

THE PLEISTOCENE OF SIMILA OPEN PIT (SCYTHIAN PLATFORM, ROMANIA)

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Abstract. Pleistocene deposits recorded on the Bârlad Valley area are largely exposed, mainly on the river terraces. An illustrative outcrop can be observed on the right bank of the Bârlad River few kilometres upstream from Bârlad town, in Simila open pit. Based on detailed study, a number of characteristic sedimentary packages were outlined, referred to as lithofacies associations. There were established a total of eight lithofacies types and three architectural elements. The interpretation of these architectural elements revealed a braided river environment with low sinuosity channels. There are two kinds of fossils collected in the sands and gravels from Simila: Late Miocene ones (fossil wood, molluscs, and vertebrates), all being reworked there; Pleistocene (most probably Middle or Late Pleistocene) ones, including freshwater molluscs and vertebrates (large herbivores). Therefore, the deposits from Simila open pit are Pleistocene and in no wise, older as presumed before.

Keywords: Pleistocene, fluvial environments, sedimentology, palaeontology, Bârlad Valley.

Rezumat. Pleistocenul din cariera Simila (Platforma Scitică, România). În aria Văii Bârladului, depozite pleistocene sunt consemnate îndeosebi la nivelurile diferitelor terase. Un afloriment deosebit de ilustrativ poate fi studiat pe malul drept al râului Bârlad, la câțiva kilometri amonte de orașul Bârlad, în cariera de la Simila. Pe baza studiului detaliat efectuat, au fost conturate o serie de litofaciesuri sedimentare grupate unor elemente arhitecturale. Au fost astfel stabilite opt tipuri de litofaciesuri sedimentare și trei elemente arhitecturale. Interpretarea acestor elemente arhitecturale evidențiază un sistem fluvial împletit, cu o serie de canale cu sinuozitate mică. În nisipurile și pietrișurile fluviale pot fi întâlnite două tipuri de fosile: unele care aparțin Miocenului superior (lemn fosil, moluște și vertebrate), toate însă remaniate; altele - pleistocene (foarte probabil din Pleistocenul mediu sau superior), precum moluște de apă dulce și vertebrate (ierbivore mari). În consecință, depozitele din cariera de la Simila sunt pleistocene și nicidecum mai vechi, precum fuseseră considerate anterior.

Cuvinte cheie: Pleistocen, paleomedii fluviale, sedimentologie, paleontologie, Valea Bârladului.

INTRODUCTION

Pleistocene deposits are largely exposed in Moldova (Eastern Romania) on the Bârlad Valley, on the terraces of both this river and its tributaries. One of the most illustrative Pleistocene successions can be studied in Simila open pit, where in the last decade, large amounts of sand and gravel were extracted from for constructions. This open pit is located on the right bank of the Bârlad River, 7 km upstream from Bârlad town, on Simila commune territory near the national road 24 (Fig. 1).

Due to the mentioned works and a continue survey in the last five years, several fossils were unearthed and collected, belonging in majority to vertebrates. All are curate at Vasile Pârvan Museum in Bârlad, Natural Sciences Branch (abbreviated VPMNSB). This paper is focused on the sedimentology and palaeontology of these deposits.

GEOLOGICAL SETTING

The whole area that Simila open pit belongs to, is located from geological viewpoint, to the Scythian Platform (SÂNDULESCU, 1984). This platform recorded a long geological history. However, in spite of numerous boreholes already drilled, there still remain few unclear geological details as the ones related to the platform basement, never crossed by drillings in Romania. Therefore, there are different opinions about the age and lithology of this basement: while students as SÂNDULESCU (1984) interpreted this platform as younger compared to the East European one, others (PARASCHIV, 1970 in IONESI, 1994) presumed that it could mean nothing else but a deeper block of the Moldavian Platform (i.e. a southwestern area of the East European Platform). In his sections concerning this region (e.g. A 14), ȘTEFĂNESCU (1985) illustrated a Proterozoic basement, but he did not give additional details concerning the geological age. In such context, we can refer to the data issued from the boreholes drilled in Ukraine, as the ones from Zadunaivka and Suvorovo (BELOV et al., 1987), where the oldest rocks are Vendian black shales, while metamorphic rocks were never drilled.

In Romania, more precisely in Bârlad area, the basement is covered by four sedimentary megacycles: Devonian, Permian-Triassic, Jurassic-Cretaceous-Eocene, Middle Miocene (Late Badenian)-Pliocene (Romanian) (IONESI, 1994). On surface, only the last sedimentary megacycle rocks are exposed, these ones being the basement for the Pleistocene and Holocene deposits. Due to the monocline structure of the platform, the last megacycle rocks are differently exposed, the older ones (Late Miocene) in northwestern areas and younger (Pliocene) in southeastern areas (Fig. 2).

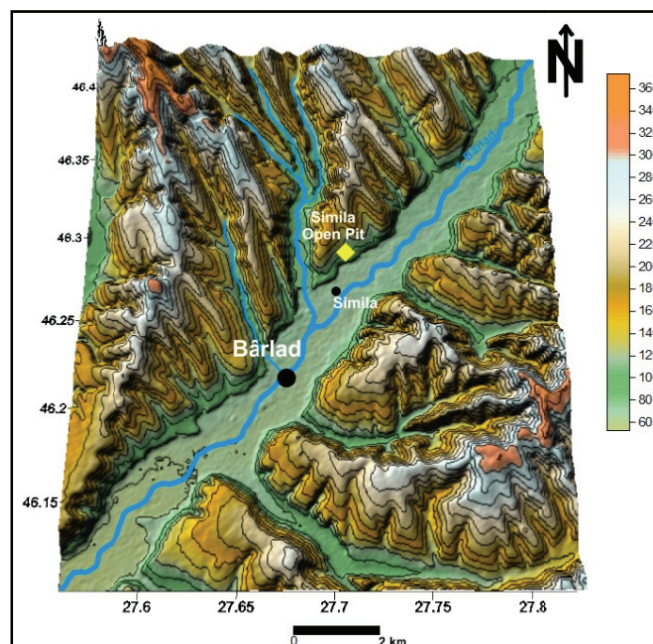


Figure 1. Location of Simila open pit (GlobalMapper13 and Surfer 8).

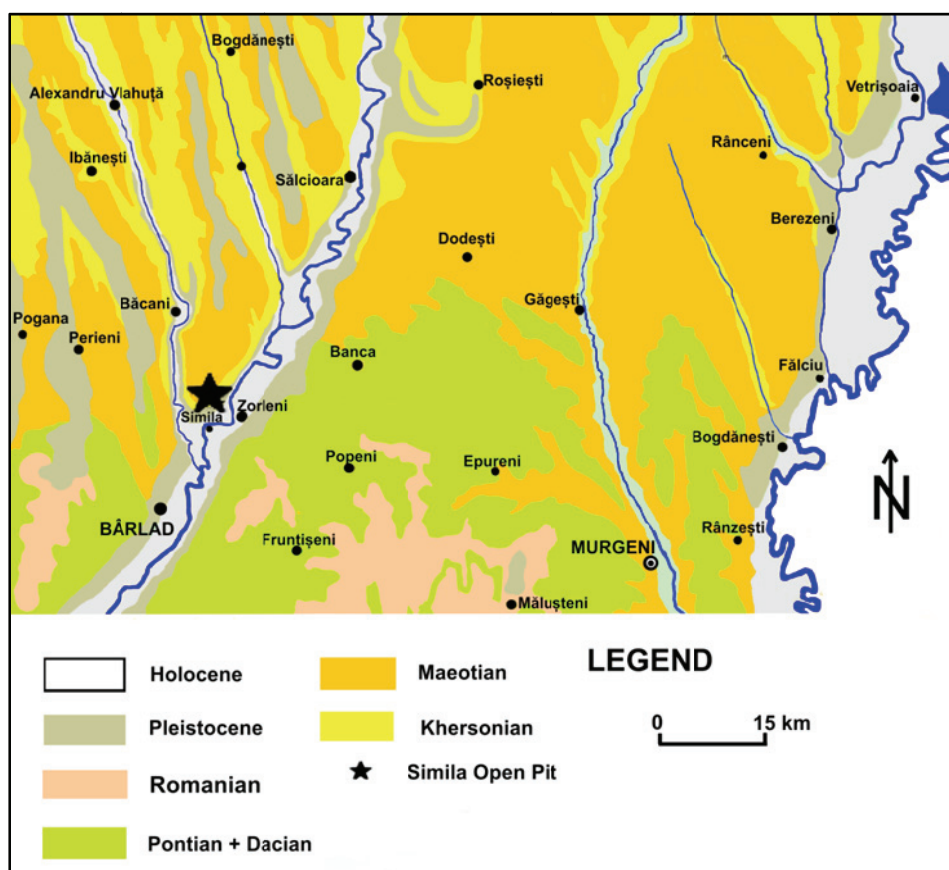


Figure 2. Geological map of the southern area of the Moldavian Platform and northern area of the Scythian Platform indicating the Miocene, Pliocene and Quaternary deposits (after GHENEA et al., 1967).

Consequence of the works carried out in Simila open pit in the last decade, a succession of clastic rocks (gravels and sands) can be now observed. All are the result of the evolution of an ancient fluvial system. The majority are channel fills, bearing also several fossils, mainly vertebrates (Fig. 3).

SEDIMENTOLOGY OF SIMILA OPEN PIT

The methods used in this preliminary study include stratigraphic section measurements, fluvial architecture and palaeocurrent analysis. The facies codes follow MIALL's fluvial lithofacies charts (1985, 2010). The designation and definition of lithofacies are based on the correlation of a rock of certain characteristics related to a specific depositional environment (READING, 1996). The basic elements used to describe these sedimentary facies are included in Table 1 and the architectural elements in Table 2.

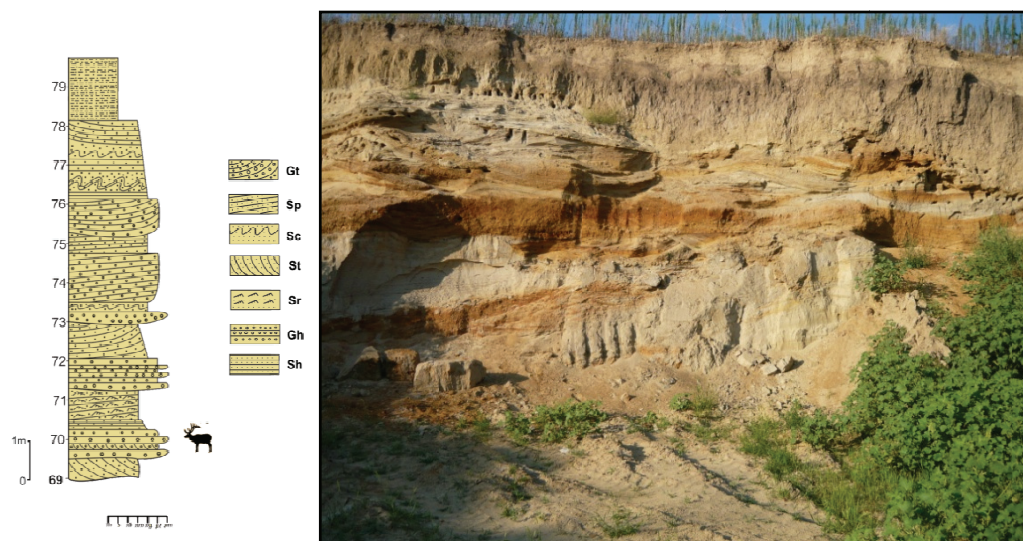


Figure 3. Lithological log of the deposits exposed in Simila open pit, indicating the level where giant deer *Megaloceros* remains were collected (also with lithofacies codes identified and described in table 1).

Table1. Lithofacies summary of codes, physical characteristics and depositional interpretations. Codes adapted from MIALL (1984, 2010).

Facies code	Facies	Sedimentary Structures	Interpretation
Gh	Clast supported crudely bedded gravel	Horizontal bedding, Imbrications	Lag deposits
Gt	Gravel stratified	Through crossbeds	Minor channel fills
St	Sand medium to coarse	Solitary or grouped through cross-stratification	Sinuuous crested and linguloid (3-D) dunes
Sr	Sand medium to coarse	Climbing ripple cross lamination	Lower flow regime
Sp	Sand medium to coarse	Solitary or grouped planar cross stratification-09	Linguloid or transverse-(2-D) dunes
Sl	Medium sand	Low angle cross beds ($\leq 15^\circ$)	Antidunes
Sh	Sand medium to coarse	Horizontal lamination	Plane-bed flow (super critical flow)
Sc	Sand medium to coarse	Convolute lamination	Soft sediment deformation structure

Table 2. Architectural elements, their two-letter codes, and a short description of their characteristics as used in this study (following MIALL, 2010).

Element	Symbol	Brief description
Channels	CH	Basal contacts usually erosive, convex upwards lens or sheet like cross section, variable scales
Sandy bedforms	SB	Lens, sheet, minor bars, occurs like channel fills
Lateral accretion deposits	LA	Commonly wedge shaped interlayer silt and sands

CH: Channels, CH: channel fills

Channel deposits comprise lithofacies Sc, Gt, and Gh (Photos 1; 2). Few abandoned channels in Simila open pit are filled by Sl and Sh lithofacies. Channel deposits expose sharp erosion bases with relief of about 1.2 – 2 m. They often erode sand bed forms and other channels. Their geometry is of the concave-up channel shape, occasionally forming multi-storey channel geometry. Channel thicknesses are up to 2 m in most cases, and rarely up to 3.5 m.

Interpretation: channels comprising facies Sc, Gcm, and Gcc record channel deposition. The presence of coarse-grained deposits may indicate a sudden increase in the velocity of the depositional current. High lateral migration of channels is a typical feature. Most channels have a multi-storey and multi-lateral nature. Channels with simple fill were frequent, e.g. in the northern part of the section cropping out in Simila open pit.

SB: Sand bars and bed forms

Sheet-like bodies of sand bed deposits comprise facies Sh, Sr, and Sc (Photos 3-5). They have sharp bases and are often eroded by channels. The erosion relief of the sand bed forms can be up to 2 m. Sand bed forms are usually about 1.5 m thick, but occasionally exceed 2 m.

Interpretation: sand bed forms record intra-channel deposition. They were probably produced by migrating dunes within the channel. This is supported by palaeocurrent measurements, which show palaeoflow directions to the NNW, NE. Because of the SSE-NNW orientations of all exposures, where channel geometry is displayed close to the longitudinal cross section (subparallel to palaeoflow direction), the channel geometry appears sheet-like. Sand bed forms were probably deposited by migrating dunes within the channel.

LA - Lateral accretion deposits

These deposits include units with geometries of wedges and lobes or sandy sheets that are reduced to a thickness between 1.2 and 2.5 m and widths of 3-5 m, without lateral continuity (photo 10). The facies components are: St, Sp, Sl (Table 1). They represent deposits accumulated by lateral accretion, with a reactivation surface, occurring as a result of changes in the base level of the river.

Interpretation: braided rivers have many channels, separated by temporary bars and islands. Rivers in alpine and arctic areas have seasonally high discharge variations and tend to be braided (MIALL, 2010).

The palaeocurrent analysis (Fig. 4) shows a relatively low spread of palaeocurrent vectors, which is characteristic of low sinuosity streams. The major palaeoflow trends are to the SE and to the SW. Therefore, one can estimate that the main sediment supply was from the NE and NW.



Photo 1. Gh (original).



Photo 2. Gt (original).



Photo 3. Sr (original).



Photo 4. Sh (original).

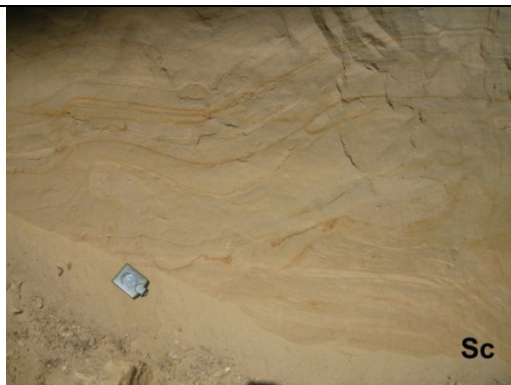


Photo 5. Sc (original).



Photo 6. St (original).



Photo 7. SI (original).



Photo 8. Sp (original).

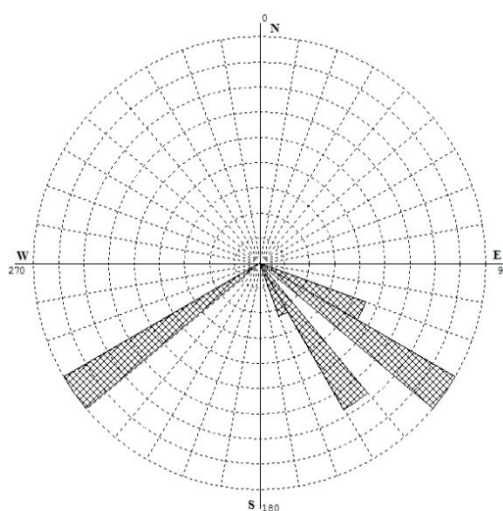


Figure 4. Rose diagram of palaeocurrent directions for Simila Open Pit.

There were collected ca. 150 pebbles to which measured axes were taken. The morphometric analysis was made after classic methods (ZINGG, 1935). Through direct measurements, by calipers, the values of the three axes (a, b, c) for each pebble issued. The distribution of the 150 pebbles in four classes (ZINGG, 1935) is: i. isometric class: 20; ii. prismatic class: 23; planar – lamellar class: 34; planar – disk class: 75 (Fig. 5). The pebbles analysed originated from jasper, sandstone and quartzite.

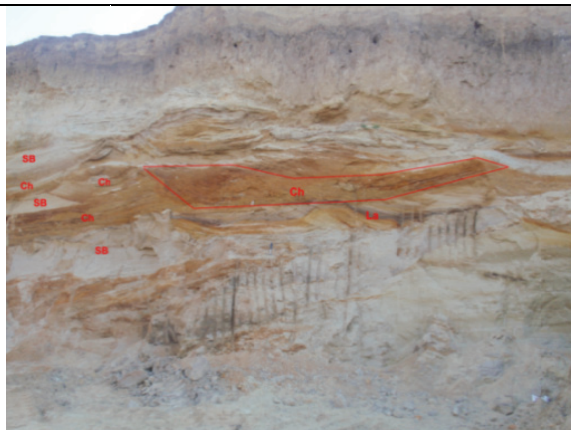


Photo 9. Ch and La (original).



Photo 10. Ch and SB (original).

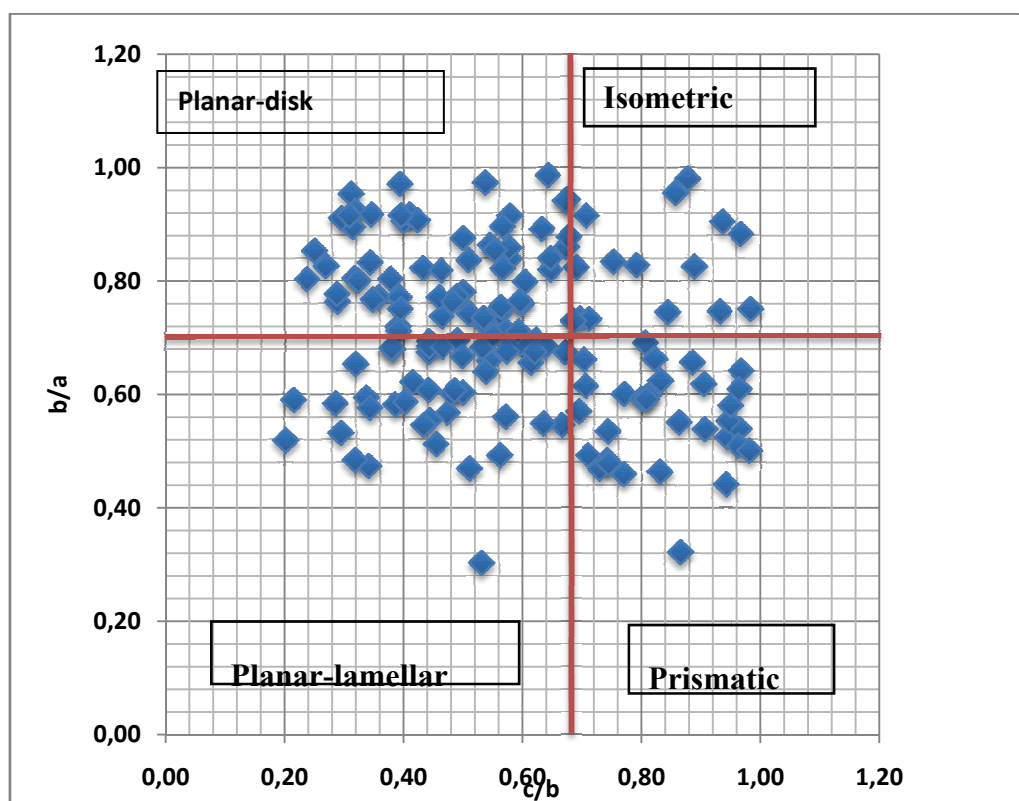


Figure 5. Zingg diagram with the distribution of the 150 pebbles in four classes.

PALAEONTOLOGY

Two kinds of fossils were collected in Simila open pit: the first are Miocene and refer to fossil wood fragments, invertebrates (molluscs) as well as to various vertebrates; the second ones are Quaternary and concern rather numerous mollusc shells belonging to Painter's Mussel [*Unio pictorum* (LINNAEUS, 1758)] and vertebrate remains.

Each of them have peculiar taphonomy: while all the Miocene fossils are in majority fragmentary, marked by a rather long transport, being reworked from older deposits, the Quaternary ones were always found as disarticulate teeth and bones, some of them being also transported by the water streams, but probably only on small distances.

Our study is focused on the vertebrate fossils, the following taxa being recorded in Simila open pit.

I. Miocene vertebrates

Class Reptilia LAURENTI 1768
 Order Chelonii BRONGNIARD (LATREILLE) 1800
 Family Testudinidae BATSCH 1788
 Testudinidae indet.

Plate I, Fig. 1

Numerous carapace fragments, extremely rolled by the fluvial transport were collected at Simila. Some of them allow an assignation to Testudinidae (e.g. VPMNSB C5270).

Remains of Testudinidae were reported from the Sarmatian (Late Bessarabian) deposits at Draxeni (Moldavian Platform) by CODREA & URSACHI (2007). Although found transported and buried in brackish littoral deposits, such remains are there widespread, indicating their rather high frequency in the continental Middle Sarmatian biota. Representatives of the genus *Protestudo* CHKHIKVADZE 1970 were also reported in the Middle Sarmatian-Meotian several localities in the Republic of Moldova (KHOSATZKY & REDKOZUBOV, 1989; LUNGU & RZEBIK-KOWALSKA, 2011).

Class Mammalia LINNAEUS 1758
 Order Rodentia BOWDICH 1821
 Castoridae GRAY 1821
 Castoridae indet. (cf. ?*Chalicomys jaegeri* KAUP 1832)

Plate I, Fig. 2

Only a fragment (VPMNSB C5271), belonging probably to a broken upper premolar or molar may be related to this group. The fragment is probably preserving a part of the paraflexus, mesostyle, paracone, mesoflexus and the posterior wall of the metacone. This cheek tooth could eventually belong to *C. jaegeri*, a castorid with a long Miocene history in Europe: first occurrence in MN4 unit, last occurrence in MN13, but typical for MN9 (HUGUENEY, 1999). It is the oldest Neogene castorid reported from Moldavia.

Ord. Perissodactyla OWEN 1848
 Genus *Hippotherium* VON MEYER 1829
Hippotherium sp. (cf. *Hippotherium primigenium* VON MEYER 1829)

Plate I, Fig. 3

Numerous hipparion teeth were collected at Simila open pit, but the majority is in a very poor state of preservation. A lot of this sample includes only fragments, clearly indicating a long transport by the river streams. Such fossils could be reworked either from the Upper Sarmatian (Khersonian), or from the Meotian deposits. Among these fragments, the most illustrative for instance are a heavy worn crown of a left P2 (VPMNSB C5272; crown length: 29.3 mm; crown breadth: 22.6 mm), and an upper incisor (VPMNSB C5273). The size, the presence of a double pli-caballin, as well as the high enamel plication in fossettes could suggest a representative of the *Hippotherium primigenium* group (BERNOR & ARMOUR-CHELU, 1999).

From the Republic of Moldova, such hipparions had been described as a distinct species, *Hipparion sarmaticum* LUNGU 1973 (LUNGU, 1984), largely distributed in the Middle and Late Bessarabian between the Prut and the Nester (LUNGU & RZEBIK-KOWALSKA, 2011). Same form of hipparions is reported in Moldova, starting with the Middle Bessarabian (COCHIOR & NECHITA, 1993) until the Late Sarmatian or perhaps the Early Meotian (RĂDULESCU et al., 1995; ȘTIUCĂ, 2003). In ALBERDI's (1989) viewpoint, such hipparions would be included in the group she called "morphotype 1".

Family Rhinocerotidae OWEN 1845
 Tribe Aceratherini DOLLO 1885
 Aceratherini indet.
 Plate I, Figs. 4; 5

Several teeth fragments belonging to rhinoceros were collected at Simila, but only a single one is enough diagnostic for a convenient systematic assignation (VPMNSB C5274). It is a fragment of a right P2, preserving a root and a portion of the crown with the whole ectoloph. The ectoloph (length: 29.1 mm) is labially convex and at this wearing, practically unfolded, although a reminiscent metacone fold can be however, noted. A continuous, but not very strong labial cingulum is present.

The tooth size is rather small, smaller than in *Aceratherium incisivum* KAUP 1832 (GUÉRIN, 1980), a frequent rhinoceros in the Late Miocene of Moldova (CODREA, 2000). This size could correspond to *Aceratherium* (*Alicornops*) *simorreense* LARTET 1851, a small rhinoceros which stratigraphic range in Western Europe is in MN6-MN10 units time span (GUÉRIN, 1980), recorded also in the Republic of Moldova (as the subspecies *Aceratherium* (*Alicornops*) *simorreense orientalis* LUNGU 1984) in the Middle and Late Bessarabian (LUNGU, 1984; LUNGU & RZEBIK-KOWALSKA, 2011). But same sizes of such teeth is mentioned also in other rhinoceros finds, as "*Aceratherium simplex*" (KROKOS, 1914). Even if the available characters are very scarce on such a fragmented and worn premolar, we consider that it belonged to an acerathere and not to a *Chilotherium*, *Acerorhinus* or *Dihoplus* representative (KROKOS, 1917; KOROTKEVICH, 1970; GERAADS & SPASSOV, 2009) based on the estimated low hypsodonty and size.

Ord. Artiodactyla OWEN 1848

Family Cervidae GRAY 1821

Cervidae indet.

Plate I, Fig. 6

A single antler fragment (VPMNSB C5276) could document unambiguously the presence of cervids at Simila. Although broken and heavily rolled, this beam with surface marked by irregular dispersed longitudinal grooves, clearly was positioned near an antler dichotomy. The size, as well as the antler outline is very close to the ones known in *Procapreolus* SCHLOSSER 1924, a genus widely distributed in Eastern Europe in the Late Miocene (DIMITRIEVIĆ & KNEŽEVIĆ, 1988; KRAKHMALNAYA, 2008; LUNGU & RZEBIK-KOWALSKA, 2011), when it occurred in this area (VALLI, 2010).

Subfamily Antilopinae BAIRD 1857

Antilopinae indet. (cf. *Gazella* BLAINVILLE 1816)

Plate I, Fig. 7

Few horn fragments could be related to Antilopinae, but the most diagnostic is a fragment of a middle portion of a horn (VPMNSB C 5277; transverse diameter of the horn: 15.14 mm; antero-posterior diameter: 13.13 mm), marked by longitudinal narrow grooves, arched backward, document most probably a representative of *Gazella*. Such presence would not be surprising, as long as gazelles are known in neighbourhood areas both in the Republic of Moldova (LUNGU & RZEBIK-KOWALSKA, 2011) and Ukraine (KRAKHMALNAYA, 2008) in the Late Sarmatian and the Lower and Middle Meotian.

II. Pleistocene vertebrates

Order Proboscidea ILLINGER 1811

Family Elephantidae GRAY 1821

Elephantidae indet.

Plate I, Fig. 8

Only few tusk fragments (VPMNSB C5278), in a very poor preservation document the presence of mammoths at Simila. These remains could belong to *M. primigenius* (BLUMENBACH 1799), but these fossils are too damaged for a clear assignment.

Family Rhinocerotidae GRAY 1821

Genus *Stephanorhinus* KRETZOÏ 1942

Stephanorhinus hemitoechus (FALCONER 1868)

Plate I, Fig. 9

An isolated upper right P4 crown (VPMNSB C5279; crown length: 39.8 mm; crown breadth: 62.0 mm; high of ectoloph: 15.0 mm) extremely worn, with broken roots, can be assigned to this species. The dimensions are in accordance with the ones indicated by GUÉRIN (1980) for this species. The ectoloph is inclined and short. The occlusion surface has an oblong outline. At this wearing few morphologic details can be observed, but obviously any crista, crochet or anticrochet were present. On any side, there is no cingulum. Cement is still adhering to ectoloph.

According to GUÉRIN (1980), this rhinoceros first occurred in Western Europe since the Middle Pleistocene (GUÉRIN's Zone 22) until the Late Pleistocene (Zone 26). It was a prairie dweller, but it could occur in woody environments too (GUÉRIN, 1980; ORAIN et al., 2013). In the Middle and Late Pleistocene, the "steppe rhino" *S. hemitoechus* was gradually replaced by *Coelodonta* (KAHLKE & LACOMBAT, 2008), and certainly this process progressed from east towards western areas of Europe. In such circumstances, the Simila deposits could be even older than the Weichsel/Würm glacial. It is the first record of this Pleistocene rhinoceros in Moldova.

Ord. Artiodactyla Owen 1848

Family Cervidae GOLDFUSS 1820

Genus *Megaloceros* BROOKES 1828

Megaloceros giganteus (BLUMENBACH 1803)

Plate I, Fig. 10

A fragment of a right antler (VPMNSB C5280) was unearthed near the base of the fluvial deposits in Simila open pit (Fig. 3). It concerns a broken beam, with the first and second tines, as well as the "palmation" broken too. The morphology of the antler resembles the one from Worms (Germany; POHLIG, 1892; LISTER, 1994). The morphology of antlers in *Megaloceros* is of low utility for the species stratigraphy, the variability being high. A similar morphology is recorded in Transylvania, in specimens as the one from Ciubanca (Cluj County; SZENTPÉTERY, 1911). CODREA & SOLOMON (2011) recently discussed the stratigraphic distribution of this species; therefore, we will not renew such a discussion. In Bârlad region, the giant deer was reported from Zorleni (CODREA et al., 2011).

CONCLUSIONS

A total of eight lithofacies types and three architectural elements were outlined. The sedimentological study of Simila deposits indicates that these rocks belong to a fluvial environment. The absence of additional outcrops in Simila

open pit area is an odd in establishing a trend of the ancient river flows and sedimentary input within the fluvial deposits. The facies analysis outlined a braided river environment with low sinuosity channels. Facies indicative for deposition from suspension or low velocity currents are absent. Palaeocurrent data indicate a prevailing SE to SW direction for the main clastic transport. The morphometric analysis on the 150 pebbles by the classical Zingg's method indicates a frequency of the planar-disk class.

We consider that the Sarmatian molluscs collected in the channel fill deposits are nothing but plain and simple reworked from older deposits largely exposed in the northeastern and northwestern areas of Vaslui County by the Pleistocene fluvial network, as the sedimentological study demonstrates now. The description of several Miocene mollusc taxa collected at Simila by BEJAN et al. (2012) was a useful paleontological study, but the deposits bearing these molluscs at Simila and Sâlcioara are certainly not Late Sarmatian (Khersonian), as their study tried to conclude. Same reworked status has the fossil wood fragments and all the Miocene vertebrate remains reported now at Simila.

The Pleistocene large herbivores give the correct geological age for the sands and gravels from this open pit. As the giant deer remains were collected near the base of the outcrop, it is obvious that all this sedimentary succession is most probably Late Pleistocene. The presence of the "steppe rhino" could argue for an older age of the Simila sands and gravels than Weichsel/Würm glacial. For an advanced stratigraphy at Simila open pit, a richer sample of fossils is needed, but the promising potential of these deposits is an argument for such further results.

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Plate I : Fossil vertebrates from Simila open-pit, Vaslui County



Miocene fossils:

- Fig. 1: Testudinidae indet., plate fragment (VPMNSB C5270).
 Fig. 2: Castoridae indet. (cf. *Chalicomysjaegeri*) ? upper cheek tooth fragment (VPMNSB C5271).
 Fig. 3: *Hippotherium* sp. (cf. *Hippotherium primigenium*), left upper P2, occlusal view (VPMNSB C5272).
 Fig. 4: Aceratherini indet., upper cheek tooth fragment (VPMNSB C5275).
 Fig. 5: Aceratherini indet., right upper P2 fragment, labial view (VPMNSB C5274).
 Fig. 6: Cervidae indet., antler fragment (VPMNSB C5276).
 Fig. 7: Antilopinae indet. (cf. *Gazella*), horn fragment (VPMNSB C 5277).

Pleistocene fossils:

- Fig. 8: Elephantidae indet., damaged tusk fragment (VPMNSB C 5278).
 Fig. 9: *Stephanorhinus hemitoechus*, upper right P4, occlusal view (VPMNSB C 5279).
 Fig. 10: *Megaloceros giganteus*, right antler fragment, front view (VPMNSB C 5280).