THE INFLUENCE OF NEOTECTONICS AND EUSTATISM ON THE DANUBE ROUTE IN THE BLAHNIŢA PLAIN

RĂDUCĂ Cristian, CRIŞU Lavinia, ENACHE Constantin

Abstract. The Danube entered the Severin Depression in the Pleistocene, passing over the Stârmina hill, near Scăpău in the Middle Pleistocene. From this point on, the southern parts of Bălăciţa Piedmont started turning into a terraced plain. After its flow on the oldest terrace (T8), due to the beginning of the tectonic movements in the Passadena phase, the Danube gradually descends to the south, onto the T5 terrace inclusively. There was a period of stagnation of the neo-tectonic movements at the level of the T4 terrace. At that time the river discharged its water into a shallow lake at the Leu-Rotunda plain level. It behaved like having an aging flowing course close to the mouth of the river. This period is probably equivalent in time to the Riss-Wurm interglacier when the vertical erosion is almost null and the Danube formed a broad meander in the north. Later, lateral erosion destroyed the previous terraces. On the later terraces, the Danube intensifies its vertical erosion to its present level, especially due to the continuous deviation from the base level.

Keywords: Danube, Blahniţa Plain, terraces of Danube, formation of the Blahniţa Plain.

Rezumat. Influența neotectonicii și a eustatismului asupra traseului Dunării în Câmpia Blahniței. Dunărea a intrat în Depresiunea Severin din Pleistocen, trecând peste dealul Stârmina, lângă Scăpău, în Pleistocenul mijlociu. Din acest punct, părțile de sud ale Piemontului Bălăciţa încep să se transforme într-o câmpie terasată. După ce a început să curgă pe cea mai veche terasă (T8), datorită începutului mișcărilor tectonice din faza Pasadena, Dunărea coboară treptat spre sud, până pe terasa T5 inclusiv. Există o perioadă de stagnare a mișcărilor neo-tectonice la nivelul terasei T4. In acea perioada fluviul se vărsa într-un lac puțin adânc la nivelul câmpului Leu-Rotunda. El se comporta ca și cum ar fi avut o scurgere îmbătrânită în apropierea gurii de vărsare. Această perioadă este probabil echivalentă în timp cu interglaciarul Riss-Würm atunci când eroziunea verticală este aproape nulă, iar Dunărea a format un meandru larg spre nord care, prin eroziune laterală a distrus terasele anterioare. Pe terasele ulterioare, Dunărea își intensifică eroziunea verticală până la nivelul actual, în special datorită deviației continue de la nivelul de bază.

Cuvinte cheie: Dunărea, Câmpia Blahniţei, terasele Dunării, formarea Câmpiei Blahniţei.

INTRODUCTION

This paper aims at taking a look at the studies and analysis of the Danube terraces bringing a contribution to the better knowledge of this area.

This study proposes a correlation between the evolution of neotectonics and eustaticism and the evolution of the river route during the ice ages up to the present day.

The studied territory is a typical plain area, an almost exclusive creation of the Danube due to the presence of its terraces, to which the sand dunes, the creation of the western winds, are added.

The neo-tectonic movements, the characteristics of the strata presented here and the quaternary glaciation contributed to the Danube's meandered flowing and its sliding, sometimes to the south, sometimes to the southeast or even to the north. The vertical erosion strength of the Danube has oscillated over time, especially due to neo-tectonic movements and glacier-eustaticism.

COTEŢ (1957), GHENEA et al. (1963), NICULESCU & SENCU (1987), ENACHE (2006, 2008), BADEA et al. (2011) BOENGIU et al. (2011), IONUȘ et al. (2015), which outlined eight terraces, performed detailed studies.

The distribution of the terraces as mapped shows an abnormal situation between the Starmina Hill to the west and the Blahniţa River to the east, where there are only terraces of T2, T3, T4 and T5 (Fig. 1)

In the previous works, the Danube terraces of the Blahniţa Plain, later modelled by Blahniţa and Drincea, were established, but only COTEŢ (1957) sketched the Danube's flow directions and turns during the ice ages, indicating that, in the Günz ice age, it made a wide meander northward between Pintenul de Batoţi and Blahniţa, destroying older terraces. (Fig. 2)

The same author presented a drawing of the territories occupied by the river south of the current route (Fig. 3), including the terraces in the sectors: Claovo-Karbovo (A) and Vidin (B). It indicates the relative elevations as well.

MATERIALS AND METHODS

Information from previous research, topographic maps at sc.1/100,000 and 1/25,000, GIS processing, as well as information from field trips were used. By comparing the topographic maps of 1979, CorineLand Cover 1990, 2000, and 2006, Global Mapper - World imagery 2009, Google Earth 2012, 2016 and current observations on the field we were able to better highlight the presence of the Danube terraces in Câmpia Blahniţei.

In order to highlight the Danube route in different stages, maps were presented with the routes including the floodplains in that stage and GIS modelling as well. For the northern boundary, STROE (2003) and BOENGIU et al. (2012) were also consulted. The quaternary geological classification, the neo-tectonic events and the alpine ice ages

were also taken into consideration.

It was also considered that, when the Danube entered the Blahniţa Plain, it was part of the Getic Piedmont that extended south, to the Pre-balkanic Plateau.

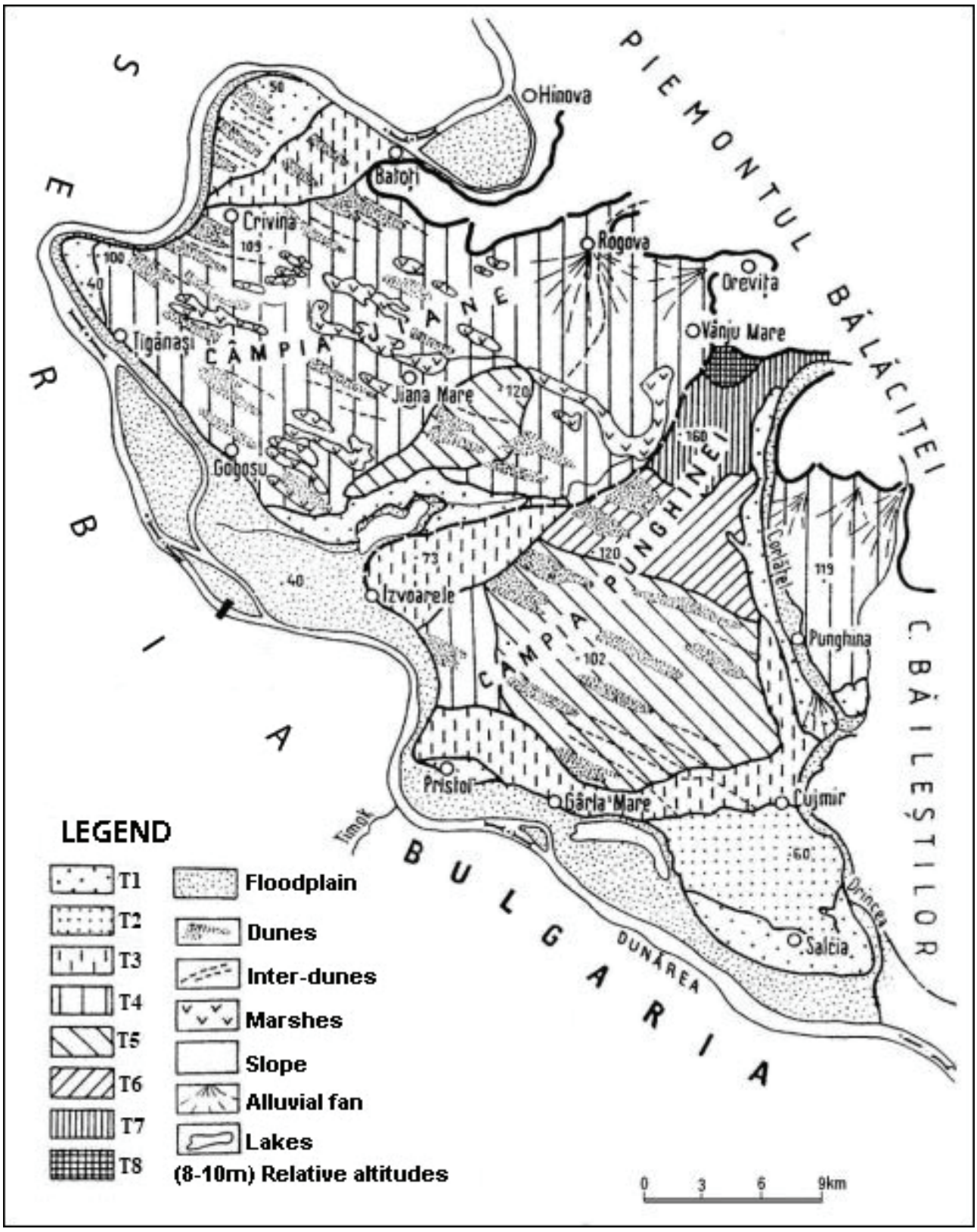

Figure1. The Danube terraces in Blahnița Plain (after BADEA et al., 2011).

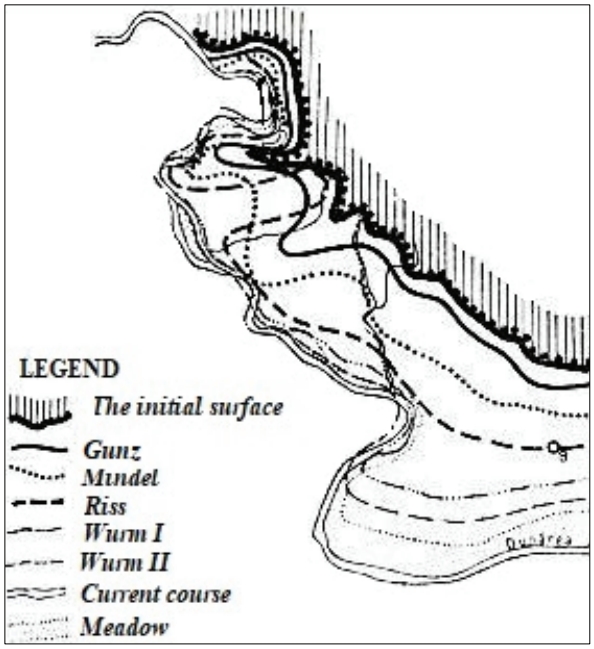

Figure 2. Schematic representation of the evolution of the Danube in the Oltenia Plain - Western sector (after COTEŢ, 1957).

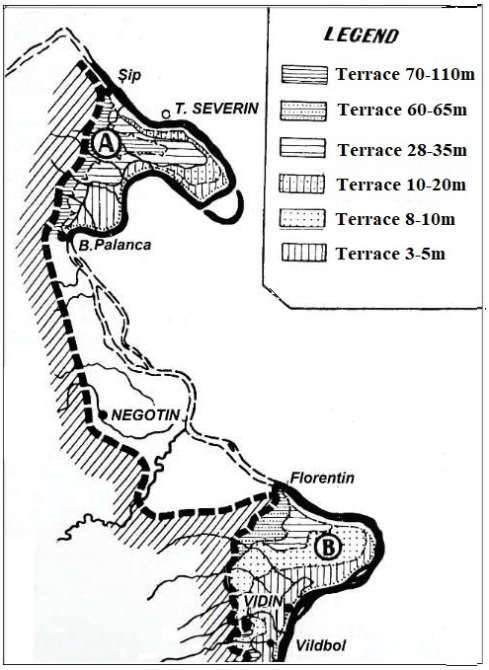

Figure 3. Drawing of the Danube position south of the current route (after COTEŢ, 1957).

RESULTS AND DISCUSSIONS

Most researchers agree that the Danube has eroded the southern part of the Bălăciţa Piedmont, which extended to the Pre-Balkanic Platform, but the way this process took place was studied to a lower extent. Therefore, in the present paper, based on the paleontologically confirmed age arguments and the neotectonic events that took place at that time, we will present the results of our studies. For the northern boundary in which this process expanded, we used the works of STROE (2013) and BOENGIU et al. (2012). Therefore, in the present paper, on the basis of paleontologically confirmed age arguments and the neotectonic events that took place during that time period, we will present the results of our studies.

The highest terrace (T8) was identified in a restricted area, in the Blahniţa Plain, only to the east of Vânju Mare (Fig. 4), located after our measurements at the absolute average altitude of +180m.

Figure 4. The terrace T8. In the distance, the limit with the Bălăciţa Piedmont (photo by C. Răducă).

It is individualized as a step between Şimian and Batoţi, the same as the surface of Ergeviţa at a relative height of 150-170 m. After a short interruption, it immediately reappears east of Vânju Mare at a 140 m relative altitude (NICULESCU & SENCU, 1969).

Comparing this terrace with the altitude of the Stârmina Hill near the village of Scăpău where the ravines from both sides of this hill have reduced the altitude at 140 m (Figs. 5, 6), the Danube may cross from the Severin Depression to the Blahniţa Plain through this corridor. At the 180 m altitude, the opening has a width of 375 m.

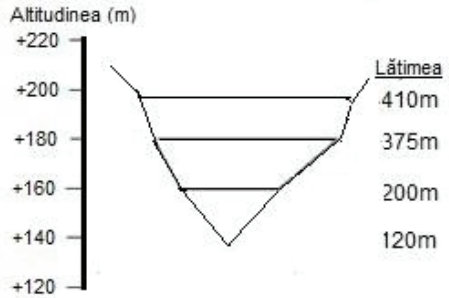

Figure 5. The Crossing of the Stârmina Hill at the Scăpău (photo C. Răducă) and the sketgh of the passage from Scăpău with the drawing of absolute quotas.

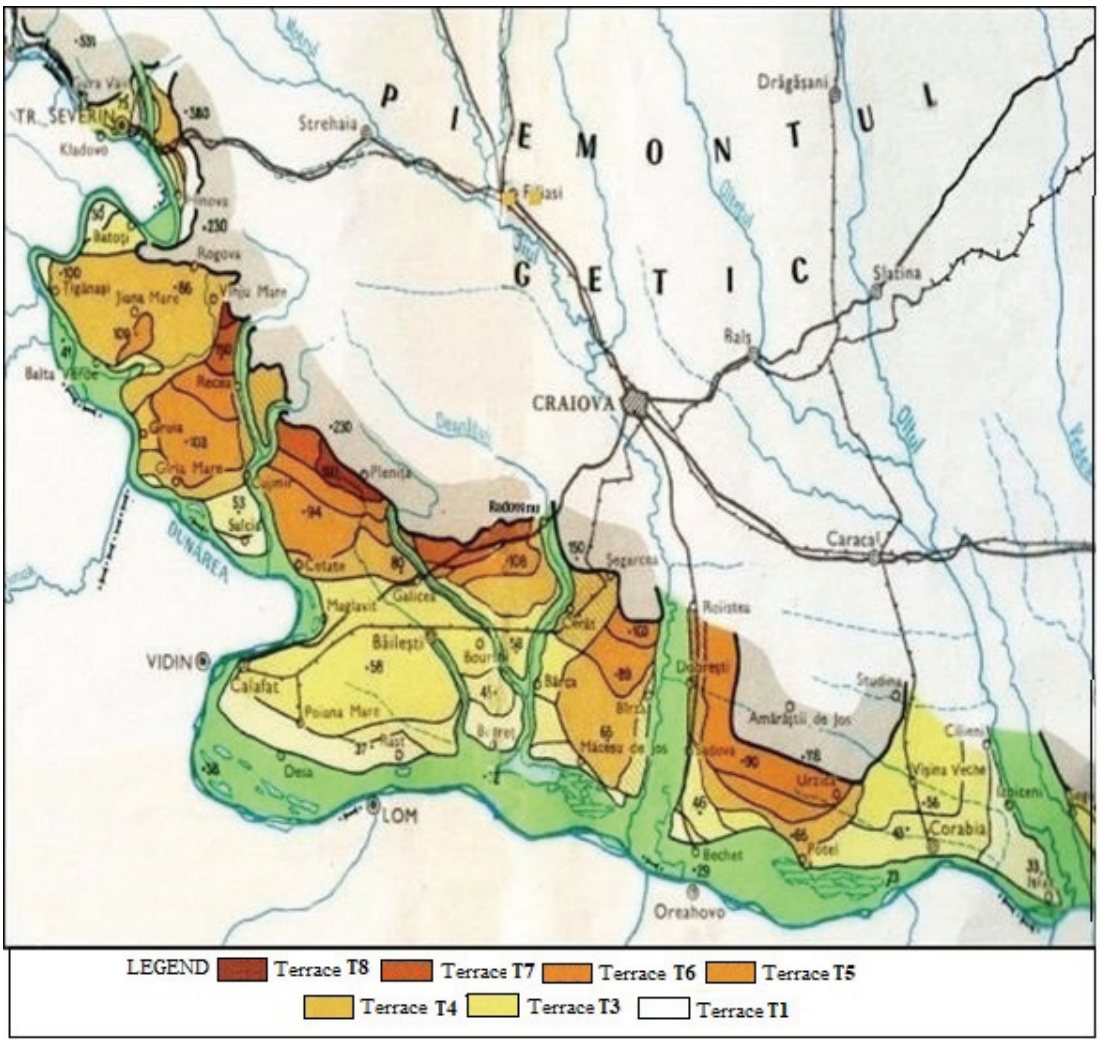

Figure 6. The map of Danube routes between Batoţi and Izlaz (after NICULESCU & SENCU, 1969).

So, we traced the first entrance of the Danube into the Blahniţa plain through the corridor at Scăpău, at the level of the T8 terrace at the east of Vânju Mare. We think that, even in the next stage, from which the T7 terrace remained, the Danube entered the plain through that corridor and eroded part of the T8 terrace. The lack of Danube

alluviums in this corridor is explained by the fact that they have been removed as some ravines regressed on both sides of the Stârmina Hill, resulting into a deeper landscape than the deposited alluviums.

To analyze the evolution of the Danube route in the Blahniţa Plain, we used the map of the Danube's terraces (NICULESCU & SENCU, 1969) (Fig. 6). We sketched the flow of the Danube (including the floodplain) at the level of each terrace. To explain how the Danube evolved on the territory of the Blahniţa Plain, I traced on every map, the route of the Danube at the level of each terrace. Because in some stages the Danube has passed the current route to the south, the situation presented by P. COTEŢ in Fig. 3 was considered.

The Danube's route on the T8 terrace was much wider than the remaining terrace that was largely eroded in the next steps. (Fig. 7). Because another fragment of the T8 terrace exists in the Cearangu Hill at Pleniţa, the route has been continued to the east of this fragment. At that stage, the major riverbed of the Danube had an approximately equal width throughout the crossing of the Blahniţa Plain.

Some researchers do not recognize the existence of the T8 terrace as an entry of the piedmont, but, as seen in the picture 4, above the terrace, which is tabular, the wavy forms of the piedmont that rise above can be observed in the background.

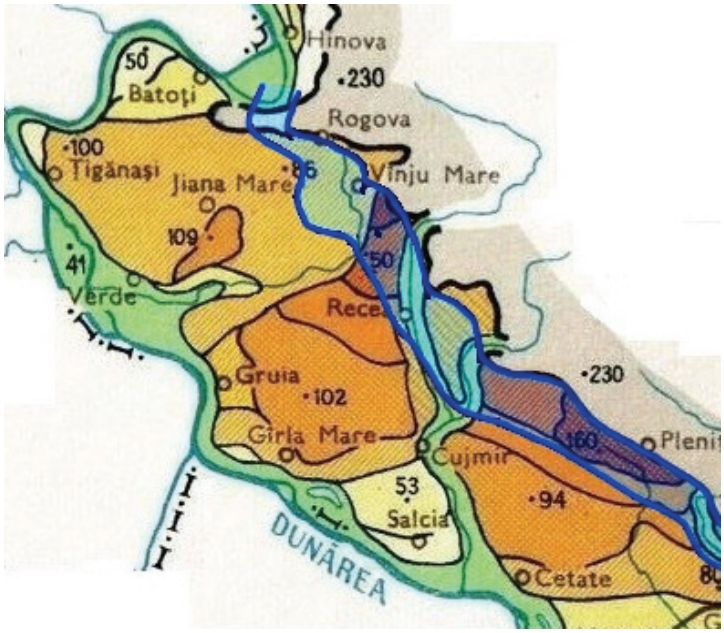

Figure 7. The Danube route on the T8 terrace. (processing after NICULESCU & SENCU, 1969)

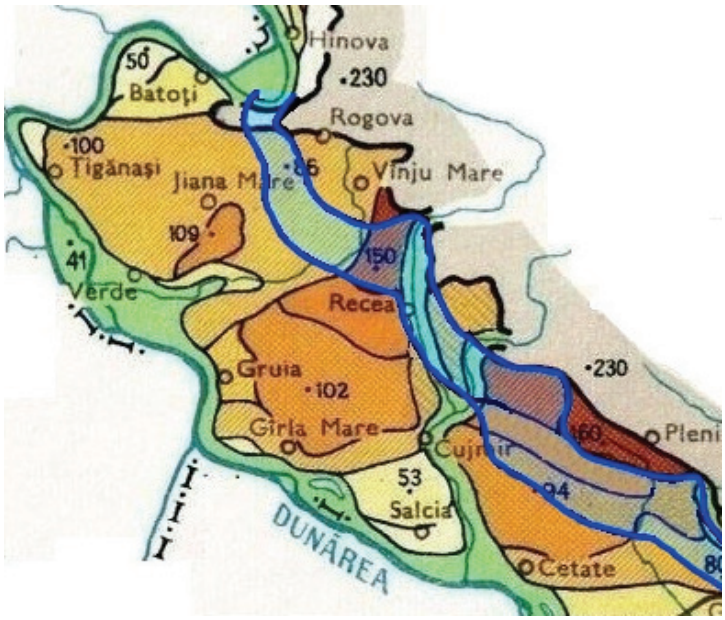

Figure 8. The Danube route on the T7 terrace. (processing after NICULESCU & SENCU, 1969)

At the T7 (Fig. 8) terrace level, the river followed a parallel run along the T8 to the west of Vânju Mare, about the same width as in the previous stage. At this stage, Corlatelul, which originally flowed east, is drained to the south on the T7 Terrace, which erodes the T8 terrace near to Pleniţa

At the level of the T6 terrace, the Danube route is kept within the boundaries of this terrace (Fig. 9), including immediately to the east of Corlatel. At this stage, the Danube went around Pintenul de Batoti, which began to rise along with the Stârmina Hill.

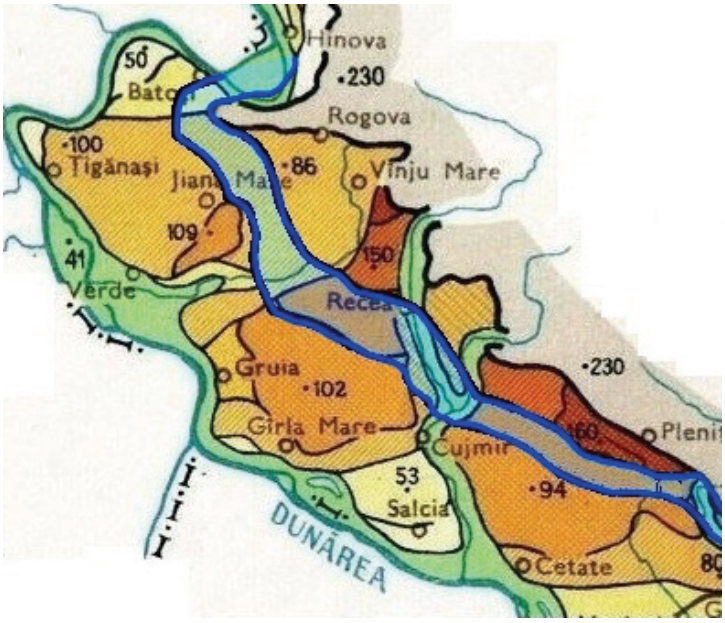

Figure 9. The Danube route
on the T6 terrace.
(processing after NICULESCU & SENCU, 1969)

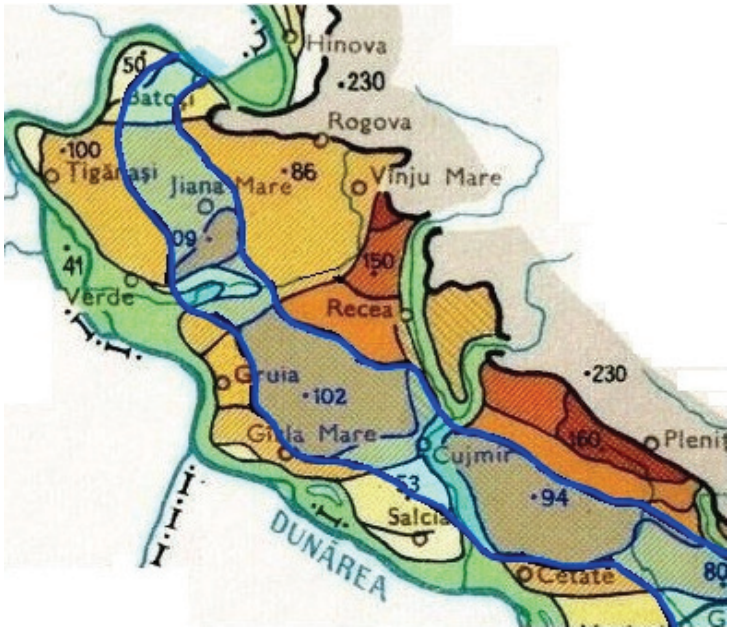

Figure 10. The Danube route
on the T5 terrace.
(processing after NICULESCU & SENCU, 1969)

The Danube route on the T5 terrace follows the T6 terrace, being wider between Blahniţa and Corlăţel. (Fig. 10) It can be said that from the terrace T8 to the terrace T5, the Danube gradually descends to the south.

The T4 (Fig. 12) terrace raises problems in terms of formation, as the Danube has not followed the general tendency to descend to the south here, but it advances far north between the Stârmina Hill and Blahniţa, eroding all previous terraces.

The meandering on a wide meadow between Rogova to the north and Negotin to the south is explained by a period of stagnation of the neotectonic movements or the altimetric lifting of the river mouth in the pleistocene lake which was then probably in the high field of Leu-Rotunda.

After making a wide meander northwards then southward across the Romanian border in the Negotin plain, the Danube route headed southeast with a rather wide floodplain. That route had its central line in the route nowadays. The subsequent south-eastern orientation was determined by the Pliocene Lake, where the river flowed at that time.

The meander of the Danube separated a part of Terrace 5 as an island shape.

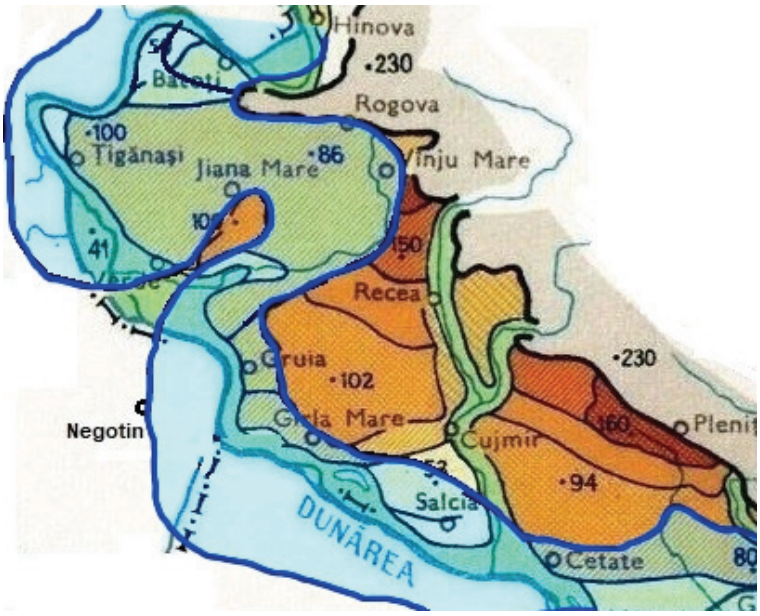

Figure 11. The Danube route on the T4 terrace. (processing after NICULESCU & SENCU,

Considering the present international chronostratigraphic scale (2017) and the chronology of alpine glaciations, the following quaternary chronology is displayed (Table 1):

Table 1. Quaternary glaciation chronology table.

Age	**Time (mil. year)**	**Glaciation**	**Time (mil. year)**
	0,0017 - present	postglaciar	-
Upper Pleistocene	0,126 – 0,0017	Würm	0,080 – 0,015
Middle Pleistocene	0,781 – 0,117	Riss Mindel	0,250 – 0,120 0,650 – 0,350
Lower Pleistocene	2,588 – 0-,781	Günz	1,200 – 0,700

For the ice age we reviewed some reference works (RUDDIMAN 1984; PETRESCU 1990; JONES 1990). Depending on these ages, the following extensions of the glacial and interglacial periods result (Table 2):

Table 2. Quaternary interglacial chronology table.

Glaciation	**Time (mil. year)**	**Inter Glaciation**	**Time (mil. year)**
Würm	0,500		
		Riss – Würm	0,04
Riss	0,665		
		Mindel – Riss	0,050
Mindel	0,300		
		Günz - Mindel	0,050
Günz	0,500		

Analysing the temporal evolution of the Danube in the Blahniţa Plain, we observe that for the highest and oldest T8 terrace, there is a paleontological argument for the lower part being dated as average Pleistocene. This is due to the discovery, at the level of this terrace to the south of Plenita, of the rhinoceros *Dicerorhinus merki* (GHENEA et al., 1963), equated by MIHĂILĂ (1971) with the Mindel ice age. We think that, at that time, the Danube discharged its water into a shallow lake, whose western end was in the lower Jiu. Probably that lake occupies the current territory of the high fields of Bălăciţa and Leu - Rotunda.

The next terrace, T7, attributed to the upper part of the Middle Pleistocene, was related by MIHĂILĂ (1971) to the Riss ice age according to the proofs of the remnants of *Parelephas trogontheri* Pohl. found by the author at Bercioiu, Vâlcea county. Because after the Danube's flow on the eighth terrace, the river gradually descended to the fifth terrace, we assign this first stage of descent to the south as an effect of the neo-tectonic phase of Pasadena that took place in the last part of the Pleistocene medium - upper Pleistocene. During this time, in the Schiau (north of Bascov) anticline, the Riss - Würmiene red clays are creased (SAULEA, 1967). At the same time, at Rovinari there is an inflation of the Jiu terraces: old, high and medium (FERU et al., 1963). In the Blahniţa Plain, the Strehaia - Vidin platform rise, stronger in the Strehaia - Vânju Mare area.

The T4 Terrace in the Blahniţa Plain between the Stârmina Hill - Blahniţa Valley has a difficult to explain extension, especially since in Holocene its southern part was covered by the dunes and inter-dunes. Here, marshes and

water meshes were installed, and on the northern boundary, Blahniţa and its tributary Oreviţa, created cones of spreading. Taking into consideration the wide meanders made at this stage by the Danube, we appreciate that in those times it was discharged into the lake mentioned above, which was at the same level. This wide meandering shows a lower course on a divagation plain near the mouth of the river. On the T3 and T2 terraces, the last in the Blahniţa Plain, the Danube route is very close to the current one.

CONCLUSIONS

The Blahniţa Plain between the Stârmina Hill and Corlăţel is definitely the result of the Danube's movement on this territory, whose footprint is the downward sliding of its landscape to the south. Regarding the moment when the river crossed over the Stârmina Hill with its extension of Batoţi Hill, we consider it certain in the Middle Pleistocene as the remains of *Dicerorhinus merki* found on the oldest T8 terrace shows. The first sliding southward on the terraces T7 - T5 is attributed to the neotectonic phase of Passadena (SAULEA, 1967).

The T4 terrace has a different extension and a different genesis. We consider that on this terrace the Danube has a wide floodplain and a meandering flowing, which occupied a territory between the Stârmina Hill to the west, Blahnita Valley to the east, Rogova to the north and Nicotin to the south. The broad floodplain and the meandering route are due to the proximity of the river mouth to a lake at the same level. The erosion witness of T5 terrace at Jiana was an island between the Danube waters.

This wide Danube floodplain that customize this part of the Blahniţa Plain, required the separation of a subunit under the name of the Jiana Plain. The part between Blahniţa and Cornăţel is called the Punghina Plain. It was preserved, with all the modifications subsequently caused by the sand dunes, by the ravines and the anthropic activities, as a downhill plain stepping down from the north to the south.

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