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# GPR Mural Study of the Commandery of Jalès (France)

Christophe BENECH<sup>a</sup>, Quentin VITALE<sup>b</sup>, Laurent D'AGOSTINO<sup>c</sup> and Côme PARFANT<sup>d</sup>

## Highlights:

- Use of high resolution GPR mapping for the study of masonry walls.
- Delineation of underlying the main characteristics of the wall.
- Evaluate the different steps of renovation and/or partial reconstruction of the wall.

**Keywords:** GPR, masonry study, Heritage archaeology, medieval building, high resolution.

## INTRODUCTION

The commandery of Jalès is located in France, at the eastern limit of Cevennes Mountains, in the South of Ardèche (Fig. 1). This establishment was founded by the Templar order during the second third of the 12<sup>th</sup> century and was continuously occupied until nowadays. From 2017 to 2020, an interdisciplinary research project was launched to study the history of the monument, including archaeology, GIS, photogrammetry, 3D modelling, dendrochronology and geophysics (D'Agostino *et al.*, 2019).

The commandery is composed of several buildings testifying of the permanent evolution of the organization of the whole establishment and can be considered as one of the most well preserved commandery of the region. During its long history, the architectural ensemble has undergone numerous renovations, reconstructions or extensions which have profoundly modified the original plan. The main building in particular retains many testimonies of this perpetual evolution: unplastered walls make it possible to identify different types of modules in the blocks used, as well as traces of windows, doors or arches which by the suite were

clogged. Some plastered walls do not allow such an in-depth study to be carried out. Moreover, it can also be interesting to study the structure of a wall beyond its exterior facing which can sometimes mask an older condition.

The objective of this study is to estimate the type of information that can be acquired by onwalls ground-penetrating radar (GPR) mapping to supplement the archaeological information of the building. The GPR has been used since several years on the monuments for different purposes (Angelis *et al.*, 2018). Most of these applications served to analyze the structure of the walls in a heritage context of the conservation of the monuments (Ferrara & Barone, 2015). The aim of this research is to evaluate the contribution of a GPR survey for the study of the different phases of the monuments through the characteristics of the walls.

## MATERIAL AND METHOD

A reconnaissance of several plastered walls of the commandery was carried out using a pulse EKKO® Pro system (Sensors & Software) associated with a TR1000 antenna

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Figure 1. The main building of the commandery of Jalès (© Photo O. Barge).

(center frequency of 1 GHz) which allows an investigation depth of around 1 m. In order to position the measurements and achieve the most regular survey grid possible, an actual grid was drawn on a flexible plastic support. This transparent support was placed on the walls during the survey (Fig. 2). The horizontality of the measurement grid is ensured by a simple spirit level. This grid makes it possible to produce measurement profiles every 5 cm. To ensure the finest sampling possible, each zone was surveyed in both horizontal and vertical directions.

These initial tests provided interesting information on the structure of the walls at different depths. The most superficial maps, around 5 cm depth, allow the characteristics of the exterior facing to be recognized: masonry seals are relatively clearly visible and make it possible to identify the size of the blocks and therefore the differences in the type of brickwork used. The blockages that affected the last condition of the wall before it was plastered are also easily identifiable.



Figure 2. GPR survey with the pulseEKKO TR1000 on a 5 cm mesh grid.

## RESULTS

At about 25 cm depth, the radar signal makes it possible to visualize the state of the wall beyond the exterior facing and therefore to highlight elements which would not have been visible even if the wall had not been plastered (Fig. 3). Older elements, such as arches or stone courses appear clearly as highly reflective features. Other reflections have less geometric shapes but also seem to show heterogeneous fillings between the two facings.

These first results clearly show the significant contribution of the GPR survey for an architectural study. Beyond the identification of obstructed doors or windows, a high resolution GPR survey succeeds to identify the different modules used in the construction of the walls which is a key information for the determination of the chronology of the construction.

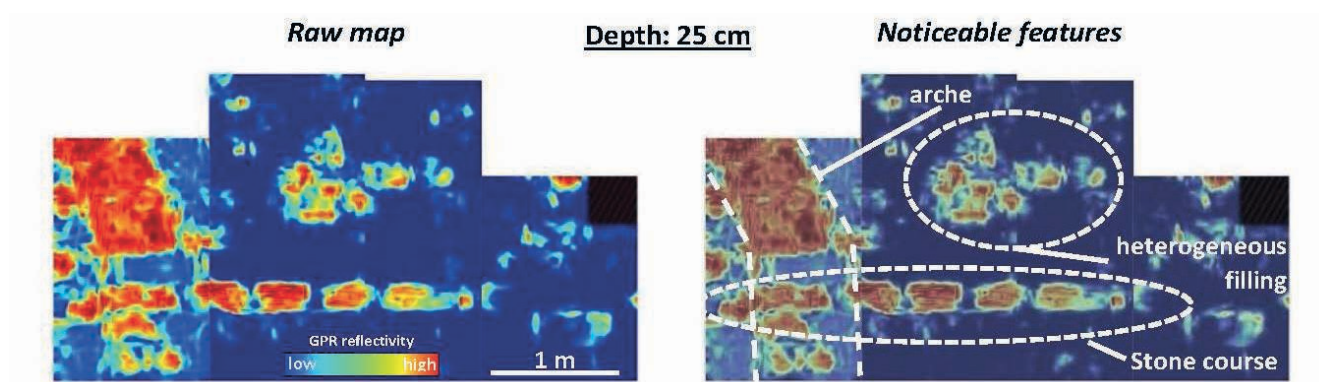


Figure 3. Example of result obtained on the walls of the commandery: the traces of an arch appear at 25 cm depth inside the wall. The color coding for the reflectivity values goes from red for high values to blue for low values.

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