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Highlights: Preventive research on an early medieval site tied to Charlemagne's family; Geophysical surveys (GPR, ERT, EMI, LiDAR) guided targeted excavations; Results revealed unknown structures at this key Mosan valley settlement.

Keywords: early Middle Ages, GPR, ERT, EMI, LiDAR

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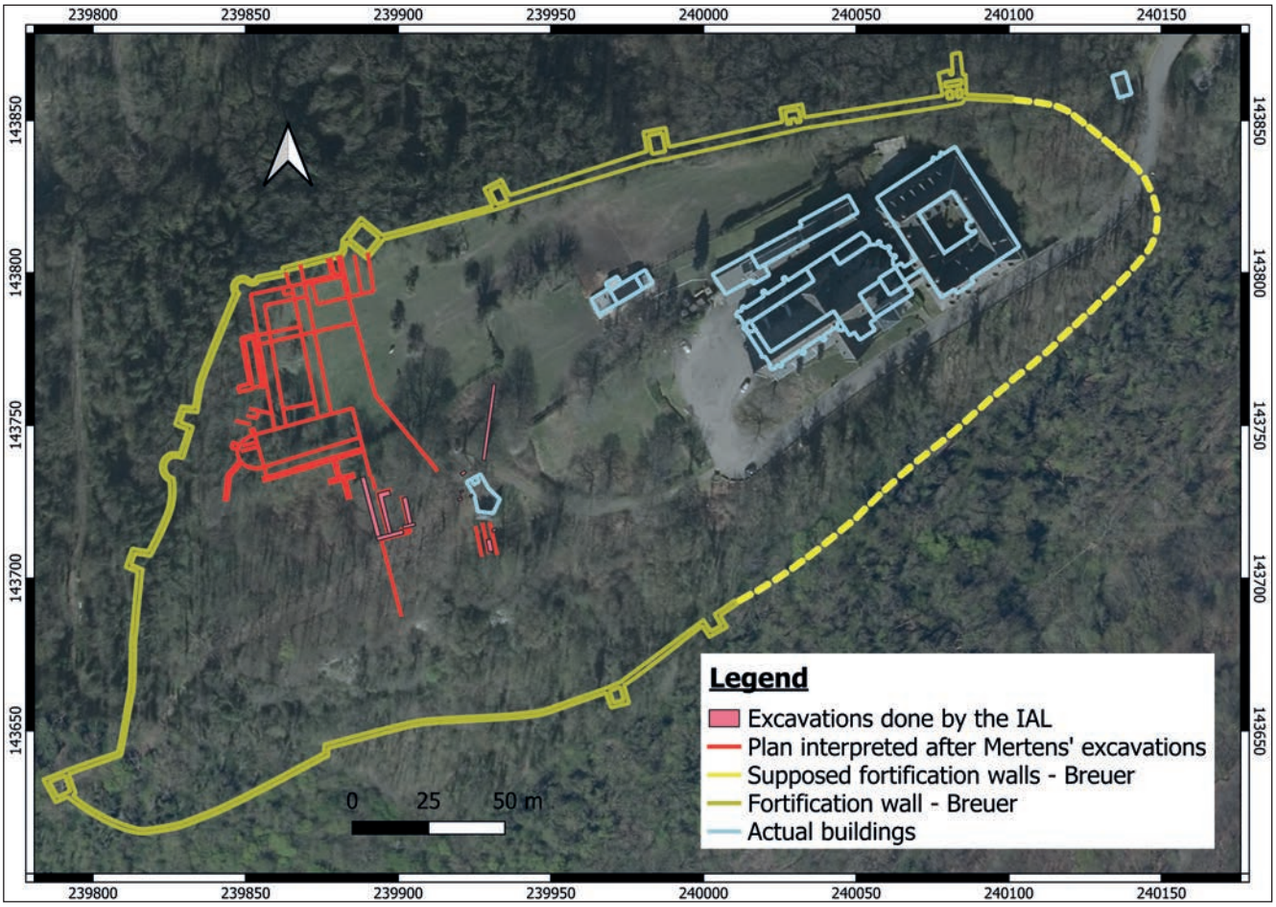

Figure 1: Plan of the ancient archaeological discoveries on the site of Chèvremont (Belgian Lambert 1972 projection system). Map done with QGIS 3.32.

Introduction

Chèvremont, located at the confluence of the Vesdre, Ourthe, and Meuse rivers, played a key historical role since the early Middle Ages. Its prominence and defense potential (Van Ruymbeke & Nys, 2022) made it a significant seat of power. While no direct records of its foundation exist, a charter from Charlemagne dated of 779 confirms donations to the Church of Sainte-Marie by his great-grandfather, Pepin II, referring to the site as "Novo Castello," suggesting the existence of fortifications. During the early Middle Ages, sources indicated that the site held political importance. In 741, Griffon, son of Charles Martel, was imprisoned there. By the 9th century, it was a royal abbey and a refuge from Norman incursions for the monks of Stavelot. The 10th century saw military conflicts, culminating in a siege by Notger, Bishop of Liège and Theophano's imperial army, leading to the fortress's dismantling. After 987, the site was largely abandoned until English Jesuits built a chapel in the late 17th century (Josse, 1988). It later became a pilgrimage site, with a Carmelite monastery and basilica constructed from 1877, the latter receiving its title in 1953. Even if the crowd and religious community left, these buildings are still standing today. Archaeological work led by the Archaeological Institute of Liège (IAL) began in 1852, uncovering walls (fig. 1), tombs, and fortifications (d'Otreppe De Bouvette, 1863). Researches in 1943 identified parts of the fortification walls and towers (Breuer, 1943). Further excavations brought to light an architectural complex interpreted as an abbey church with a cloister to the north (Mertens, 1970; Hoffsummer-Bosson, 1988). Classified as a protected site in 1976, Chèvremont underwent first preventive archaeo-geophysical prospections in 2022 when plans emerged to convert the basilica and cloisters into housing.

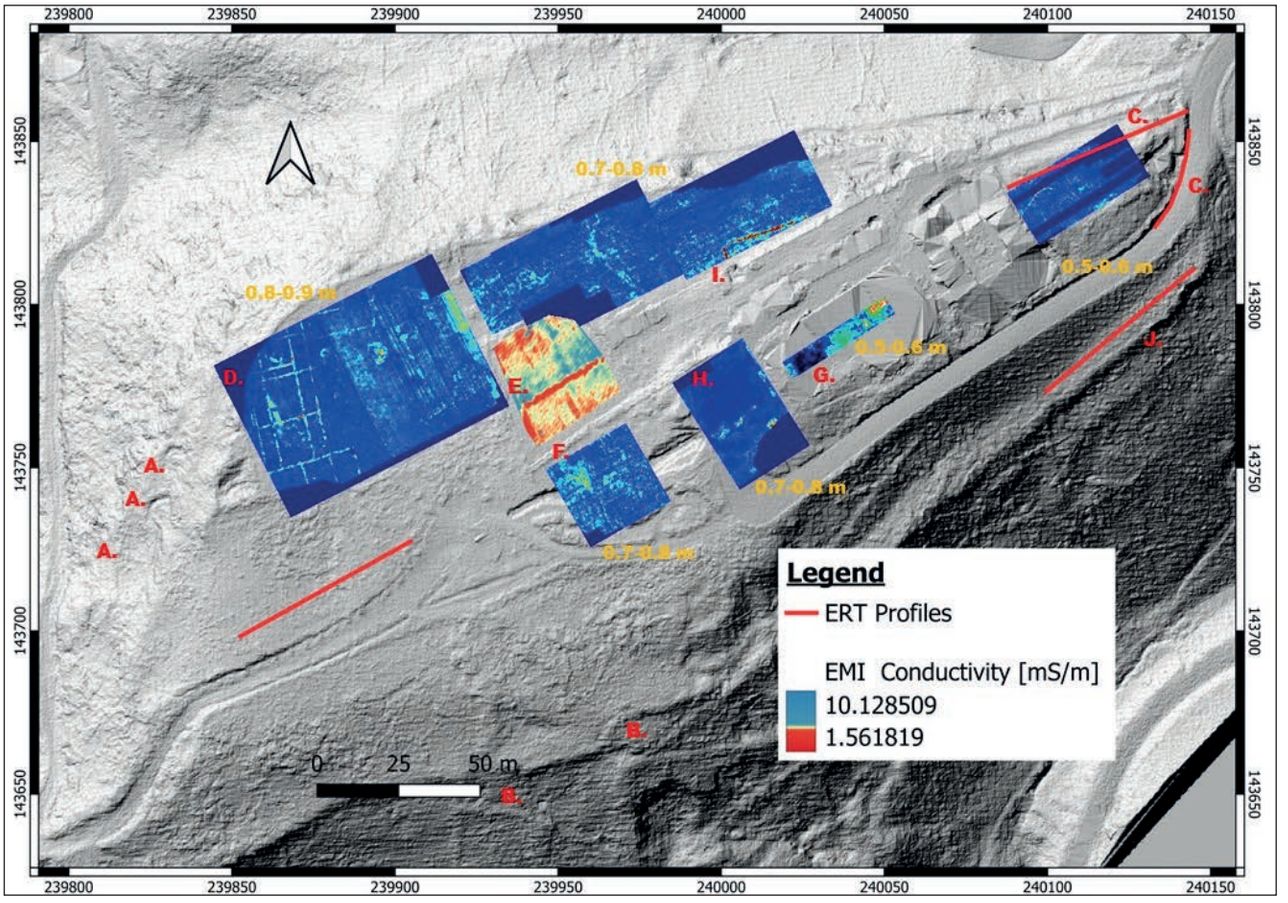

Figure 2: Results of the prospections on the site of Chèvremont (Belgian Lambert 1972 projection system).
Map done with QGIS 3.32.

Aims

The prospections aimed to reassess the site's overall occupation, guide archaeological interventions, and identify previously unknown structures. Investigations first focused on areas affected by upcoming construction work on the basilica and convent. Due to the subsoil, mainly sandstone and shale with a thin arable layer (max. 50 cm), ground-penetrating radar (GPR) was prioritized in accessible zones. In areas with denser vegetation, electromagnetic induction (EMI) and electrical resistivity tomography (ERT) were employed. Additional measurements were taken outside the immediate construction zone where discoveries from the July 2023 excavations raised new questions. Further LiDAR mapping provided comprehensive site coverage.

Methods

GPR was conducted using a Malå Easy Locator Core with 450 MHz antennas, enabling investigations up to 2 m deep thanks to quasi real-time sampling and 32 bits resolution. Data was collected at 5 cm intervals along parallel profiles spaced 25 cm apart, with real-time kinematic (RTK) positioning for geo-referencing. The average propagation velocity (0.1 m/ns) was estimated from diffraction hyperbolas. Time profiles were corrected for geometric distortions, converted to depth, and processed with high-pass filtering to highlight short-length reflectors. Profiles were interpolated onto a regular grid and assembled in a final volume, to create “depth slices “. Given the average radar frequency used, 20 slices were computed with a 10 cm thickness allowing buried structures to be progressively imaged. ERT provides imaging, complementing GPR. Multiple 2D profiles with 64 electrodes were conducted, using

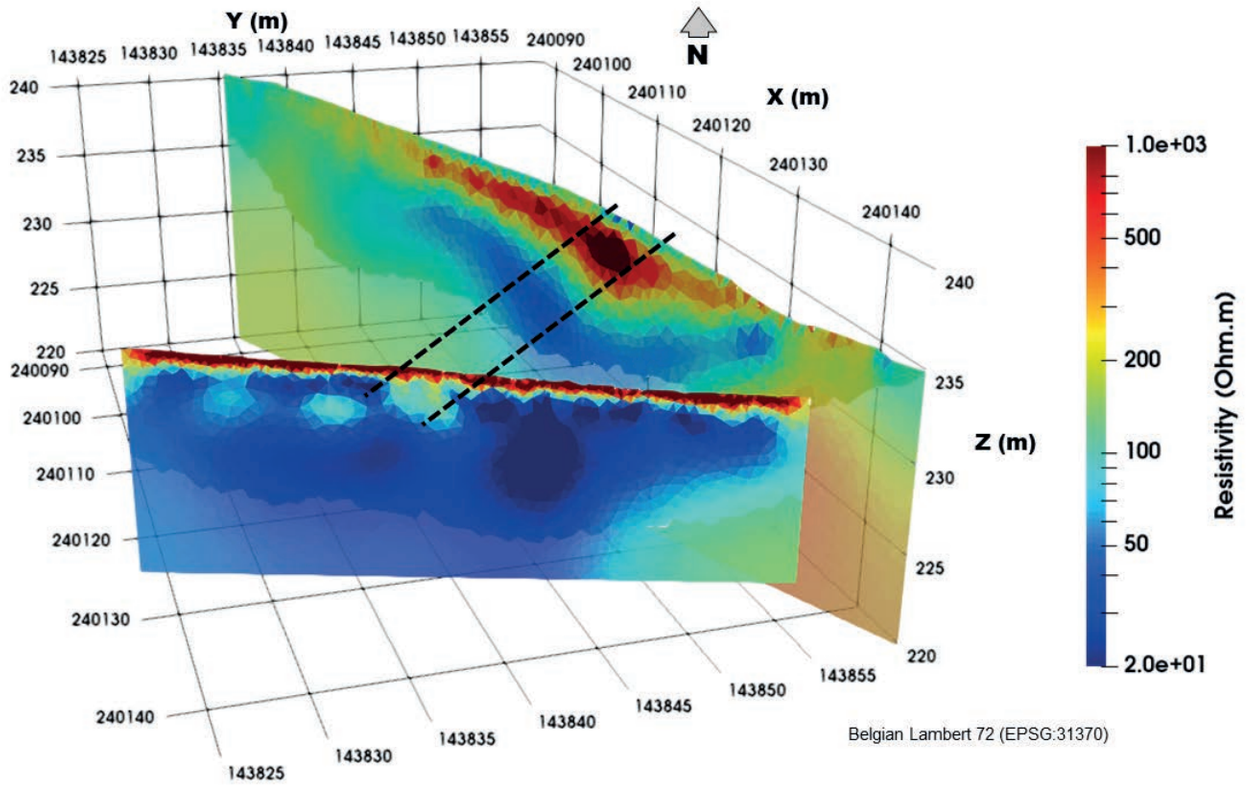

Figure 3: ERT profiles acquired on the site of Chèvremont.

Profiles corresponding to locations C on fig. 2.

a gradient protocol sensitive to lateral and vertical resistivity variations (Dahlin & Zhou, 2004). Electrode spacing ranged from 0.5 to 1 m, balancing resolution and depth. EMI surveys used a CMD Mini-Explorer, a < 300 kHz EM detector, capturing three simultaneous measurements via receiver coils at 0.32 m, 0.71 m, and 1.18 m (Bonsall et al., 2013). A Horizontal Coplanar (HCP) configuration optimized data integration at greater depths. Measurements were taken on a 1 m grid in two perpendicular directions. LiDAR mapping was performed with a DJI Zenmuse L1 sensor mounted on a DJI Matrice 300 RTK drone. The system captured up to 240,000 points per second, achieving a point density of 1846 points/m² at a 50 m altitude. RTK technology ensured spatial accuracy of 10 cm (horizontal) and 5 cm (vertical). A 20 MP RGB camera enabled colorized point cloud generation. Data was processed in DJI Terra, producing a high-resolution Digital Terrain Model (DTM).

Results

The fortification wall

The northern hill retains visible wall sections and four towers, while remains on the west are partial and inaccessible to the south. LiDAR mapping traced the full 850 m long wall, enclosing a ha fortified area. It also identified western towers (fig. 2-A) and refined details of the southern section from previous plan (fig. 2-B). Research near the eastern plateau, behind the current cloister, focused on the fortress entrance and wall closure. Excavations in fall 23 uncovered a large section, aiming to connect it with the northern and southern portions. ERT detected walls in both areas (fig. 2-C, fig. 3).

The fortified space

GPR confirmed much of J. Mertens' 1960s findings (Mertens, 1970), though some walls outside previous trenches

remained undiscovered. It refined the layout of several areas, particularly a large southern structure, previously identified as a church, which is divided into three spaces (fig. 2-D), questioning its function. ERT indicated possible additional structures to the south. To the west, no anomalies were detected except in the EMI-surveyed field, where modern garden paths created by 20th-century monks obscured older structures (fig. 2-E). Excavations in summer 2024 revealed highly leveled sandstone block remains, forming part of a large building extending southward. GPR detected only one possible wall in this area (fig. 2-F). On the hilltop, GPR surveys in the basilica revealed angular features near modern heating systems and cisterns (fig. 2-G), requiring archaeological verification. Investigations will also focus on two parvis areas with voids, possibly indicating pits or wells (fig. 2-H). North of the basilica, GPR detected two long anomalies forming a right angle (fig. 2-I), where no structures were previously known. Excavations in summer 2023 confirmed a large sandstone building (27.5 m x 14 m) extending southward, better preserved than the western structure, with lime-mortar bonding. In the site's southern section, a terrace visible in the landscape and LiDAR data (fig. 2-J) prompted further investigation. ERT indicated possible buried structures in this area requiring further direct information.

Conclusion

Many areas of the site remain to be explored through geophysical surveys and excavations. However, the multi-method approach has already provided valuable insights, identifying previously unknown buildings and confirming extensive occupation across the plateau. It also facilitated access to previously unreachable sections of the fortification wall. This study highlights the importance of geophysical methods in preventive archaeology. While they cannot replace excavations, they help focus research on key areas, improving efficiency and site understanding.

References

Bonsall, J., Fry, R., Gaffney, C., Armit, I., Beck, A., Gaffney, V., 2013. Assessment of the CMD Mini-Explorer, a New Low-frequency Multi-coil Electromagnetic Device, for Archaeological Investigations. *Archaeol. Prospect*, 20: 219-231.

Breuer J., 1947. Chèvremont (prov. de Liège). *Archéologie*, 1: 127-128.

Dahlin, T., Zhou, B., 2004. A Numerical Comparison of 2D Resistivity Imaging with Ten Electrode Arrays. *Geophysical Prospecting*, 52: 379 -398.

d'Otreppe De Bouvette, A., 1863. Rapport complémentaire sur les fouilles de Chèvremont. *Bulletin de l'Institut archéologique liégeois*, 6: 75-76.

Hoffsummer-Bosson, A., 1988. Chèvremont : l'apport des sources archéologiques. *In* A. Hoffsummer-Bosson (ed.), *Chèvremont. Un tricentenaire, un millénaire. 987-1688-1988, Actes du colloque de Chèvremont du 22 avril 1988*, (Bulletin de l'Institut archéologique liégeois, 100), Liège: 71-88.

Josse, M., 1988. Les sources historiques. *In* A. Hoffsummer-Bosson (ed.). *Chèvremont. Un tricentenaire, un millénaire. 987-1688-1988, Actes du colloque de Chèvremont du 22 avril 1988*, (Bulletin de l'Institut archéologique liégeois, 100), Liège: 13-20.

Mertens, J., 1970. Vaux-sous-Chèvremont. In *Vingt-cinq années de fouilles archéologiques en Belgique,* catalogue d'exposition. Bruxelles, 121-123.

Van Ruymbeke, M., Nys, G.-A., 2022. Voir ou être vu : analyses de visibilité depuis le site de Chèvremont (commune de Chaudfontaine, Belgique). *Bulletin de la Société géographique de Liège*, 78 (2022/1): 147-156.