Impact of the Mid-Pleistocene Transition on Meuse River Terraces in the Southern Netherlands: New Terrace Burial Ages

Ewerton da Silva Guimarães[1,2], Cornelis Kasse[1], Freek S. Busschers[2], Naki Akçar[3], Duna Roda-Boluda[1], Fritz Schlunegger[3], Renaud Bouroullec[2], Alain Demoulin[4], Tom van Haren[5], Marcus Christl[6], Christof Vockenhuber[6], and Ronald T. van Balen[1,2]

[1]Vrije Universiteit Amsterdam, Earth Sciences, Amsterdam, Netherlands; [2]TNO, Geological Survey of the Netherlands, Utrecht, Netherlands; [3]University of Bern, Institute of Geological Sciences, Bern, Switzerland; [4]Department of Geography, University of Liège, Liège, Belgium; [5]VITO, Dept. RMA, Mol, Belgium [6]Laboratory of Ion Beam Physics, ETH Zurich, Zurich, Switzerland

Introduction

The Mid-Pleistocene Transition is characterized by a major change in the climate cyclicity, in which the frequency of glacial and interglacial stages shifts from low-amplitude 40-ka cycle to high-amplitude 100-ka cycle. The impact of this transition is significant in both the marine and continental realms, with overall increase in the global ice volume, longer glacials and shorter interglacials. Concerning the mid-latitudes, especially in N and NW Europe, significant sea-level changes and intensification of periglacial processes are evident. We investigate the impact of the Mid-Pleistocene Transition on river systems by exploring the compositional and geometrical parameters of the Quaternary Meuse River terraces in the southern Netherlands (**Figure 1**).

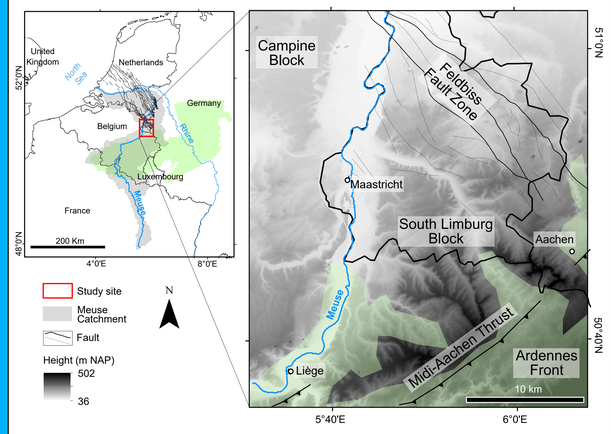

Figure 1: Study site location. The Rhenish massif is displayed in green

Hypothesis

As climate deteriorates along the Quaternary, and glacial stages become longer and colder, a response is expected from the Meuse River. The expected response could be in the form of changes in main sedimentlogical characteristics, and reorganization of the drainage system. Overall increase in the following parameters are expected: sediment input, average grain-size, average terrace thickness, average incision rates, average erosion rates. Colder and longer glacial stages are expected to decrease vegetation cover in the source zone, the Ardennes (western Rhenish Massif), intensifying (peri)glacial processes.

Objectives

- Estimate content and geometrical parameters of the terraces
- Correlate these parameters with the known climatic and geological record of the Quaternary
- Age-date the burial of specific terrace levels, and improve the age control of the terrace staircase
- Improve the understanding of the Quaternary development of the Meuse River from a source-to-sink perspective

Methods

- Terrace mapping
- Exploratory borehole data analysis
- Age-date of terrace burial with cosmogenic ^{26}Al-^{10}Be isotopes

Results

- Updated cross-border terrace map (**Figure 2**)
- New burial age of the terrace level marking the abandonment of the East Meuse valley and starting of the carving of the West Meuse valley (**Figure 3**)
- New burial age of the terrace level marking the onset of extreme incisional phase of West Meuse valley and shift from Higher/Main Terraces to Middle Terraces (**Figure 4**).
- Temporal constraints for terraces lithological content, terraces thickness, terraces gradient (bottom and top surface) spanning the Quaternary (**Figure 5**).

New burial ages will be shown upon request

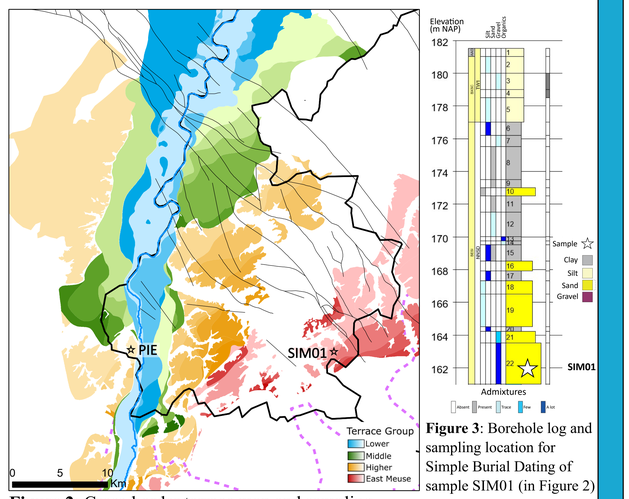

Figure 2: Cross-border terrace map and sampling location for cosmogenic age-dating

Figure 3: Borehole log and sampling location for Simple Burial Dating of sample SIM01 (in Figure 2)

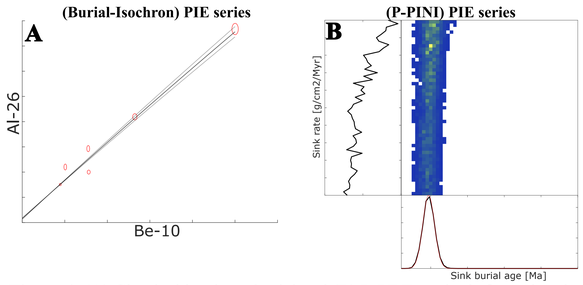

Figure 4: (A) Classical isochron-burial and (B) P-PINI methods for estimating terrace burial age of sample PIE (in Figure 2).

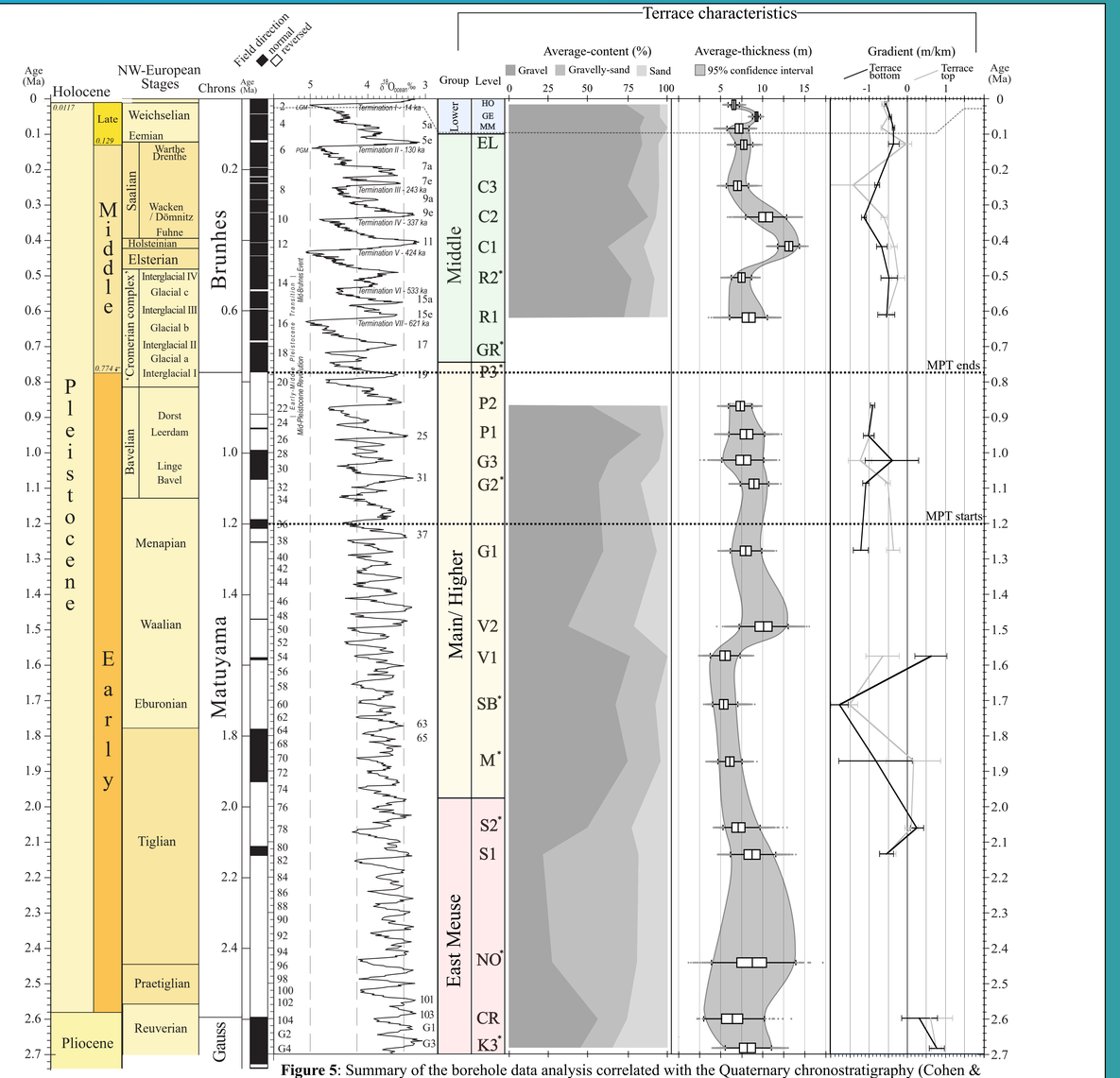

Figure 5: Summary of the borehole data analysis correlated with the Quaternary chronostratigraphy (Cohen & Gibbard, 2019).Terrace levels with * have been age-dated in this study. Terrace age control proposed by Van den Berg & Van Hoof (2001).

Observations and discussion

- Increasing trend of gravel content
  - Gradual removal of heavily weathered overburden of the Ardennes?
  - Subsequent erosion of "fresh" bedrock of the Ardennes?
  - Gravel front migration?
- Relatively stable trend of terrace thickness
  - Climate deterioration does not seem to strongly affect average thickness
  - Peak in C1 could be related to the onset of the Elsterian glaciation
  - Average thickness slightly increases after the onset of the MPT
- Reversed gradient of the East Meuse:
  - Tectonic tilt?
  - Oversupply followed by avulsion?
- Steepening gradients around Elsterian and Early Saalian

Scan for abstract

References

Cohen K.M. & Gibbard, P., (2019), Global chronostratigraphical correlation table for the last 2.7 million years, version 2019 QI-500. *Quaternary International*, 500, 20–31

Van den Berg, M. W., & van Hoof, T. (2001). The Maas terrace sequence at Maastricht, SE Netherlands: evidence for 200 m of late Neogene and Quaternary surface uplift. *River basin sediment systems: Archives of environmental change*, 45-86

Funding

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 860383T

Scan me