Modelling the base of fluvial Quaternary sediments in the „Seewinkel“ area (Austria)

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Overview of the Pannonian Basin

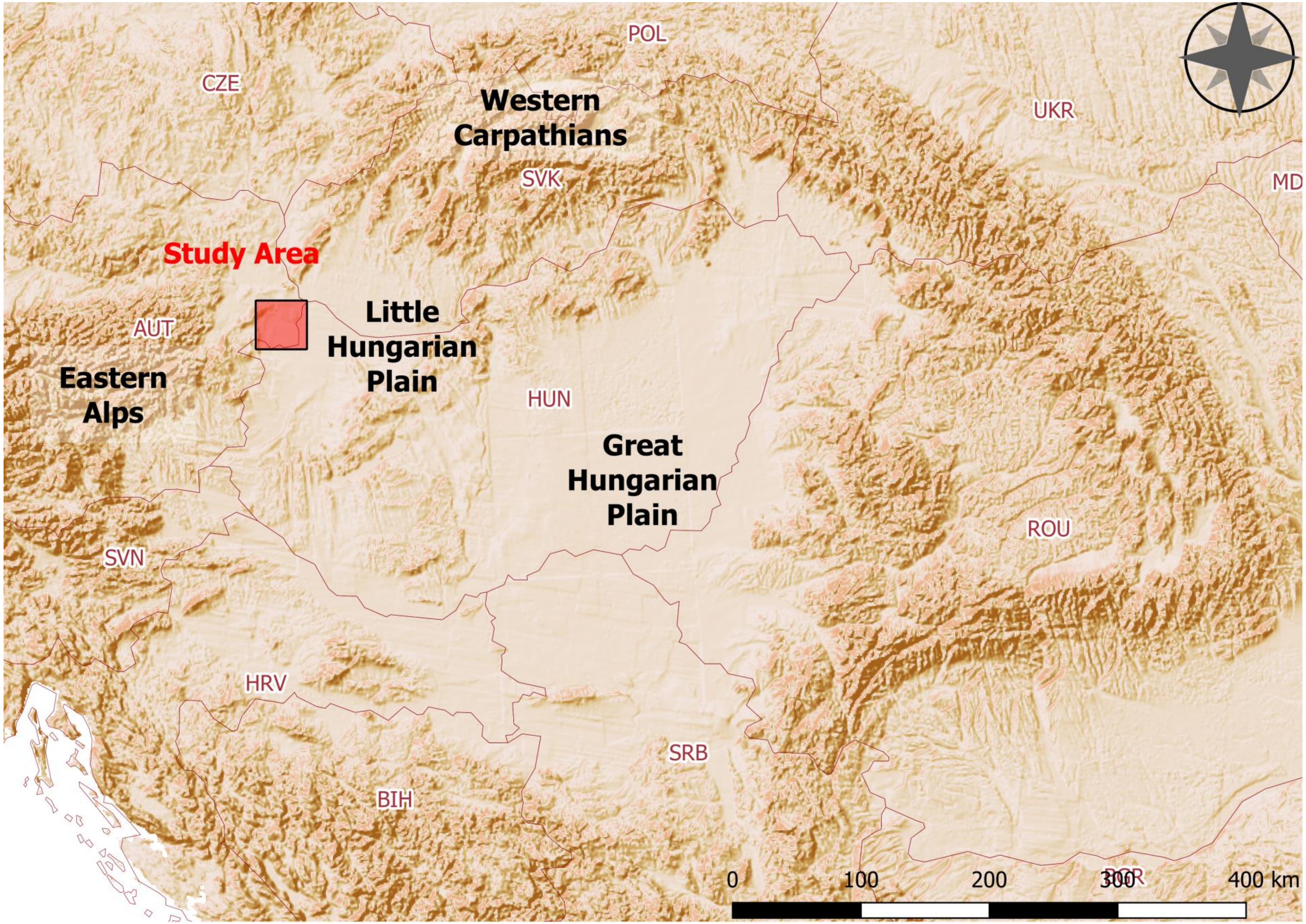


Fig. 1: Location of the study area at the northwestern part of the Pannonian Basin (Background: DTM 1 km x 1 km; USGS)

Study Area

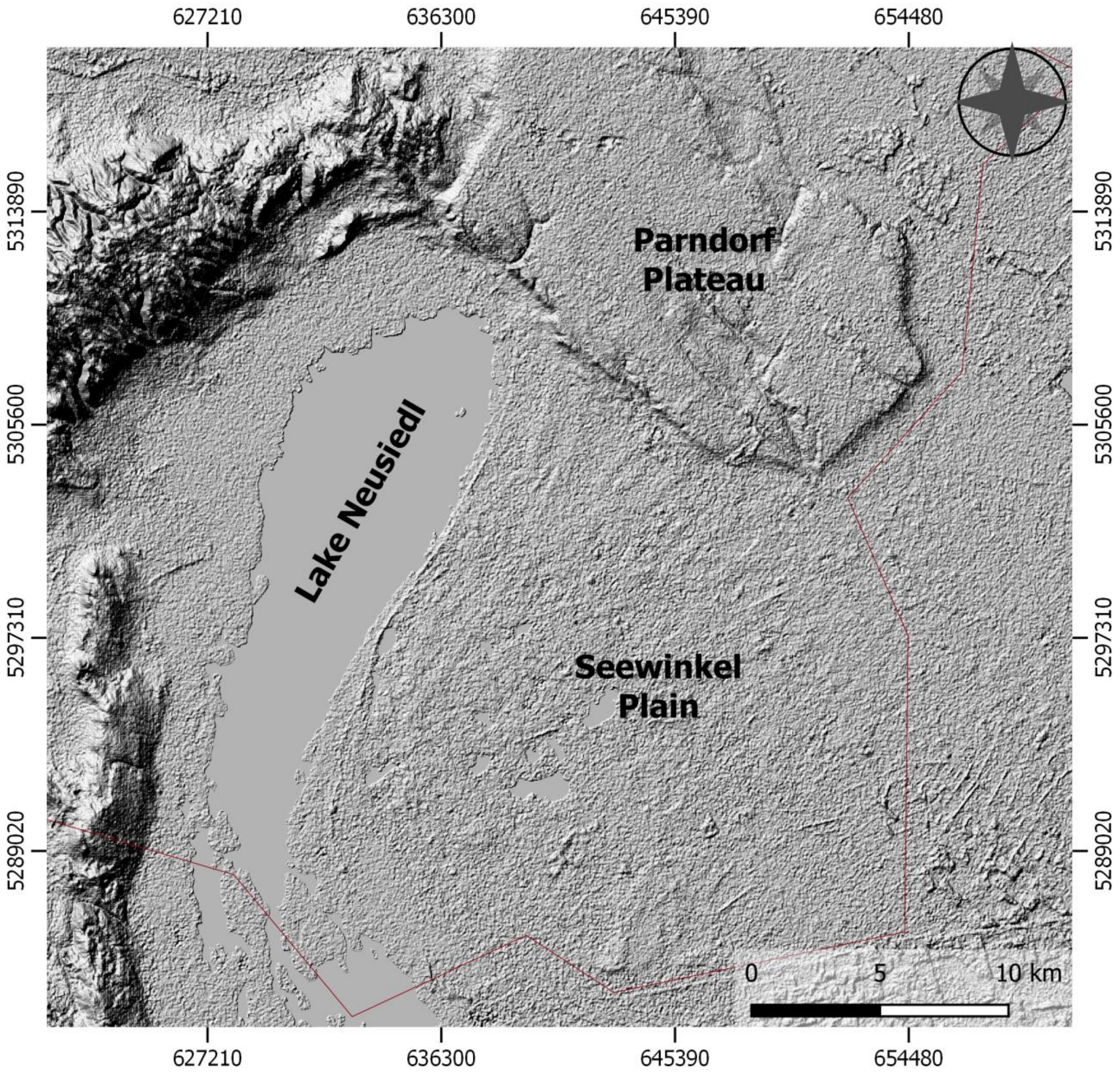


Fig. 2: Geomorphological overview of the Seewinkel Plain (Background: SRTM 30 m x 30 m; USGS)

The Seewinkel area is situated in the Little Hungarian Plain (LHP), in the northwestern part of the Pannonian Basin (PB) (Fig. 1) and is located east of Lake Neusiedl, Austria´s largest lake and south of the Parndorf Plateau (Fig. 2).

The landscape of the Seewinkel plain is characterized by extremely low relief. Geologically, the fluvial Quaternary sediments (FQS) covered with minor occurrences of aeolian sediments overlie the Pannonian (Miocene, Tortonian) fine-grained limnic sediments (Fuchs *et al.*, 1985; Pistotnik *et al.*, 1993).

Aim

In this study we model the base and thickness of the FQS to gain more insight about the active tectonics in the northwest PB and changes in the active sedimentary input. A detailed model is crucial to understand the history of Quaternary deposition and the relation with the still ongoing subsidence of the Little Hungarian Plain, as well as the influence of pre- and post-tectonic structures.

Geodynamic setting of the LHP

After the formation of the PB (Cloething *et al*., 2002; Horváth *et al*., 2006; Bada *et al*., 2007) and the orogenic collapse (Ratschbacher *et al*., 1991) changes in the stress field led to post orogenic basin inversions (Cloething *et al*., 2005). This process was accompanied by fault reactivation (Loisl *et al*., 2018), vertical movement and changes in the tectonic topographies (Dombrádi *et al*., 2009).

As a result the margins of the PB started to uplift while the Great Hungarian Plain was subsiding (Horváth and Cloetingh, 1996) (Fig. 1). This could also be documented for the LHP, where the subsidence rate reaches up to 2 mm/year (Joó, 1992). In the respective area the thickness of Quaternary sediments increases with a higher subsidence rate (Franyó, 1992).

An increase of Quaternary sediments is also recognizable in the Seewinkel area from northwest to southeast on older descriptions (Tauber, 1959) and shows the same tendency as the underlaying Pannonian sediments (Fuchs and Schreiber, 1985).

Borehole data and geocoding

For this study data from 96 boreholes were interpreted and geocoded to determine the base and thickness of the FQS in the Seewinkel area.

1. Interpretation and determination of the base of the FQS in the borehole data.

   A clear lithological contrasts marks the transition from the loose, generally coarser-grained FQS to the underlaying finer-grained sediments of the Pannonian (Fahrion, 1944).

2. Geocoding of the borehole locations or converting of coordinates from another coordinate system to WGS 84 / UTM 33N in a QGIS 3.4.12 (QGIS Development Team) environment.

The data for this project was provided by Geologische Bundesanstalt (Geological survey of Austria), Biologische Station Illmitz, Gruppe Wasser© - Ziviltechnikergesellschaft für Wasserwirtschaft GmbH and OMV.

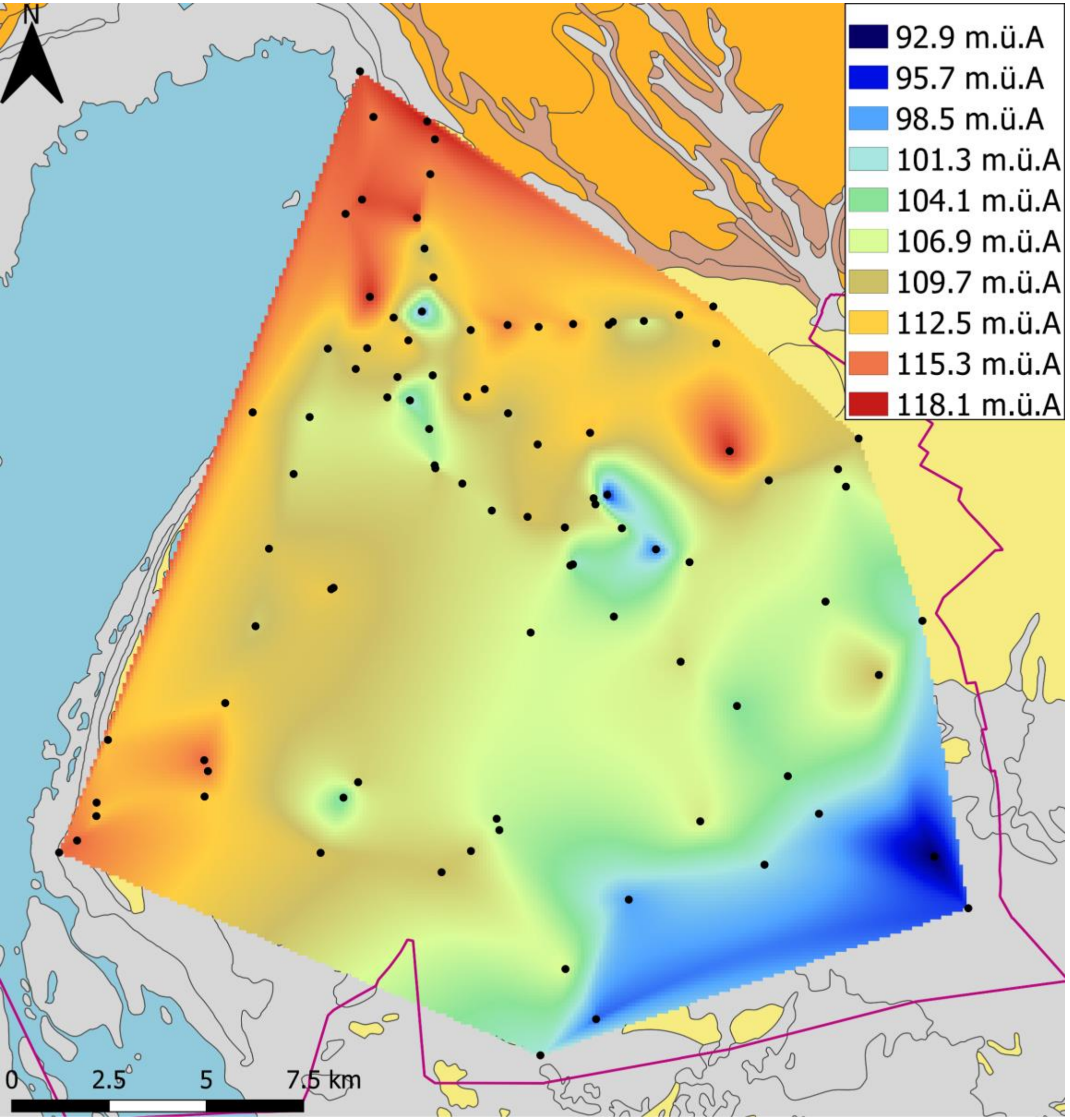
Interpolation of borehole data

To create a continuous model of the base of the FQS the point data was interpolated with ArcGIS 10.7.1 (Esri). Here we used a natural neighbor interpolation (Fig. 3) and an inverse distance weighting (IDW) interpolation (Fig. 4) to gain more insight about the general orientation and trend of the FQS.

Both the lower edge and the thickness of the FQS were interpolated to make a comparison possible and see if similar trends are visible.

(For the thickness of the FQS the ground surface was used as the upper edge.)

Natural Neighbor Interpolation



Lower edge (base) of FQS

Thickness of FQS

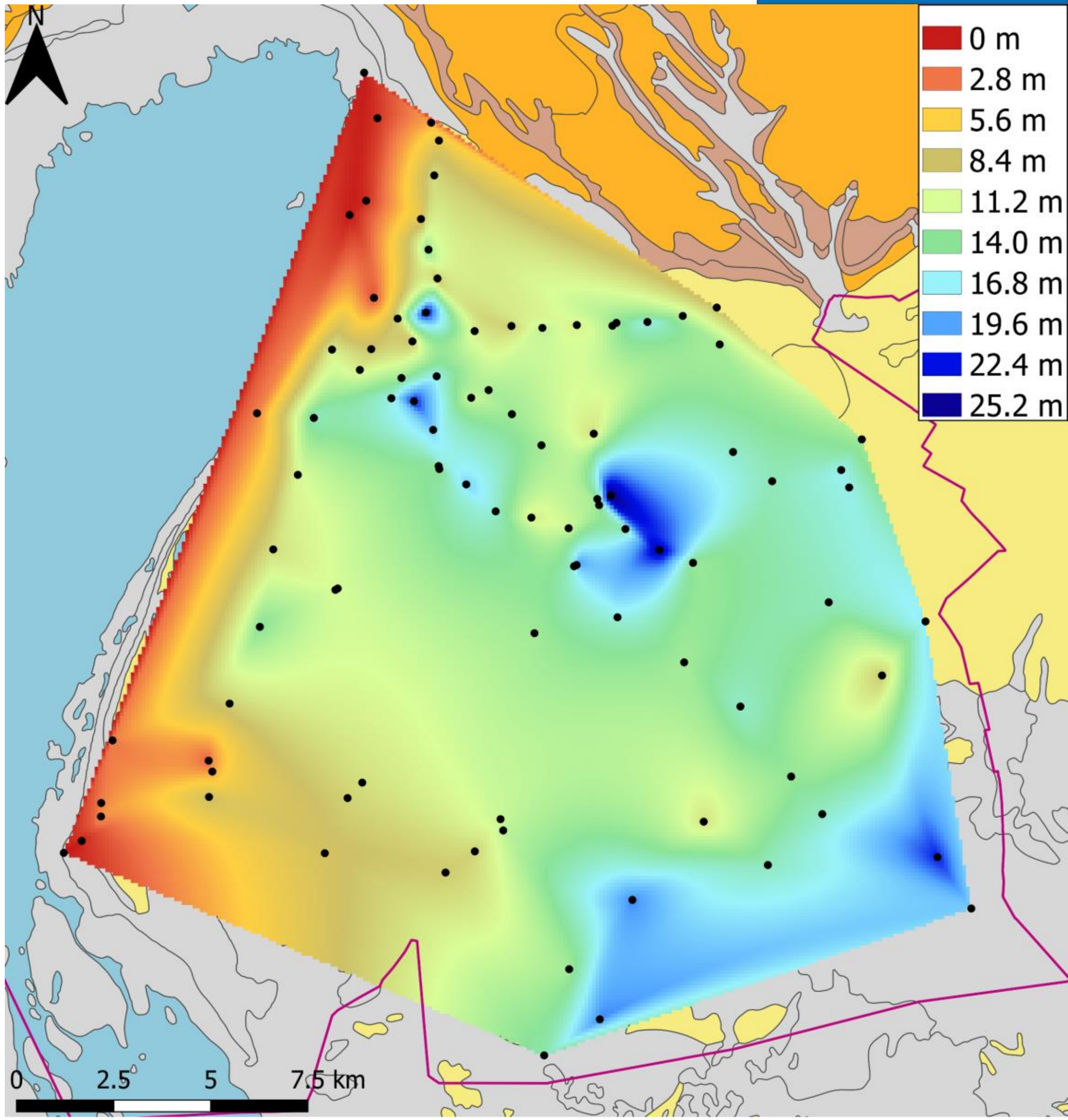
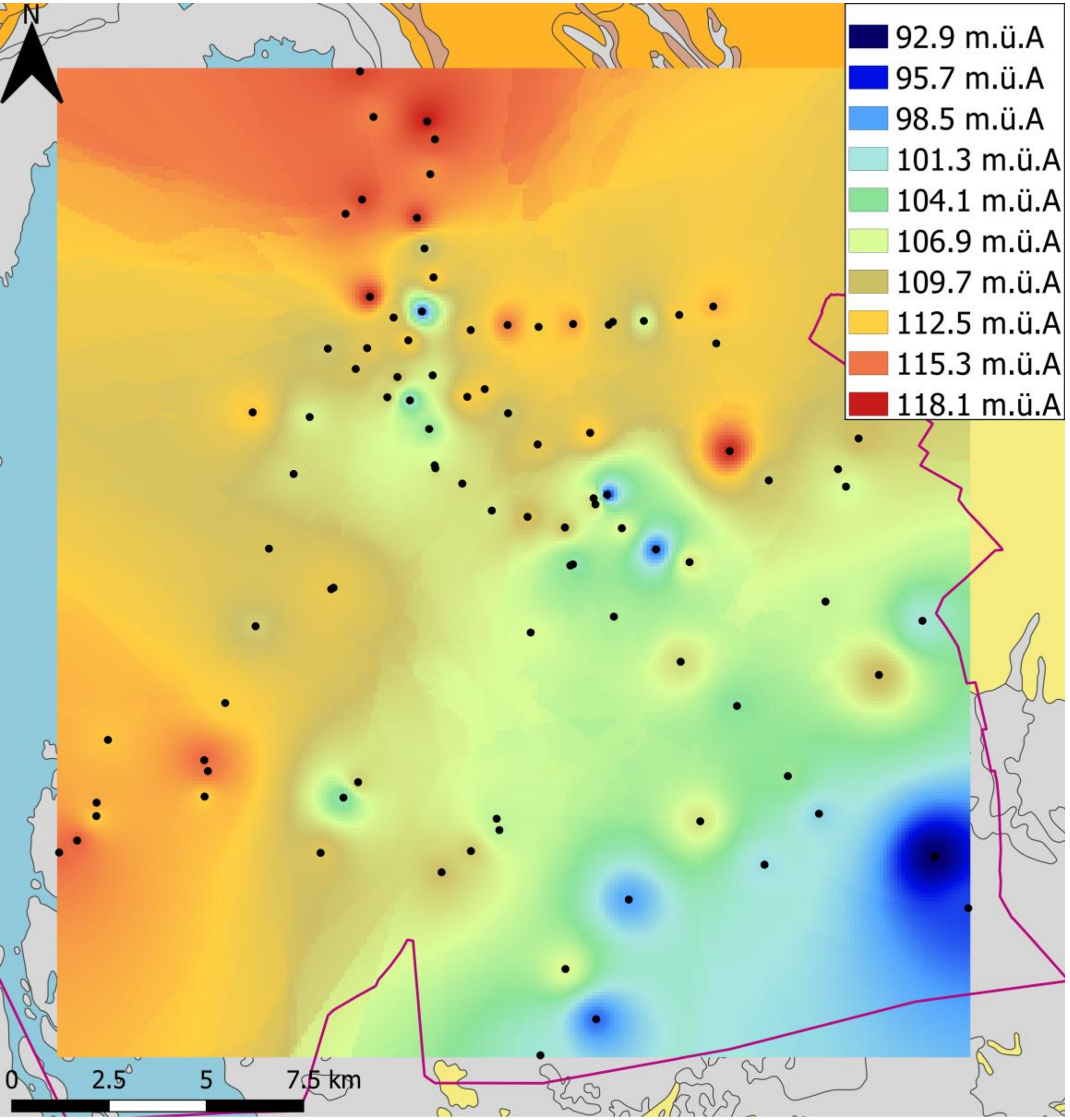


Fig. 3: Natural neighbor interpolation of the lower edge and thickness of the FQS

- Borehole data

IDW Interpolation



Lower edge (base) of FQS

Thickness of FQS

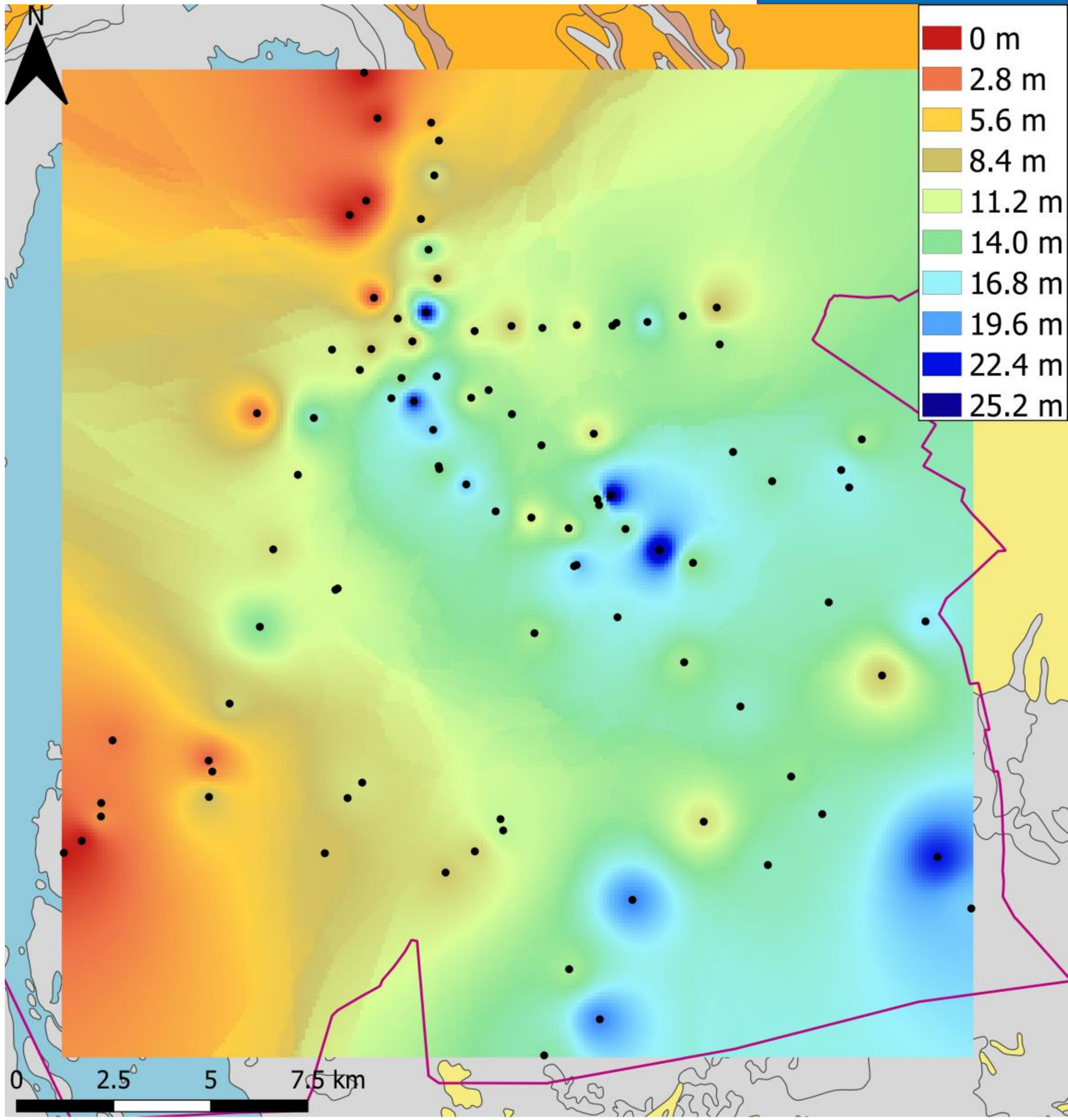


Fig. 4: IDW interpolation of the lower edge and thickness of the FQS

- Borehole data

Results

- The base of FQS declines in altitude from northwest to southeast and the thickness increases in the same direction.
- In both models a thickness of 25 m – 30 m towards the Austrian/Hungarian border and distinct thinner FQS at the shore of lake Neusiedl are visible.
- The obvious difference in the models is that with a natural neighbor interpolation (Fig. 3) the FQS thickness becomes virtually zero at the eastern shore of lake Neusiedl, while the IDW interpolation (Fig. 4) shows that the FQS base pinches out towards northeast.

Discussion

While the base of the FQS dips from the eastern shore of lake Neusiedl towards southeast, the thickness of the FQS increases in the same direction, reaching almost 30 m at the Austrian/Hungarian border. This tendency is mimicking the thickness trend of the underlaying Pannonian sediments and shows that this process is still affecting the Quaternary deposition in the Seewinkel area and is most probably still ongoing.

Conclusion

- Interpolation is a useful tool to analyze spatial geological data and plays an important role when investigating the base of FQS in the Seewinkel area to recognize and quantify their trends.
- Different methods of interpolation provide different models for the base of the FQS. To improve these models more data is required, especially in areas of sparse data points.
- The modelling of the base of FQS in the Seewinkel area shows a decline in altitude from northwest to southeast and an increase of thickness of Quaternary sediments. This is a strong indicator that the regional subsidence of the LHP was still active in the Quaternary and most probably still is.

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Online and software resources:

Esri
url: url: https://www.esri.com

QGIS Development Team
url: https://www.qgis.org

U.S. Geological Survey – USGS
url: https://www.usgs.gov/centers/eros/science/usgs-eros-archive-products-overview?qt-science_center_objects=0#qt-science_center_objects