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Driving archaeological interpretation of geophysical data using 3D geomodelling

Paul Cupillard, Judith Sausse, Eva Despinoy, Thibault Fleury, Joseph Dogui, Raymond Éguin, Romain Baille, Louise Houbre (École Nationale Supérieure de Géologie)

Introduction

Geophysical prospection methods make it possible for archaeologists to investigate sites in a non-destructive way. They provide images of physical properties of the underground over large areas. Interpretation of such images can reveal archaeological and sedimentological structures, which helps in better understanding a site and/or estimating the potential of it prior to excavation. However, interpretation can be ambiguous due to i) the uncertainty derived from the imaging process, ii) the limited resolution of the obtained images and iii) the sparsity of the observations. In this work, we show how geomodelling tools can guide the interpretation of geophysical data.

Archaeological questions

Gombervaux case study, South Meuse, France (e.g. Baudoin, 1993)

-  1338 – 1428 :
Maison de Nancy
-  1428 – 1490 :
Maison de Vernancourt
-  1490 – 1594 :
Maison des Salles
-  1594 – 1685 :
Maison de Myon
-  1685 – 1766 :
Maison du Breuill de la Brossardière
-  1766 – 1843 :
Maison de Mailliart
-  1843 – present :
Famille Plauche Gillon



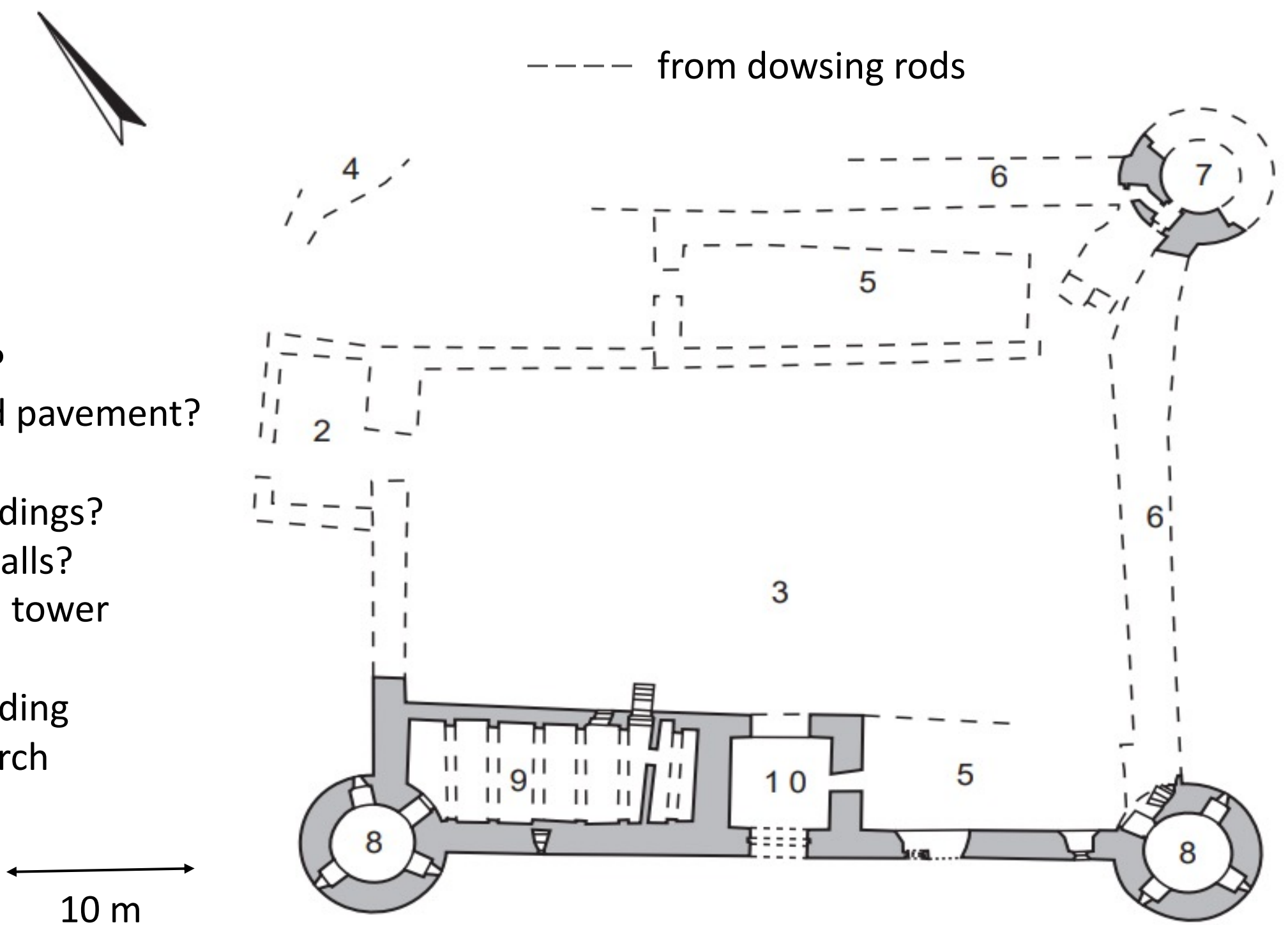
Courtesy of Association Gombervaux



Drawing by Edmond Richardin (1906)

- Depth and extent of the courtyard pavement (if any)?
- Presence of the features detected using dowsing rods?
- Other features?

2. Barbican?
3. Courtyard pavement?
4. Tower?
5. Main buildings?
6. Curtain walls?
7. Collapsed tower
8. Towers
9. Main building
10. Tower-porch



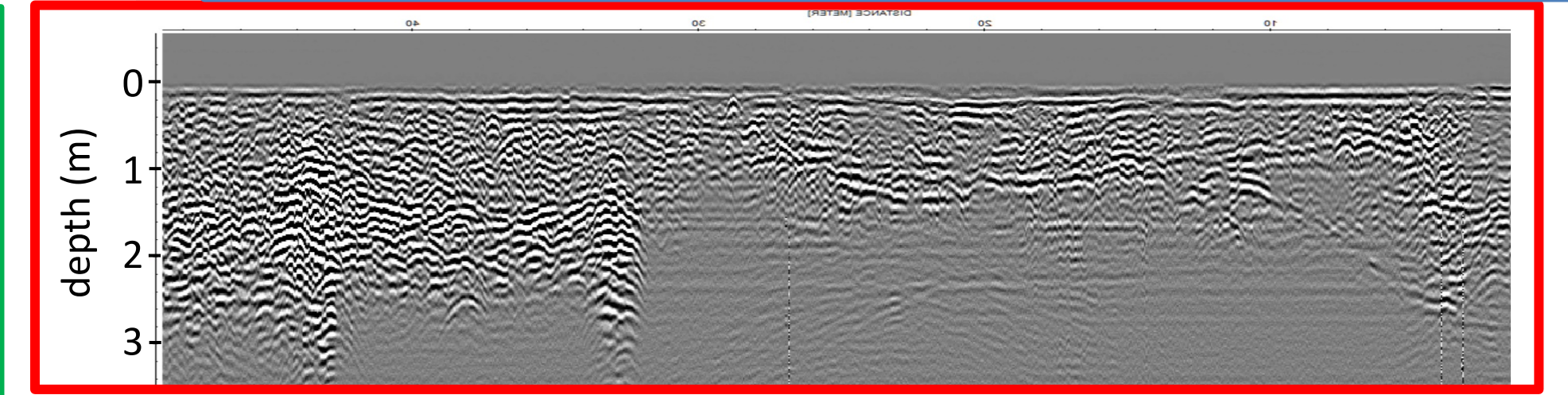
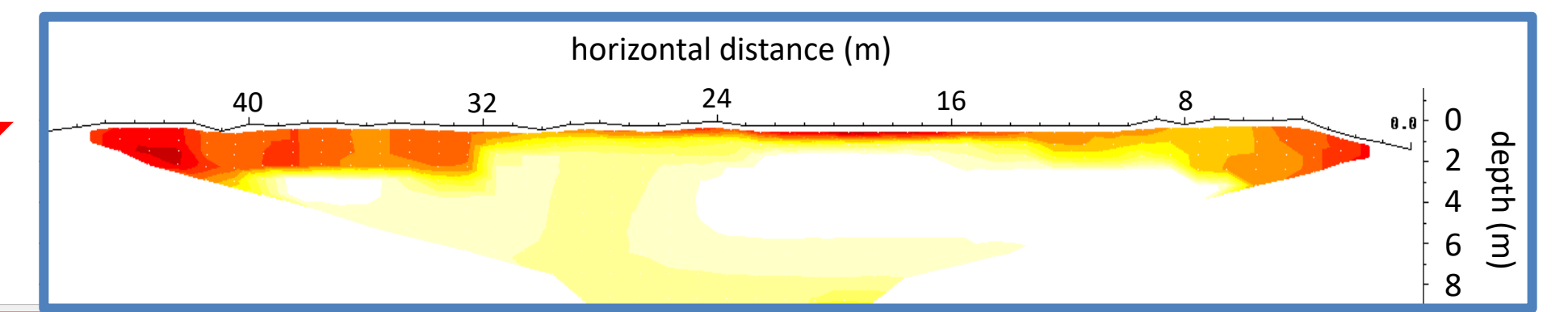
Modified from Giulato (2009)

➤ Only two materials within the sections (i.e., backfill and substratum) or several materials in the shallow, resistive part (backfill, preserved walls and foundations, collapsed walls, etc.)?

➤ Does the backfill continue westward or does it become suddenly thinner?

➤ What is/are the material(s) between the walls?

Geophysical data acquisition & processing



Computing attributes on GPR sections to

- Estimate backfill thickness over the new features
- Clearly define lateral borders

virtuous circle

Geomodelling

Science is what we understand well enough to explain to a computer (D. Knuth).

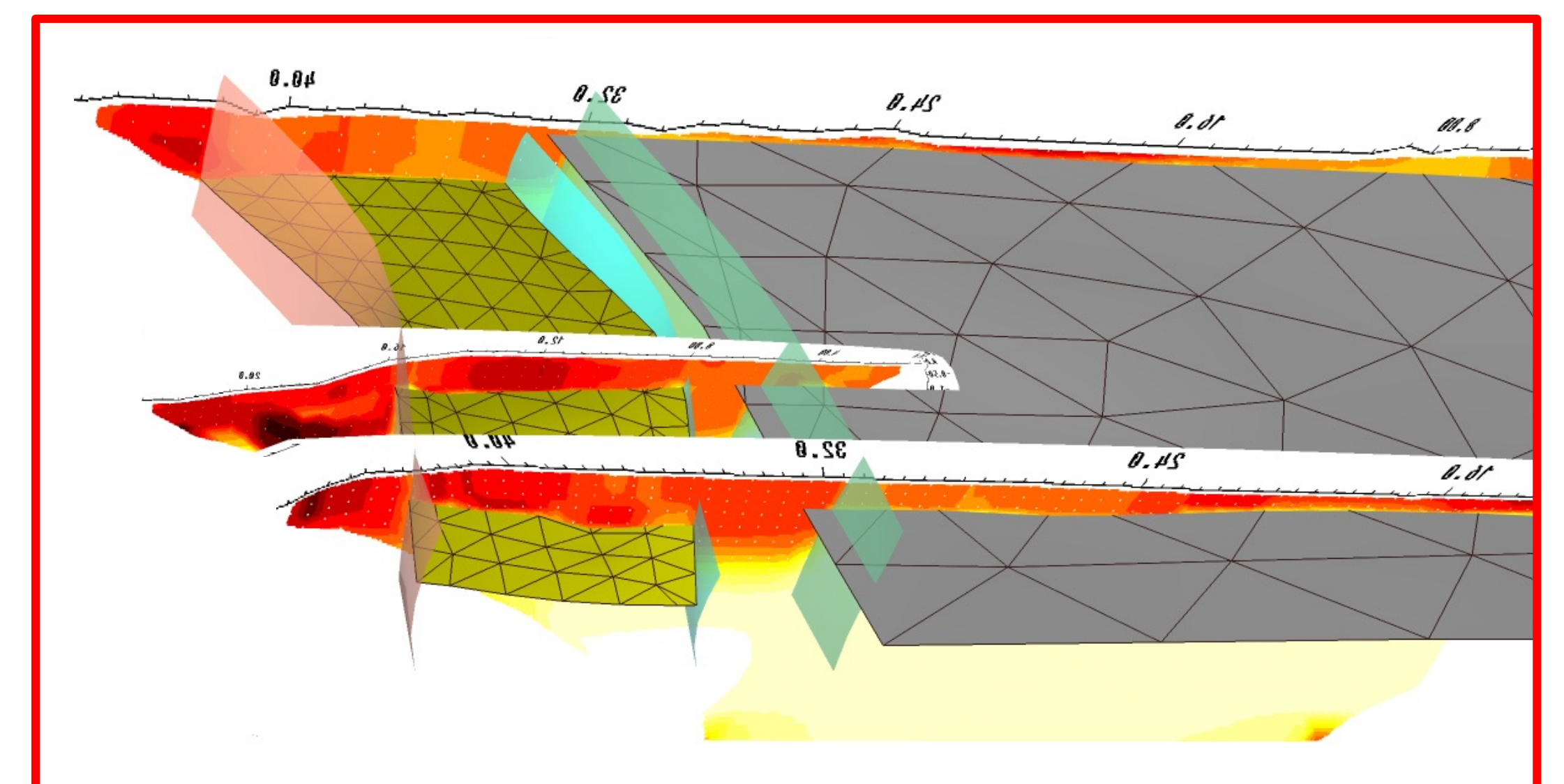
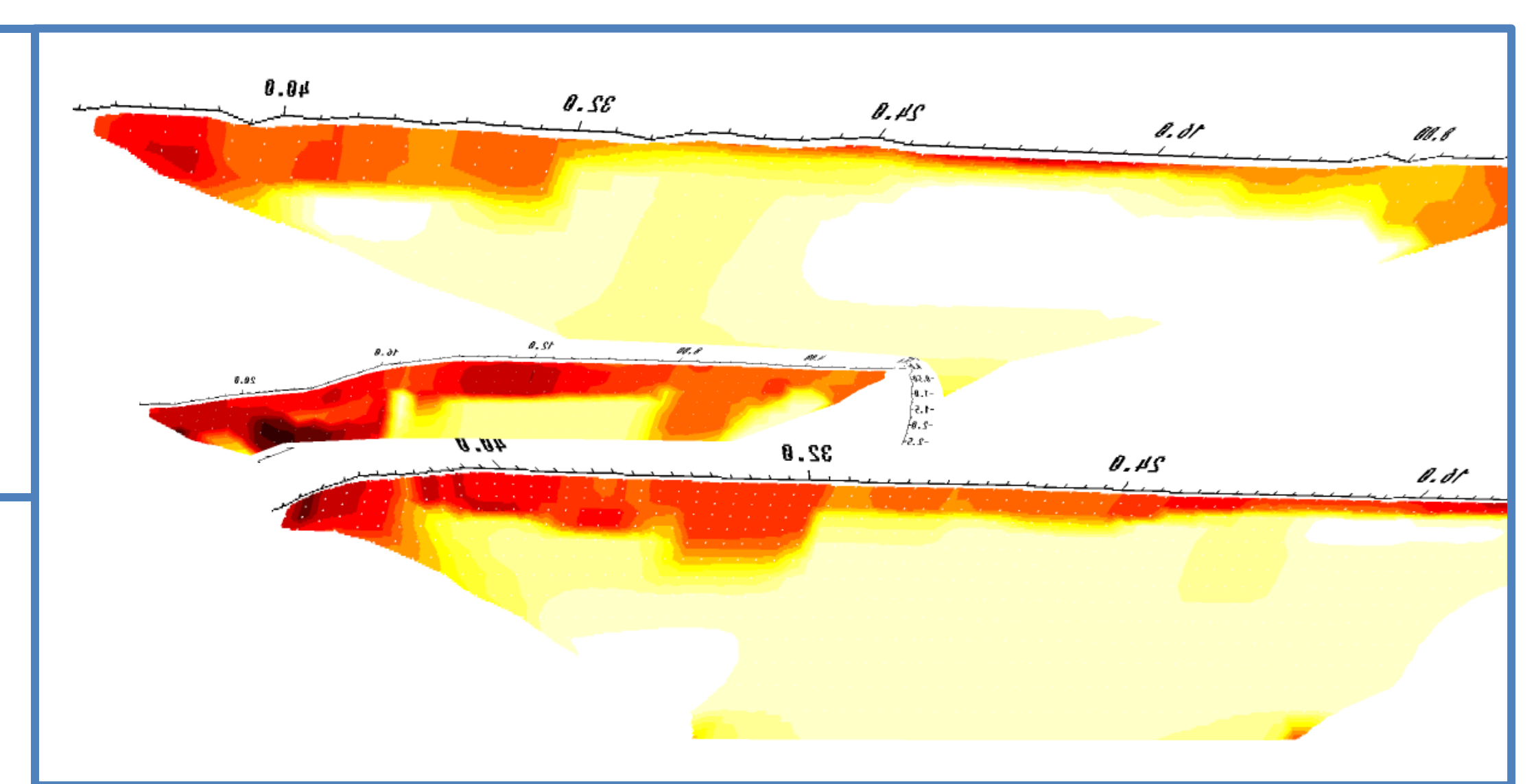
- Visualizing results within a single and consistent geographical system
- Recognition of both isolated and extended features
- Picking boundaries of these features
- Construction of interfaces and bodies

➤ A single, sub-horizontal interface between the resistive and the conductive regions, or several sub-horizontal and sub-vertical interfaces?

➤ What is the topological relation between the interfaces (i.e., who is cutting who)?

Qualitative interpretation

Quantitative interpretation



Once [...] units are geometrically modelled, it is possible [...] to handle them in various ways (zoom, rotation, translation), to perform on them 3D spatial analysis such as volumetric calculus [...], to generate sections anywhere in the 3D model... (Losier et al., 2007)

Conclusion

In the past, geomodelling helped archaeological studies to analyze the earth topography (e.g., Verhoeven, 2017) and excavation units (e.g., Losier et al., 2007). In the present work, we illustrated how geomodelling can also help in interpreting geophysical images. When building boundaries between heterogeneities identified on the images, spatial consistency and extent of archaeological or geological bodies arise. Most of all, new questions emerge, leading to a virtuous circle of more relevant geophysical acquisitions and processing, and more precise and quantitative interpretation.

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