

[Supplementary material]

Reccopolis revealed: the first geomagnetic mapping of the early medieval Visigothic royal town

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In recent decades, geomagnetic prospection has become a standard tool for investigating archaeological sites. In addition to large stone structures, it can detect features such as pits, hearths, postholes and the like. The resulting geomagnetic plots are visualised in digital images. Joachim Henning headed the geomagnetic prospecting, and the Goethe University supplied the specialised personnel and equipment for the survey and geomagnetic investigation. The total project was directed by the four authors, each contributing support and personnel according to his expertise and means. Twelve archaeologists and students surveyed and prospected accessible spaces covering 8ha, including 2.6ha outside the walls, in July 2015. We surveyed fields of up to 50 × 50m and prospected them using a Foerster Ferex magnetometer with three probes set at 0.5m intervals (50Hz) operated by teams of three led by Eyub Fikrit Eyub of the Goethe University under Henning's direction. A fluxgate magnetometer is designed to detect the magnetic field vertically with a measurement range of ±10 000nT. Henning and Eyub also prepared the geomagnetic plots used in this study. The geomagnetic survey at Reccopolis was conducted as follows. Each plot to be surveyed was laid out with a local survey using a total station; the survey included measurement of altitude and position. Surfaces to be surveyed were divided into rectangular grids. The usual grid size was approximately 50 × 50m, although smaller areas were needed to fill small gaps. A survey was conducted to fit the prospection area into aerial photographs, using the national

reference system. Identical fixed points with known coordinates in the aerial photographs (e.g. corners of wall towers or of the palatine chapel) were included in the measurements to this end.

The measurement height of the instrument was set between 0.2 and 0.3m above the soil surface depending on the situation. Given that the ground was uneven due to stone and bush obstacles the measuring distance, over all surfaces, was between 0.25 and 0.5m. Measuring was always accompanied by at least two student helpers who helped lay out and conduct the survey fields.

Data processing and presentation

Each evening the geomagnetic results were downloaded and exploited using IFR Dataload (Foester International). The postprocessing of the data was based on Surfer 9. The final step including the combination of orthophotographs and magnetic maps based on ESRI ArcGIS 10.4. The magnetic data represented in this article are unfiltered and uncorrected and have been subject to no additional image processing.

GIS treatment

A GIS system was developed and applied to Reccopolis in order to georeference the surveyed surfaces. With the help of the survey data and the available orthophotograph the magnetic map was georeferenced. The aerial photograph used was:

: PNOA_ANUAL_2009_OF_ETRS89_HU30_h50_0584 (1).ecw

ESRI ArcGIS 10.4 was used for the GIS treatment.

The data of the coordinate system that was used are as follows:

Coordinate System: ETRS 89 UTM zone 30N

Projection: Transverse Mercator

Date: ETRS 1989

False easting: 500.000,000

False northing: 0.000

Central meridian: -3,0000

Scale factor: 0,9996

Units: Metre