

Tracing alluvial sediments using geophysical surveying, Braunsbach, Germany

Mauricio Arboleda-Zapata¹, Julien Guillemoteau¹, Ana Lucía², Jens Tronicke¹, Oliver Korup¹
1. University of Potsdam.
2. University of Tübingen

Introduction

Sedimentary deposits in **alluvial fans and terraces** preserve valuable information about **morphodynamics processes**, including possible evidence of catastrophic floods. In relatively flat alluvial fans, instructive outcrops are often rare. However, **near-surface geophysical surveys** might provide additional information on the general stratigraphic and geometric characteristics in such environments. This study focuses on the **Grimmbach fan** located near Braunsbach, southern Germany (**Fig. 1**). This fan and its catchment were highly impacted during a **flash flood in May 2016** that caused massive erosion and sedimentation (**Fig. 1**). To understand up to which extend this event was **exceptional** and learn more about **past hydro-meteorological events** in this catchment, we use the few available outcrops in the alluvial fan area and extend our data base and knowledge using different geophysical surveys.

Methodology

In two field campaigns (November 2019 and September 2020), we collected several geophysical data sets (**Fig. 2**) including electromagnetic induction (**EMI**), electrical resistivity tomography (**ERT**), and ground-penetration radar (**GPR**). For each dataset, the first processing step consists of a quality control and filtering erroneous data points. Furthermore, we invert the ERT data using a smooth inversion approach to obtain 2D subsurface resistivity models and we migrate our GPR data to obtain reliable structural images. Additionally, the coordinates recorded during EMI mapping were used to create a digital elevation model (**DEM**) used to explore small-scale geomorphological structures (**Fig. 3**).

Results

We created hillshaded maps considering the DEM and various azimuths (**Fig. 4**). These maps highlight several **linear and semicircular structures**, which in the EMI map (**Fig. 5**) and ERT profiles (**Fig. 6**) correspond to areas of **high resistivity**. In addition, the high amplitudes in the GPR profile (**Fig. 6**) coincide with the most resistive areas, which may be advantageous for characterizing linear structures at this field site. The EMI and GPR data reach **penetration depths** <3 m while our ERT model images up to depths of 15 m.

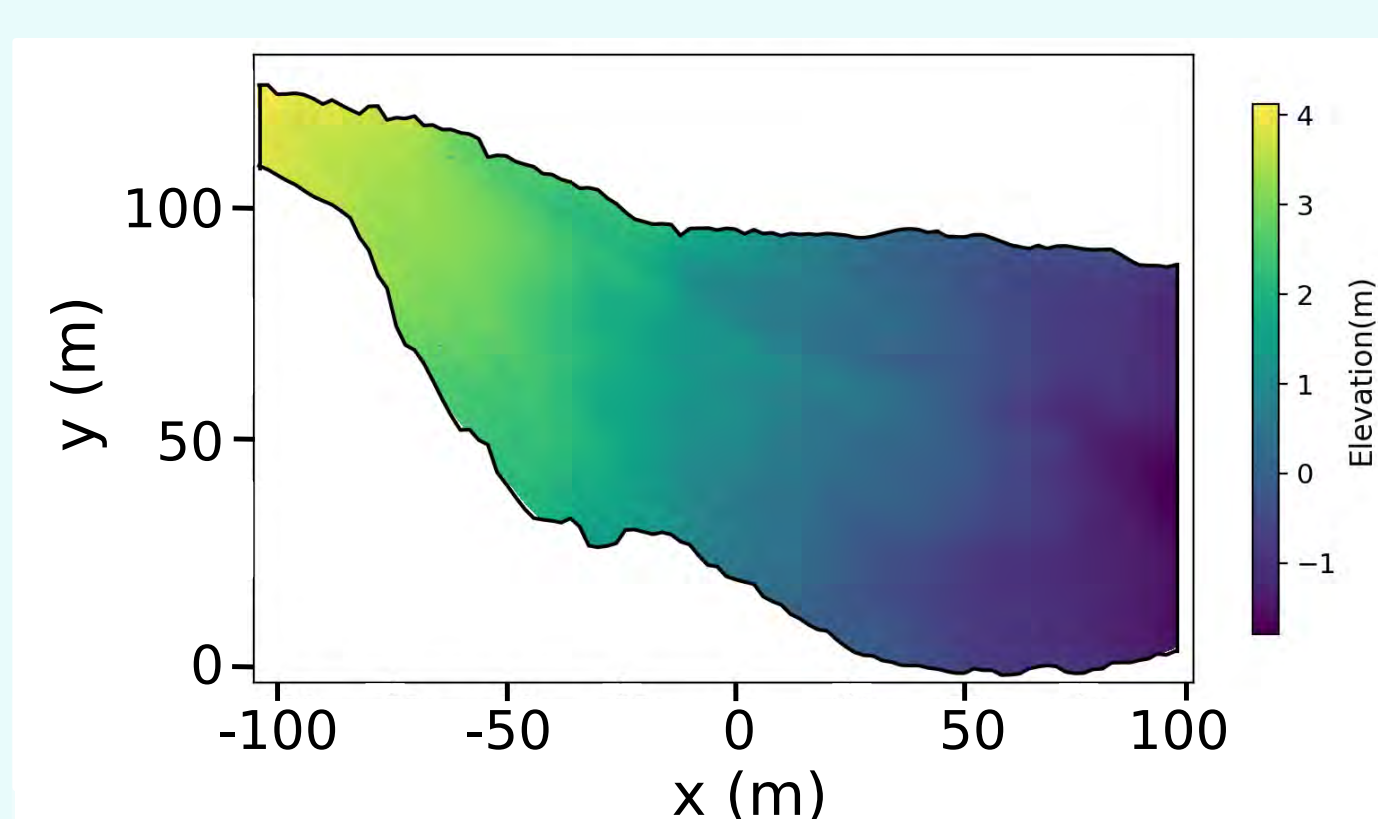


Fig. 3. Digital Elevation Model (DEM).

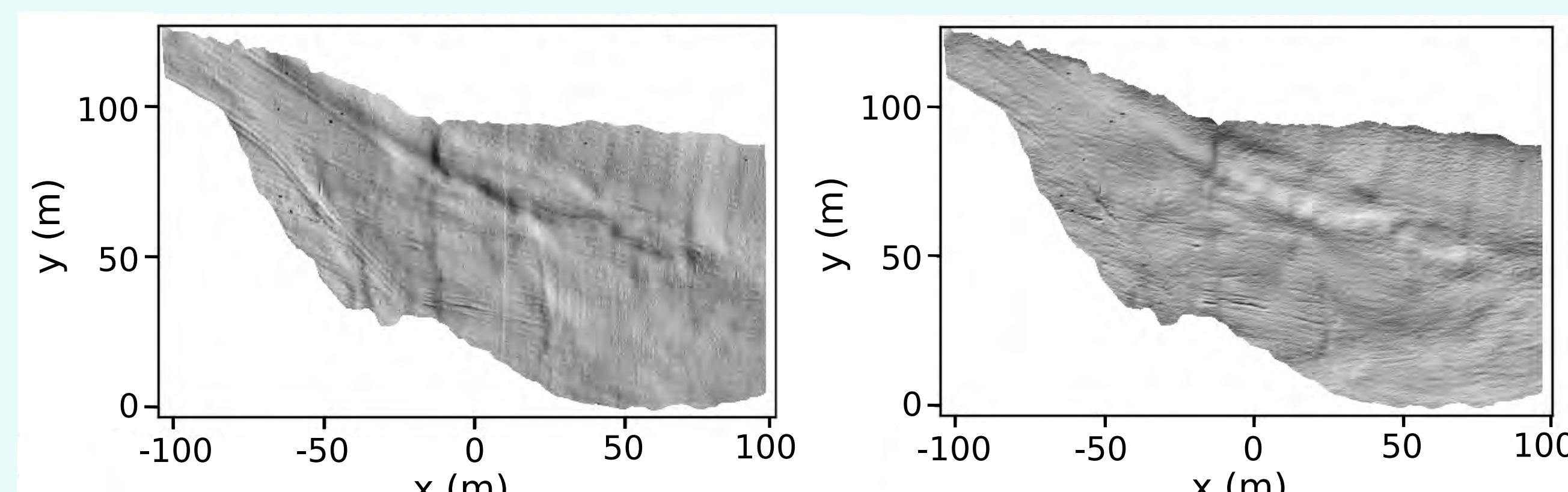


Fig. 4. Hillshaded DEMs with azimuths of 290° (left) and 200° (right).

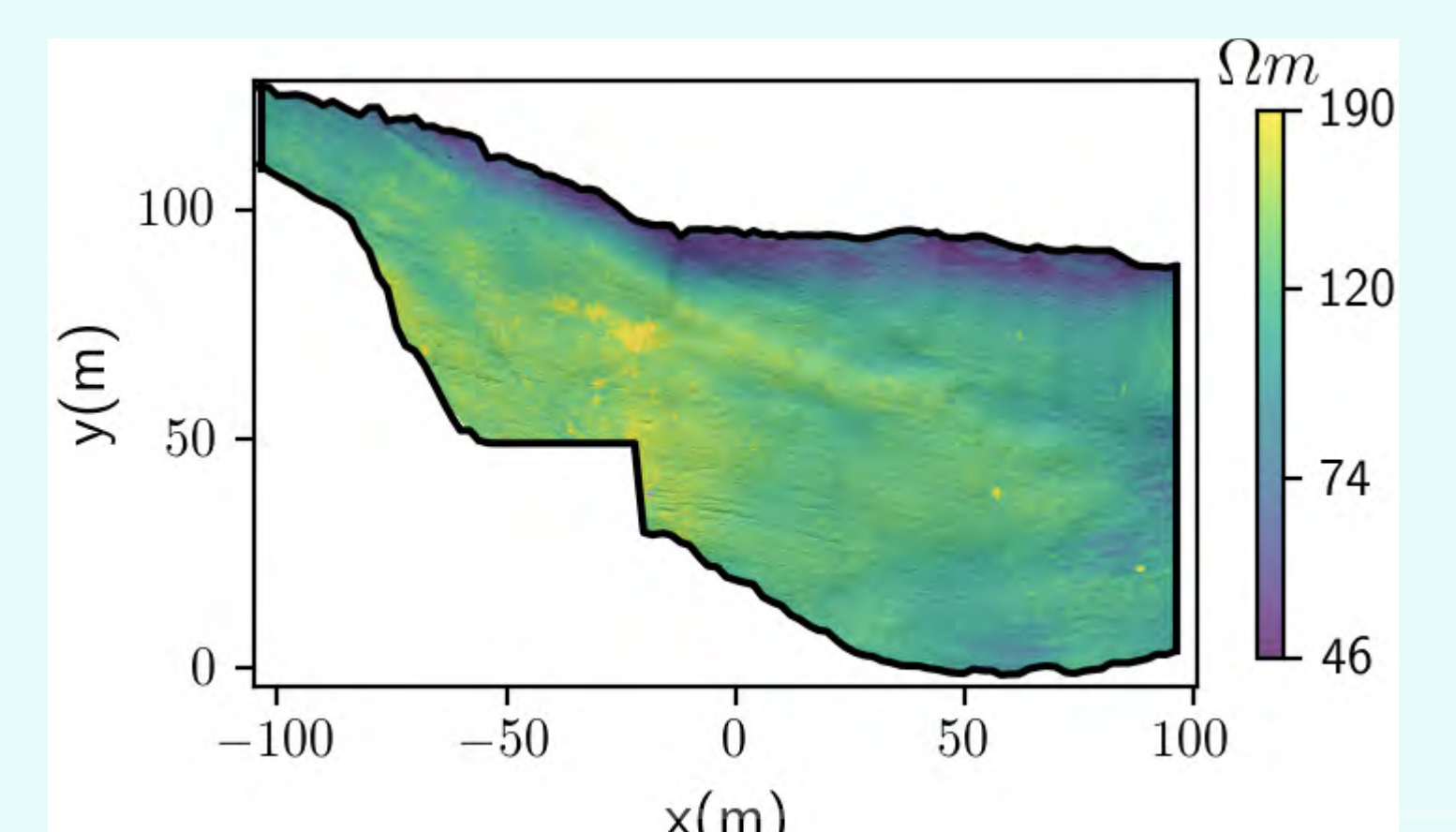


Fig. 5. Electromagnetic (EMI) data

Discussion and conclusions

The relatively recent history of the Grimmbach alluvial fan has probably experienced past catastrophic events that have caused a sudden **lateral change in the channel** (avulsion). This hypothesis is also supported by one outcrop (**Fig. 7**), where we distinguished **sharp contacts** between clayey silt sediments and coarse materials. The sharp nature of these contacts indicates that the river in this area is shifting laterally abruptly during major floods instead of gradual lateral migration as expected in meandering rivers, mainly transporting fine sediments. This case study demonstrates that **linking field observation and geophysical models** in small alluvial fans can provide valuable information to inform or improve hazard models of extreme sediment transport.



Fig. 7. Outcrop showing intercalation of clayey silt layers with coarse materials.

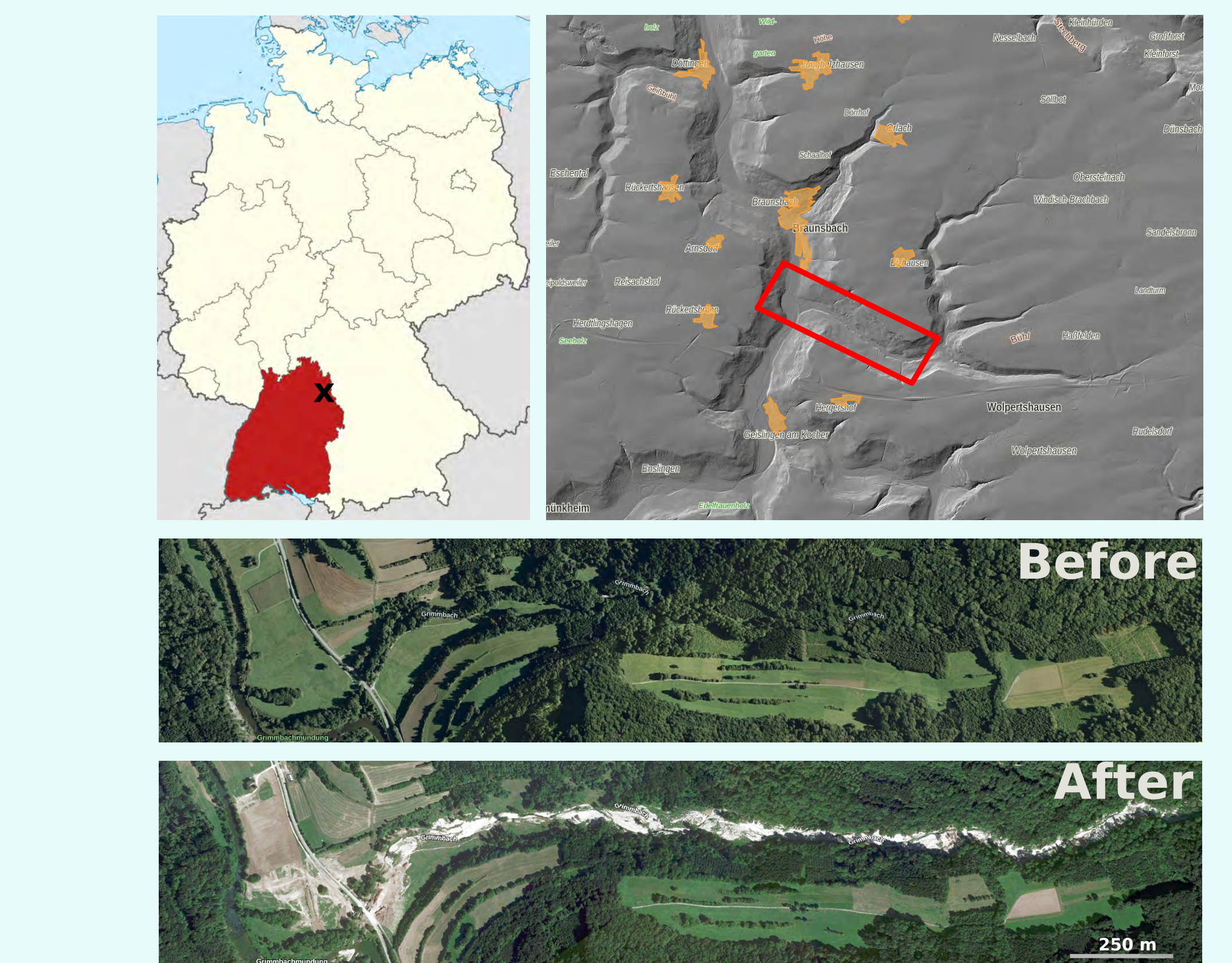


Fig. 1. Location of the study area (top left and right) and before (middle) and after (bottom) the May 2016 flash flood.

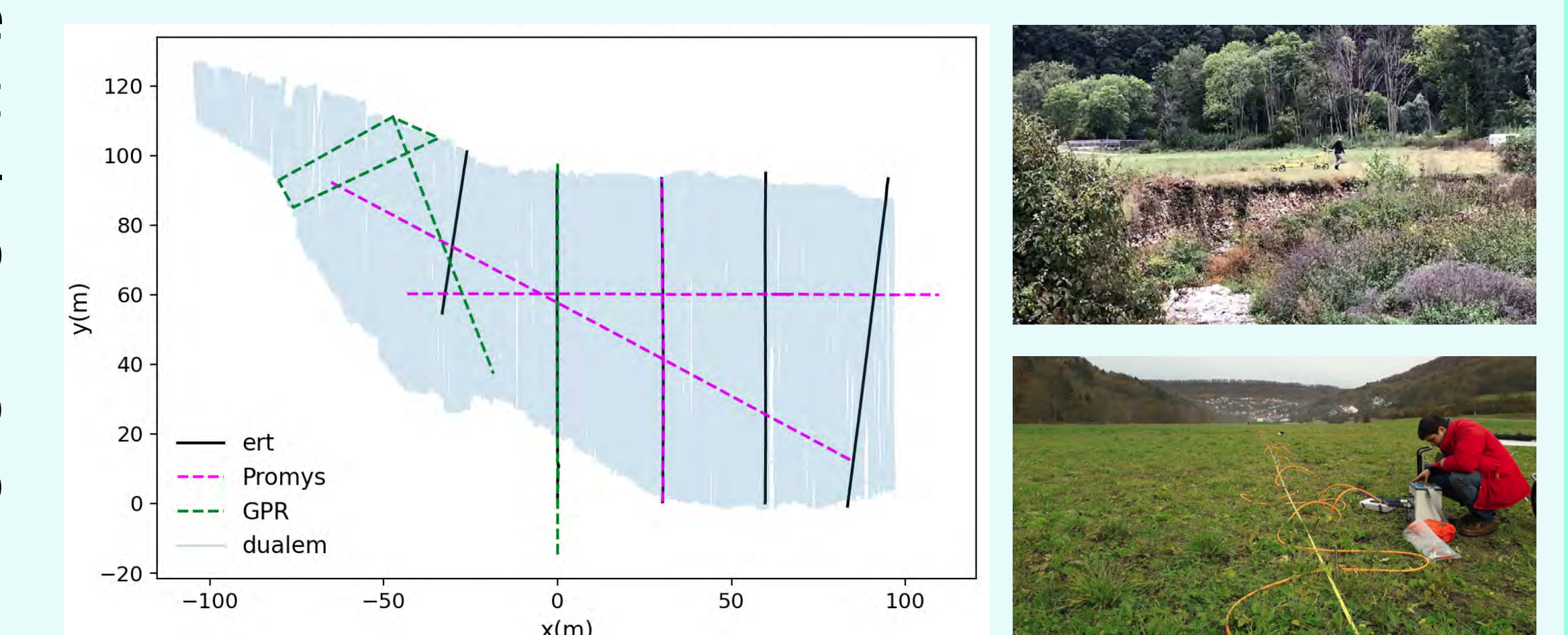


Fig. 2. Location of the geophysical soundings in the Grimmbach alluvial fan. Acquisition of EMI (top right) and ERT data (bottom right).

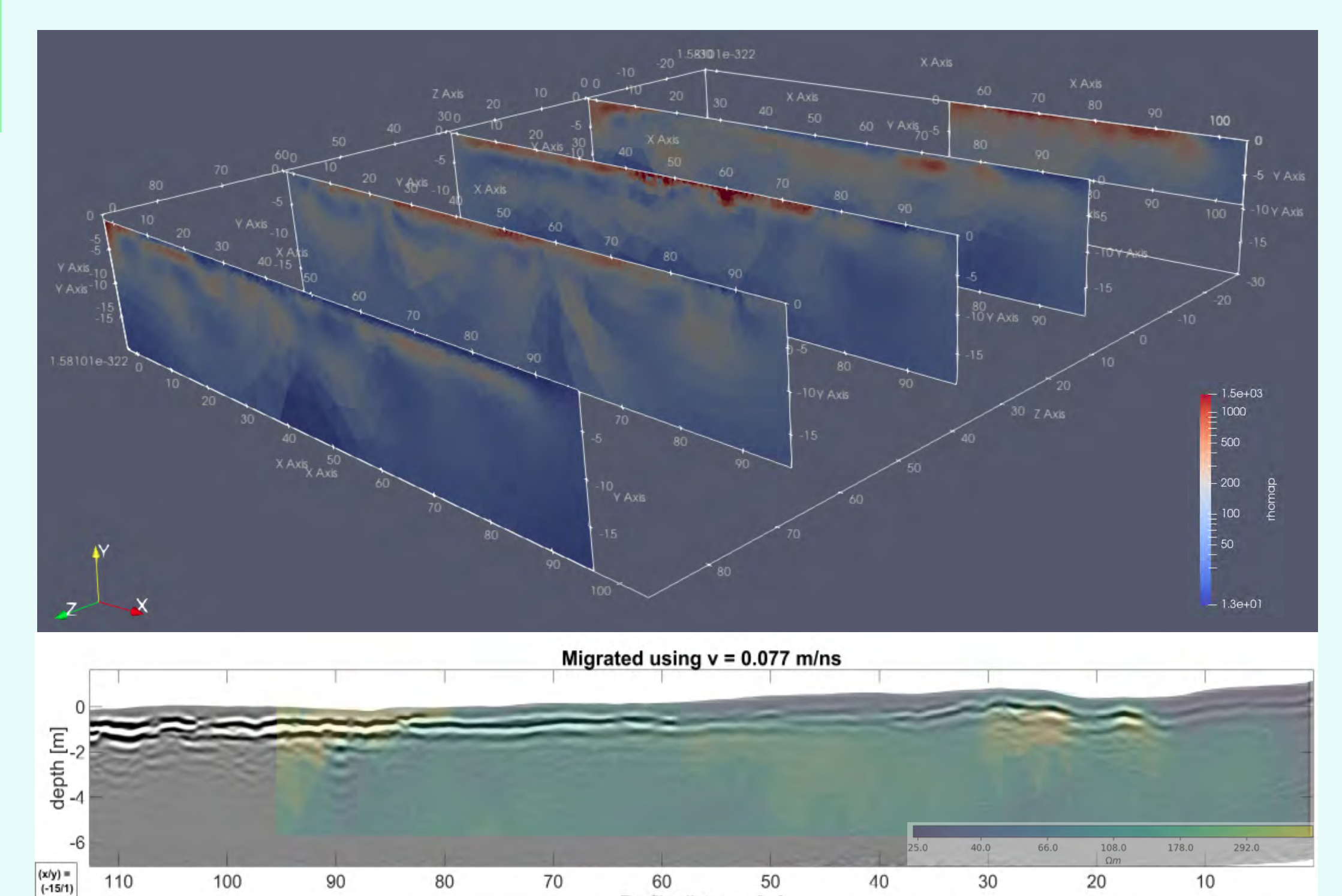


Fig. 6. Inverted ERT profiles (top) and ERT profile (at x=0 m) overlying GPR migrated data (bottom).

Acknowledgments

We thank Philipp Koyan for his collaboration in processing the GPR data.