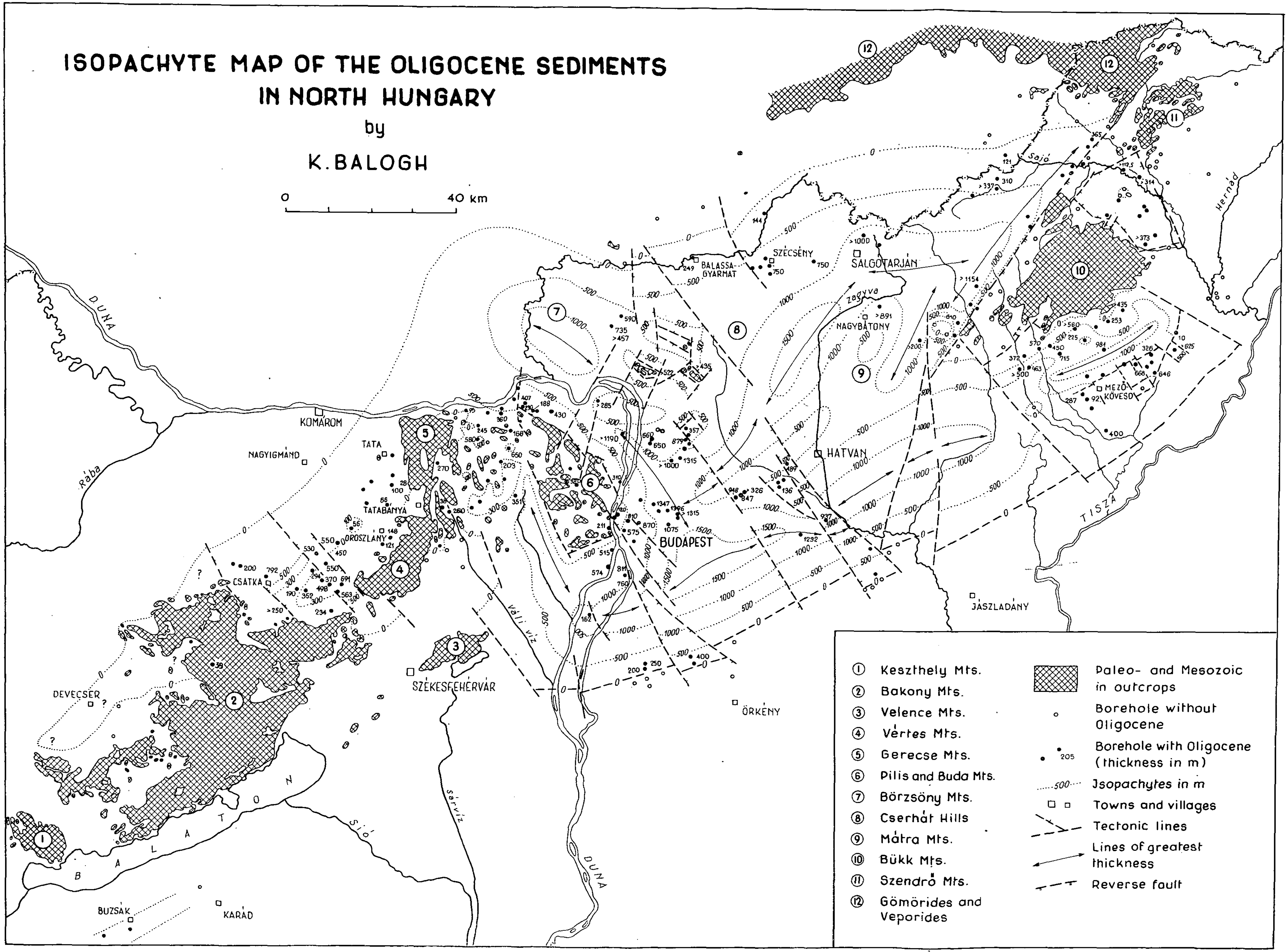
ISOPACHYTE MAP OF THE OLIGOCENE SEDIMENTS IN NORTH HUNGARY
by
K. BALOGH
0 40 km
① Keszthely Mts.
② Bakony Mts.
③ Velence Mts.
④ Vértes Mts.
⑤ Gerecse Mts.
⑥ Pilis and Buda Mts.
⑦ Börzsöny Mts.
⑧ Cserhát Hills
⑨ Mátra Mts.
⑩ Bükk Mts.
⑪ Szendrő Mts.
⑫ Gömörides and Veporides
Paleo- and Mesozoic in outcrops
Borehole without Oligocene
Borehole with Oligocene (thickness in m)
Isopachytes in m
Towns and villages
Tectonic lines
Lines of greatest thickness
Reverse fault
DUNA
Rába
KOMÁROM
NAGYIGMÁND
TATA
TATABÁNYA
OROSZLÁNY
CSATKA
DEVECSER
SZÉKESFEHÉRVÁR
BALATON
Sió
Sárviz
Váli víz
BUZSÁK
KARÁD
BUDAPEST
ÖRKÉNY
JÁSZLADÁNY
HATVAN
NAGYBÁTONY
SALGÓTARJÁN
SZÉCSÉNY
BALASSAGYARMAT
Zagyva
MEZŐKÖVESD
TISZA
Sajó
Hernád

Fig. 3

Mátra and a part of the Borsod Basin. Accordingly, on the basis of the above, its sequence attaining even 800 m in thickness can be simply “peeled off” (with relatively little error) the Oligocene profiles, explored as they are *thus far* by drilling at Somoskőújfalu, Szécsény, Balassagyarmat, Sóshartyán, Nagybátony, Fedémes,

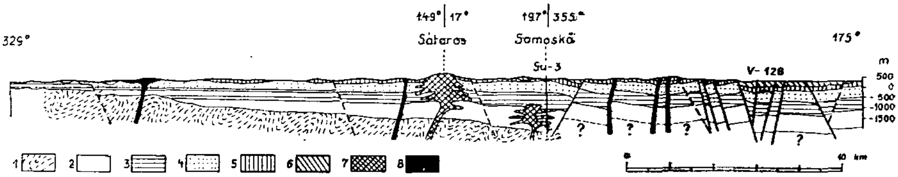

Fig. 2. The Rupelian transgression towards North. *1.* Paleozoic crystalline schists. *2.* Kiscell Clay (Rupelian). *3.* Amussium Schlier of the Salgótarján Formation. *4.* Glauconitic Sandstone of the Salgótartján Formation. *5.* Sandstone with Anomia and larger Pectinids. (*3—5.* Eggenburgian.) *6.* Coal-bearing beds of the Helvetian. *7.* Amphibole andesite subvolcanoes (Tortonian). *8.* Latest Pliocene basalte.

Ózd and Susa. Since there are no strata of such a controversial position anywhere else, a reduction like this need not be done for the lithological logs of boreholes drilled in other parts of the Oligocene basin. The cartographic representation of the total thicknesses, corrected or without correction, will then yield such a smallscale isopach map which provides a rather real portrayal of the contemporary vertical and lateral dimensions of the North-Hungarian—South Slovak Oligocene sequences — a general review consistent with the current stratigraphic conception *(Fig. 3)*.

The mapped contours of the extension of the Oligocene, supposed or observed, have been controlled naturally by post-Oligocene tectonics and denudation. Hence they can be identified with the contemporaneous basin margins just in a few places. Particularly striking is the effect of post-Oligocene denudation on the NE and S borders of the Oligocene belt. Presently, this is the principal drawback to reconstructing the connections that existed between this belt and the other parts of the Paratethys.

Because of the uneven distribution of drilling data the thicknesses have had to be determined in many places by extrapolations relying upon the trends of increase or decrease, shown by the thickness of the sequence in the surroundings, as well as upon the general *gravitational* or *seismic* pattern of the region. Most of the hypothetical thickness data thus obtained coincide, of course, with the areas of greatest potential thicknesses. Nevertheless, on account of post-Oligocene tectonics and denudation as factors controlling the extension of the formation the areas of maximum thicknesses do not in all of the cases represent those basin portions which subsided at the highest rate. However, it can also be supposed that later tectonics happened to rejüvenate along “synsedimentary” foult-lines responsible for the most intensive subsidences. This is the reason why the authors has sought to adjust the strikes of the greatest thicknesses to the trends of tectonic lines borrowed from the general geologic maps of Hungary [K. Balogh, L. Kőrössy, 1966.] The rightness of this approach is proved by several examples substantiated by drilling logs:

(a) The greater thickness of the Oligocene beds of the Maklár Graben running on the S side of the Bükk Mountains, as compared to the figures observed in the vicinity. for instance, seems to be due to the pre-Miocene origin of the Graben.

Hence the unusually great thickness even of the Lower Miocene terrestrial sediments accumulated in this base level zone *(Fig. 4)*. On the other hand, on account of the deeper morphological position the Oligocene beds themselves have been preserved as shown by their profile which is more complete than to the N and S of the Graben.

(b) On the W border of the Bükk and Uppony Mountains the so-called Darnó Reverse Fault, accompanied in the west by a SSW—NNE trending gravimetric minimum, can be traced to run up to the Rudabánya Mountains. The minimum is seemingly due to local thickening of the Oligocene and Lower Miocene formations here, for on the E side of the Darnó Line the Oligocene is totally absent, the Lower Miocene being very limited in thickness. The situation is complicated by that the Darnó movement appears to have taken place on the very boundary between the rapidly — and slowly — subsiding parts of the Oligocene (and Lower Miocene) basin. Consequently, the thickening of the Oligocene here may also be indicative of a more rapid subsidence of the original sedimentary belt and of the rejuvenation of synsedimentary tectonics. Whichever be the case, the connection of the thickening of the sequence with the present-day pattern of the Darnó Reverse Fault is obvious.

(c) The thickness-controlling role of the tectonic lines is also evidenced by the comparatively dense drilling data of the piedmont basin portions of the Transdanubian Central Mountains.

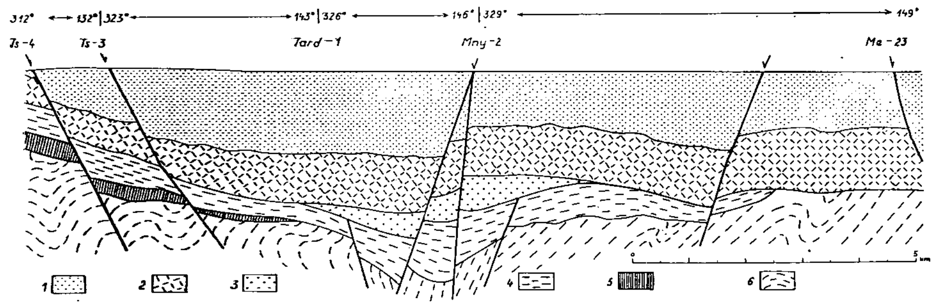

Fig. 4. Profile of the Maklár Graben. *1.* Pliocene. *2.* Miocene eruptive tuffs. *3.* Lower Miocene terrestrica. *4.* Oligocene. *5.* Eocene. *6.* Triassic.

In general, it can be observed that the major Mesozoic blocks are surrounded — after transitional zones of varying width — by zones of marked basement deepening showing greater, though varying, thicknesses of sediment. The opposite flank of these zones of subsidence is indicated by greater elevations of the basement and, correspondingly, by smaller total thicknesses of the Oligocene. On our map *(Fig. 3)* this observation has been extrapolated to the zones along the SE, N, NW and W borders of the North Hungarian Paleogene belt, so to the areas of Tököl and Kerecsend; Cinkota, Salgótarján and Fedémes; the central Börzsöny Mountains, and the Mány Basin, too. On the contrary, smaller thicknesses of sediment are shown to occur in the region of Tököl, Őrszentmiklós, Gödöllő—Tura (*observed* data) and beneath the Mátra Mountains (*extrapolated* data).

The present map will only become paleogeographically interpretable, when beside the isopach lines the geographic boundaries of the principal (marine, brackish and terrestrial) facies traversed by these lines are also indicated. Geohistorically, the main point is to know the relation of the Oligocene beds to the earlier members of the Paleogene. In this connection the following can be said.

The North Hungarian Paleogene includes two distinct subdivisions:

i. The lower member of maximum 350 to 400 m thickness, which ranges from the Sparnacian up to the uppermost Eocene, begins with terrestrial, fresh and brackish water deposits including brown-coal seams. These grade into a marine, warm-water limestone and marl sequence characterized by *Nummulitids* and *Discocyclines* suggesting Alpine and North Italian connections. This transgression must have been interrupted several times by ephemeral oscillations (as evidenced by further coal-seams). However, this has caused little change, if any, in the *predominantly calcareous type* of the sediments accumulated. Accordingly, the Paleocene-Eocene sequence, which is considered, with some simplification, to have the Bryozoan and the Buda Marls as its final member, is a very, for the most part calcareous, formation.* The inherent transgression progressed on the NW and SE sides of the Transdanubian Central Mountains in SW—NE direction, overriding, with angular unconformity, various Palaeo—Mesozoic horizons. It was not until the Middle Eocene that it reached the areas of the contemporary Danube Bend. The Bükk and the Rudabánya Mountains' territory was reached by it as late as the Upper Eocene. As for its basin, merely the W part of it is known with satisfactory precision. The line of maximum depth seems to have extended on the N side of the Transdanubian Central Mountains, letting coal-accumulating bays intrude into the depressions of varying size and kinetic machanism of the Central Mountains.

ii. A totally different pattern is exhibited by the *higher member* (spanning the entire Oligocene) of the North Hungarian Paleogene. Beside being 3 to 4 times as thick as the former, it is entirely *clastic* (conglomerates, sandstones, sands, sandy and clayey siltstones, and clays). Layers exceeding clay-marls in $CaCO_3$ content are very rare. However, interbedded andesite tuffs occur frequently. Most conspicuous of the changes in the fauna is the total decline of *Nummulites*. New paleogeographic connections were brought about, as evidenced by the admixture of boreal forms to the Mediterranean faunal elements.

In these changes the Latest Eocene emergence of the Transdanubian Central Mountains played a considerable role. Although in the NE part (region of Tokod and Esztergom, Pilis and W half of the Buda Mountains) of the Central Mountains this movement was of short duration, the depressions which had been carved out by erosion were covered by a variety of terrestrial sediments. However, the basin portions at Héreg, Gyermely, Szomor, Mány and Zsámbék and the territory of the basins between the Bakony, Vértes and Gerecse remained emergent till Late Oligocene time, the Bakony territory was dry land during the whole Oligocene. The emergence largely reduced the connections with the SW which had existed here throughout the Eocene epoch. Accordingly, the only marine connection that may be supposed to have existed in the afore-mentioned direction seems to have been to the S of Lake

* Newest references to the problem of the Eocene-Oligocene boundary are: M. BÁLDI BEKE, 1970, E. DUDICH, JR.—L. GIDAY, 1969, Á. JÁMBOR et al., 1966, G. KOPEK, 1969, A. ONDREJIČKOVÁ—J. SENEŠ, 1965, J. SENEŠ, 1964, E. SZŐTS, 1961, 1968.

Balaton, as suggested by the Lower and Middle Eocene deposits uncovered by drilling at Karád and Buzsák.

So the wide and long sea branch which had crossed Hungary in Late Eocene time, shrank into an ill-aërated brackish-water inland sea by the beginning of the Oligocene: a sea basin which did not grow wider until the advent of Middle and Late Oligocene transgression which progressed partly westwards and partly northwards *(Fig. 5)*. Geohistorically, the resulting North Hungarian Paleogene basin can be

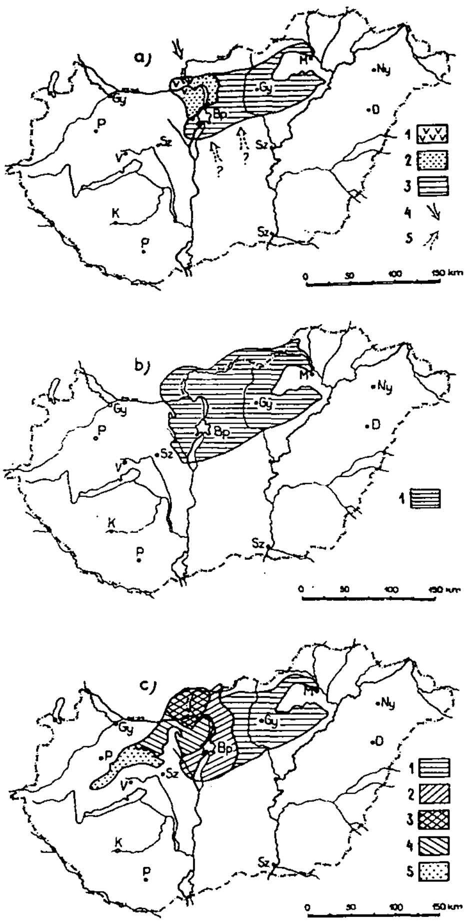

Fig. 5. Paleogeographical sketches of North Hungary in the Lower *(a)*, Middle *(b)* and Upper Oligocene *(c)*.

a) *1.* "Hárshegy Sandstone" in fluviolimnic facies, covered with brackish "Lower Cyrena Beds". *2.* "Hárshegy Sandstone" with marine intercalations, without Cyrena beds. *3.* The euxine "Tard Clay" facies. *4.* River-course. *5.* Assumed river-course.

b) *1.* Pelagic "Kiscell Clay".

c) *1.* "Eger Formation" (deep-littoral to littoral—lagoonal beds). *2.* "Törökbálint Formation" (Schlier to shallow-sublittoral Pectunculus-sands). *3.* "Esztergom Formation" (regressive, then marine beds, covered with alternation of Pectunculus- and Cyrena-beds. *4.* "Mány Formation" (predominante Cyrena-beds, poorly intercalated with Pectunculus-beds. *5.* "Mór Formation" (deltaic facies, in W more terrestrical).

divided into the following four main subdivisions progressing from the NE to the SW (*Fig. 6*).

(a) The eastern main basin now traceable (because of later denudation) from the SE part of the Buda Mountains only to the Bódva—Sajó line. Its depression is filled up by a complete Oligocene sequence joining the Upper Eocene *without any break in sedimentation (Fig. 6: a).*

b) The Danube Bend part of the Hungarian—North Slovak area, where the complete Oligocene sequence beginning with deltaic sediments is separated from the Eocene by a *short hiatus (Fig. 6: b).*

c) The basin portions lying on the E and W sides of the Gerecse and extending from there up to the NE border of the Bakony Mesozoic — areas that were reached only by the *Upper Oligocene transgression* decayed towards W *(Fig. 6: c).*

d) The Bakony Mountains and their immediate foreland characterized by purely terrestrial sedimentation *(Fig. 6: d).*

Ad a) The Oligocene sequence of the eastern main basin represents essentially one cycle of sedimentation.

The *lowermost member* is constituted by 40—80—130 m of *Tard Clay-Marl* — a formation abunding in bacteriopyrite, bitumen, and plant and fish remains referring to Euxine conditons. Despite the continuity of sedimetation, it shows definitely regressive features as compared to the final Eocene beds rich in Foraminifera and

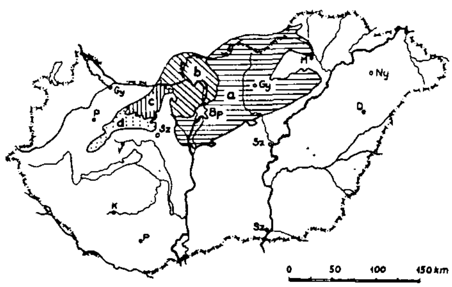

Fig. 6. Subdivision of the North Hungarian Oligocene Basin. *a)* The Eastern Main Basin. *b)* The NW margine of the Eastern Main Basin. *c)* The western regions submerged only in the Upper Oligocene. *d)* The foreland of the Bakony Mountains with terrestrical sediments.

other marine fossils. This observation is corroborated by its alternation with sandstones and andesite tuffs and laminae resembling menilitic shales; by the lack of Foraminifera in it and by the limitation of its *Mollusc* fauna to a few brackish-water species *(Cardium lipoldi* ROLLE*).*

The *transgressive branch of the cycle* is represented by the 400- to 1100-m-thick sequence of the *Kiscell Clay* developing gradually from the Tard Clay-Marl. In its fauna — beside thin-shelled *Bivalves* and *Gastropods* and mud-eating sea urchins — the representatives of *Foraminifera* are predominant. On the basis of the last-mentioned fossils the formation can be split up into a number of local horizons, for the most part of local significance. *Clavulinoides szabói* (HANTKEN), the index-fossil of the formation, is present in all of the horizons.

Although interbedded sandstones of varying thickness and grain size increasing towards the basin margins and andesite tuff layers are not absent in the Kiscell Clay either, this formation is considered on the whole to have been deposited in a pelagic, neritic to bathyal environment. In accordance with its transgressive character, the clay is of larger extension as compared to the Tard beds underneath. Its northward expansion is clearly observable in the vicinity of Szécsény, Balassagyarmat (Hungary) and Bušince (South Slovakia). In the last two localities its strata correlated with the higher levels of the Kiscell Clay rest, with their 40 to 50 m of basal sands and gravels, directly on the crystalline schists of Vepor type [V. HOMOLA, 1958, K. SLAVÍKOVÁ, 1958, K. BALOGH *et al.*, 1966]. It is, however, a debatable point whether this unfossiliferous, gravelly, basal formation may replace *only* the deeper part of the Kiscell Clay, or it may correspond to both the Kiscell Clay and the Tard Clay-Marl combined? The superposition of the Kiscell Clay to the crystalline basement is nevertheless a clear testimony to transgression *(Fig. 2)*.

The *regressive branch of the cycle* is represented by the Upper Oligocene sequence becoming upwards gradually sandier. Its 180-m-thick profile uncovered in WIND's clay pit at Eger and in its footwall (by drilling), contains the richest Upper Oligocene fauna of the Central Paratethys. On account of its having been exhaustively studied [T. BÁLDI, 1966] the Eger Formation has become the stratotype of the central Paratethyan Upper Oligocene, despite the fact that pre-Miocene denudation had removed about 50 m of sediment with similar fauna from the top of the Eger type-section, as suggested by a comparison with other profiles. Above the Upper Oligocene glauconitic-tuffitic sandstone sequence, developing gradually from the Kiscell Clay, the formation comprises deep-littoral molluscan clays (bottom) and an alternation of shallow-littoral sands and clays (top). The sequence ends with littoral-lagoonal gravels and coarse-grained sands including layers with *Cyrena, Mytilus, Cerithium* and *fossil plant remains*. Consequently, regression is paleontologically proven, too.

As for the western margin of the main basin (SE half of the Buda Mountains, Pest Plain), its geohistorical evolution differs from the above only by that the Upper Oligocene sequence is of „Törökbálint" (or „Kováčov") — but not of "Eger"—type. Accordingly, the Lower Oligocene, lying above the "Buda Marl" which on the basis of *Nannoconus* [M. BÁLDI-BEKE, 1970] can still be referred to the Upper Oligocene, is represented here too by a typical "Tard Clay", and the Middle Ogilocene is by a typical "Kiscell Clay". The Upper Oligocene regression, however, is here less acute than it is in the east, for it has come only to the sedimentation of *shallow-sublittoral* beds ["Pectunculus" or, more properly, "Glycymeris Sands"], wich overly — at Kováčov (Czechoslovakia) immediately, at Törökbálint (Hungary) through the interposition of a schlier facies — the pelagical "Kiscell Clay" ("Kováčov Formation" or "Törökbálint Formation", respectively, T. BÁLDI, 1969).

The most marine sequence of the Oligocene thus occurs on the eastern slope of the Buda Mountains. This fact is particularly conspicuous, since the marine sedimentation observable in the east grades into purely continental one in the west. Let us review the various stages of this development in the following.

Ad b) To the west, first of all a transitional zone is found, which can be delineated by the Nyergesújfalu—Tát—Nagysáp—Dág—Biatorbágy line and includes the region of Dorog, Esztergom, Šturovo and Kovačov as well as the Triassic blocks on the Hungarian side of the Danube — the Pilis and the western part of the Buda Mountains. This belt is always devoid of the two final members of the Upper Eocene: the Bryozoan and Buda Marls. The more so, the Oligocene rests directly on the Trias in many places: a manifestation of the higher intensity of "infra-Oligocene denudation". Its sequence begins with an average of 50 to 80 m of coarse-detrital "Hárshegy Sandstone" which was observed in several places intertonguing with the "Tard Clay" of the eastern basin.

In the vicinity of Dorog, Esztergom and Šturovo the Hárshegy sandstone is comparatively thin (a max. of 20 to 25 m, if present at all) and of definitively continental (fluviolimnic) origin. They are overlain here by 50 m of what is called "the Lower Cyrena Clay" whose deposition in a water environment of limited salinity (increasing upwards nevertheless) is evidenced beside the presence of brown-coal stringers by its fauna indicative of a Lower Oligocene age [Z. SIPOSS, 1964, A. ONDREJIČKOVÁ, J. SENEŠ, 1965, J. SENEŠ, 1964].

In the blocks occurring on the Hungarian side of the Danube the thickness of the Hárshegy Sandstone increases to 150 m, whilst the "Lower Cyrena Clay" is absent. The sandstone overlies the Upper Eocene through the intermediary of shaly clays of Tard facies. Whereas its deeper member is terminated by refractory clays with brown-coal stringers (*i. e.* a limnic facies), the higher member was found to include *Ostrea-* and *Pecten*-bearing intercalations, *i. e.* layers of marine character. However, intercalations of this kind have also been shown to occur in the Hárshegy Sandstone of the Pilis and Buda Mountains as well [E. VADÁSZ, 1960].

On the strength of its features and limited extent the Hárshegy Sandstone may be considered with conviction to represent deltaic deposits of a short, but steeply sloping, river (or river system) that came to enter the Oligocene basin from the direction of the crystalline masses of the Western Carpathians.* Consequently, it is not an abrasional detritus originating from high river banks, but it is constituted by river-transported gravels and sands which were distributed — at least locally — by sea water movement. Their conditions of deposition varied with the different stages of development of the delta, showing the following facies: river-channel and flood-plain, limnic, lagoonal, brackishwater and littoral. Whereas in the quiet bays on the west flank of the delta coal formation was coupled with accumulation of comparatively fine detritus, the coarse detrital material of some branches of the delta penetrated astonishingly far into the eastern basin centre characterized by the Tard facies (see the „Hárshegy Sandstone" which is 63-m-thick in the borehole Csepel-2 and 130-m-thick in Tóalmás-2).

In the Middle Oligocene, transgression continued here, too. However, in accordance with the basin-marginal position of the area, its sequence begins with sediments coarser than the Kiscell Clay (the "*lower transgressional sandstone*" of J. SENEŠ, 1964 a and b), and the "*foraminiferal clay facies*" follows only above this.

The *Upper Oligocene* is characterized by a great variety of facies. For example, in the vicinity of Esztergom and Štúrovo, it seems to form an independent cycle that can be called *Esztergom Formation.* The shallowing of the sea is manifested by the "*Upper Sandstone Beds*" of Štúrovo, respectively of the borehole Solymár-72., in the hanging wall of the Kiscell Clay. These beds are followed here by the deposition of purely marine sediment. This ephemeral transgression, however, which seems to be connected with the inundation of the basins of the Gerecse region in Late Oligocene time, leaded finally into an oscillatory (thus, taking the *entire* sequence in considera-

* So far not too many objections to the inclusion of the Hárshegy Sandstone in the Lower Oligocene have been raised. It is plausible, however, that the formation of a few isolated, continental (hence unfossiliferous) occurrences began as early as the Upper Eocene — a hypothesis seemingly supported by the absence of the Hárshegy Sandstone above the Buda Marl throughout the occurrences of this latter. Accordingly, the deepest member of the Hárshegy Sandstone would replace the Buda Marl, while its bulk would be equivalent to the Tard Clay-Marl.

tion: regressive) phase. This phase is characterized by the frequent alternation of shallow-sublittoral "Pectunculus-beds" with brackish-water "Cyrena-deposits".

In other points of the parts of the Pilis and Buda Mountains belonging here, the whole Upper Oligocene is filled up by an oscillatory sequence varying among littoral, brackish-water and even terrestrial facies.

Ad c) Particularly enough, it is this oscillatory Upper Oligocene, with the total absence of the Lower and Middle Oligocene, that transgresses farther west in the basins around the Gerecse Mountains. According to T. BÁLDI [1965, 1967], in the Mány—Zsámbék basin the transgressive character would gradually wane from the E to the W, because in the oscillatory sequence, with the progressive decrease in the number of shallow-sublittoral intercalations, it is the brackish-water deposits that will predominate, being associated with freshwater layers. This "*Mány Formation*" of brackish-water predominance has periodically penetrated into the freshwater Tatabánya—Csatka Basin (formed simultaneously on the N side of the Vértes) across the internal (Héreg, Tardos and Tarján) basins of the Gerecse.

Ad d) The bulk of the Upper Oligocene Tatabánya—Csatka Basin, and particularly its borders facing the Vértes and Bakony Mesozoic, are constituted, however, for the most part, by the "*Mór Formation*" of terrestrial-limnic type. Beginning with variegated clays and coarse basal detritus, the sequence of this formation locally contains coal stringers and even minor brown-coal seams (already stripped off): in the vicinity of Vértessomlyó, Bakonycsernye, Jásd and Szápár. Now filled up by sediments of 500 to 800 m thickness, the basin was joined in the west by a river delta. In these deltaic sediments accumulated in the territory of the Northern Bakony Mountains the ratio of the fine-grained rocks increases from the Hárskút—Zirc—Bakonycsernye—Bakonyszentkirály area towards the Réde—Csatka—Nagyveleg—Mór zone, while the variety of gravels decreases [J. KNAUER, 1969]. Accordingly, the trends of distribution of the facies here are the same as in the marine-brackish facies of the Upper Oligocene.

The outlined distribution of the facies and geohistorical characteristics of the North Hungarian—South Slovak Oligocene indicates at the same time the potential occurrences of associated mineral raw materials (deposits).

Oil and gas reservoirs, for instance, are expected to occur in the eastern basin only. This conclusion can be motivated by the following considerations:

i. The bituminous Tard Clay, which may have served as mother rock, could develop only there where sedimentation on the Eocene—Oligocene boundary was not interrupted, but continued under euxinic conditions.

ii. Here the Tard Clay is overlain by a Middle Oligocene so thick that it must contain several layers capable of trapping hydrocarbons enclosed in impervious clays or clay-marls.

Brown-coal deposits workable from both quantitative and qualitative points of view can only be found, however, in the western basin portions and always at the base of those marine, brackish or freshwater sequences whose deposition was preceded by a shorter or longer infra-Oligocene denudation. There were possibilities for deposition of coal in thinner lentils or beds in two instances and two different places:

i. in the Lower Oligocene on the west flank of the Hárshegy Sandstone delta (vicinity of Esztergom—Šturovo);

ii. in connection with the Late Oligocene shallowing of the basin (Šturovo) and transgression in the marginal parts of the Tatabánya—Csatka Basin (Vértessomlyó, Szápár, Jásd, Bakonycsernye).

The thicker portions of the layers are already falled. The economical value of the rest has no importance.

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