Anthropogenic stratigraphic signals downstream a metropolis: Extracting Vienna's signature from Danube river plain archives

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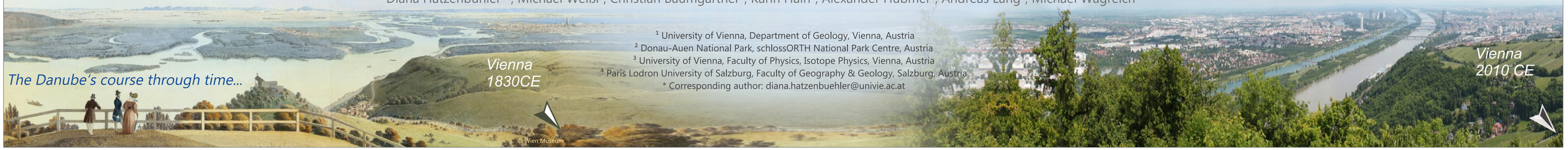

Introduction and Study Area

The Danube river has been an essential part of Vienna since the first settlements. Being located along the river, Vienna profits from the constant water access. However, floods had presented a constant threat to the inhabitants, and as a consequence, construction measures were implemented to gain control over the highly dynamic river. These measures are concentrated in and upstream of Vienna, while the area downstream, the nature reserve „Donau-Auen" remained far less impacted. For our project, this area presents a natural laboratory to investigate the anthropogenic impact of the metropolis Vienna on ist peri-urban environment.

Study area: Nationalpark Donau-Auen = nature reserve, extending from Vienna (Austria) to Bratislava (Slovakia; Fig. 1)

1

Minimal human intervention and **free flowing river section**

Recent **floodplains as geological archives** recording transport and expression of the anthropogenic fingerprint in natural sediments.

Changes in sedimentation dynamics over the last 150 years

The sedimentation pattern can be divided into three major phases and types of deposits:

Phase I (Fig.2) is defined by brown to reddish clay and organic rich layers (mm to cm) with interbedded thin sand lenses and gleization features.

2

In **Phase II** (Fig.3), these layers are rapidly replaced by alternating beige silt and white to light-grey sand packages (5-20 cm beds).

Phase III (Fig.3) shows a silt to fine-sand dominated, massive section. It exhibits a distinct uniform light grey colour and shows barely any sediment structures, unlike underlying deposits/ phases.

3

Flood plain deposits as archives of a river's history

Human interventions

4

Time [CE] *(not to scale)*

1992-1998:
Construction of the hydro-power station Freudenau downstream of Vienna

1972-1988:
Construction of an artifical side channel, the „New Danube", to provide flood relief by channeling excess water, and reinforcement of dams

1960-1990:
Construction of hydro-power stations and dams upstream of Vienna

1870s-1890s:
River channelization in Vienna & upstream:
Increased flow velocity and initial rise in sediment input, suspension load and water level

Sedimentation Phases & Features

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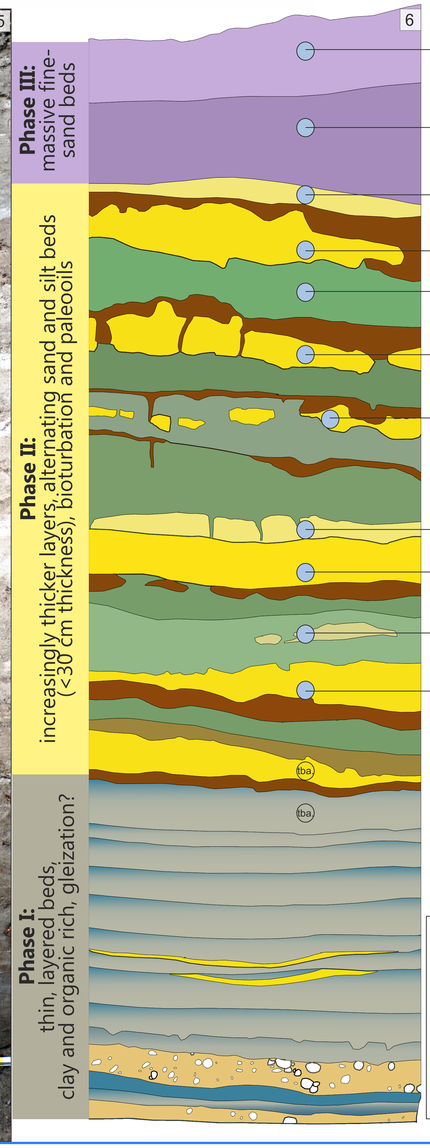
6



Grain Size

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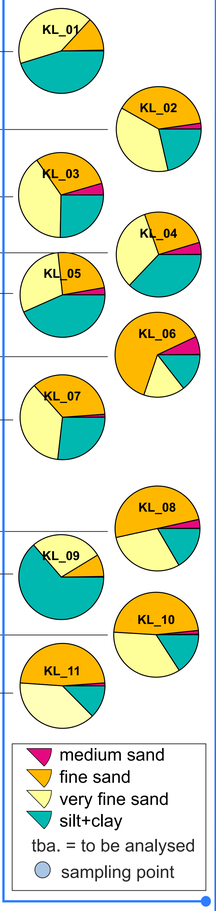

Trace Elements

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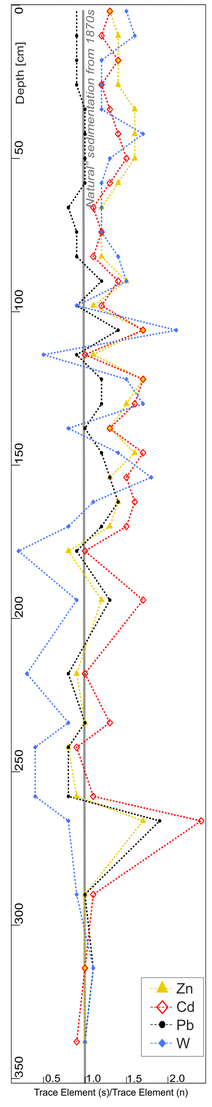

s= sample, n= mean value of „natural" sedimentation from bottom of profile (~1870s)

Anthropogenic input on macroscale

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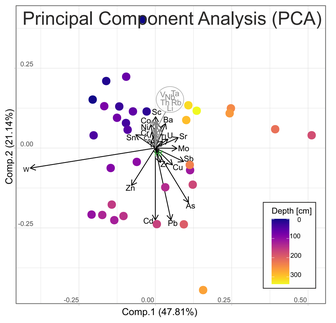
Various anthropogenic relicts, e.g. plastic scraps, a trash bin (Fig. 9) and pot were deposited during the latest extreme flooding events in the Donau-Auen.



work in progress

PCA exhibits 4 association groups:

- W perpendicular to almost all elements;
- Zn, Cd, Pb, As, Cu (,Zr) ~2m depth,
- Sb, Mo, Sr, U (,Tl) ~2-3m depth,
- other elements ~0-1m depth

Challenges: „Dating in the Anthropocene"

Dating of very young deposits (e.g. last 10-100 years) presents a challenge to geoscientific methods. This difficulty is approached by applying the thermonuclear weapon tests from 1952 to 1963 CE, which have generated artificial radionuclides and produced a global signal, the so-called 'bomb-spike' of ^{239}Pu, excess ^{14}C (Fig. 10) and other isotopes (e.g. ^{137}Cs, ^{210}Pb; Waters et al., 2016).

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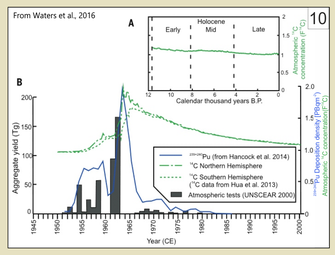

Current & Future Work

- Analysis and comparison of radioisotopes ^{137}Cs, ^{239,240}Pu and ^{236}U, and ^{210}Pb and correlation of flood plains deposits to human interventions
- Major element and compositional data analysis

Major human interventions (Fig. 4) began in the 1870s and resulted in increased aggradation in the area downstream of Vienna. Since the last decade, the water table has dropped and erosion has become more prominent, having opened up the erosional profile from Fig.5.

Grain size distribution becomes more various towards the top showing proportionally more medium sand and/or silt+clay (Fig. 7). Trace elements (Fig.8) show a relative increase in Zn, Cd and Pb to the end of Phase I. In Phase Zn, Cd, Pb and W fluctuate with W being initially lower than the other elements. Phase III shows relatively constant values.

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Cooperation with:

References:
Waters, C.N., Zalasiewicz, J., Summerhayes, C., et al., 2016. The Anthropocene is functionally and stratigraphically distinct from the Holocene. Science 351, a2622.