Krzysztof Kiersnowski and Arne Anderson Stamnes

Ground-penetrating radar investigations of the Hiort chapel in Røros

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The GPR system inside the Hiort Chapel. Photo: Krzysztof Kiersnowski, NTNU University Museum

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Sammendrag

K. Kiersnowski and A. A.Stamnes 2023: NTNU Vitenskapsmuseet arkeologisk rapport 2023:14. Ground-penetrating radar investigations of the Hiort chapel in Røros.

Den 21 november 2022 ble det gjennomført en geofysisk undersøkelse av Hiort kapell i Røros, for å undersøke tilstedeværelse og plassering av graver under tregulvet. Kapellet er siste hvilested for Peder Hiort (d.1879), en tidligere direktør for Røros Kobberverk. Det ble anvendt en GSSI Sir-3000 georadar med en antenne med senterfrekvens på 400Mhz. Undersøkelsen påviste flere interessante anomalier, inkludert ett utslag som trolig er en grav. Denne er rett til venstre for selve inngangen til kapellet. To andre utslag er også trolig spor etter begravelser. Georadarundersøkelsene gir også noe innsikt i konstruksjonsdetaljer til selve kapellet, blant annet bærebjelker til selve gulvet og muligens noen spor etter selve fundamentene til kapellet.

Stikkord: georadar – kapell – graver – Røros – 1700 tallet – Peder Hiort

Krzysztof Kiersnowski og Arne Anderson Stamnes, Institutt for arkeologi og kulturhistorie, NTNU Vitenskapsmuseet, NO-7491 Trondheim

Summary

K. Kiersnowski and A. A.Stamnes 2023: NTNU Vitenskapsmuseet arkeologisk rapport 2023:14. Ground-penetrating radar investigations of the Hiort chapel in Røros.

On the 21st of November 2022, a geophysical survey was conducted to investigate the presence of burials under the floor of the Hiort Chapel in Røros Municipality. The Chapel is known as a place of burial of Peder Hiort, a former director of Røros Kobberverk, who died in 1789. The ground-penetrating radar method was applied to these investigations. The survey using GSSI-SIR 3000 system paired with a 400 MHz antenna revealed interesting images of the structures buried below the Chapel's floor. One of them, located in the main room, just to the left from the entrance, may be with high certainty interpreted as a grave. Two other structures are also likely related to the burials. The GPR images also bring some insight into the construction details of the chapel itself, showing clearly floor support beams and likely some elements of foundations.

Keywords: ground penetrating radar – burials – chapel – Røros – 18th century

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Archival references

K. Kiersnowski and A. A.Stamnes 2023: NTNU Vitenskapsmuseet arkeologisk rapport 2023:14. Ground-penetrating radar investigations of the Hiort chapel in Røros.

Fylke	Trøndelag
Kommune	Røros
Gårdsnavn	Røros kirkegård (ingen stedsnavn i matrikkelinformasjonen).
Gårdsnummer	160/177
Lokalitet	Hiort kapell
Kulturminnetype	Gravlund
Askeladden id.:	246946
Datering	1782

Content

List of figures

1. Background

The survey was undertaken on behalf of Byantikvaren in Røros Municipality. The research was initiated to investigate the presence of burials under the floor of the Hiort Chapel in Røros.

1.1 Area Description

The chapel is situated within the churchyard of Røros Kirke, surrounded by a stone wall just west of the Røros church. The survey was undertaken inside the chapel, on the existing floorboards.

Figure 1: The location of the Hiort chapel just west of the Røros church.

1.2 Cultural-Historical Background

The Hiort chapel is the final resting place of a former director of Røros Kobberverk, Peder Hiort, who died in 1789. The chapel was built as the final resting place for him and his relatives from the Ablidgaard and Hiort families. The existing building is one of the best-preserved rococo-style buildings in Norway, and it is known that coffins were moved from a crypt within the church and into the chapel. The coffins were visible until the cellar of the crypt was backfilled with sand around the year 1900, and the existing wooden floor is about 50cm above the backfilled sand.

Figure 2: Foto taken within the chapel during the GPR investigation.

2. Survey framework

2.1 Time and collaborators

Planning and execution the fieldwork and data collection were done by Krzysztof Kiersnowski, who also authored the report. The work was supervised by Arne Anderson Stamnes from the Terrestrial, Marine and Aerial Remote Sensing for Archaeology Research Group at the Department of Archaeology and Cultural History, The Norwegian University of Science and Technology (NTNU) in Trondheim, Norway.

The survey at Hiort kapell was undertaken on the 21st of November 2022 in temperatures of about -4 to -8 Celsius degrees in a chilly room of the chapel.

2.2 Aims and objectives

The purpose of this survey was to gather subsurface information and identify any potential location and number of graves buried under the chapels' floor.

2.3 Dissemination

There was no active dissemination of this project in the media or social media platforms.

2.4 Method

2.4.1 Data Collection – methodological approach

The investigations were undertaken using a single channel ground penetrating radar (GPR). More specifically a GSSI Sir 3000 system with a 400Mhz center frequency antenna (see Figure 2).

2.4.4 GPR Survey

Ground-penetrating radar (GPR) is a geophysical method that uses electromagnetic waves to penetrate the subsurface and image the structure of the ground, based on received waves' reflections. The GSSI SIR 3000 system paired with a 400 MHz antenna is a typical setup for GPR surveys. The antenna frequency determines the depth of penetration and resolution of the image while the system processes and records the data (Lawrence B. Conyers, 2012; Larry B. Conyers, 2013). This survey aimed to gather subsurface information and identify any potential archaeological features.

The survey was carried out by walking the antenna over the survey area in a systematic grid pattern in a parallel mode with 0.25 m spacing between the profiles (see Figure 3). The GPR system was set to continuously record data as the antenna moved, and the data was saved for later analysis. The GPR system was set to a time window of 50 ns which can penetrate the ground to the depth of approximately 2 meters.

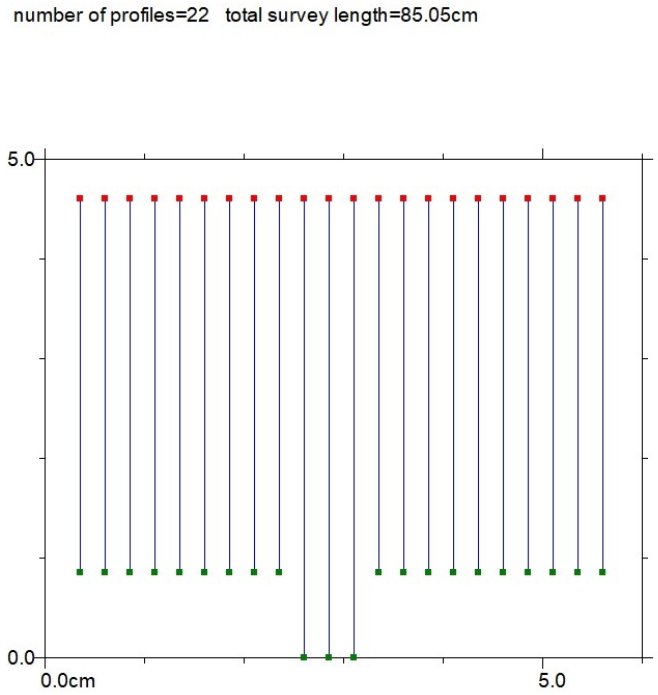


Figure 3: Grid map of the collected GPR profiles. The entrance to the chapel is located where the three longer lines are. Lines were collected from the green dot to the red dot in parallel lines.

The survey was carried out over the whole floor of the main chapel room and covered a surface of approximately 26 square meters. A total survey length was 85 meters collected over 22 lines. The lines started and stopped a little bit away from the actual walls of the chapel due to the geometry of the GPR system.

The collected data has been processed in GPR-Slice software, utilizing various techniques to enhance the results. The processing steps included the application of a bandpass filter (approximately 100-700 MHz), removal of background noise, migration, and the use of a Hilbert transform. The images presented showcase different processing stages.

3. Observations, interpretations, and discussion

To the left of the entrance to the chapel, an oblong structure (feature no. 1, see Figure 4) characterized by high reflectivity at its top layer, and measuring approximately 2 meters by 0.8 meters has been detected starting at a depth of 0.80-0.90 cm. This finding is noteworthy due to its distinctiveness and location. Although one end of the feature extends beyond the measured area, it is highly probable to be a grave based on its depth and size. This depth aligns well with the known level of the ground surface.

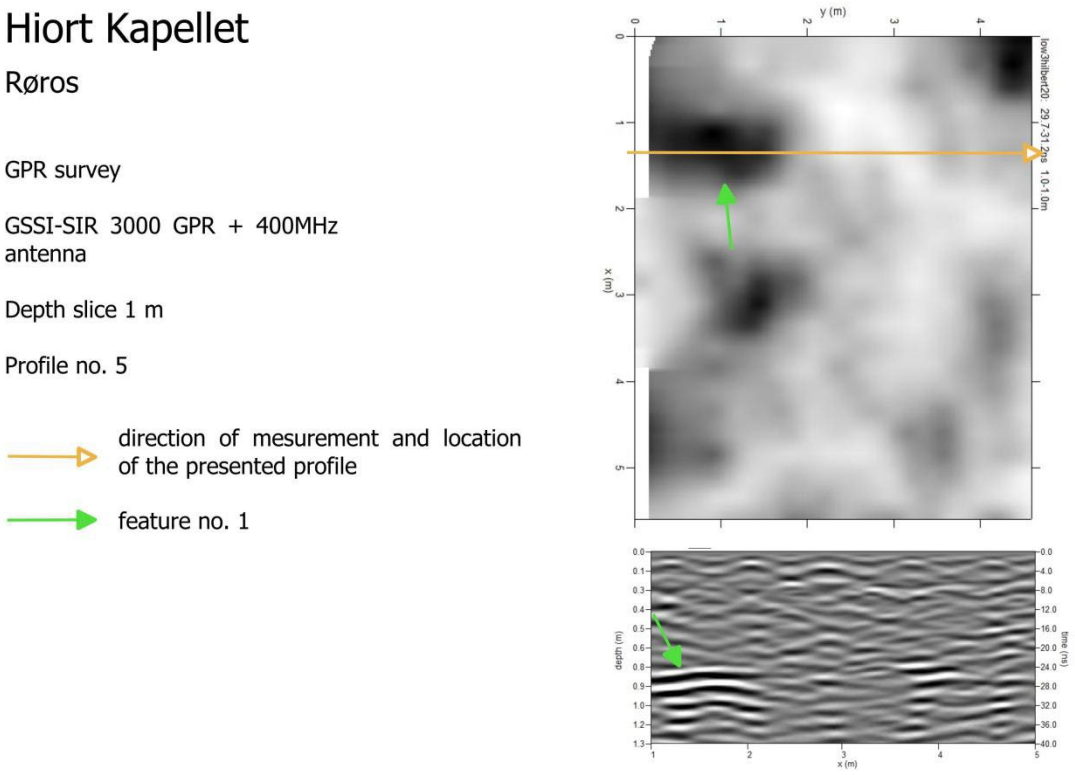


Figure 4: GPR image of the feature no. 1 interpreted as a possible grave.

Symmetrically, a similar structure (feature no. 2, see Figure 5) has been recorded to the right of the entrance, although the picture is not as clear. It begins at a depth of approximately 1 meter. This finding is intriguing and requires further investigation to fully understand its implications.

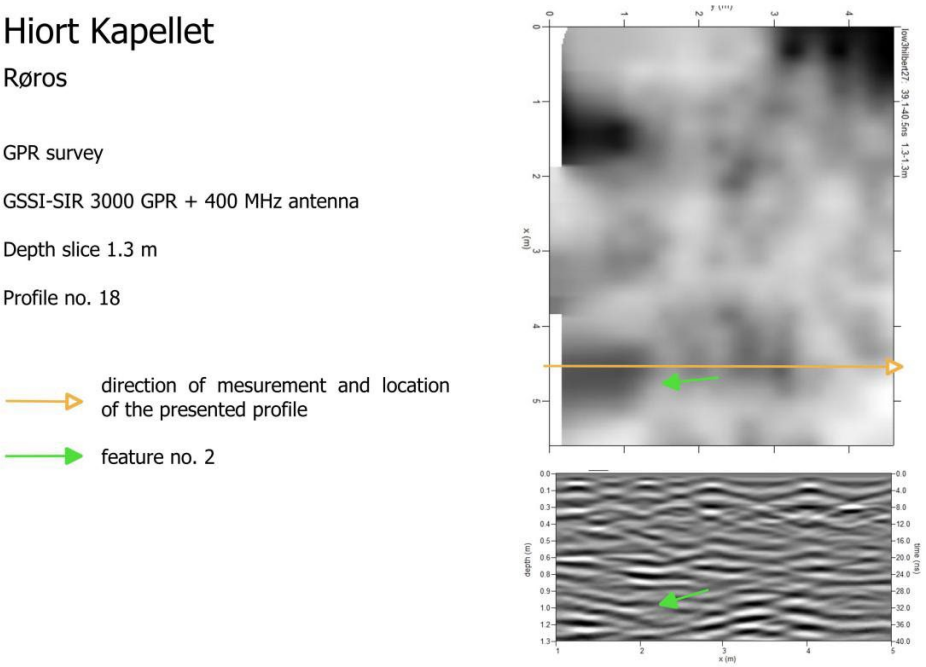


Figure 5: GPR image showing feature no. 2 in the 1.3 m depth slice and in the profile view.

In the centre of the chapel room, about 1.5 meters past the entrance into the main room of the chapel, another highly reflective object (feature no. 3, see Figure 6) was detected at a depth of around 1 meter. This feature is much smaller than the two previous and circular in shape, measuring approximately 0.5 meters in diameter. The object could be interpreted as an urn or a child's grave based on its size and location, with a chance of the source of the responses being just beyond the reach of the GPR antenna, i.e. placed against the back wall and originally larger.

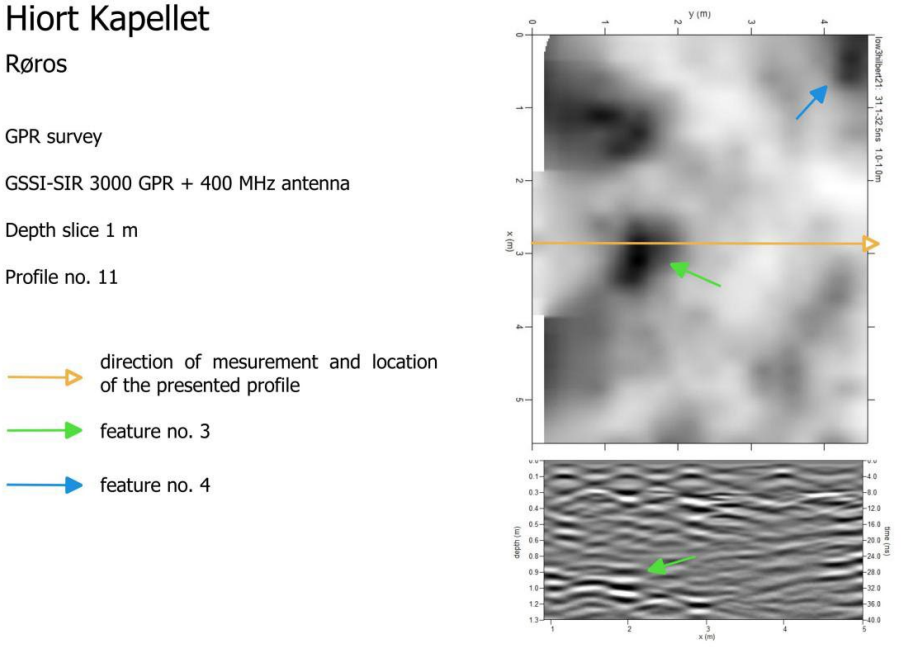


Figure 6: GPR image showing locations of the features no. 3 and 4 in the 1 m depth slice and in the profile view of the feature no. 3.

Another object (feature no. 4, see Figure 6) characterized by a high reflectivity is located by the southern corner of the chapel and extends beyond the surveyed area. It is visible in a circular form of ca. 0.6 m in diameter at buried at a depth of 0.9 - 1 m. However, the image shows a larger, possibly 1.8 by 1 m, object (feature no. 5, see Figure 7) buried below, starting at a depth of 1.1 m. The size of that feature would fit an interpretation of a grave, however, the acquired GPR image reveals that part of that feature is located very close to or even under the chapel's wall at its corner. Since the feature is located very close to the wall, it is also possible that the received signal is a result of some kind of noise caused by that location and construction elements, such as foundation rocks. Additionally, the described feature might also be caused by signal reflection from several closely placed objects.

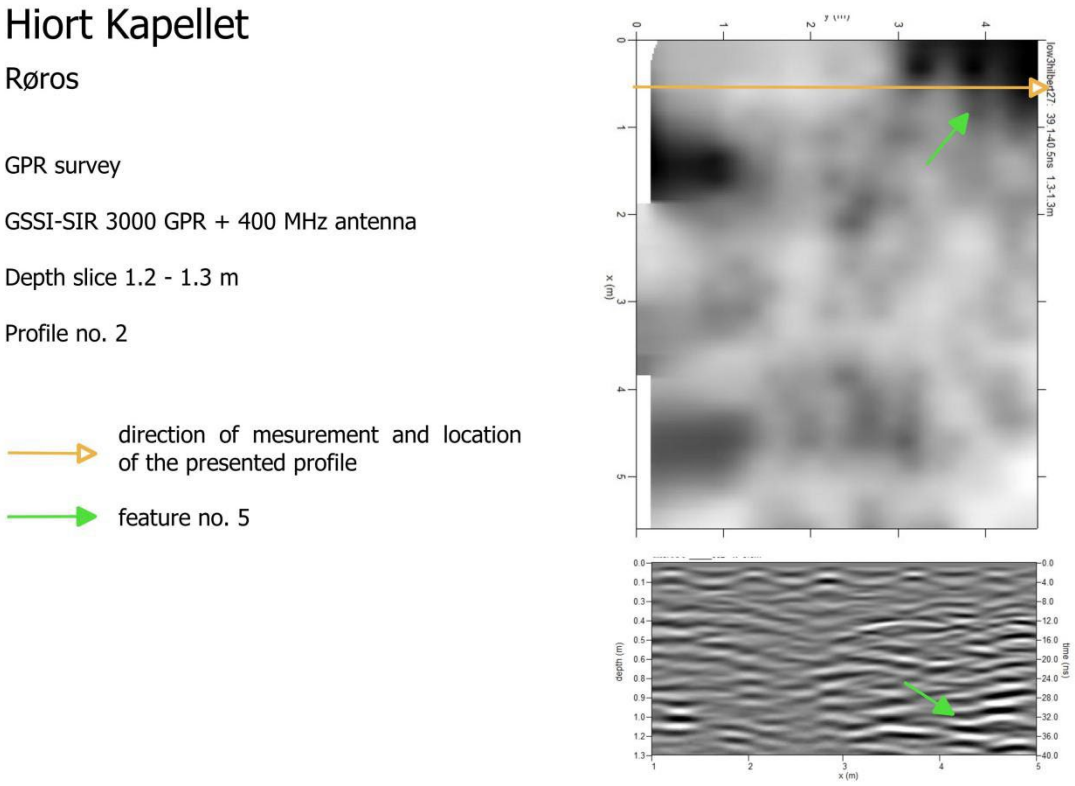


Figure 7: GPR image showing feature no. 5 in the 1.2 - 1.3 m depth slice and in the profile view.

The construction of the floor within the top 0.3-0.4 meters is very well visible, showing support beams oriented in perpendicular direction to the floor boards (see Figure 8). This information is providing valuable information about the building's history.

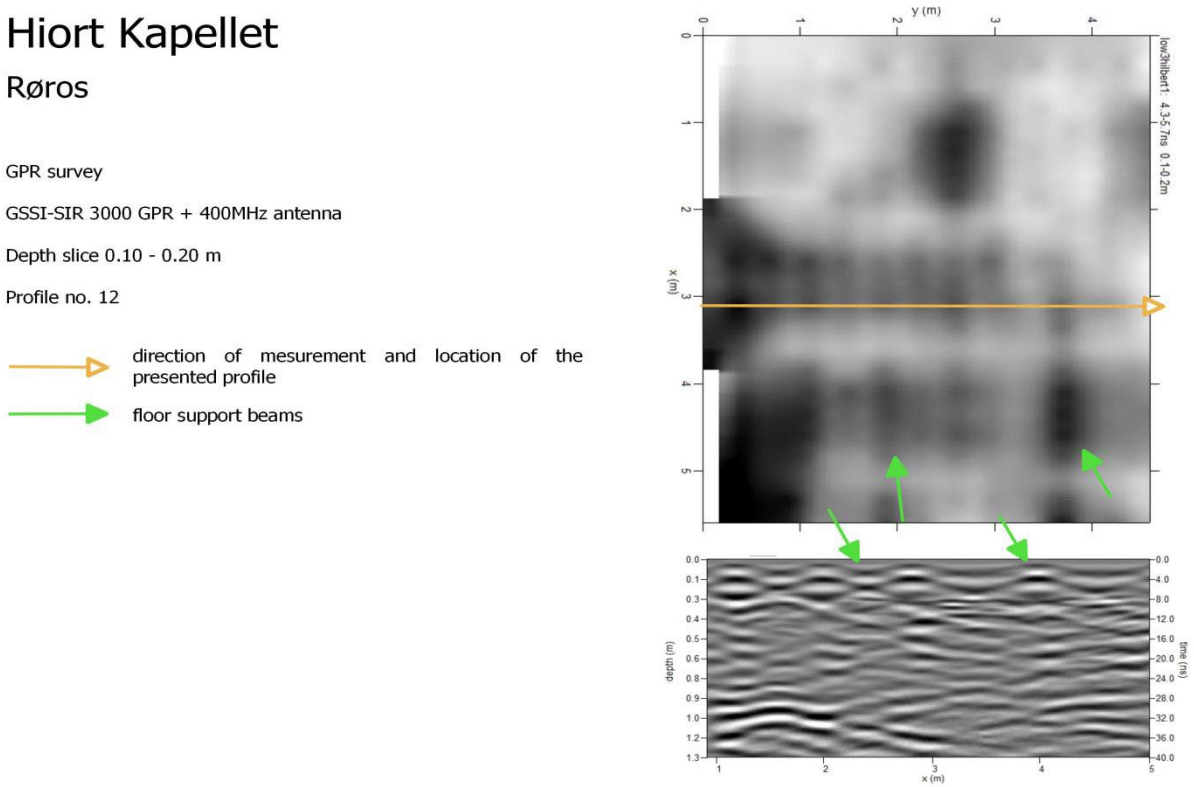


Figure 8: GPR image showing floor support beams.

4. Conclusions

The survey revealed interesting images of the structures buried below the Chapel's floor. One of them, located in the main room, just to the left from the entrance, may be with high certainty interpreted as a grave. Two other structures are also likely related to the burials. The GPR images also bring some insight into the construction details of the Chapel itself, showing clearly floor support beams and likely some elements of foundations.

5. Literature

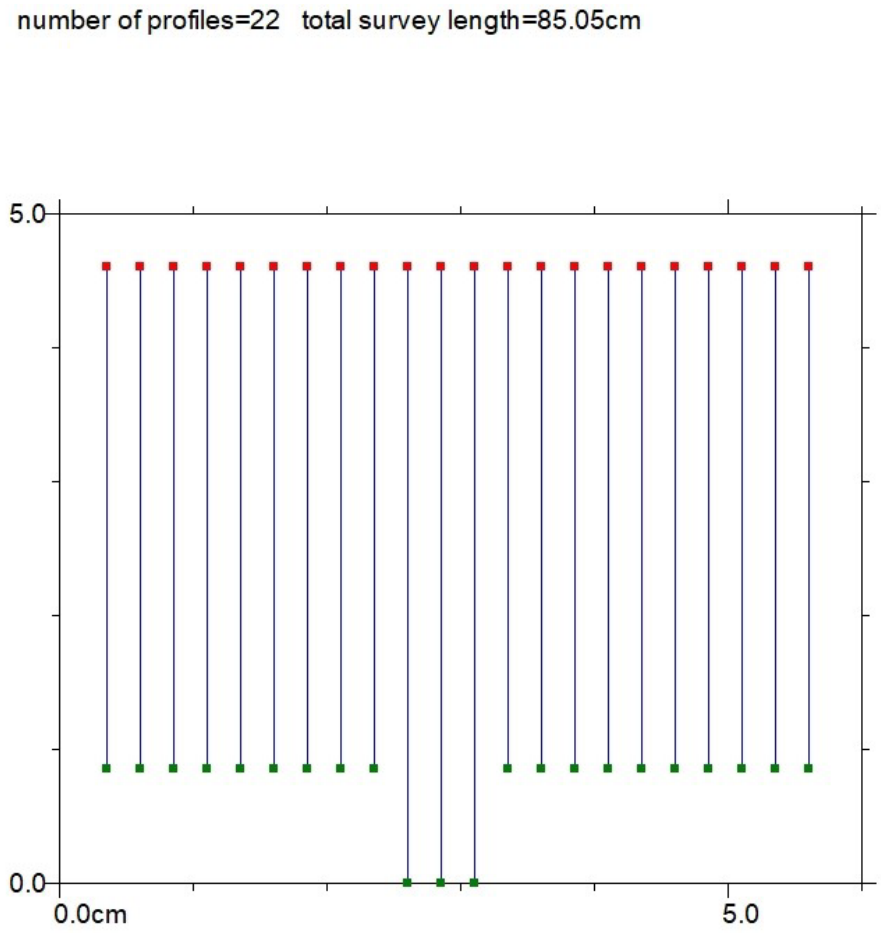
Conyers, L. B. (2012). *Interpreting ground-penetrating radar for archaeology*. Walnut Creek, Calif.: Left Coast Press.

Conyers, L. B. (2013). *Ground-penetrating radar for archaeology* (3rd Edition ed.). Plymouth, United Kingdom: AltaMira Press.

Schmidt, A., Linford, P., Linford, N., David, A., Gaffney, C., Sarris, A., & Fassbinder, J. W. E. (2016). *EAC guidelines for the use of geophysics in archaeology - Questions to ask and points to consider* [2]. In E. Jerem (Ed.), EAC Guidelines

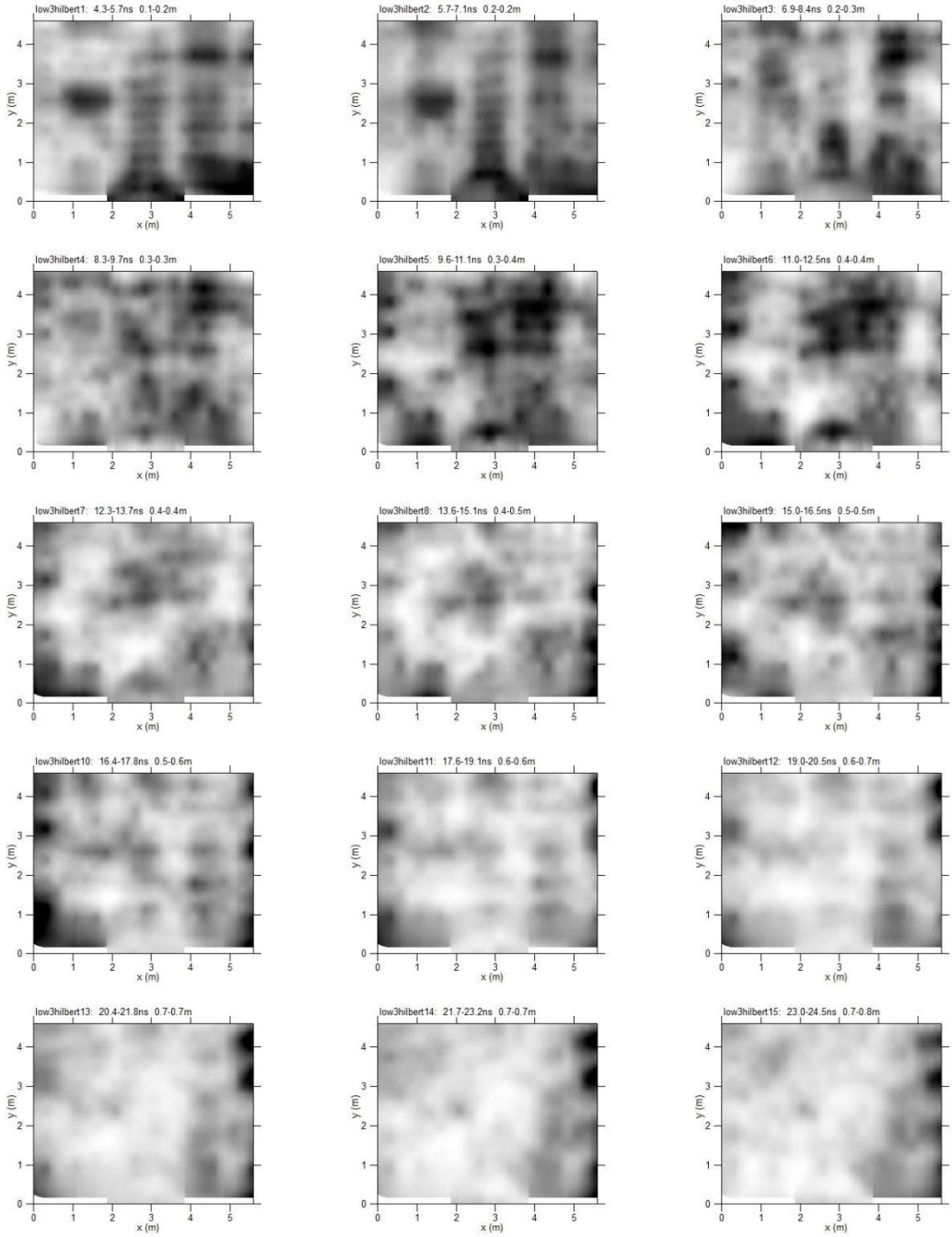
6. Appendix – extra maps, technical info, all depth slices and radar profiles, and photos from the survey

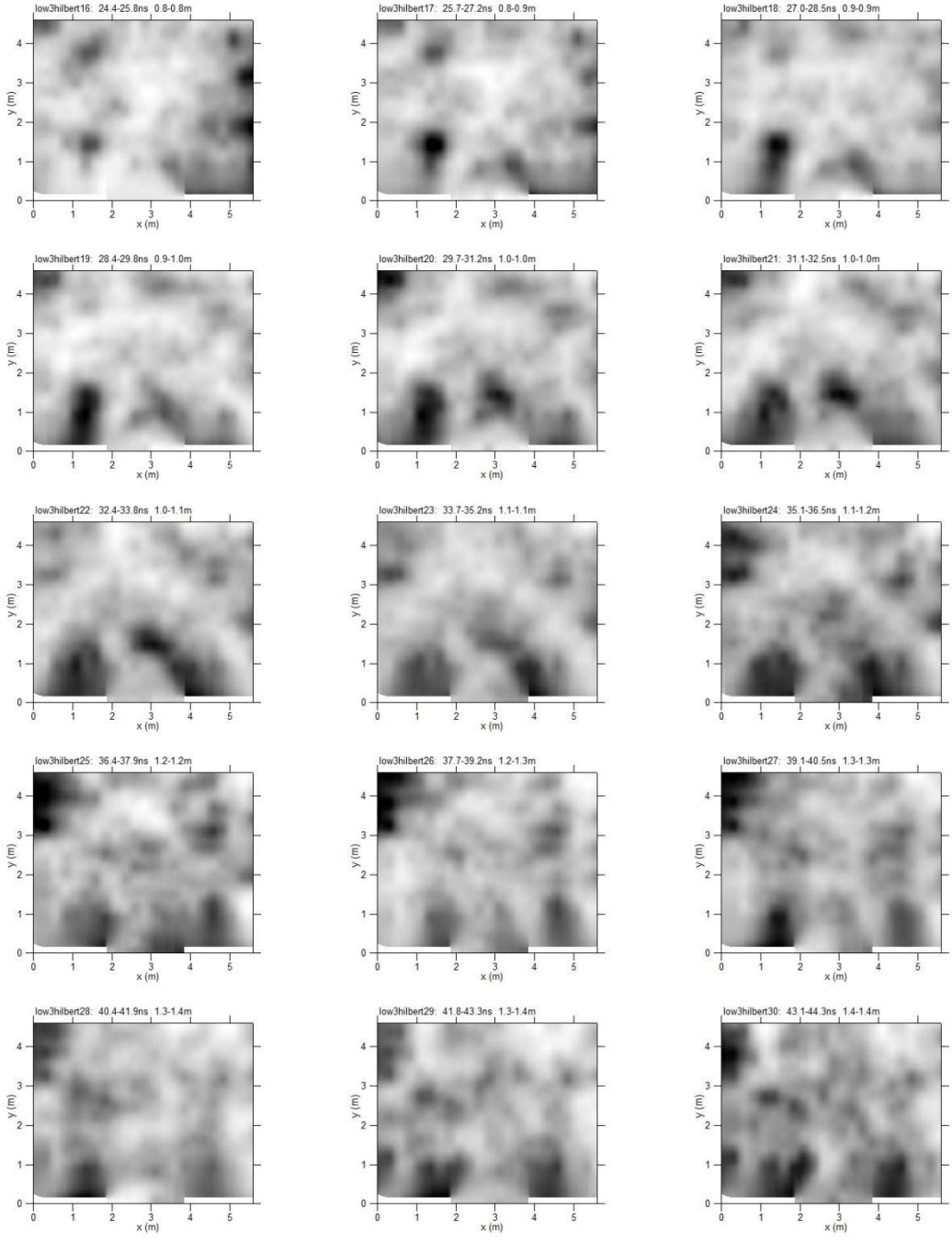
6.1 GPR Grid Plot



6.2 All GPR depth slices

6.2.1 Depth slices in greyscale

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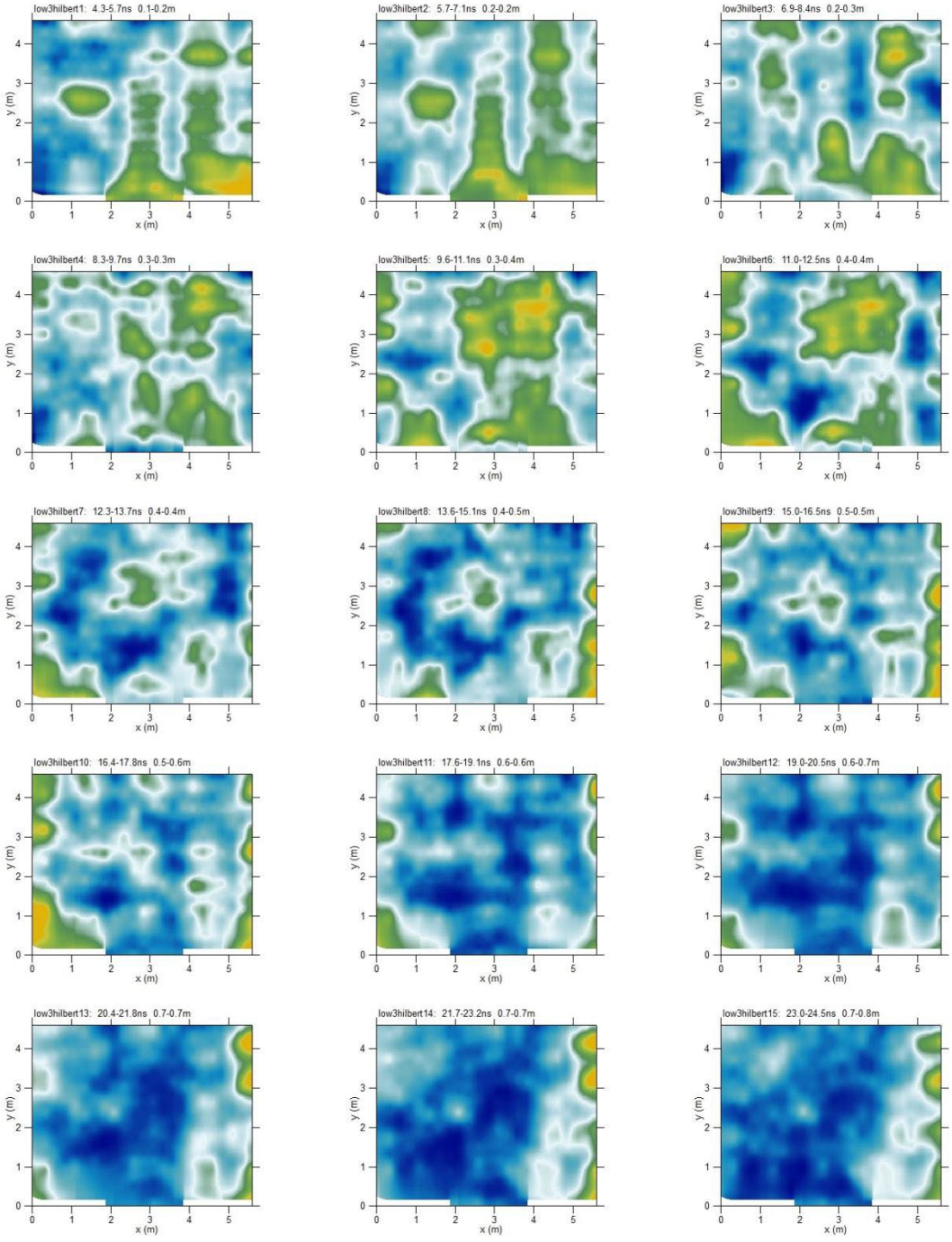
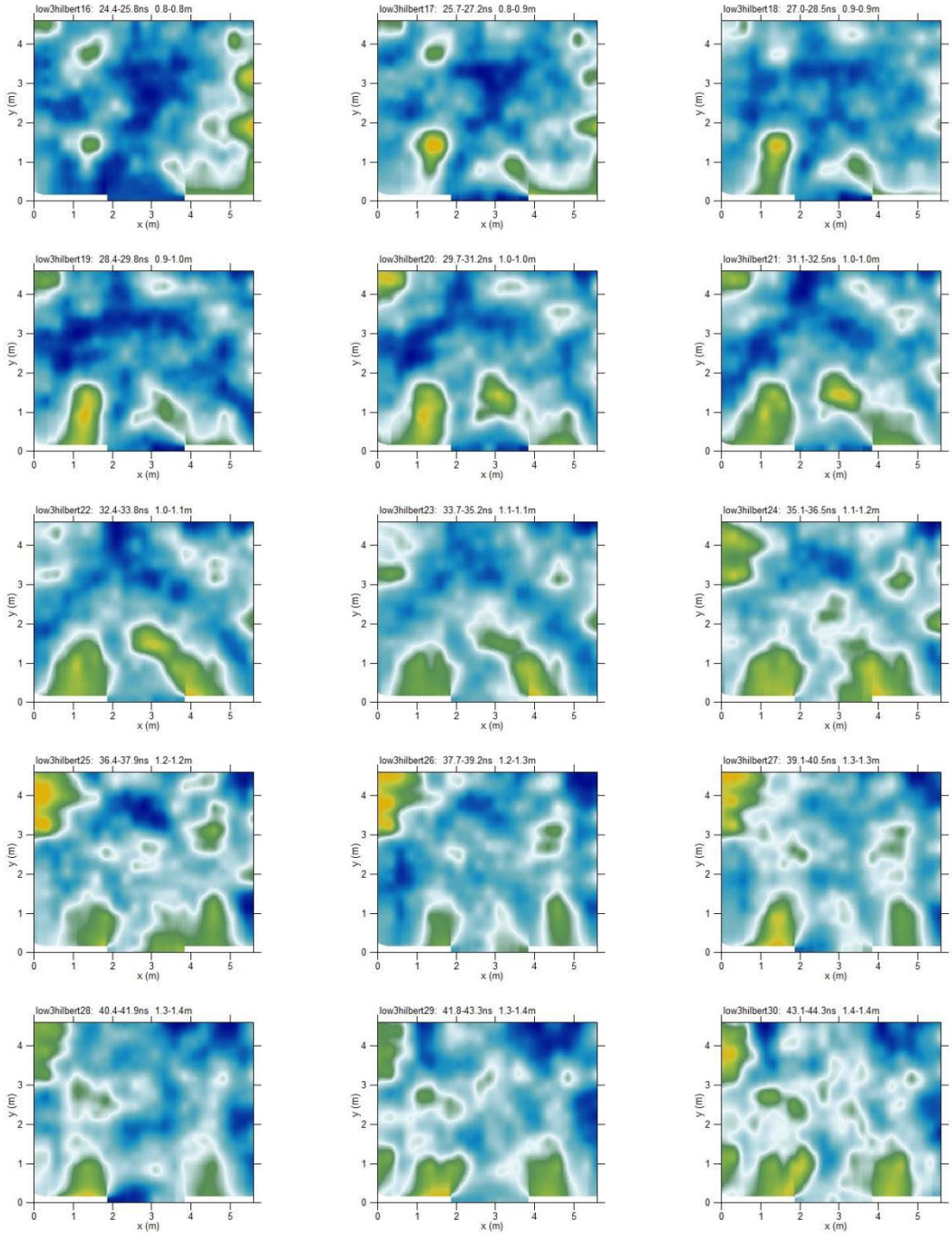
low3hilbert19: 28.4-29.8ns 0.9-1.0m
low3hilbert20: 29.7-31.2ns 1.0-1.0m
low3hilbert21: 31.1-32.5ns 1.0-1.0m
low3hilbert22: 32.4-33.8ns 1.0-1.1m
low3hilbert23: 33.7-35.2ns 1.1-1.1m
low3hilbert24: 35.1-36.5ns 1.1-1.2m
low3hilbert25: 36.4-37.9ns 1.2-1.2m
low3hilbert26: 37.7-39.2ns 1.2-1.3m
low3hilbert27: 39.1-40.5ns 1.3-1.3m
low3hilbert28: 40.4-41.9ns 1.3-1.4m
low3hilbert29: 41.8-43.3ns 1.3-1.4m
low3hilbert30: 43.1-44.3ns 1.4-1.4m
x (m)
y (m)

6.2.2 Depth slices in color

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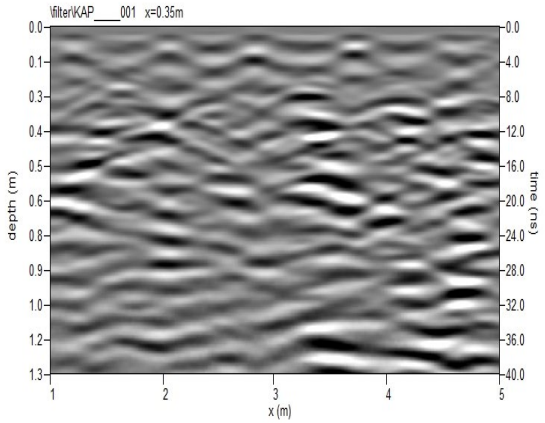
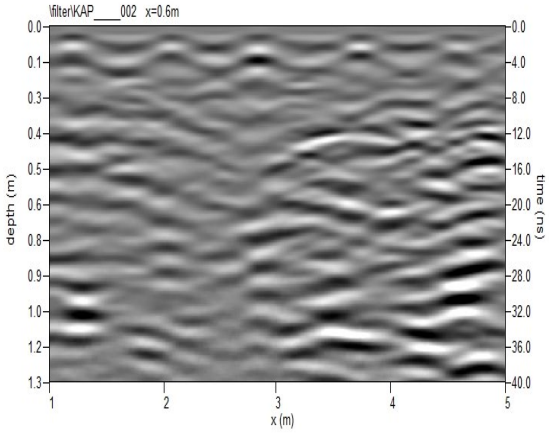
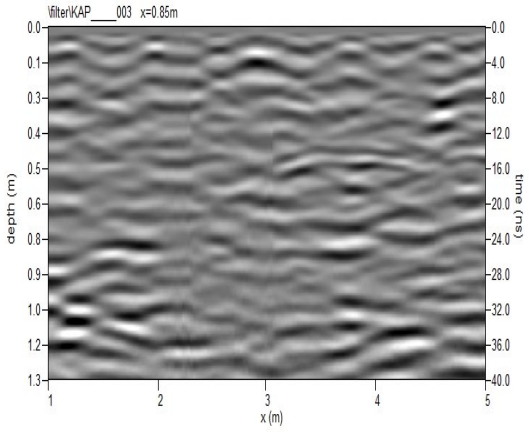
y (m)
x (m)

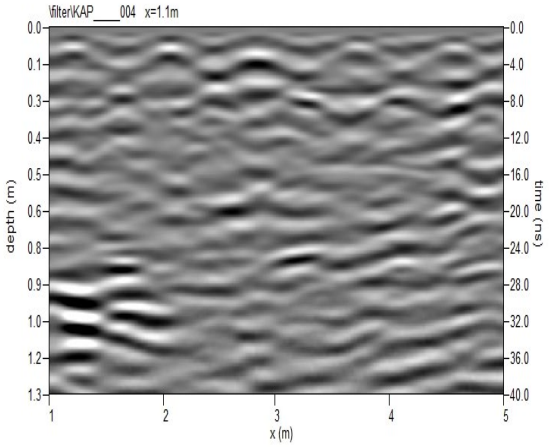
6.3 GPR profiles

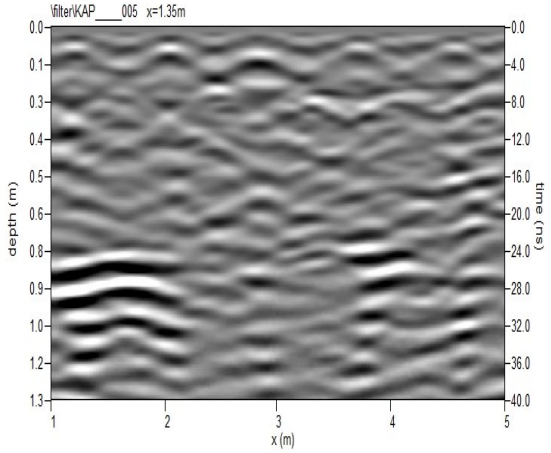
Presented radargram profiles are processed and filtered through bandpass (approx. 100 - 700 Mhz) and background noise removal, but before migration and Hilbert transform, which were used for the depth slices.







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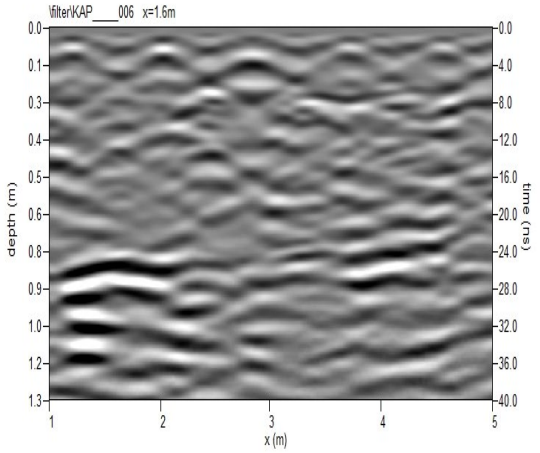
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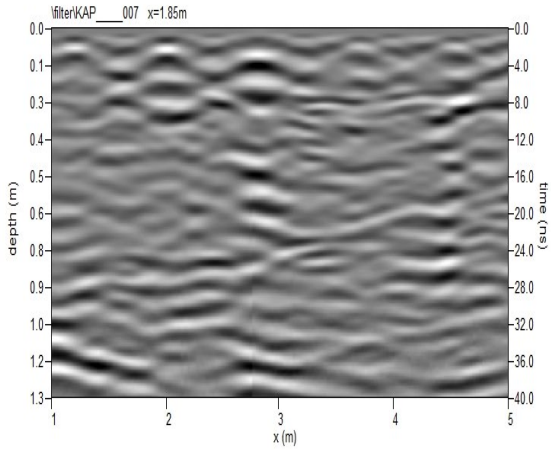
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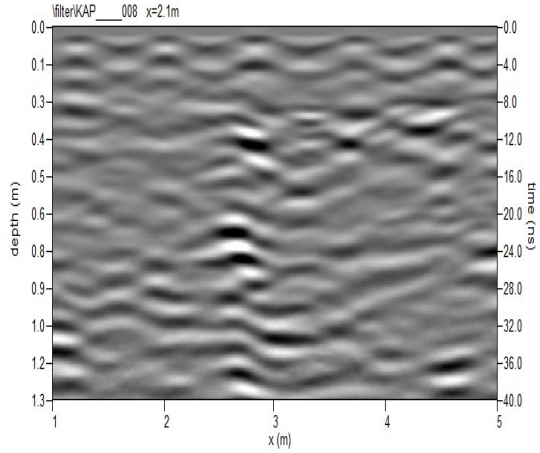
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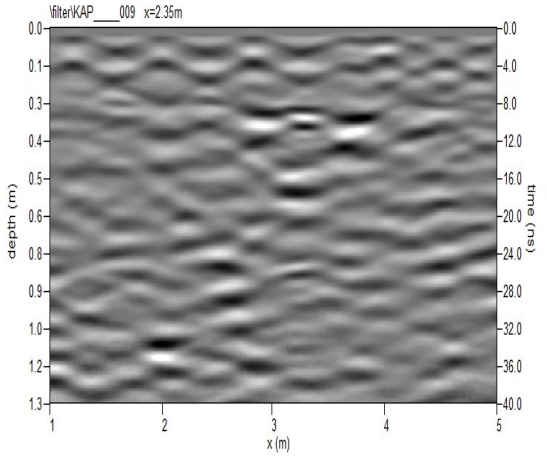
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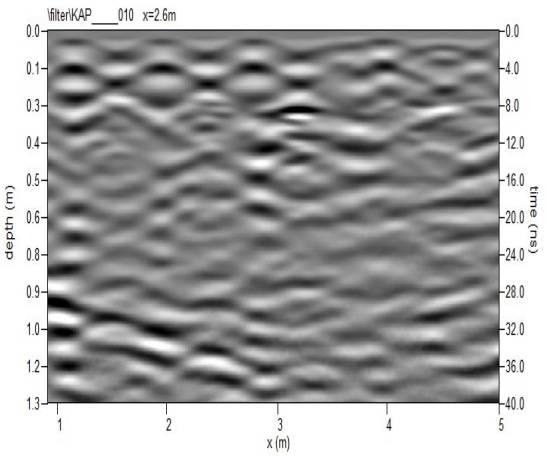
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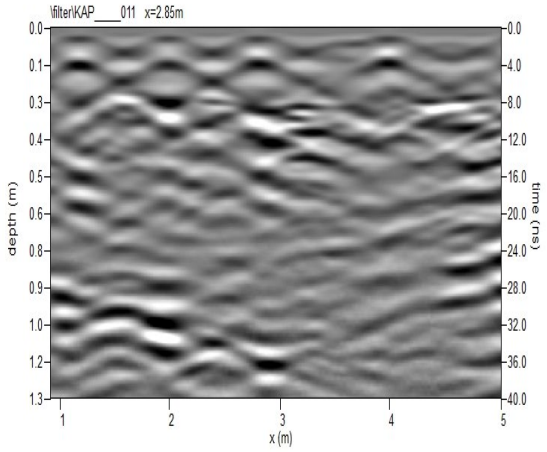
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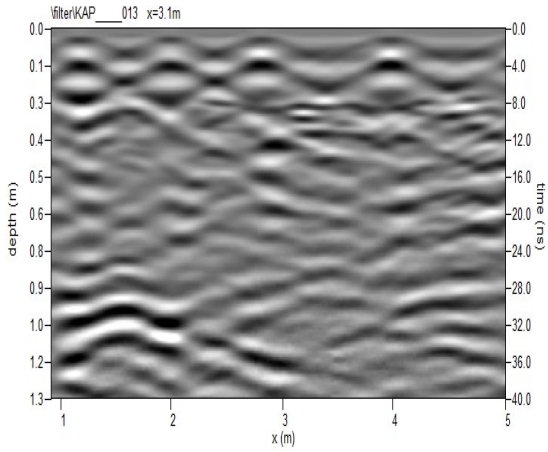
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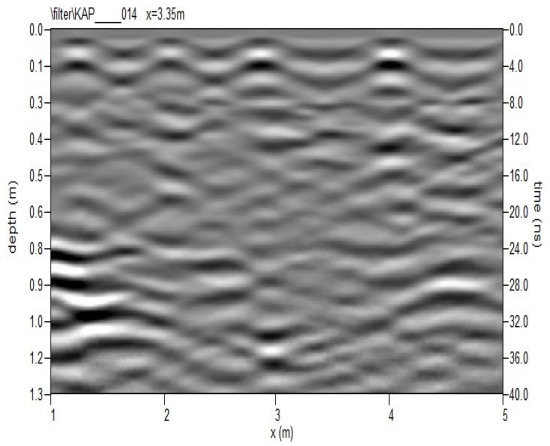
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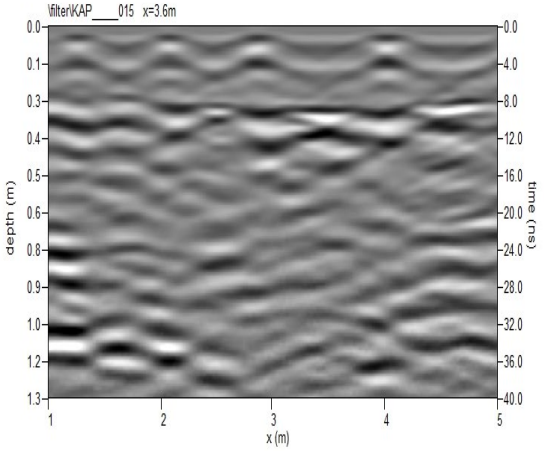
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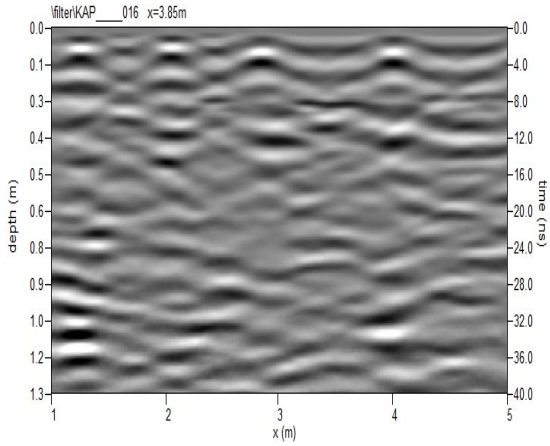
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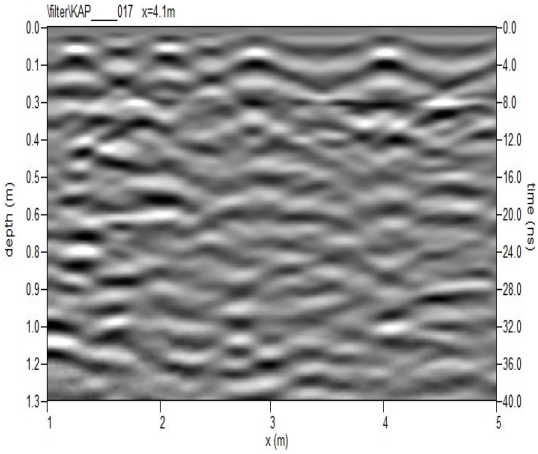
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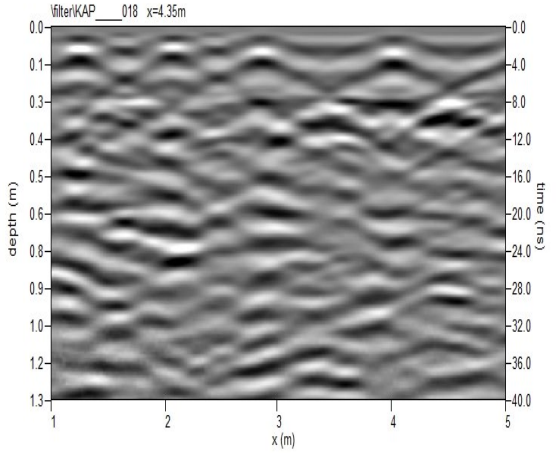
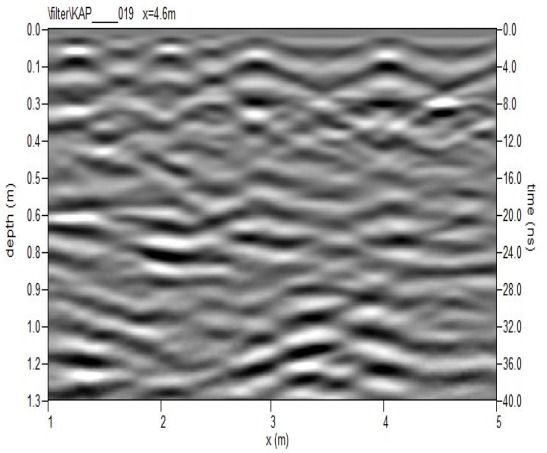
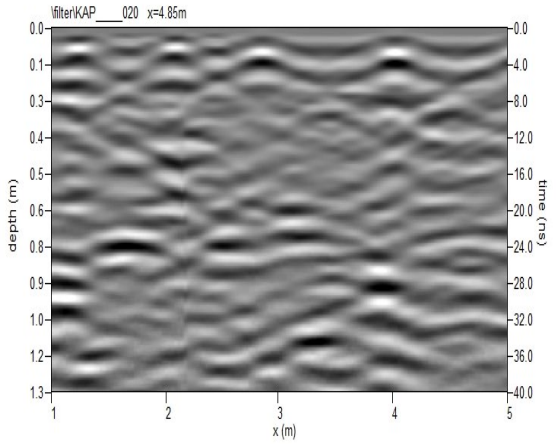
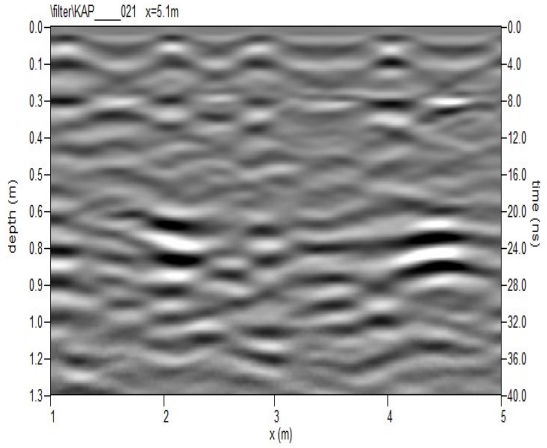
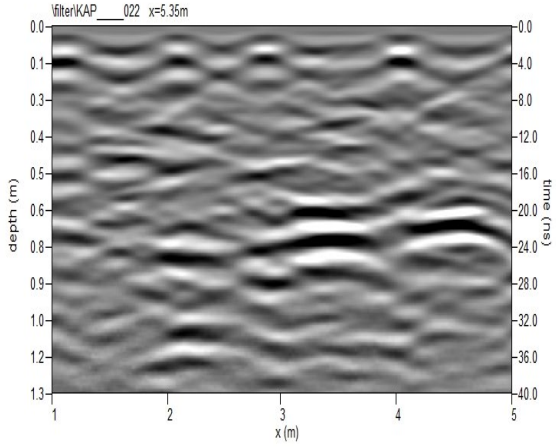
x (m)

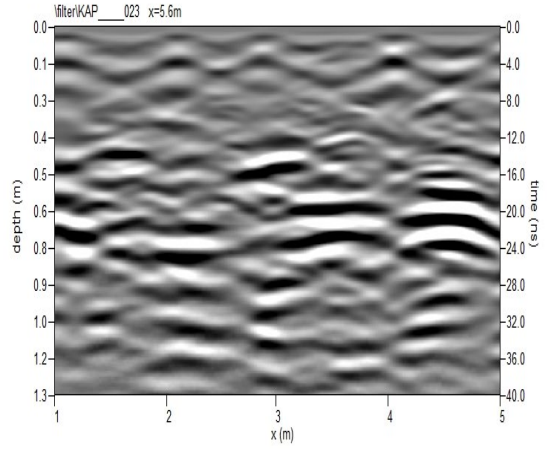

\filter\KAP____018 x=4.35m
depth (m)
time (ns)
x (m)


\filter\KAP____019 x=4.6m
depth (m)
time (ns)
x (m)


\filter\KAP____020 x=4.85m
depth (m)
time (ns)
x (m)

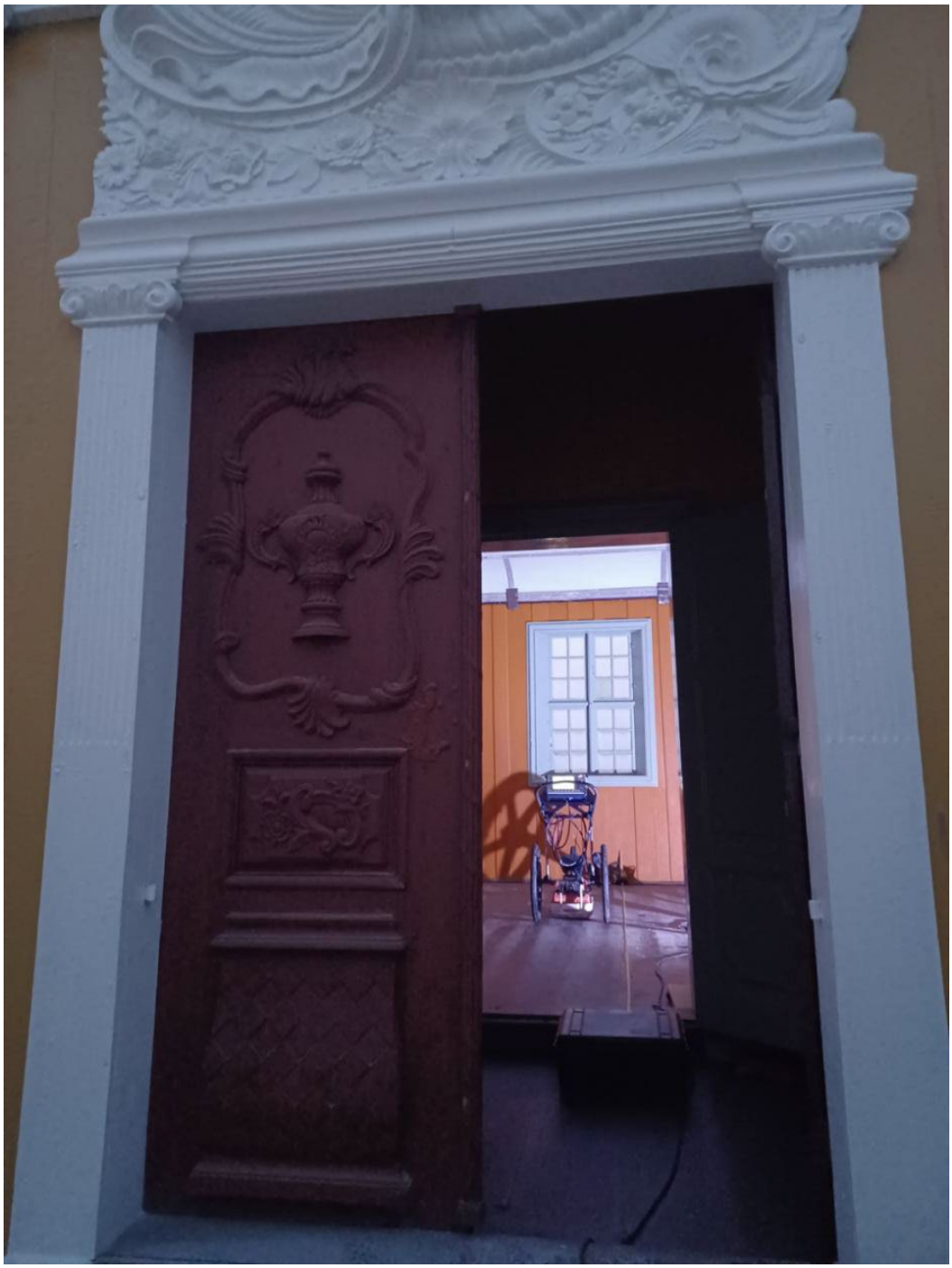

\filter\KAP____021 x=5.1m
depth (m)
time (ns)
x (m)


\filter\KAP____022 x=5.35m
depth (m)
time (ns)
x (m)


\filter\KAP____023 x=5.6m
depth (m)
time (ns)
x (m)

6.4 Photos from the survey

Photos: Krzysztof Kiersnowski



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