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Geomorphic expression of neotectonic activity in a low relief area in an Airborne Laser Scanning DTM: A case study of the Little Hungarian Plain (Pannonian Basin)

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ABSTRACT

The NW corner of the Little Hungarian Plain, which lies at the junction of the Eastern Alps, the Pannonian Basin and the Western Carpathians, is a neotectonically active region linking the extrusional tectonics of the Eastern Alps with the partly subsiding Little Hungarian Plain. The on-going deformation is verified by the earthquake activity in the region. An extremely flat part of the area, east of Neusiedlersee, the so-called Seewinkel, has been investigated with Airborne Laser Scanning (ALS, also known as airborne LiDAR) techniques, resulting in a digital terrain model (DTM) with a 1 m grid resolution and vertical precision of better than 10 cm. The DTM has been compared with known and inferred neotectonic features.

Potential neotectonic structures of the DTM have been evaluated, together with geological maps, regional tectono-geomorphic studies, geophysical data, earthquake foci, as well as geomorphological features and the Quaternary sediment thickness values of the Seewinkel and the adjacent Parndorfer plateau. A combined evaluation of these data allows several tectonic features with a relief of <2 m to be recognized in the DTM. The length of these linear geomorphological structures ranges from several hundred meters up to several kilometers. The most prominent feature forms a 15 km long, linear, 2 m high NE–SW trending ridge with gravel occurrences having an average grain size of ca. 5 cm on its top. We conclude this feature to represent the surface expression of the previously recognized Mönchhof Fault. In general, this multi-disciplinary case study shows that ALS DTMs are extremely important for tectono-geomorphic investigations, as they can detect and accurately locate neotectonic structures, especially in low-relief areas.

1. Introduction

Neotectonic evaluation of low relief areas, such as alluvial plains, are typically based on seismic profiles, because of the lack of outcrops. The active status of detected faults characterized by low, but present seismicity is an important issue for the safety of vulnerable industrial facilities, including hydroelectric and nuclear power plants.

The determination of the fault pattern helps to recognize principally uplifting and subsiding structural units, which is extremely important for long-term prognosis of sites of denudation in low-relief areas. The activity of the majority of the faults in alluvial regions cannot be proven by seismic studies, because the topmost part of seismic sections is typically muted. However, it is known that almost all active faults have a topographic expression (e.g., Persaud and Pfiffner, 2004), although normally it is difficult to observe this in the field, especially in densely populated alluvial plains with strong anthropogenic surface modifications. On topographic maps, these features are sometimes present, but the interval between the contour lines is typically spaced too far, making it hard to identify them. Digital terrain models (DTMs) may help, but their resolution is often not enough to allow satisfactory results.

Airborne Laser Scanning (ALS, also known as airborne LiDAR) is a relatively new and promising technology that is capable of providing very high quality DTMs with a vertical precision of better than 10 cm, at which scale active faulting can be detected, even in low relief areas (Cunningham et al., 2006). A further advantage of ALS technology is that DTMs can also be determined in vegetated areas if the leaves do not cover the ground fully, allowing some laser beams to reach the ground surface. Consequently, tectonic faults can be detected in these regions as well (Prentice et al., 2003).

To locate possible faults in the Seewinkel, a meadow and vineyard area east of Neusiedlersee (Lake Neusiedl or, in Hungarian, Fertő-tó), we analyzed an ALS DTM (Attwenger and Chlaupek, 2006; Attwenger et al., 2006) with a grid resolution of 1 m and vertical precision of

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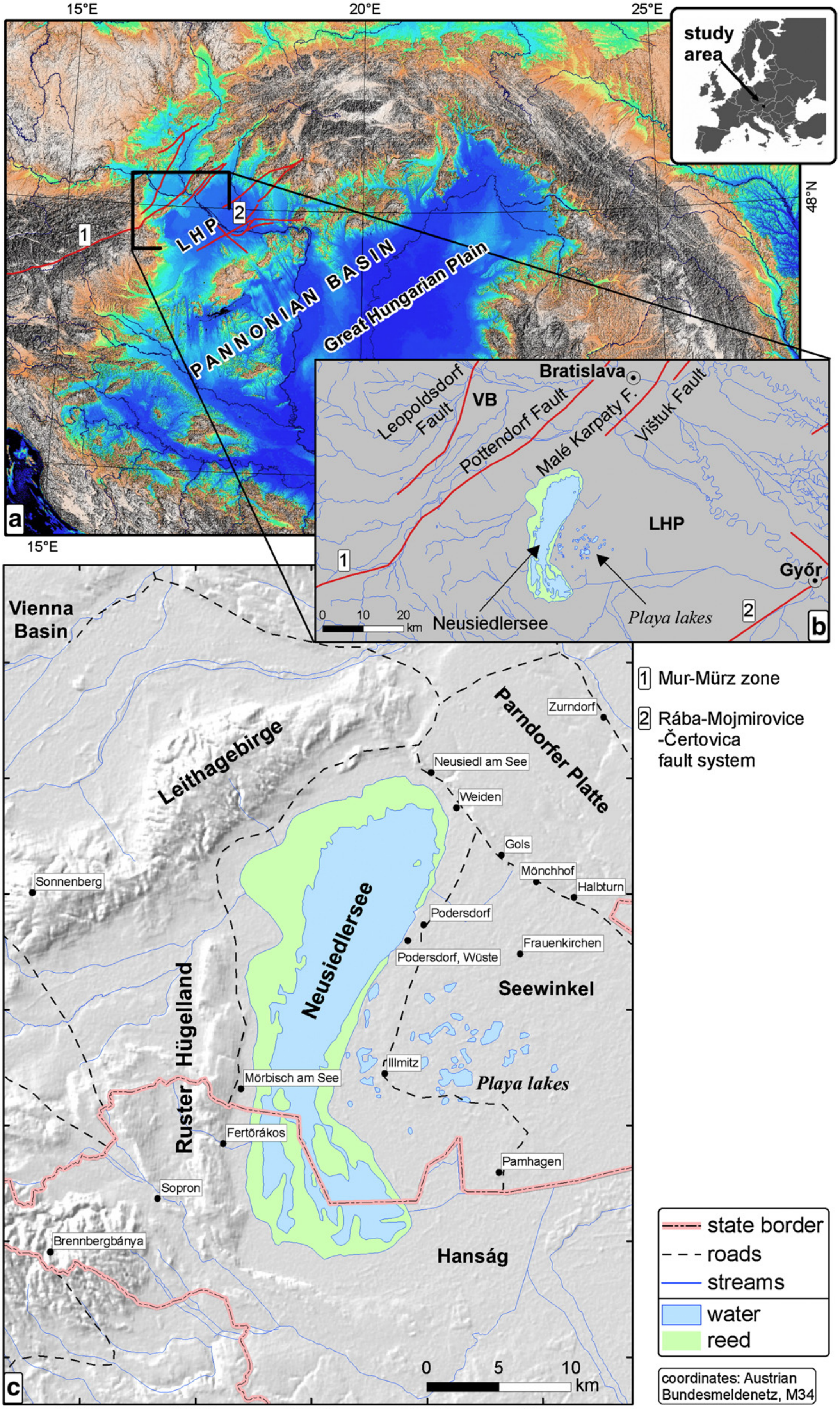

15°E
20°E
25°E
48°N
45°N
study area
1
2
LHP
PANNONIAN BASIN
Great Hungarian Plain
a
Bratislava
Leopoldsdorf Fault
VB
Pottendorf Fault
Malé Karpaty F.
Vištuk Fault
LHP
Győr
Neusiedlersee
Playa lakes
0 10 20 km
b
Vienna Basin
Leithagebirge
Parndorfer Platte
Zurndorf
Neusiedl am See
Weiden
Gols
Mönchhof
Halbturn
Sonnenberg
Podersdorf
Podersdorf, Wüste
Frauenkirchen
Seewinkel
Neusiedlersee
Ruster Hügelland
Illmitz
Playa lakes
Mörbisch am See
Fertőrákos
Pamhagen
Sopron
Brennbergbánya
Hanság
0 5 10 km
c
5320000
5312000
5304000
5296000
5288000
5280000
5272000
764000
772000
780000
788000
796000
1 Mur-Mürz zone
2 Rába-Mojmirovice -Čertovica fault system
state border
roads
streams
water
reed
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