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The early Vallesian vertebrates of Atzelsdorf (Late Miocene, Austria). 2. Geology

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(With 3 figures)

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Abstract

Excavations of the Natural History Museum Vienna and the activity of collectors at the Atzelsdorf section in Lower Austria resulted in a large amount of Late Miocene (early Pannonian) vertebrate remains. These fossils are concentrated in a single crevasse-splay deposit in the fluvial Hollabrunn-Mistelbach Formation. In the region of Atzelsdorf, this formation was formed by distributary channel which was part of the delta of the palaeo-Danube. A marked change of lithology in the upper part of the section resulted from a major transgression of Lake Pannon into that delta. Based on correlations with well-logs and seismic data from the Vienna Basin, this transgression can be dated at c. 11.0-11.1 ma. Due to the event-like nature of the accumulation, the vertebrates are interpreted to represent a faunistic snap-shot of few hundreds to thousands of years, and are a rare chance to evaluate the vertebrate communities in the palaeo-Danube delta.

Keywords: Pannonian, Vallesian, Lake Pannon, Hollabrunn-Mistelbach Formation

Zusammenfassung

Ausgrabungen des Naturhistorischen Museums und die Aktivitäten von Privatsammlern an der Fundstelle Atzelsdorf (NÖ) resultierten in einer umfangreichen Sammlung an Wirbeltierresten des späten Miozäns (frühes Pannonium). Die Fossilien sind in einer einzelnen Lage konzentriert, die als Schwemmfächer innerhalb der Hollabrunn-Mistelbach-Formation interpretiert wird.

In der Region rund um Atzelsdorf wurde diese Formation durch einen kies-dominierten Seitenarm der Paläo-Donau gebildet. Ein deutlicher lithologischer Wechsel im oberen Teil der Abfolge wurde durch einen Vorstoß des Pannonischen Sees in dieses Delta verursacht. Basierend auf Korrelationen mit Bohrlochmessungen und seismischen Untersuchungen im Wiener Becken kann diese Transgression auf etwa 11,0-11,1 Mio. Jahre datiert werden. Aufgrund der event-artigen Natur der Akkumulation dürften die Wirbeltierfossilien einen faunistischen Schnappschuss repräsentieren, der eine der seltenen Gelegenheiten bietet, die Wirbeltiergesellschaften des Paläo-Donaudeltas aus einem nur wenige hunderte bis tausend Jahre umfassenden Intervall zu studieren.

Schlüsselwörter: Pannonium, Vallesium, Pannonischer See, Hollabrunn-Mistelbach-Formation

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Introduction

Several sections with early Vallesian vertebrate assemblages are recorded around the Vienna Basin and the adjacent North Alpine Foreland Basin (NAFB) (e.g.: Grill 1968; Pia & Sickenberg 1934; Zapfe 1949; Daxner-Höck 1975, 1996, 2000). These are all associated with the deposits of the Late Miocene palaeo-Danube and its delta. Consequently, the scattered vertebrate remains derive from numerous gravel pits which usually lack a reliable dating. Especially the interrelation between most of the sections is vague. To overcome the problem, that classical museum-based "faunas" may often reflect various horizons even if coming from a single locality, an excavation of the Natural History Museum in 2003 tried to exploit a distinct vertebrate-bearing horizon at the Atzelsdorf section (unit 2; fig. 1).

Geographic and geological setting

The studied section is an abandoned gravel pit (N 48° 30.62'; E 16° 21.65') in the NW of the Atzelsdorf village in Lower Austria (fig. 1). It lies at the western margin of the Vienna Basin on the Kronberg uplifted block which is part of the larger Mistelbach block. This tectonic unit separates the deeper Vienna Basin from the North Alpine Foreland. It is delimitated towards the basin by the Bisamberg and Steinberg faults and towards the NAFB by the Waschberg Unit (Grill 1968; Wessely 2006). During the Late Miocene, the palaeo-Danube followed the eastern part of the NAFB as gravel-bed river, crossed the Waschberg Unit through the Zaya Gate and entered the Vienna Basin via the Mistelbach block, where it changed into a braid-delta system (fig. 1). The associated sediments are united into the Hollabrunn-Mistelbach Formation (HMF). A very detailed description of the lithofacies and sedimentary environments of the HMF is given in Nehyba & Roetzel (2004). At that time, the palaeo-Danube discharged in the Vienna Basin into Lake Pannon where the siliciclastics of the HMF intercalate into the mainly pelitic Bzenec Formation (Harzhauser et al. 2004; see Magyar et al. 1999 and Harzhauser & Mandic 2008 for details on Lake Pannon).

Lithology

During excavation a total thickness of 13 m gravel, sand and marls have been exposed (fig. 2). Now (2008) only the uppermost 5 m are still accessible. The following description follows largely the detailed facies analysis of the Hollabrunn Mistelbach Formation of Nehyba & Roetzel (2004).

Unit 1. The basal unit of >1 m thickness is a succession of moderately sorted polymict fine gravel and coarse sand with low dip-angle cross-stratification. A c. 20-cm-thick layer of greenish clay is intercalated. Scattered mud-clasts occur within the upper part of the gravel. This gravel is overlain by 20-25 cm of cross-stratified coarse sand with bioturbations penetrating few centimetres down from the foresets.

Unit 2. Above follows an up to 35-cm-thick layer of poorly sorted coarse sand, fine and medium gravel with numerous, unsorted mud-clasts of up to 15 cm diameter. The base is erosive and the thickness fluctuates strongly. Especially the upper parts of the thicker

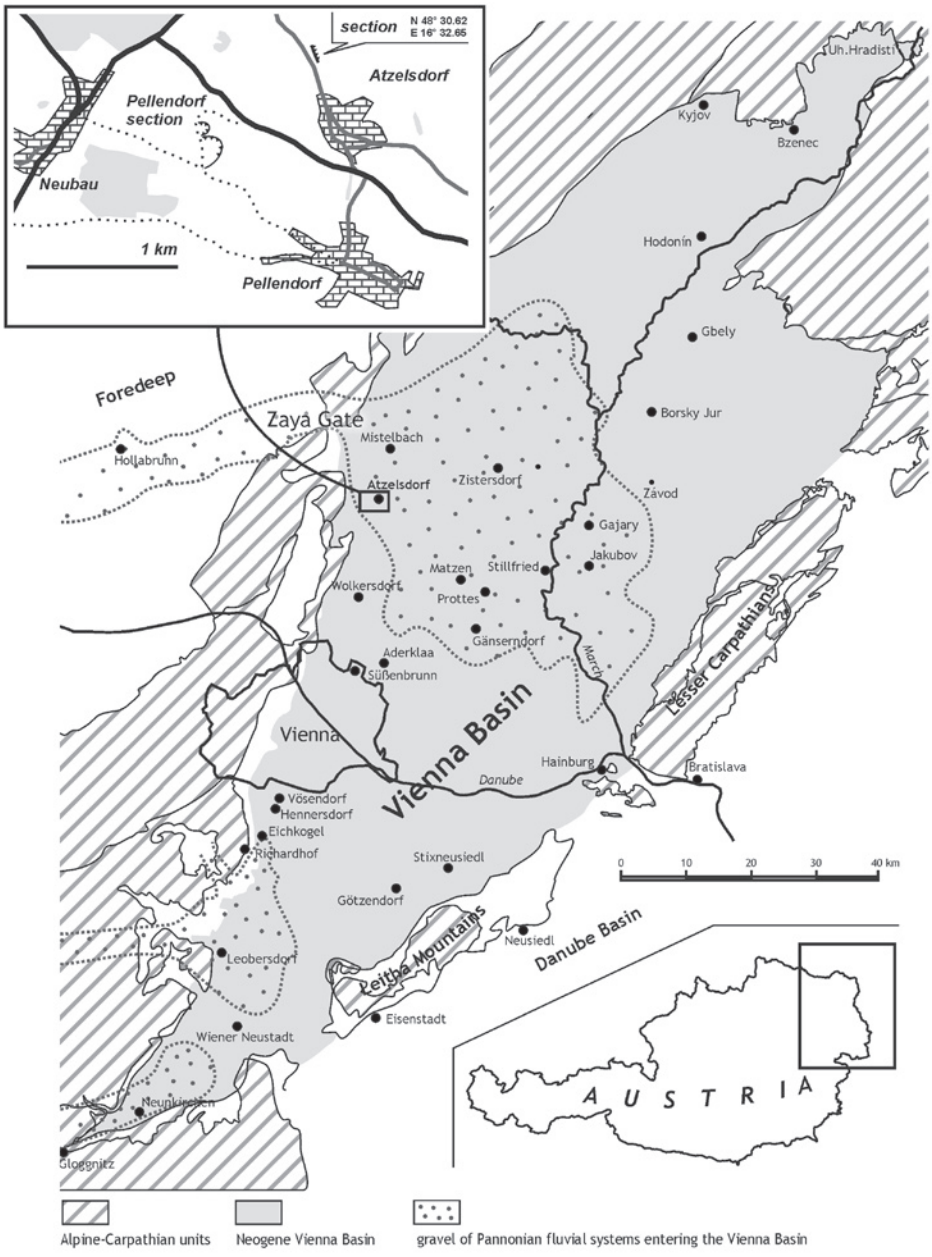

Fig. 1. Geographic and geologic position of the section (modified from HARZHAUSER et al. 2003; 2004).

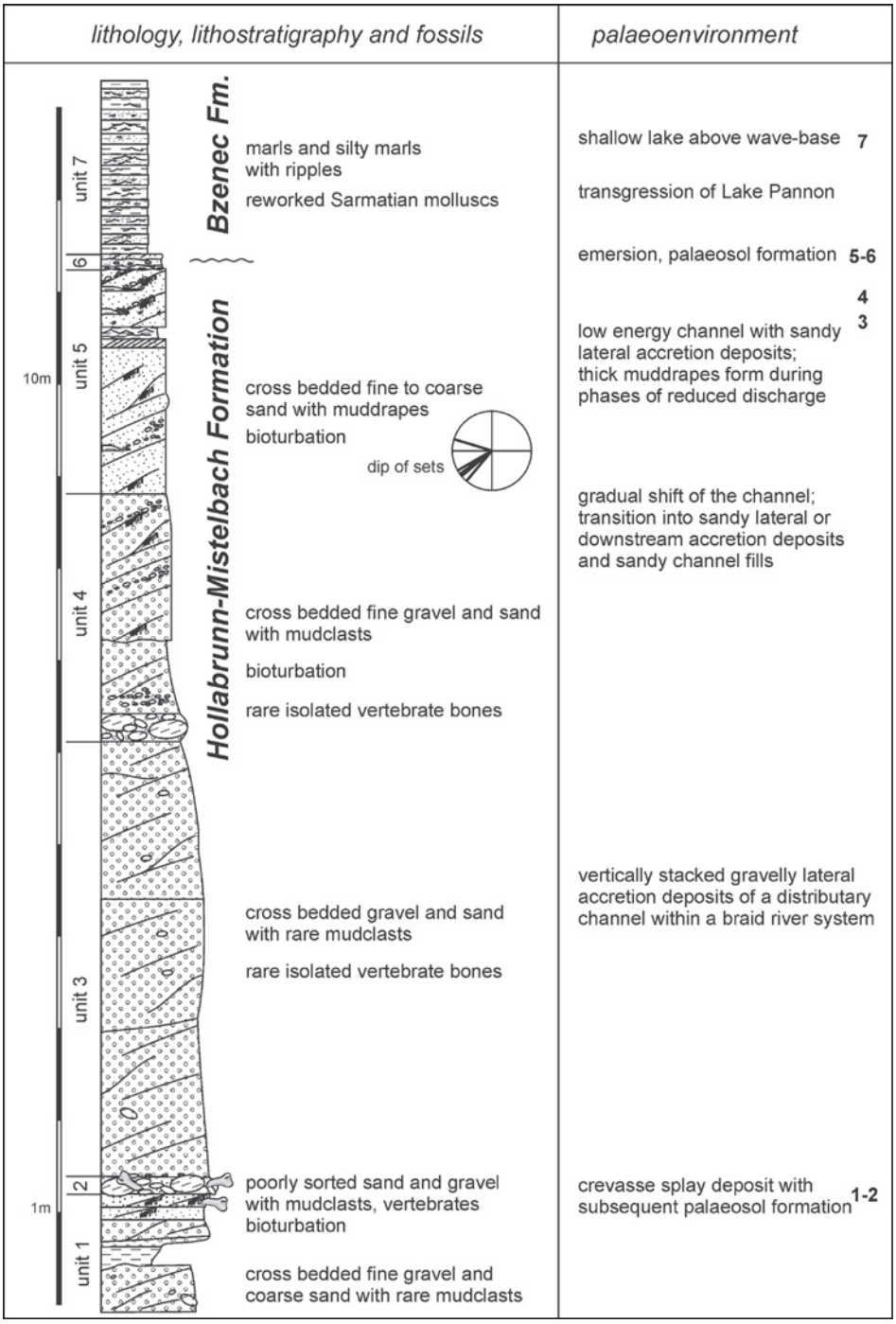

Fig. 2. Lithological log of the Atzelsdorf section with lithostratigraphic affiliations and interpretations of depositional environments. The vertebrate remains, described in this volume, have been nearly exclusively collected in unit 2. The numbers on the right refer to figure 3.

areas display palaeosol formation by dark-brown colouring and rare calcrete concretions. This unit bears disarticulated vertebrate remains, which are very irregularly dispersed and frequently fractured. Plant debris, small pieces of lignite and rare and poorly preserved remains of helicid gastropods occur as well.

Unit 3 is formed by 480 cm of moderately sorted fine to medium gravel and gravely sand with rare mud-clasts. The gravels are clast supported but high amounts of medium to coarse sand form the matrix. Open-fabric gravels are absent. Distinct stratification is caused by flat trough to planar cross-stratified sets of alternating sand-gravel dominance. The dip angles are low (10-14°) and the thickness of sets ranges from 10-30 cm. Smaller scaled sigmoidal foresets may occur as well and are usually related to isolated dunes of gravely sand and gravel lenses of about 1 m length and 5-10 cm in height. Very rarely isolated vertebrate remains are found in these lenses.

Unit 4 consists of about 3 m of whitish cross bedded fine gravel and sand, being separated from unit 3 by a 20-cm-thick layer of mud-clasts. The sets are trough shaped or sigmoidal and attain heights of up to 10-20 cm and dip-angles of up to 15°. Bases of the forests are frequently erosive and cannibalise adjacent sets. Mud-clasts, consisting of greenish mudstone, cover the foresets and are accumulating in front of the sets. Bioturbations consisting of 1-4 mm thick limonitic vertical burrows occur especially in the upper part of the foresets. These bioturbations are reminiscent of roots but display a tendency to branch towards the surface.

Unit 5. About 240 cm of yellowish medium sand follow. Cross bedding is steep and characteristic drapes of laminated mudstone cover the foresets. These drapes attain up to 8 cm thickness and become strongly disintegrated into angular mud-clasts along the slopes of the sets (Fig.3/4). Laterally, in front of the sandy foresets, the drapes are already fully destroyed and only layers of rounded mud-clasts indicate their former presence (Fig. 3/3). The large sigmoidal foresets display dip angles of 20-30°. Bioturbations as in unit 4 are very common. Units 3, 4 and 5 reflect a general fining upward trend and form a genetic succession. The entire unit is strongly coloured by ground-water related iron-oxides and iron-hydroxides which frequently pretend steep cross-stratifications.

Unit 6. The sandy foresets are erosively overlain by a 10-cm-thick unit which starts with dark-brown planar sandstone containing rare quartz-pebbles of up to 4 cm diameter and reworked Sarmatian gastropods (*Granulolabium bicinctum*). This 3-4-cm-thick part grades irregularly into a whitish calcrete layer which bears dispersed dark-brown sand-lenses and large calcareous concretions. Dark-brown colouring, related to palaeosol formation, may sometimes penetrate down into the top of unit 5.

Unit 7. A rhythmic succession of marl and silty marl intercalations of 5-10 cm thickness form the upper 2 m of the section. Silty intercalations display ripple-bedding whilst the marl intercalations are laminated. Mollusc shells of reworked Sarmatian deposits of the Upper *Ervilia* Zone are frequent (*Sarmatimactra vitaliana*, *Venerupis gregarius*, *Granulolabium bicinctum*). Leave imprints are rare.

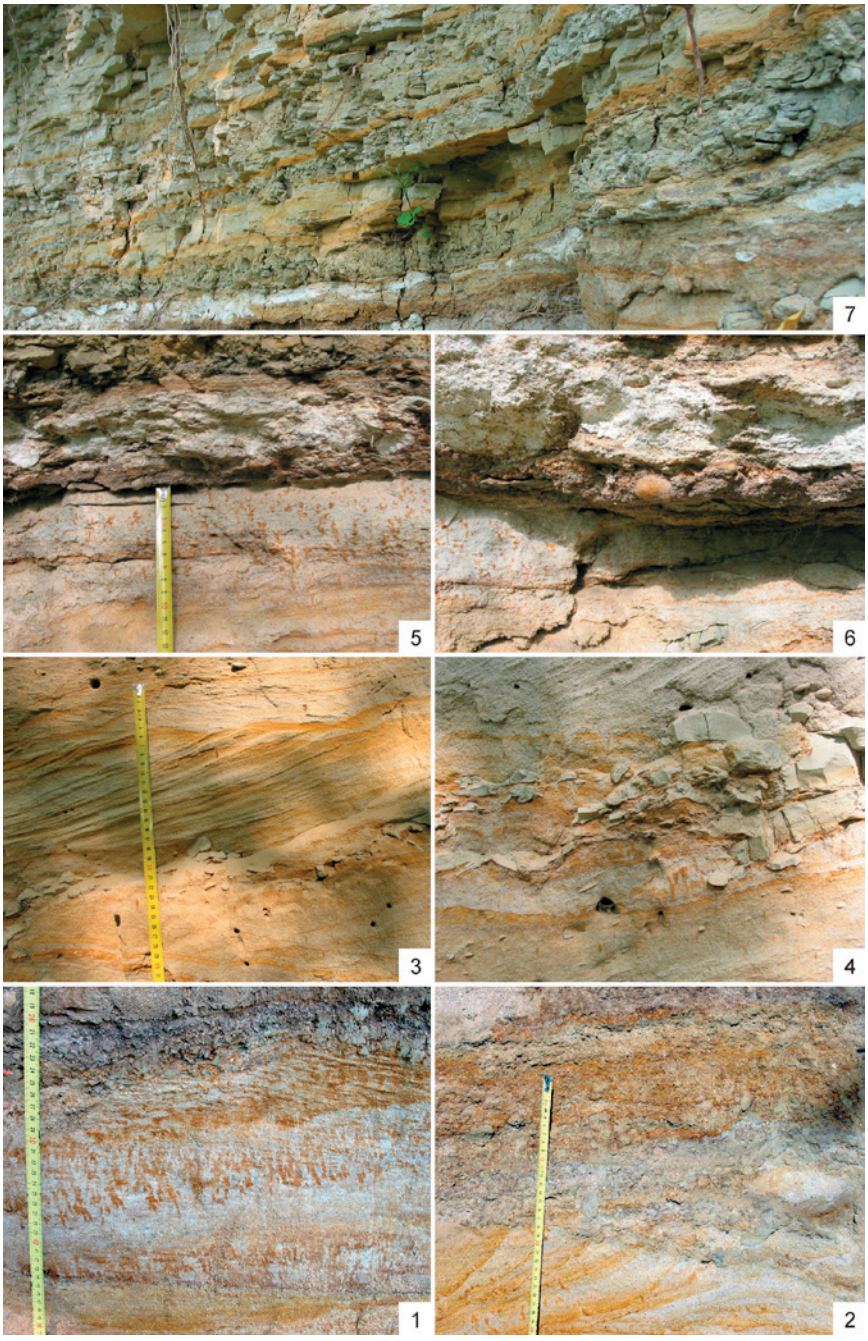

Fig. 3. Pictures of the excavated section. 1-2: the vertebrate bearing crevasse splay of unit 2 erosively overlaying bioturbated fine gravel of unit 1. 3-4: cross-bedded sand of unit 5 with partly disintegrated mud-drapes. 5-6: palaeosol and calcrete formation with scattered quartz pebbles of unit 6 overlaying bioturbated sand of unit 5. 7: marls and silty marls of the Bzenec Formation reflect the transgression of Lake Pannon.

Lithostratigraphy

Units 1-6 represent typical deposits of the Hollabrunn-Mistelbach Formation. The marls and silty marls of unit 7 reflect the transgression of Lake Pannon into the delta wetlands and thus are treated as part of the Bzenec Formation (NEHYBA & ROETZEL 2004; HARZHAUSER et al. 2004). The identical flooding surface is outcropping 1,100 m in the SW at the Pellendorf section where the lake marls contain *Congeria partschi* (HARZHAUSER et al. 2003).

Integrated stratigraphy and age

No absolute dating exists for the section. The age estimation is thus based on cross-correlations and an integrated stratigraphy. The most important feature is the flooding surface between unit 6 and unit 7 due to a major transgression of Lake Pannon. This flooding surface is traceable in seismic surveys and in geophysical well-logs close to the Mistelbach block as described in HARZHAUSER et al. (2004). Following their age-model, the flooding surface falls within the Vienna Basin Pannonian Zone C and corresponds to an absolute age of c. 11.0-11.1 ma.

Interpretation

Units 1-6 formed within an early Late Miocene braid river system (NEHYBA & ROETZEL, 2004). This braid river system developed after the narrow passage of the Zaya Gate on the Mistelbach block from a gravel-bed river.

At the section, the lowermost part might represent the late fill of a distributary channel with sandy cross-bedding. The intercalated mudstone bed might represent overbank deposits which partly became eroded and reworked by a crevasse splay, which is reflected by unit 2. Poorly sorted sand and gravel with rounded and angular mud-clasts were deposited together with a huge number of vertebrate teeth and bones, plant debris and terrestrial gastropods. Thereafter, palaeosol formation took place leading to staining of the underlying sediment and scattered calcrete formation. The shift or re-appearance of a distributary channel caused partial erosion of the crevasse splay deposits. Above follows a succession of vertically stacked gravelly lateral accretion deposits which grade into sandy lateral or downstream accretion deposits and sandy channel fills (units 3-5). The fining upward trend and the reduction of transport energy are also documented by the increase of mudstone thickness. Low energy phases become frequent in unit 5, being reflected in mud-drapes and bioturbation of the then stable sandbars. During episodes of higher discharge, the drapes become reworked especially at the lee-sides of the bars. The dip directions of the foresets suggest a general migration direction of the sandbars in south-western direction. The position of the outcrop in the south-western margin of the delta (fig. 1) as well as the south-western propagation direction indicates that the river channel at Atzelsdorf was rather an anabranch, as the general transport of the palaeo-Danube was oriented towards the east or south-east. The partly very complex geometry of the bedforms in the HMF, as described by NEHYBA & ROETZEL (2004), however, calls for attention when interpreting the few foresets at Atzelsdorf in a too

naïve way. Later, the channel disappeared and the deposits became subaeral as part of the interdistributary area. Thin sheets of poorly sorted sand with numerous reworked Sarmatian gastropods may be related to overbank deposits. Soil-forming processes altered these sands and a laterally traceable layer of calcrete formed during exposure. Eroded tops of the foresets in unit 5 suggest that parts of this unit became eroded during this phase. Thereafter, the entire palaeo-Danube delta on the Mistelbach block became flooded by Lake Pannon during the Vienna Basin Pannonian Zone C. At the Atzelsdorf section very shallow lacustrine conditions established, reflected by ripple formation. The rising lake level caused erosion of the widespread Sarmatian deposits and caused the accumulation of reworked bivalve and gastropod shells. Some 1100 m to the SW, at the Pellendorf section, this ingression is reflected by clays that were deposited below wave base (HARZHAUSER et al. 2003). In 3D seismic surveys in the adjacent Vienna Basin, this intense perturbation of the wetlands and of the river course is reflected by a strong switch of delta lobes (pers. comm. P. STRAUSS, OMV-AG).

Conclusion

The most important feature of the vertebrate fauna of Atzelsdorf is its low time-averaging. It represents a single crevasse splay event and thus has accumulated the remains of a geologically very short time span of few thousand years. The position of the section in an anabranch of the palaeo-Danube warrants that all individuals derive from a few km^2 within the wetland area of the delta. The taphonomic bias by time averaging and long fluvial transport, as typical in the Hollabrunn-Mistelbach Formation, is low. However, the small amount of smaller mammals documents, that even this snapshot assemblage is suffering from a very selective spectrum. No such event-horizon is recorded so far from the surroundings of Lake Pannon. Moreover, the flooding surface related to the ingression of Lake Pannon, topping the vertebrate bearing deltaic section, allows the first correlation of a Hollabrunn-Mistelbach Formation site with wells of the Vienna Basin.

Based on well-log correlations and the age-model of HARZHAUSER et al. (2004), the age of the flooding may range from c. 11.1-11.0 ma. Assuming that only little time is represented by the thin palaeosol formation below the flooding surface, the age of the Atzelsdorf mammal assemblage may be estimated to range around 11.2-11.1 ma. Hence, the fauna of Atzelsdorf may serve as marker for comparisons and correlations of other Vallesian faunas in Central Europe.

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