Combined geophysical prospection of kurgans on the Uzun Rama plateau in the Caucasus, Azerbaijan: first results

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Abstract
In November 2021, a geophysical prospection using magnetics, electromagnetics, and ground penetrating radar, as well as a surface archaeological survey and aerial photography were conducted in the kurgan area on the Uzun-Rama plateau in central Azerbaijan. These non-destructive investigations aim to obtain information on the morphology, structure and spatial distribution of the kurgans in order to classify them according to various features. The preliminary results show that increased magnetic field intensity, increased electrical conductivity, and increased reflection energy in the GPR are observed in the top region of the kurgans, which contain information about the burial chamber.

Keywords
archaeological prospection; Caucasus; kurgan; electromagnetics; ground penetrating radar; magnetics

Introduction

The uniquely well-preserved and highly visible archaeological burial mounds in the Caucasus, known as kurgans, are a source that has been little explored to date and can provide crucial information on the spread of early metal cultures. In this region, kurgans were constructed and used from the mid-4th to 1st millennium BC. The resource wealth of the southern Caucasus, with its rich metal deposits (including copper, silver, and gold), is often reflected in the rich furnishings of the tombs, attesting to the use and accumulation of precious raw materials. Previous studies (Laneri et al. 2019) in this region have only focused on individual burial mounds and thus have not contextualized them with other kurgans or in relation to environmental and landscape conditions, including geology and topography. New analysis capabilities, including satellite imagery, Digital Terrain Models (DTM), and geophysical prospection allow for a large-scale survey of the barrow phenomenon for the first time in this region.

In November 2021, as part of the Cluster of Excellence ROOTS, work was carried out with geophysical prospection, as well as archaeological surface survey and aerial photography in the kurgan area on the Uzun Rama Plateau, approximately 15 km east of the city of Gence in central Azerbaijan (Fig. 1a & 1b).

These non-destructive investigations aim at obtaining information on the morphology, structure and spatial distribution of the kurgans in order to classify them according to different features. Prospecting work on monumental burial mounds has been challenging for geophysics depending on their size, height, slope steepness, and surface characteristics (Forte and Pipan 2008; Polymenakos and Tweeton 2017; Tsokas et al. 2018; Mecking et al. 2020). The kurgans in the Caucasus, due to the great geomorphological variability, offer us the opportunity to study these different structures in order to further develop our methods and contribute to the construction of the kurgans.

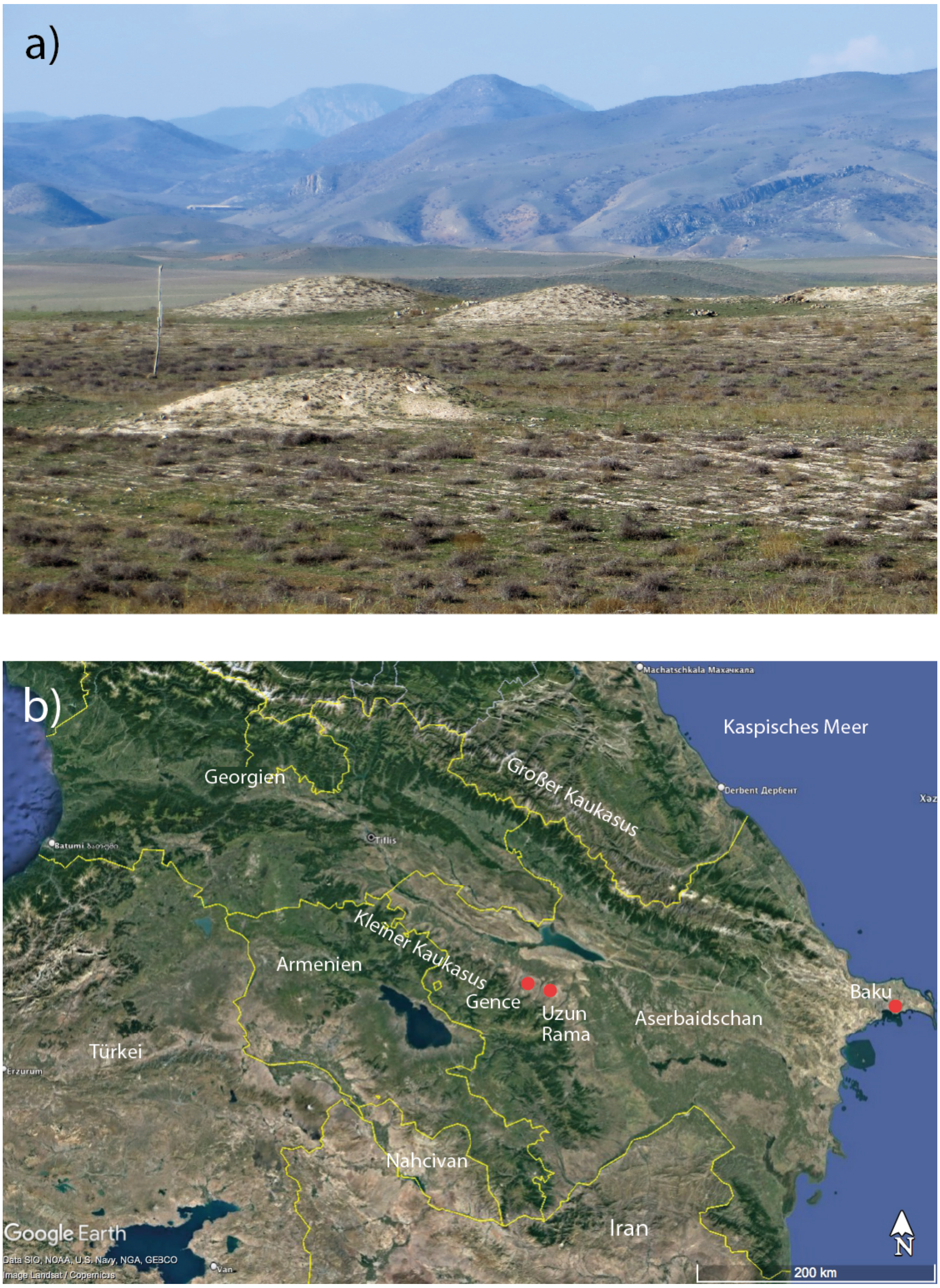

Fig. 1: a) Kurgans in the landscape. b) Site plan of the investigation area Uzun Rama Plateau in the Caucasus, Azerbaijan (Source: Google Earth, Data SIO, NOAA, U.S. Navy, NGA, GEBCO, Image Landsat / Copernicus).

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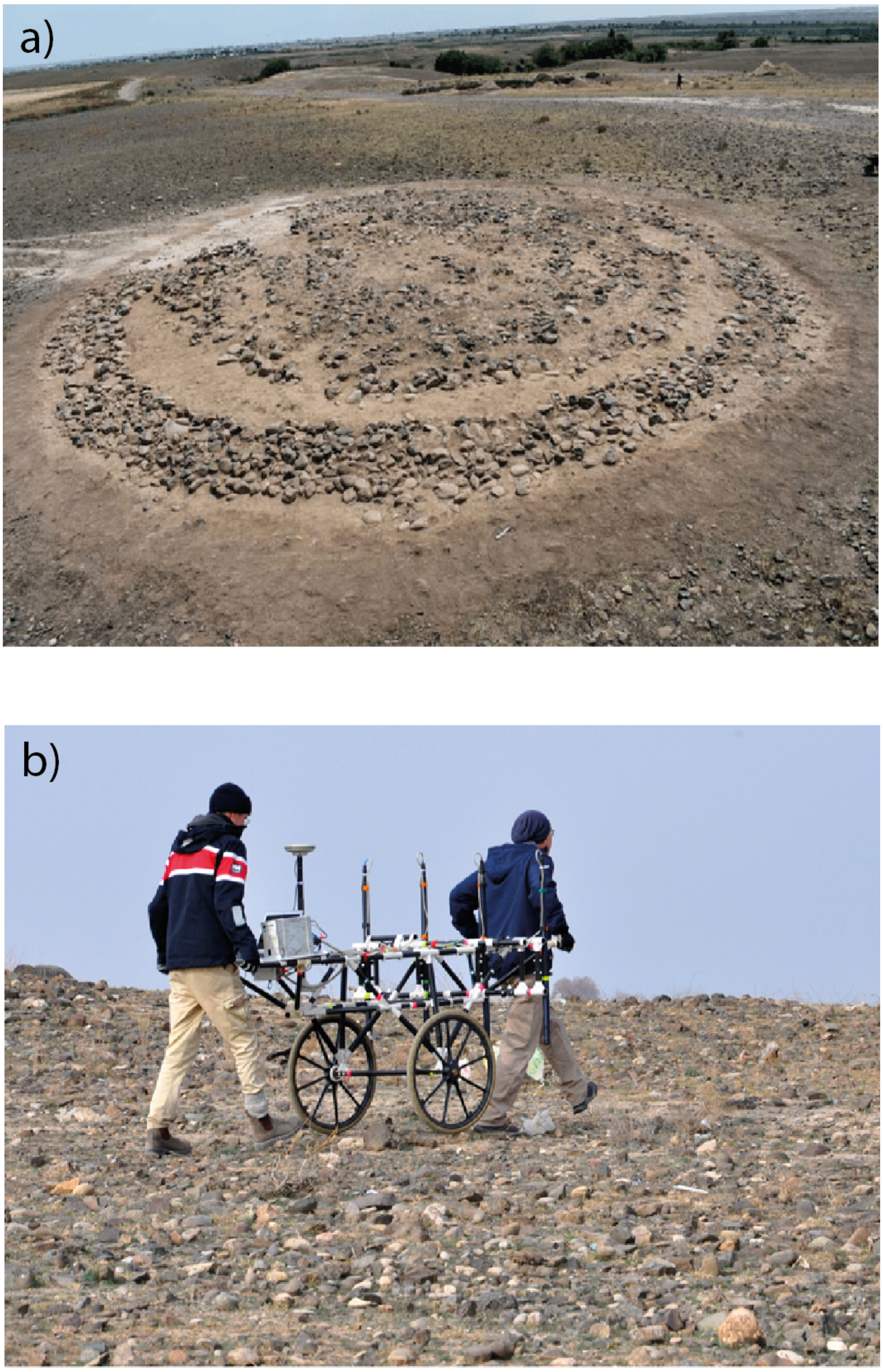

Fig. 2: a) Kurgan surface. b) Magnetic measurements with the cart on the Kurgan K9.

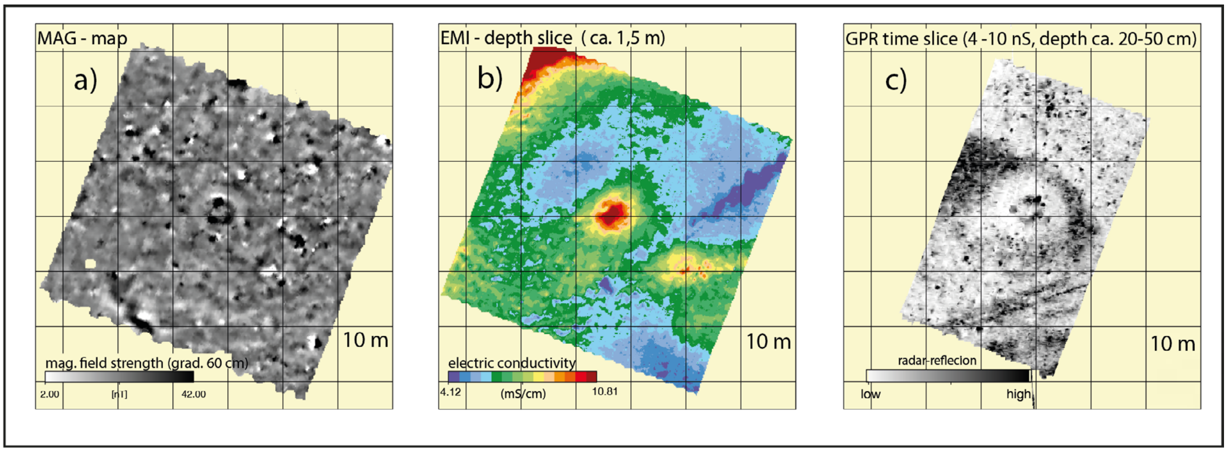

Fig. 3: Results of magnetics (a), electromagnetics (b) and georadar shown as time slice from 4 ns to 10 ns (c) on the Kurgan K9.

Methods

Geophysically, magnetics (MAG), electromagnetics (EMI) and georadar (GPR) methods were applied on 7 representative kurgans. In 4 cases, the layers of stones on the kurgan surface posed a challenge for conducting the measurements (Fig. 2a).

For the magnetic mapping a magnetometer array with 6 fluxgate probes of the company Dr. Förster (probe type Ferrex CON650) was installed on a hand cart. The individual probes are mounted on the trolley (Fig. 2b) at intervals of 0.5 m in such a way that a width of 2 m is covered during the field measurements with parallel profiles. Approximately a measured value was registered in-line every 5 cm. The electromagnetic mapping was carried out with the CMD-MiniExplorer from GF Instruments. The profile spacing was 1 m and a reading was recorded in-line approximately every 5 cm. For the GPR measurements a single-channel instrument, SIR 4000 from GSSI, was used with a dual frequency antenna including the center frequencies of 300 MHz and 800 MHz. The profile spacing was 0.3 m and a scan was recorded in-line approximately every 2 cm.

Results

Figure 3 illustrates the results of the measurements on Kurgan 9. This kurgan has a total diameter of about 20 m. The diameter of the top flat area is about 10 m. The height difference between the surrounding and the top of the kurgan is approximately 1 m.

Magnetics

In the central top area, higher magnetic anomalies form a signature, which delimits an area of about 5 m x 4 m. In the inner and outer area of this signature, moderate magnetic amplitudes are observed, forming a circular area of about 10 m in diameter (Fig. 3a).

Electromagnetics

In the central area, increased electrical conductivities up to 10 mS/m are observed. Between the central area and the edge of the kurgan the electrical conductivity decreases to 5.5 mS/m up to a diameter of 20 m (Fig. 3b).

Georadar

Increased reflection energy is observed in the central region and at the edge of the kurgan (Fig. 3c).

Discussion

These preliminary results show that increased magnetic field intensity, increased electrical conductivities, and increased reflection energies in GPR are observed in the top area of the kurgans. Thereby, the magnetic minimum in the central area correlates with increased electrical conductivities and low reflection energy. Additionally, observed magnetic maxima, which correlates with lower electrical conductivities and high reflection energy in GPR (Fig. 3) are visible. These anomalies are probably due to the walls of the burial chamber, which are made of dried mud bricks and were burned at the end of the use of the kurgan.

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Conclusion

These results suggest that the combination of magnetics, electromagnetics and georadar makes it possible to prospect the burial chamber as differentiated as possible. Additionally, results from measurements on a topographically flat area with destroyed burial kurgans indicate that geophysical prospection can also be used to map them. In this way, kurgans can be explored in a non-destructive and as differentiated manner as possible to obtain information about their dimensions and internal structure, and to support archaeological interpretation for kurgan classification.

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