Scientific Annals, School of Geology, Aristotle University of Thessaloniki Proceedings of the XIX CBGA Congress, Thessaloniki, Greece	Special volume 99	519-526	Thessaloniki 2010

THE LATEST PALEOGEOGRAPHICAL REALITIES OF THE PANNONIAN BASIN IN THE LATE QUATERNARY: THE RELICT PANNONIAN LAKE, ITS SUCCESSOR AND THE FINALIZATION OF THE DANUBE WAY IN THE UPPER HOLOCENE

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Abstract: The new studies on the southeastern part of the Pannonian Depression confirm our idea concerning the existence in this basin of a lake with its shores around +100 m in the Uppermost Pleistocene (the Relict Pannonian Lake, Belgrade – 2006). A morphologic peculiarity placed in the Cazanele Mici area seems to have been permitted the maintaining of the shores for some time at this elevation. The Relict Pannonian Lake could be the direct successor of the Middle Pleistocene Lake made evident as a paleogeographical reality by the Serbian scientists (Beograde, 2006) in the southeastern part of the Pannonian Basin. The severe restriction of the surface of this lake has taken place at the beginning of the Holocene, as a result of the mega-floods, which mark the boundary between the Pleistocene and the Holocene. Therefore, a successor of the Relict Pannonian Lake seems to have maintained for some time in the Lower Holocene with its shore around the +85 m elevation. This perspective confirms the idea of some geomorphology researchers, which accepted a gradual retirement of the Pannonian Lake in Quaternary, associated with a succession of shorelines. In this case, the finalization of the stream system of the Danube, as a unitary river, has very recently happened (in Upper Holocene). In addition a possible connection between a stream system tributary to the Black Sea and another one tributary to the Pannonian area along the actual Danube Gorge could be realized only in the Greben zone (most probably during the Pasadenian phase). The existence of the Relict Pannonian Lake at the end of the Upper Pleistocene seems to be confirmed by the altitude of the all pre-historical sites in the Pannonian area. In addition, important data of mythical paleogeography are consistent with all these possible paleogeographical realities of the Pannonian area.

Key words: Pannonian Depression, shore alignments, Greben zone, Iron Gates, mythical paleogeography, pre-historical site.

1. Introduction

Subsequently after the last glacial phase (Wurm I+II) it seems to have taken place a partial restoration of the Pannonian Lake, although the Pannonian Depression had lost its endoreic character as far back as in the end of the Lower Quaternary. The lowest areas of the Pannonian Basin, placed in the southeastern part of the basin, were gradually covered with water that, in time, gave the last lacustrine surface in this intra-mountain basin. In our previous papers, we have used for this water surface the syntagm "Relict Pannonian Lake" (RPL) – Ticleanu et al. (2006). To the end of the Pleistocene, the water level of this lake seems to have been at the +100 m elevation. Although the actual Danube Gorge already existed at that time, separating the Carpathians and the Balkans, an important morphologic peculiarity (of karstic nature) made possible water accumulation upstream till the water level elevation in the lake reached the +100 m value. The natural hindrance was located, in our opinion, in the actual area of the Cazanele Mici, made of Jurassic limestone. The studies in this direction led us to the idea of the subsequent existence, in Lower Holocene, of a new shoreline placed around the +85 m elevation that meant a very restricted lacustrine surface with shallow water. Only after the Lower Holocene it was possible the outlining of the actual stream system of the Danube, both in the Pannonian Depression and in the Romanian Plain. Such perspective reminds us

the opinions of some geographers that admitted the existence of lacustrine surfaces in the Pannonian Depression in the Quaternary, associated with gradual retirements of the shore alignments. But this vision makes us reconsider the data on the genesis of the Danube Gorge, laying stress on its morphologic peculiarities. The maintaining of some lacustrine surfaces in the south-eastern part of the Pannonian Basin, till the end of the Upper Pleistocene, could have been very favorable for the human habitation. In this case the confronting of such palegeographical picture with the geographic position of the archeological sites becomes urgent. The altitude of the sites can confirm the idea of successive shore alignments and the privileged anthropogenetic importance of the Pannonian area. Moreover, some date of mythical paleogeography were successfully confronted with possible paleogeographical realities of the Pannonian Depression (Ticleanu et al., 1993; 2008).

2. General geological considerations

The conceiving of a possible lacustrine shoreline at +100 m elevation in the Pannonian area originated in the field research for correlation of the Quaternary deposits along the border between Hungary and Romania. Subsequently, the research activity of the Romanian part moved to the south till the Danube Gorge area and then, through sporadic and punctual observations, even in Serbia. In the same time, other studies pointed the Pleistocene loess and loess-like deposits of the eastern part of the Romanian Plain, Dobroudja and downstream Baziaş, and the Holocene sand deposits in Valea lui Mihai and downstream Turnu-Severin areas. In this context, the new book edited by Enciu (2007) can be useful. In the northern part of the Romanian sector of the Western Plain, shallow bores (~2.2o m depth) have been drilled. This drillings often met loess and loss-like deposits above the +100 m elevation and grey and yellowish clays under this elevation, which were considered of lacustrine origin. In the same time, it was considered the possible mixed origin (eolian in transport and lacustrine in the sedimentation environment) of the Pleistocene loess with red levels of the Western Plain, the Romanian Plain and Dobroudja. In this context, the levels rich in carbonate concretions were considered to have been formed in lacustrine basins with shallow waters able to achieve at least +23˚ C. As a result of these studies and taking into account other data, we correlate the periods of loess banks accumulation with the inter-glacial phases and the red fossil soils with the glacial phases. This is a point of view previously belonging to other authors (the most important Spirescu 1970). For the border area between Hungary and Romania a new interpretation of all geological sections, attached to the hydrogeological maps scale 1:100.000, was made. New images were obtained, very different from the erroneous old ones. They correspond to an alternation of rough levels (sands and gravels) with finer deposits (clays and sandy clays) of Quaternary age, corresponding of lacustrine and fluvial-lacustrine environments. In this context the Upper Pleistocene deposits, forming the last sedimentation hemicycle, are composed of one sandy level (with gravels) placed under the loess which contain red or brown thin layers. Above the loess, we can find the Holocene sands of the Valea lui Mihai-Debrecen area, whose absolute age was established by a team of Hungarian scientists (Borsy et al., 1985). For the Western Plain it were often made paleogeographical reconstructions in gradual steps using the topographic maps scale 1:25.000, which are from the period before the great draining campaign begun after 1960. These reconstructions suggest that, not very far in the past, the water surfaces in the eastern part of the Pannonian Depression were much larger. We consider these areas as successors of much larger lacustrine surfaces, which can gradually lead us to the paleogeographic picture of the Relict Pannonian Lake (in the Upper Pleistocene). In this case the explanation of the extended lacustrine and marshy areas, maintained till in the present, through a Holocene subsidence process (Cotet, 1973) is not necessary anymore.

3. Possible shore alignments of the Pannonian Lake

Various authors starting with Ficheux (1928), considering the reciprocal transformations of the glacises into terraces in the eastern part of the Pannonian Depression, admitted that there are several moments of stagnation of the Pannonian Lake water, which was in a gradual retirement process during the Quaternary. The authors quoted by Posea (1997) with this opinion are Ficheux (1928), Berindei (1964) and Mahara (1977). The old shore alignments according to these authors were at the following elevations: +200 m (210 m, Berindei), +180-160 m, +155-140 m, +140-125 m and 120-100 m. The +200 m elevation of the shore seems to have maintained for a long time period and afterwards it followed a shorter stagnation period between +180 m and +160 m. Then for a longer pe-

riod, the water maintained between +155 and 140 m. After a lowering of the water level at 140-125 m followed, according to Mahara (1977), a new water level elevation between +120 and +100 m. In 1928, Ficheux admitted the following stages: +180, +160, +140 and +120 m. Posea, in 1997, admitted the existence of a lake with the water level elevation at the actual +200 m for the end of the Lower Quaternary. This lake extended itself especially in the southeastern part of the Tisza Plain. He accepted also the segregation of the Pannonian Lake into several distinct lakes during the Romanian stage (i.e. the Upper Pliocene, in the actual meaning). Their surface diminished even more during the Willafranchian, because of the dry climate. The existence of a diminished Pannonian Lake which was restored at the end of the Lower Quaternary because of a favorable climate (temperate) was also admitted by Pecs in 1960 (quoted by Mahara, 1973), and also by other authors. This lake became completely dry in the Middle Quaternary, according to Posea, because of the Iron Gates (s.str.) strike through and the penetration of the Danube in the Romanian Plain. However, the analysis of the disposition of the Quaternary deposits along the Danube Gorge, correlated with a morphological analysis suggests that a possible lake with its shore at such a high elevation (+200 m) could not exist in the Lower Quaternary, along the future gorge, downstream the actual Moldova Veche depression area. The maintaining of different shore levels in the Pannonian Depression was strictly controlled by the morphology of the Danube Gorge between the Carpathians and the Balkans. This made us reconsider the entire area in which the gorge is placed, through a morphological analysis, made on the topographic maps scale 1:25.000. From this new morphological perspective, it result easily important conclusions on the genesis of this impressive European defile.

4. The genesis of the Danube Gorge (modern considerations)

This morphologic analysis suggests that the most probable location in which the Gorge really began to form is connected with the narrow area of the old Danube stream at Greben-Vrani. These results confirm the hypothesis issued by Valsan (1919) which placed the connection point between the two-stream systems tributary to the Pannonian space, respectively to the Dacian space, not faraway upstream Svinita. In the same time, this is in dissension with Posea's hypothesis that places this critical point in the Iron Gates (s.str.) area and considers a stream system tributary to the Pannonian space including Cerna and Bahna rivers. In our opinion, the Wallachian Paleo-Danube was composed mainly of the old stream of Porecka and of Cerna. Towards the old saddle zone, in the Greben-Vrani area, pointed a left tributary of Paleo-Porecka. Towards the Pannonian area, the stream system was composed of the old Bolijetin stream associated with the Sirinia valley and then with the Berzasca stream. As a matter of fact, towards the valley head of these rivers, a right tributary of Bolijetin is directed to the saddle area at Greben-Vrani. But a strike through in this low saddle area didn't ensure, by no means, the complete diverting of the Pannonian Paleo-Danube. The formation of the gorge and the contact by retrogressive erosion with the lowest areas of the southeastern parts of the Pannonian Basin was certainly a long process. During this several successive stream captures of the rivers tributary of the Pannonian space (according to the chronology: Bolijetin, Sirinia, Berzasca, Orevita, Pek and Radimna, to name only the important ones). This point of view is very well sustained by the position of the old Danube cataracts. In this way between the ex-confluence with the Porecka valley in the Danube stream came one after another the following rocky zones and cataracts: Doica, Piatra Lunga, Bivolii, Islaz, Tachtalia Mica, Tachtalia Mare, Greben, the narrow zone Greben-Vrani and the Iuti cataract (data after Pasarica, 1936). The strike through moment of the low saddle area at Greben-Vrani could be placed at the end of Lower Quaternary (Pasadenian phase). If we admit for this moment a lake with the water level at +200 m elevation in the Pannonian area, then this strike through provoked a gradual lowering of the Quaternary Pannonian Lake level, associated with a gradual formation of the gorge through completion of the stream system tributary of the Pannonian space with its simultaneous inclusion in the stream system tributary of the Black Sea. Nevertheless, the scenario is much more complicated because the stream system tributary to the Pannonian area was in fact restored along the old water streams that were gradually covered by waters at the end of the Lower Quaternary by a partial restoration of the old Pannonian Lake. The detailed morphological analysis of the entire Danube Gorge area suggests moreover that the strike through in the Greben-Vrani zone was facilitated by a possible strike-slip that may have happened along a fault oriented NW-SE. By all means, we can admit

that at the end of the Upper Pleistocene, the entire Danube Gorge was already formed and the Pannonian Basin had definitively lost its specific endoreic character. In this case the maintaining of a lacustrine area (the Relict Pannonian Lake) was due to a karstic nature hindrance zone placed in the Cazanele Mici (Vechi) area. This morphologic peculiarity was inherited by the Danube Gorge from the old river Paleo-Porecka whose stream seems to have contained a karstic sector including also a short underground passage.

5. The Relict Pannonian Lake

Consequently, at the end of the Upper Pleistocene, in the non-endoreic Pannonian Depression area it seems to have maintained a lacustrine area which water level stayed for some time at the actual +100 m elevation. A shore alignment at this altitude observed by us in 2006 (Belgrade) is in good agreement with the data of Mahara (1977) which presumed a last shore alignment of the Pannonian Lake at the +120 – 100 m elevation. The +100 m elevation separates even nowadays the Middle Danubian Depression in two distinct areas. The area above +100 m contains only few lacustrine or marshy zones. The area under +100 m contains numerous lakes, marsh and dry marsh areas, covering large surfaces. Moreover, at this elevation a clear breach of slope can be observed. In some cases, the +100 m elevation separates area with completely distinct morphology, like at the left valley side of Pek, west of Kusice (Serbia) – figure 1. Often, above the +100 m elevation, older deposits outcrop: Pleistocene loess and loess-like deposits and under this elevation the hand drillings met grey, yellowish-grey clay, most likely of lacustrine origin. The relict lake collected the water of main streams coming from the Schwarzwald Massive to the Pannonian area, of the Paleo-Sava, Paleo-Drava, Paleo-Tisza and other minor river, through oblong gulfs. It can be presumed that, in its water, there were underwater currents in those gulfs and along their prolongations. This relict lake had a narrow prolongation along the Danube Gorge till the the karstic nature hindrance placed at the downstream entrance in the Cazanele Mici (Vechi) area (fig. 2). Downstream this point a large river was developed (the Wallachian Paleo-Danube) which followed the actual Danube flow, having its mouth in a lacustrine area covering at least ex-Ialomita and Braila flood plain meadows. According to some Serbian authors (Krstic et al., 2006), during a wet phase placed in the Middle Pleistocene (which came after a dry phase of the Lower Pleistocene) it took place the restoration of a lake in the Pannonian area, but only in the actual Middle Danubian Deprssion. This “Middle Pleistocen Lake” had the greatest depth (~ 18 m) in area of the actual Vojvodina (between Kikinda and Zrenjanin). This depth is sustained by the ostracode Cytherissa lacustris found in the sediments of this lake for the 250 ka moment. Such a paleogeographical representation can be placed just in the middle of the Quaternary Ice Age, that is in a moment of highest restriction of the surface of the “Middle Pleistocene Lake”. The same Serbian authors admit also several smaller lakes in the Pannonian area during the Holocene, which were placed in sub-structural depressions, such a lake being described by Menkovic et al. in 2004. In our opinion, the restriction of the Relict Pannonian Lake took place after the mega-floods which mark the Pleistocene/Holocene boundary (~ 11,560 yrs ago). Those floods provoked a partial removal of the karstic hindrance and the water of the relict lake dropped for some time at +85 m elevation.

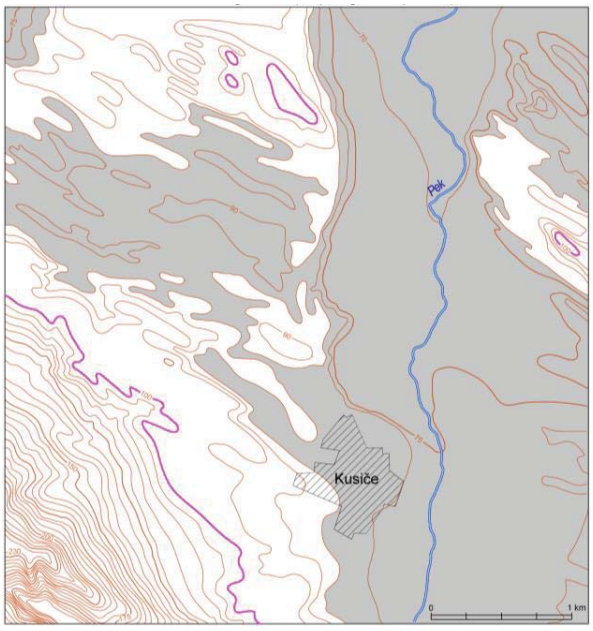

Fig. 1. The possible shores with +100 and +85 elevation in the left bank of the river Pek near Kusiče village-Serbia (morphological interpretation).

6. The temporary successor of the Relict Pannonian Lake

The extensive surfaces covered with lakes, marsh or dry marsh zones placed under the +85 m elevation in the eastern and southeastern part of the Pannonian Basin make us presume that a last, tem-

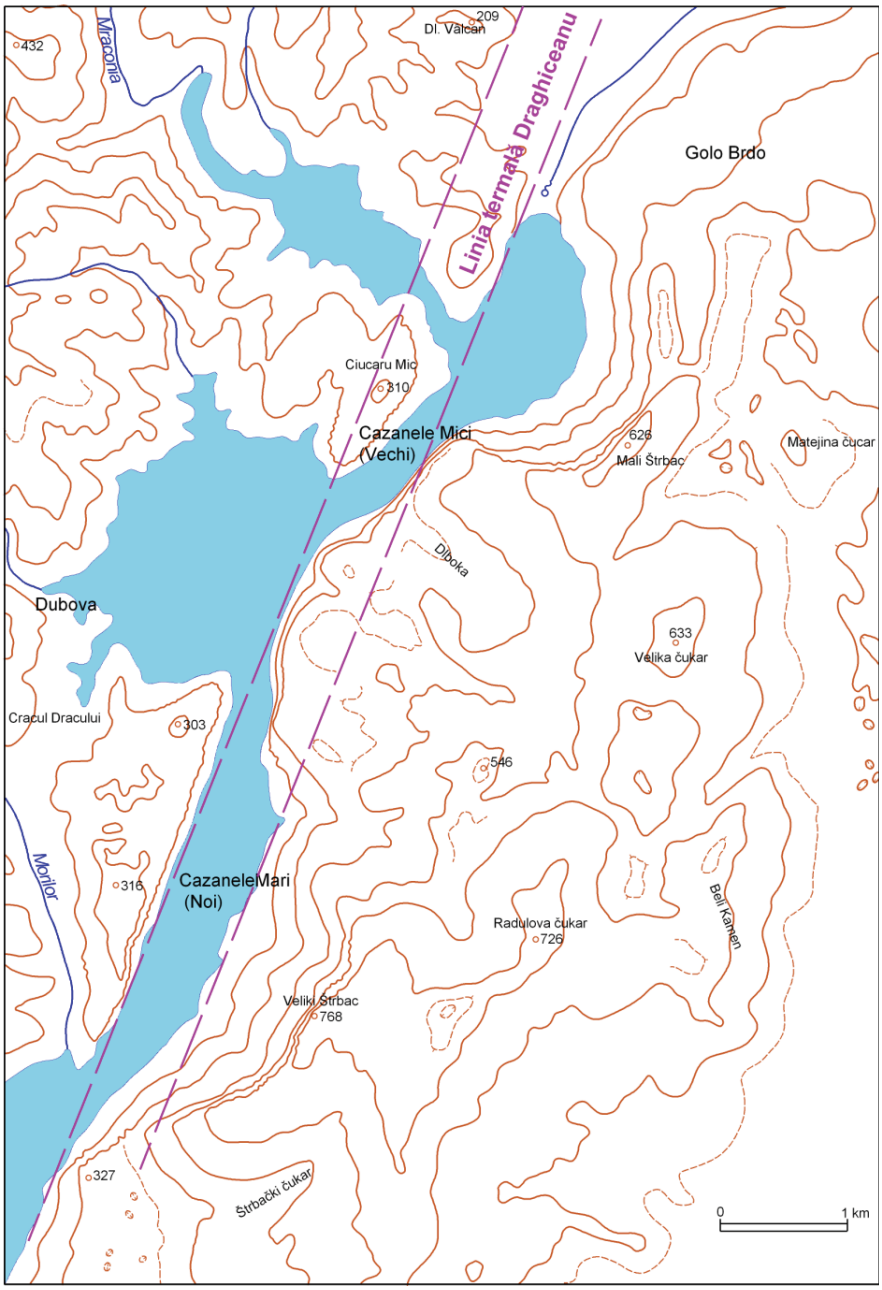

Fig. 2. Paleogeographical image of the Cazane area 11,5600 yars ago (Pleistocene/Holocene boundary) with the shoreline at about +100m elevation and the Thermal Line Alexinac – Herculane – Călan – Geoagiu.

porary lacustrine shore alignment marked the partial but severe water retirement of the Relict Pannonian Lake. This successor could mark the beginning of the Lower Holocene. Its possible shape can be schematized in a first approximation through a re-interpretation of the geological maps covering this part of the Pannonian Basin. This lacustrine area is very well illustrated by the marshy areas and the lakes between the village Satchinez and Timisoara (Romania) – figure 3. Here the surface with dry land is very restricted and not far back in the past, the surface covered with water was much larger. In any case, we presume that all surfaces covered now or in the past with marsh or dry marsh zones are ex-lacustrine surfaces, successors of an older, much larger lacustrine area. Only after the gradual removal of the hindrance in the Cazane area it came, during the Lower Holocene, to the gradual restriction of the last important lacustrine surface that once existed in the southeastern part of

the Pannonian Depression. This led to the outlining of the actual stream system of the Pannonian area, which has reached its present shape only in the Upper Holocene. Nevertheless, the water flow in the Danube Gorges has been marked by the remains of the hindrance in the Cazanele Vechi zone even in historical times. During the great inundations affecting the Middle Danubian Depression, upstream the Danube Gorges, a lake was formed which advanced to the west, sometimes very far away. The Romans, in their time, named this partial restoration of the temporary successor of the Relict Pannonian Lake "Mare Album" (Valsan, 1919). Most recently, a rocky cliff appearing out the Danube water at Calnic point in the upstream entrance in the Cazanele Mari often provoked, in the old Danube, accumulation of floating ice.

7. The finalization of the Danube way in Upper Holocene

From all data presented before, it results that the Danube can be considered a unitary stream only starting with the Upper Holocene. The existence of one lacustrine surface that made a Danube stream in the Pannonian area and another stream downstream the Gorge, maybe even in the Middle Pleistocene is not consistent with the idea of a unitary stream (river) from its source till its mouth at the

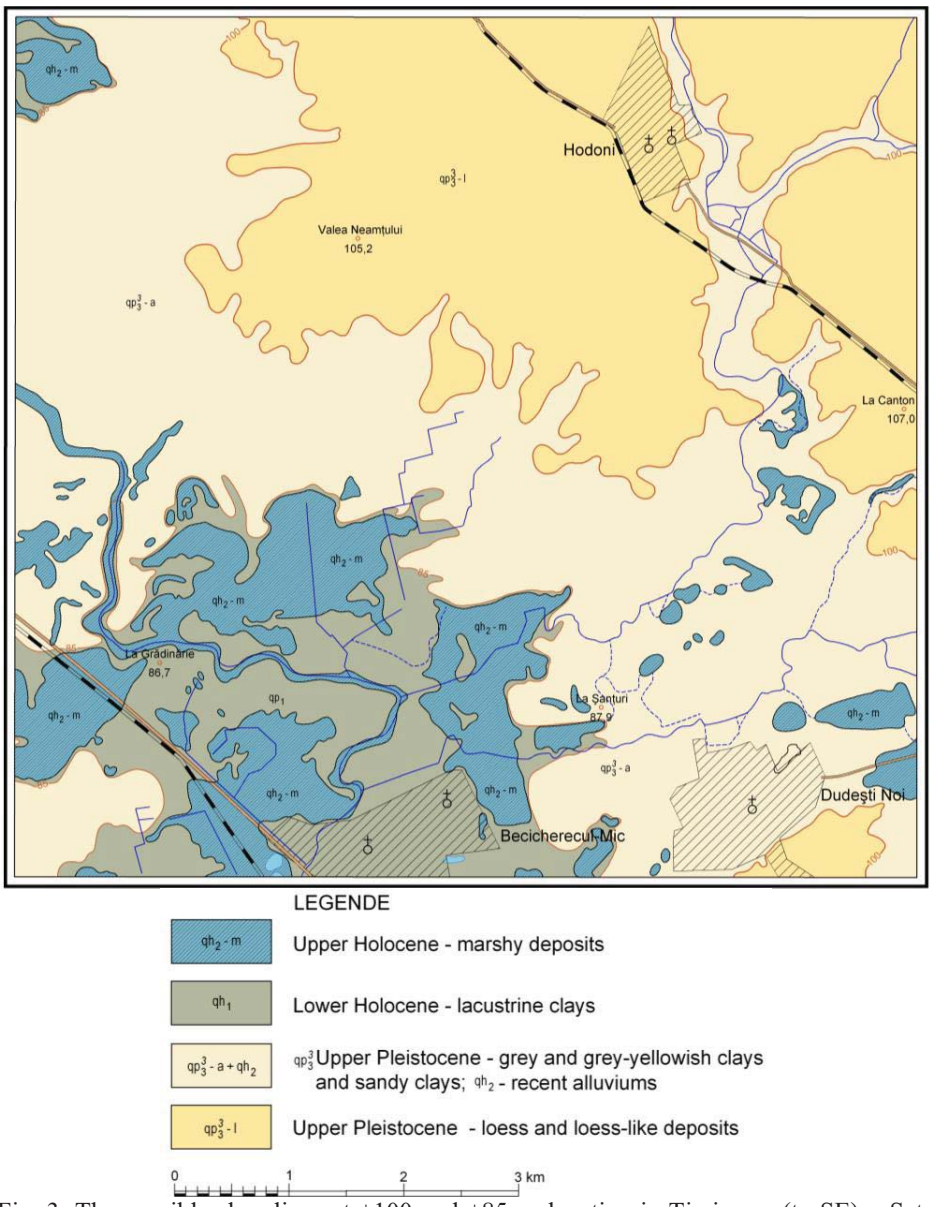

Fig. 3. The possible shorelines at +100 and +85m elevation in Timişoara (to SE) – Satchinez (to N) area (geo-morphological interpretation).

Black Sea. The actual stream system of the south-eastern part of the Pannonian area seems to have been outlined only after the Lower Holocene. The gradual improvement of the water drainage through the actual Danube Gorge, especially both in the Cazane area and in the cataracts zones provoked the gradual restriction of the lake surface which was the successor of the Relict Pannonian Lake during the Lower Holocene, in the south-estern part of the Pannonian Depression. The shoreline at the +85 m elevation is step by step abandoned and the Danube stream and its major tributary streams were extended to lower and lower zones. In the ex-lacustrine areas, these streams are meandered and the lowest areas on the bottom of the ex-lake became marshy zones or relict small lakes. In time, the river way had become more and more stable and a lot of secondary branches of the rivers have become dead channels. The ex-meanders and dead channels have become oblong lakes and then marshy areas. Many such areas can be found in the present in the valley flat of these rivers, often in an advanced stage of clogging. Often, small lakes can be found, which are supplied during the seasonal inundations. The difficulty of the drainage through the Danube Gorge of the entire water quantity of the Pannonian Depression have been maintained even in the historical times and great water accumulation was reported during the Romans invasion (the beginning of our era) upstream the Danube Gorge. More recently (XIX century), great inundations have been reported on the Tisza stream and large dry surfaces have been covered by water. Such phenomena were reported in Banat as well, because of the Timis river. To the Danube mouth, its stream has been very lately finalized. It is possible that, during the Lower Holocene, the entire surface of the actual Ialomita and Braila flood plain meadows was entirely covered with water. A situation close to the actual one has been very late achieved and, during the great inundations, the surface of these lakes was temporary restored. In this context, the genesis of the actual Danube Delta could be analyzed through the same pattern but this subject deserves a special treating.

8. Archaeological and mythical implications of this new paleogeographical perspective

The possible existence of a lacustrine area, with variable surface in the Pannonian area, during the Quaternary and especially during the Upper Pleistocene, should have played an important role in the habitation conditions of the human communities of this space. In the first place, the climate in the entire Pannonian area would have been favorably influenced. This meant higher annual average temperatures, with mild and shorter winters. In addition, the southern part of the Pannonian area can be under Mediterranean climatic influences, clearly favorable for human habitation. In such depression area, the annual average temperatures are higher and attract most inhabitants. In particular, the natural higher thermal gradient of the Pannonian area, which seems to have been even higher in the past, could have been very important for the habitations. Nevertheless, a first analysis of the archeological sites of the Pannonian area shows a surprising aspect: the oldest sites are placed in zones near the border of the Pannonian Basin, at higher elevations. The most recent habitation places can be found at lower elevations. For the Neolithic the archaeological sites are placed in the lowest areas of the depression, inclusively those placed in its southeastern part. Such reality can be consistent with the model with successive shore alignments of a Pannonian Lake in a gradual process of retirement. It is not possible to find habitation traces in a place underwater at that time, but instead they are found either in places connected with successive shore alignments or which were before underwater. Concerning a shore of the Relict Pannonian Lake placed to the end of the Pleistocene around the +100 m elevation it can be ascertained that no site of Upper Paleolithic age (equivalent in time with the Uppermost Pleitocene) can be found, in the south-eastern part of the Pannonian Basin, under this elevation (+100 m). In fact, the altimetric position of the Upper Paleolithic sites, in the Pannonian area, has a great paleogeographical role. Very important are the so-called “loess sites” of the Hungarian Paleolithic which belong to the Eastern Gravettian. These sites are present at the lowest Wurm levels (Gabori, 1968). It should be stressed that the oldest Gravettian sites in this area are located in Slovakia (Hernad valley). The most important sites of this type are at Sagvar (eastern part of the Balaton Lake) and at Pilismarot (in the Pannonian bend of Danube). The Sagvar site is placed above the +100 m elevation (~ 145 m) and contains two cultural levels with the age ~18,900 and ~ 17,760 years. The Pilismarot site is associated with steppe episode of the Wurm 3 glacial sub-phase. This is one of 15 gravettian sites in the Pannonian bend area of Danube. It should be mentioned that the only mammoth remains of the southern part of the so-called Great Hungarian

Plain is connected with the Szeged site, a seasonal habitation which is synchronous with the Sagvar and Dunafoldvar sites. It should be remembered here also the sites in the southern part of Mecsek Mountains of Uppermost Gravettian age.

9. Conclusions

Placing in time the principal moments in the paleogeographcal evolution of the Pannonian area in the Late Quaternary, the following succession can be obtained:

1 - The strike through of the ridge connecting the Carpathians with the Balkans in a low saddle zone in the Danube Gorge may have taken place at the end of the Lower Pleistocene.

2 - The exact strike through point seems to be placed in the narrow part of the old Danube way (Greben zone).

3 - The strike through seems to have been facilitated by a strike-slip along an important fault oriented NW-SE.

4 - The Pannonian Lake seems to have survived at least till the end of the Lower Pleistocene and then followed a gradual process of retirement of its shores.

5 - This retirement seems to have been not smooth, but in steps so, in time, several successive shore alignments have maintained for some time, whose altitude can be established by the analysis of the glacis-terrace systems at the borders of the Pannonian Depression.

6 - The formation of actual Danube Gorge begun in the Greben zone and continued, through retrogressive erosion, to the west, by successive captures of the rivers tributary to a main stream, flowing to the Pannonian area.

7 - In the Upper Pleistocene a morphologic peculiarities of the already formed gorge would allow the existence of a lacustrine area in the southeastern part of this basin (the Relict Pannonian Lake with the shoreline at about +100 m elevation).

8 - The retirement of the shores of this lake could be due especially to the mega-floods, which made the shoreline to lower to the +85 m elevation.

9 - This shoreline seems to be characteristic of the paleogeography of the Lower Holocene.

10 - The finalization of the Danube way have taken place only in the Upper Holocene, conditioned by the gradual removal of the hindrances along important sectors of the Danube Gorge.

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