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Highlights: New discoveries in the surrounding of the Gelati Monastery, Archaeo-geophysical prospecting on UNESCO World heritage sites, Integration of supplemental prospecting methods

Keywords: Medieval Monastery Gelati, UNESCO World Heritage Site, resistivity prospecting, magnetometry, Georgia

Introduction

The Gelati Monastery is considered a masterpiece of the Golden Age of medieval Georgia, a period of political strength and economic growth between the 11th and 13th centuries.

The site is located northeast of Georgia's third-largest city, Kutaisi, with around 140,000 inhabitants (Figure 1). The monastery church was the burial place of Georgian kings, including Dawid IV the Builder. In 1106, Dawid also founded the Gelati Academy, where important scientists and philosophers taught. In addition to this builder of the monastery, other important kings are buried in Gelati. The complex with the monastery represented an important spiritual and cultural centre in Georgia and is considered one of the most important buildings in the country. UNESCO declared the monastic complex a World Cultural Heritage site in 1994 (UNESCO, 2024).

Geophysical prospection

The geophysical prospection in Gelati represents a particular challenge. The site is visited by hundreds of tourists every day, and there will also be many additional technical constructions due to the restoration work. Nevertheless, the geological, pedological and topographical conditions for geophysical measurements in Gelati are suitable for carrying out magnetometer, resistivity and radar studies around the monastery. We designed our measurement grids in a way that covers as many freely accessible areas around

Figure 1: Gelati. Drone image view from the north-west. May 2024.
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the monastery as possible (Figures 2, 3). Although many areas of the monastery are currently covered with scaffolding and material for restoration, we could map almost all areas around and between the buildings with magnetometer and resistivity measurements. The prospecting area practically extends around the main building. We scanned the area magnetically by a sampling interval of 10 cm (inline) x 50 cm (crossline) (resampled to 25 × 25 cm) with a Geometrics G858 total field magnetometer in a duo-sensor configuration. For the resistivity survey, we chose the Geoscan RM85 resistometer in dipole-dipole configuration and, the sampling rate of 50 x 100 cm (interpolated to 25 x 25 cm). The ground was never ploughed. Unusual strong magnetic sandstone combined with a partly thin layer of topsoil and substantial magnetic interference from iron structures in Gelati makes highly sensitive magnetometer measurements nearly impossible. Nevertheless, the measurements provided important and additional information about hidden structures in the subsurface that other geophysical methods cannot obtain.

Results

From the first view, the data mainly reveal the heavy contamination of the surface with significant layers of old debris (magnetic anomalies of more than +/-50 nT) and the site's topographical irregularities (Figure 2 right). By applying a high-pass filter to the original data, the dynamics of the magnetic field disturbance could be reduced to a minimum.

Figure 2: Gelati.

Left: Resistivity survey area superimposed on the drone image. Geoscan RM85 resistometer in dipole-dipole configuration. Right: Magnetometer survey superimposed on the drone image. Caesium total field magnetometer Geometrics, G 858-special in duo-sensor configuration and high-pass filter of the data. The total Earth's magnetic field at Gelati in 05/2024, 49,910 ± 50 Nanotesla standard deviation, sensitivity ± 10 Picotesla.

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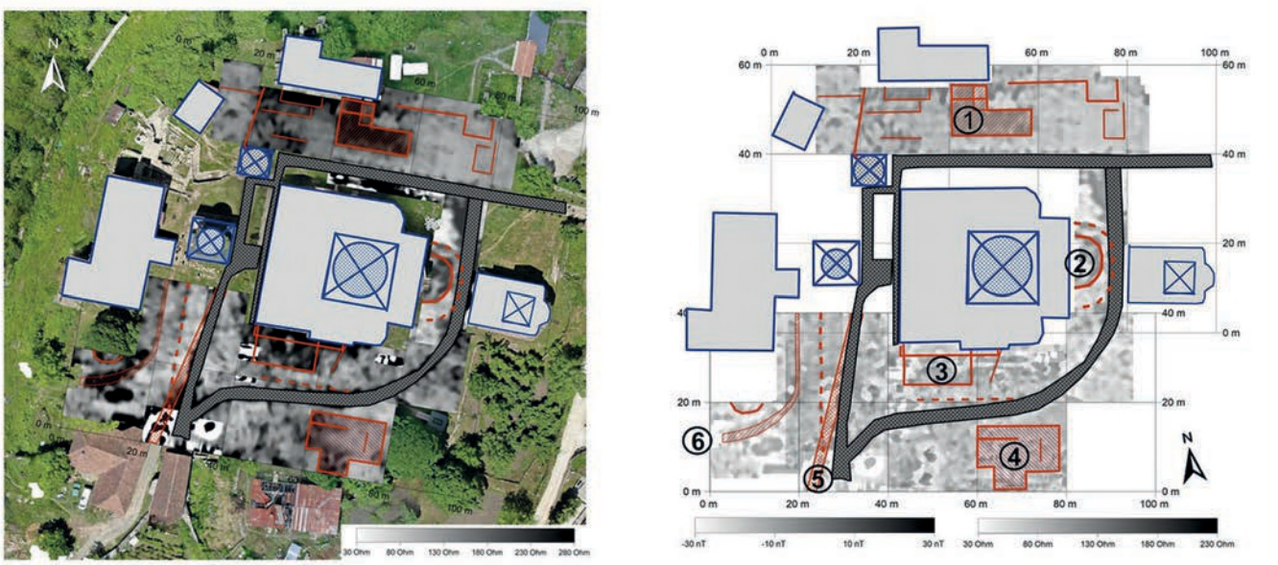

Figure 3: Gelati: Integrated interpretation of all geophysical data of the measurements and the drone image (left) and right archaeo-geophysical interpretation (red) of the integrated data analysis.

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Therefore, a large number of archaeological structures become visible. At first glance, the measurement image shows many extreme anomalies that stand out as black-and-white spots. In the southwest of the measurement area, we find a strong linear anomaly about 1m wide directly under the modern path that leads to the southwest gate of the monastery complex (figure 3). All of these strong anomalies are due to modern findings, with the linear structure being either an electrical or a water pipe (Figure 3.5). The strong black and white spots, on the other hand, are caused by iron maintenance hole covers.

Interpretation

For interpretation, we integrate all available information, all our geophysical measurements, and additional in situ analysis using a portable kappa meter SM30 to assess the magnetic properties of the soil and construction materials. Some of the linear anomalies mark hidden remains of walls in the ground. Three others can be expanded to create a rectangular house floor plan (see figure 3.1,3,4). The ones north and south of the church (figure 3.1 and 3.4) also show traces of a paved floor. Their orientation is parallel to the main building of the monastery. There is also another apse to the east of the church and further extensions to the south of the main building. Directly adjacent to the east wall of the main building, there are two semi-circular walls parallel to each other, which we interpret as the apse of a previous church (see figure 3.2). Of particular note here is the course of a canal and a large number of pits that are not visible on the surface, as well as evidence of a building complex south of the church. The anomaly figure 3.5 marks the trace of a pipeline or an electrical powerline, figure 3.6 marks the trace of an old irrigation canal. The magnetic measurements detected the pipeline only – since it is right beneath the modern paved road.

Conclusion

The geophysical results discussed above clearly reveal several archaeological features in the selected survey area. We can identify all of these features as archaeological features. In many areas, the magnetometer and resistance measurements complement each other and corroborate our interpretation. Exact depth information on the archaeological findings cannot be obtained using our methods. However, exact depth information could be determined using radar measurements (Linck *et al.*, 2024a,b). Furthermore, the precise dating and archaeological classification of the new findings must remain an open question.

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