Geomorphological and paleoseismological investigations on the Gaenserndorf Terrace in the central Vienna Basin (Austria)

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Abstract: *In the central Vienna Basin normal faults define the eastern and western margins of Pleistocene Danube terraces north of Vienna. The terrace body is built up of coarse sandy gravel and sand. The gravels are locally covered with eolian sand and loess of the last glacial revealing OSL/IRSL ages of about 15 ka. High resolution digital terrain models (LIDAR) show relicts of a periglacial landscape in the northern part of the MIS 8 terrace. Large elongated depressions are interpreted as the basins of former thermokarst lakes due to analogies in recent periglacial zones, and presently dry valleys which are interpreted as the outflows of these lakes and drainages of the terrace surface. The periglacial morphology on the terrace is only preserved in the elevated part of the terrace which is located in the footwall of the bounding normal faults. In the hanging wall Quaternary basins are filled with up to 40 m thick Pleistocene and Holocene growth strata.*

Key words: *Vienna Basin, Paleoseismological Trenching, Geomorphology of the Quaternary.*

INTRODUCTION

The Vienna Basin is a SSW-NNE oriented Neogene basin of about 200 km length and 55 km width. It extends from the eastern Alps in Austria to the western Carpathians in the Czech Republic. This noticeable crustal-scale pull-apart basin evolved between two left stepping segments of a major sinistral transform system with basin subsidence starting in the early Middle Miocene. Recent analyses of Miocene and active tectonics show that a number of Miocene faults form offsets or boundaries between Middle and Late Pleistocene deposits. These faults are consequently regarded as active and capable of generating severe earthquakes with magnitudes up to M ~ 7 (Fig. 1).

Active kinematics is characterized by a seismically active sinistral strike-slip fault system, which is located at the SE margin of the Miocene basin. This fault system splits up into a number of normal fault splays crossing the basin. Geological, geophysical and geomorphological mapping reveal seven normal faults of that type in the central part of the Vienna Basin. Even though those splay faults do not show any historical or instrumental seismicity, geological and morphological data proof that they moved at very slow velocities of <0.1mm/a during the Quaternary (Decker et al., 2005).

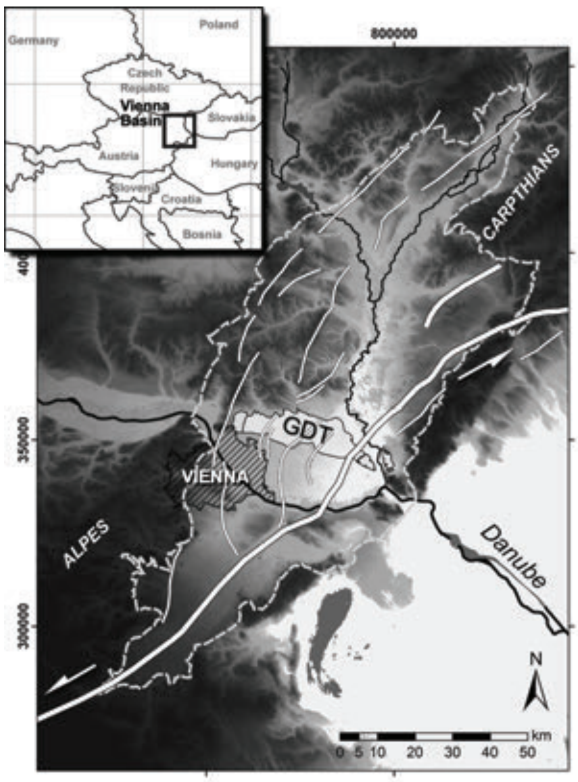
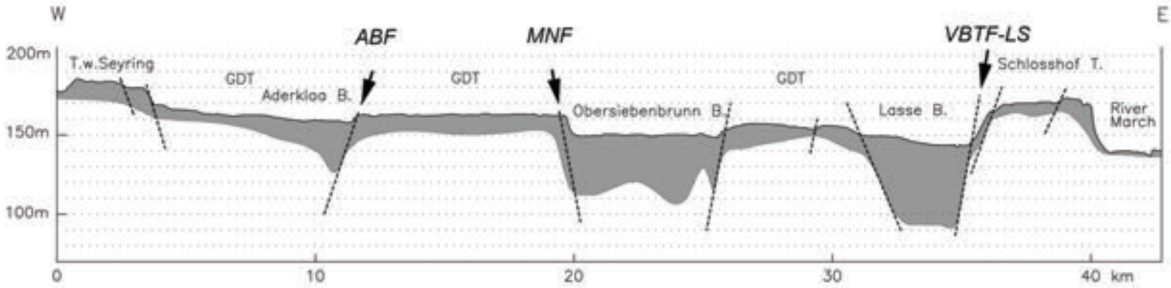


Figure 1: The Vienna Basin Transfer Fault (VBTF) and splay faults dissecting the Gänserndorf Terrace (GDT) in the central basin. Coordinates are Gauss Kruger, MGI M34.

THE PLEISTOCENE GÄNSERNDORF TERRACE

The central Vienna Basin is covered by wide floodplains of the Danube River and the Morava River. A Pleistocene river terrace extending from Vienna to the Carpathian Mountains in Slovakia is called Gänserndorf Terrace (GDT).



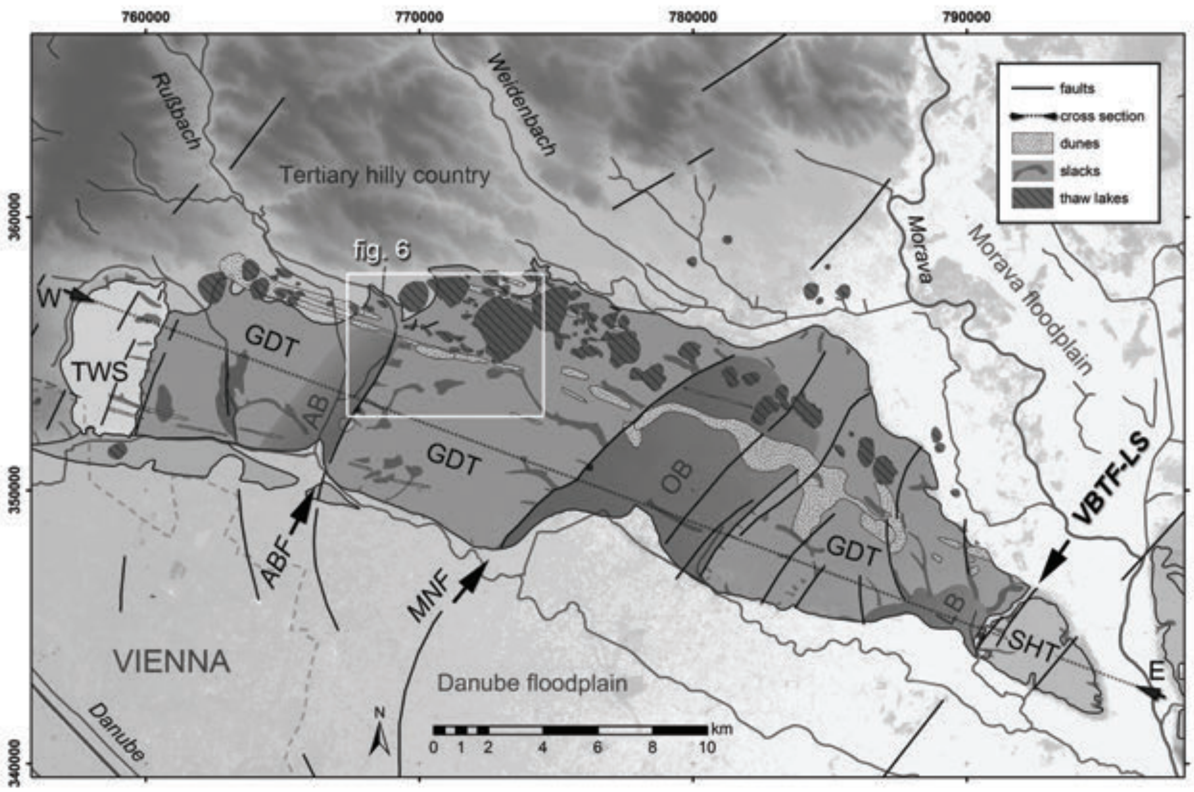


Figure 2: (above): DEM based cross-section of the Vienna Basin and thickness of the Quarternary sediments based on drilling data. Faults: Aderklaa-Bockfliess Fault (ABF); Markgrafneusiedl Fault (MNF); Lassee segment of the Vienna Basin Transfer Fault (VBTF-LS).

Figure 3: (below): Geomorphology of the Central Vienna Basin area: Gänserndorf Terrace (GDT); Terrace west of Seyring (TWS); Schlosshof Terrace (SHT); Basins: Aderklaa Basin (AB); Obersiebenbrunn Basin (OB); Lassee Basin (LB).

The terrace body consists of coarse sandy gravel and sand. Usually, those Quaternary river sediments reach a height of about 10 m on the terrace. Due to tectonic subsidence in the basins the sandy gravels accumulated to a thickness of about 30 m in the Aderklaa Basin, 40 m in the Obersiebenbrunn Basin, and 60 m in the Lassee Basin (Fig. 2).

Infrared Stimulated Luminescence (IRSL) age data reveals ages between about 300 and 200 ka (MIS 8) for the gravel terrace (Fiebig et al., 2011). The gravels are locally covered with loess of the last glacial revealing SL/IRSL ages of about 15 ka.

Several parallelly striking faults cross the the GDT (Fig. 3). In the western part the NW-dipping Aderklaa-Bockfliess normal fault forms a distinct fault scarp with a height up to 5 m. In the central part, this terrace is offset by the SE-dipping Markgrafneusiedl normal fault which forms an up to 17 m high fault scarp. In the East, the Lassee segment of the Vienna Basin Transfer Fault (VBTF) produced a ~25 m high NW-dipping fault scarp forming the margin of the so called Schlosshof Terrace (SHT). IRSL dating of terrace sediments revealed MIS 8 ages indicating the tectonic subsidence of the GDT relative to the Schlosshof terrace since the Pleistocene.

In the South, the erosional forces of the River Danube form the terrace margins. In the North, the terrace adjoins to the slopes of the Tertiary hilly country and the erosional force of the Weidenbach river valley.

SURVEYING

Miocene and active tectonics in the Vienna Basin have been analysed since 10 years. It is obvious that the Miocene faults can offset and delimit Middle to Late Pleistocene and Holocene deposits. But the interpretation is not easy in many cases because erosional, glacial and anthropogenic processes can produce similar morphological features as active faults.
During earlier projects, faults were investigated at places in the central parts of the Gaenserndorf terrace and on the western slope of the Schlosshof terrace. The Aderklaa-Bockließ Fault, Markrafneusiedl Fault, and the Lassee segment of the VBTF were investigated at three sites by paleoseismological trenches (Fig. 4. Chwatal et al., 2005; Hintersberger et al., in press). All fault scarps were surveyed by a series of GPR profiles, reflection seismic, and resistivity profiles to localize the fault precisely (measurement and processing by the Technical University of Vienna).
The West-Austria-Gasleitung (WAG-Pipeline) crosses the Gänserndorf terrace in East-West direction in its northern part. During the construction of the pipeline some faults were observed in the trench walls (Posch-Trözmüller & Peresson, 2010).

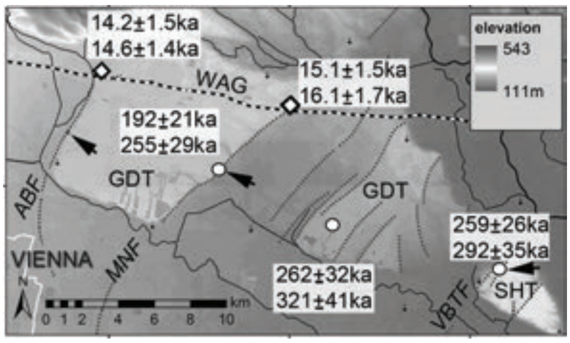


Figure 4: OSL-ages of the Pleistocene river terrace sediments (circles) and of the eolian/alluvial cover (diamonds); trench sites (arrows); course of the WAG pipeline: dashed line; terraces: Gänserndorf terrace (GDT); Schlosshof terrace (SHT); faults: Aderklaa-Bockfliess fault (ABF); Markgrafneusiedl fault (MNF); Vienna Basin Transfer Fault (VBTF). OSL ages (Fiebig et al., 2011).

Especially the normal fault of the Markgrafneusiedl Fault is well documented (Fig. 5). The margin between the hanging wall of the Obersiebenbrunn Basin and the foot wall of the Gänserndorf Terrace is clearly visible. The sandy sediments of the subsided Basin in the East adjoin the gravels of the Terrace in the West.

PERIGLACIAL MORPHOLOGY

DEM, high resolution digital terrain models (LIDAR) and satellite images show relicts of a periglacial landscape (Fig. 6). Large elongated depressions in the northern part of the GDT terrace are interpreted as the basins of former thermokarst lakes due to analogies in recent periglacial zones (Grosse et al, 2013). Presently dry valleys are interpreted as the outflows of these lakes.

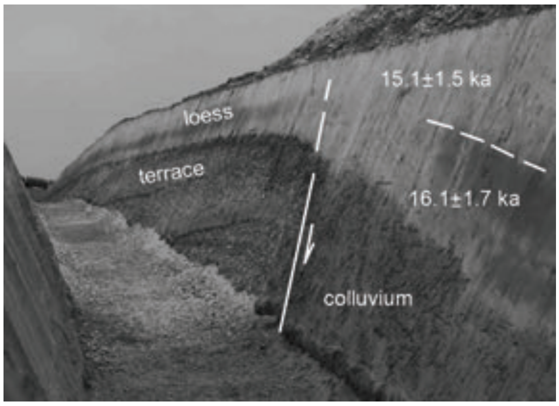


Figure 5: Markgrafneusiedl fault exposed in the pipeline construction pit WAG. The fault cuts off the deposits of the Gänserndorf terrace and also displaces the overlying loess. Numbers refer to sediment ages determined by IRSL/OSL techniques.

The central part of the GDT is characterized of eolian sand cover and wind parallel dunes (Fink, 1955; Wiesbauer et al., 1997). Depressions and dry valleys in this zone are interpreted as slacks drainaging the terrace surface during the glacial. Diverse forms of periglacial phenomena in different areas of the terrace are explained by different substrates and formation conditions.
The periglacial morphology on the terrace is only preserved in the elevated part of the terrace which is located in the footwall of the bounding normal faults. Both, the Markgrafneusiedl and the Aderklaa-Bockfliess faults delimit the terrace from fault-bounded Quaternary basins in the hanging walls of the faults as well the Lassee segment of the VBTF. These basins are filled with up to 40 m thick Pleistocene and Holocene growth strata composed of Danube river sediments and sandy alluvium transported by creeks from the northern tertiary hilly country. The most important creek is the Rußbach which crosses the Gänserndorf Terrace in the western part parallel to the Aderklaa-Bockfließ fault. The youngest sedimentation in these basins is dominated by Holocene high-stage floods of the Danube River and reworked sand and silt which were eroded in the higher areas.
The digital terrain model shows especially in the northern part of the terrace many depressions of different size. Mostly they have rounded rims forming with flat ridge at SE side.
The depressions are very shallow with a flat ground and hardly appreciable in the landscape. It is possible to distinguish different types of rather oval or more fan shape contour. The diameters can vary from hundred meters up to two kilometres. The depressions are

situated in the parts covered by reworked loess whereas the sand covered central parts and the southern margins of the Gänserndorf terrace alike the adjacent higher terrace don´t show comparable morphological features.

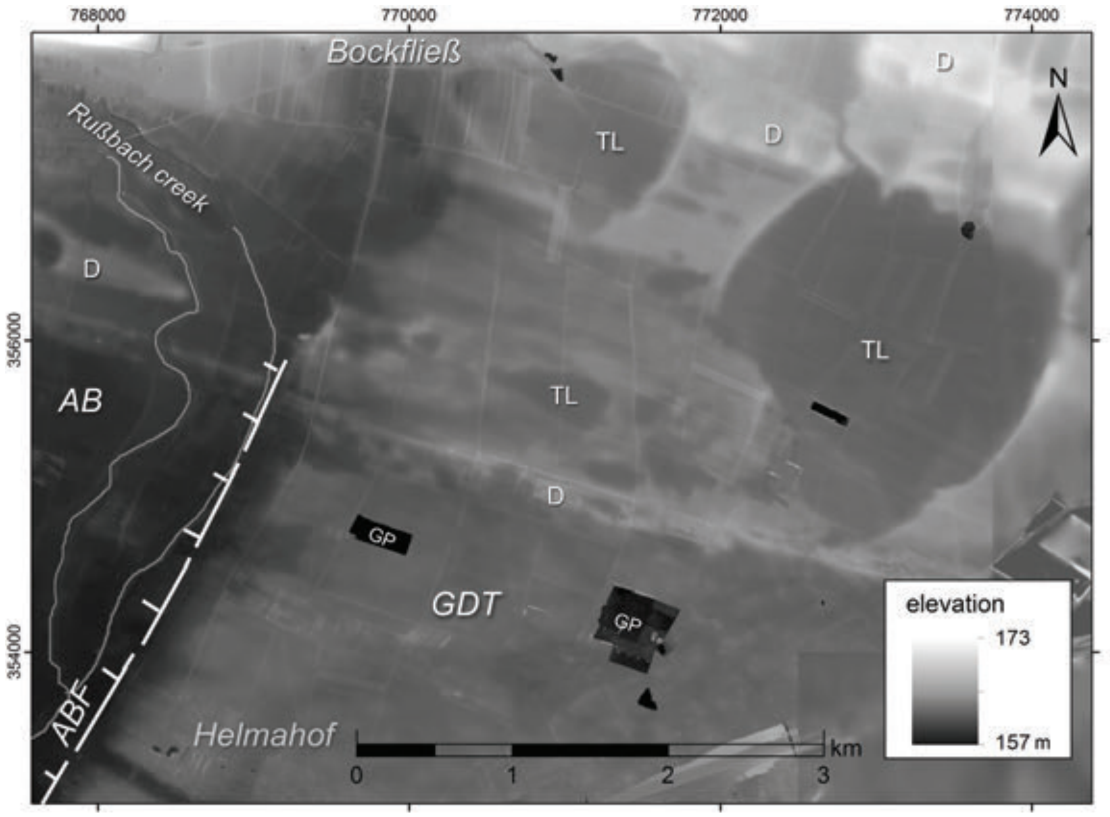


Figure 6: LIDAR (1 m ground resolution) showing the geomorphology of the northern Gänserndorf terrace (GDT); in the W: Aderklaa Basin (AB) with floodplain of the Rußbach creek. This creek runs parallel to the Aderklaa–Bockfliess fault. Former Taw lakes (TL) and wind parallel dunes (D) in the northern part of the Gänserndorf terrace. Dry valleys corrugating the fault scarp indicate advanced subsidence before the last Glacial. Gravel pit (GP).

CONCLUSIONS

Three faults delimit well defined parts of the Pleistocene Gänserndorf Terrace from fault-bounded Quaternary basins in the hanging walls of the faults. Characteristics of the periglacial morphology are preserved in elevated parts of the terrace, in the footwall of the bounding normal faults. Draining valleys corrugating the fault scarps are an indication of the advanced subsidence of the Aderklaa and Obersiebenbrunn Quaternary basins before the last Glacial.

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