

Geophysical and UAV surveys on Konya Karahöyük (central Anatolia, Turkey)

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Abstract

Geophysical prospection and unmanned aerial vehicles (UAV) were applied systematically to improve excavation strategies. Magnetic results were verified using GPR in the suitable areas.

Keywords

Bronze Age Anatolia; GPR survey; magnetic prospecting; remote sensing; thermal image

Introduction

The archeological site of Konya-Karahöyük is located in the Konya plain of central Anatolia, Turkey (Fig. 1). Situated almost 8 km southeast of modern Konya, the site is at the crossroads from Syro-Mesopotamia to the Aegean (Alp 1994). The archaeological material collection collected from the site dates to the 3rd-2nd millennia BC and displays Anatolian, Syrian, and Aegean influences confirming it as a dynamic hub of the Bronze Age.

The mound of Konya-Karahöyük covers an area of 33 ha. With its lower town, which is heavily filled with alluvial deposits, the site spans almost 100 ha. Previous excavations at the site (from 1953 to 1994 with breaks) yielded remains of monumental architecture, yet, there is a lack of a systematic understanding of the architectural patterns. Excavations reinitiated at the site in 2022 aim to expose architectural remains of the upper and lower towns as well as to investigate the expansion of the site via using interdisciplinary methodologies. Thus, in the first season of the new round of excavations, a combined methodology of ground penetrating radar (GPR), magnetic prospection, and unmanned aerial vehicles (UAV) including thermal imaging was applied systematically to unfold the architectural layout of this multilayered archaeological site. The results of this combined methodology, applied

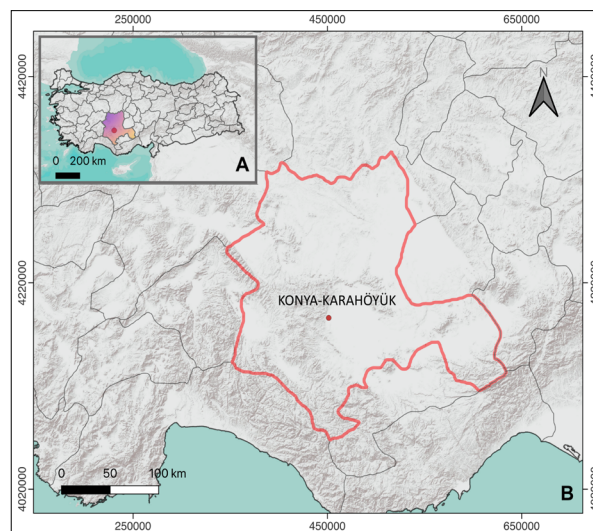


Fig. 1: The maps show the locations of A) Konya in Turkey, B) Konya in the region. Red color line shows the Konya province in Turkey. The red color dot denotes the Konya-Karahöyük.

only at a small section of the mound, yielded promising results to detect architectural remains made of mudbrick and stone.

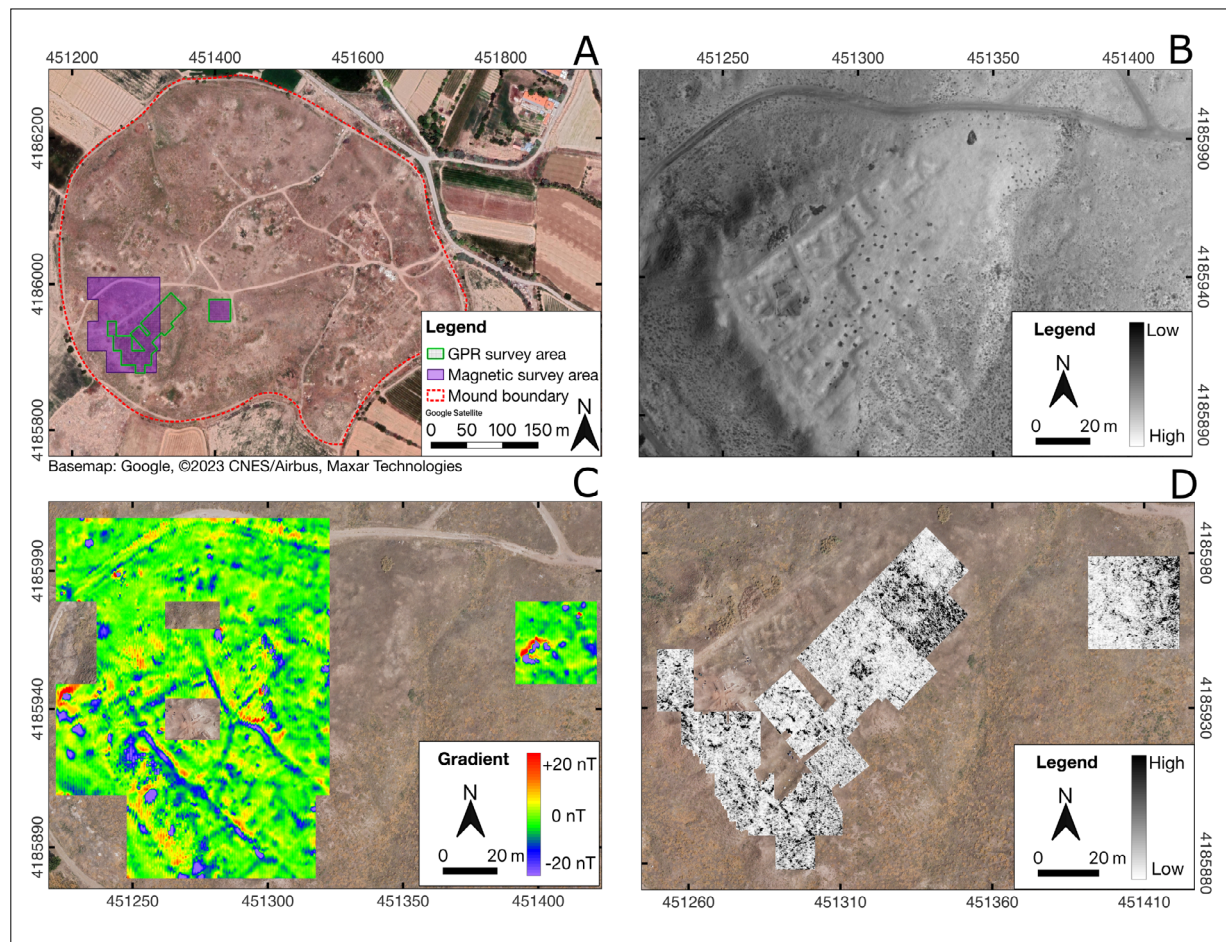


Fig. 2: The area that the mound of Konya Karahöyük covers is illustrated with red color dotted line and geophysically covered areas are displayed on the figure (A). The results of the thermal imagery (B), magnetic (C), and GPR (D) surveys are shown respectively.

Methods

The fieldwork involved applying a combination of newly acquired aerial and geophysical survey data that include GPR and magnetic methods. The GPR used was GSSI UtilityScan with 350 MHz central frequency, and the magnetometer was Geometrics G-858 MagMapper cesium vapor magnetometer. The profile spacing was 0.25 m for GPR and 0.5 m for the magnetic survey.

The mound rises 19 m above sea level, and it shows varying elevations at different parts due to archaeological as well as alluvial accumulation. Considering the complex morphology of the mound, the magnetic survey was favored for the detection of mudbrick and stone architecture. GPR was used in areas where the method is applicable morphologically and is comparable to magnetic survey results. Approximately an area of 4400 m² was covered by GPR with a selected penetration depth of 3 m. Magnetics

was applied approximately to 1.2 ha. The duration of data collection was two weeks. For the process of the GPR and magnetic datasets, ReflexW and MagPick software were used respectively.

The aerial survey involved capturing both multispectral and thermal images using a DJI Mavic 2 Enterprise Advanced drone (Dual Imaging: 640 × 512 px Thermal Camera, 48MP Visual Camera). A high-resolution Digital Elevation Model (DEM) and aerial thermography were applied to emphasize crop marks on the mound utilizing the spectral information contained in the solar radiation (Casana et al. 2017). The images were processed via Agisoft software for creating point clouds, mosaicking, orthorectification, georeferencing, multispectral processing, and creating DEM. QGIS was used to visualize the results of the geophysical and aerial survey data.

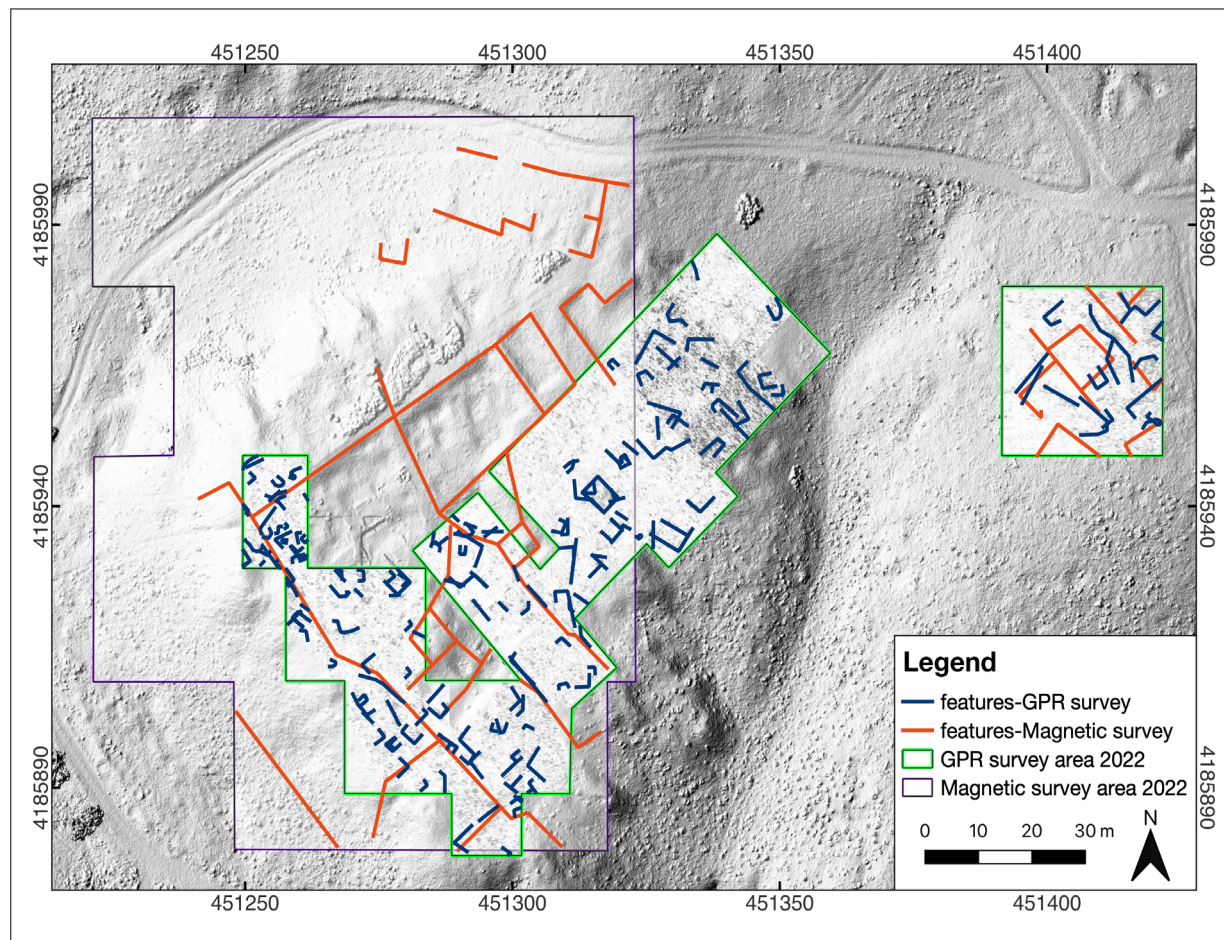


Fig. 3: Interpretation of geophysical surveys in comparison with thermal imagery and DEM is illustrated.

Results and discussion

This project applies a combination of geophysical and UAV surveys at a central Anatolian Bronze Age site in the first archaeological excavation season after 30 years of break. The objectives of the interdisciplinary research in this very first season were to 1) investigate possible architectural remnants with various methods to understand the best working techniques for the following field seasons; 2) provide a brief view of below surfaces before opening new excavation squares.

This study mainly focused on the southwestern part of the mound to provide general information for future excavation seasons. The preliminary results of the geophysical exploration identified several architectural remnants at different depths (Fig. 2). Along the NW-SE direction, the produced profiles identified two linear marks that could possibly be the walls of a monumental structure extending approximately 70 m (Fig. 3). The results are in accordance

with the thermal images and DEM. Between these linear structures, nearly perpendicular walls were also identified. The structures were mostly starting from 0.25 m – 0.5 m below the surface. The 2023 season at the site will ground-truth the results via excavation.

Conclusions

In conclusion, the preliminary results of this multi-technique survey demonstrate that methodologically different remote sensing methods have broad prospects for studying Bronze Age mound-like settlements with mudbrick and stone architecture such as Konya-Karahöyük. The site with its diverse morphology, various architectural remains (mudbrick, different types of stones, etc.), and complex archaeological strata require a combination of geophysical and UAV survey methods.

In the next excavation seasons, a similar methodology will be applied to the other sections of the mound. Yet, the results of our first survey season -especially DEM- indicate that the rest of the mound requires further attention in the following years. Subsurface structures revealed by the thermal images and DEM need to be confirmed with geophysical methods and test trenches. Only after the test trenches, post-excavation reevaluation of UAV and geophysical data will be possible. The following excavation seasons and further research will lead to a more precise processing and accurate interpretation while combining UAV and geophysical datasets. ■

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