Easy targets, or "who has marked out my anomalies"?

Armin Schmidt[a]

The Roman city of Pessinus is famous as the cult place of Cybele, the Magna Mater, goddess of the Roman Empire. The city is situated in central Phrygia, about 150 km south-southwest of Ankara and 15 km southeast of Sivrihisar in the modern village of Ballıhisar. The Phrygian settlement and its temple, attested by several ancient authors, developed subsequently into a Greek and Roman temple-state led by a high priest. In Late Antiquity (c. 500–700), an early Byzantine citadel was built next to one of the late Roman cemeteries and evidence for Christian architecture was found in the city (e.g., several Byzantine pillar capitals, Tsetskhladze 2013). However, the location of the actual church remained elusive.

During intensive surface surveys several sites were identified to the west of the city, on the expanse of the Neogene continental high plateau pediment south of a metamorphic massif. Some of these sites seem to be related to a chain of defensive instalments, linked to the early Byzantine citadel. Slightly outside (i.e., west) of this chain and close to the Western Cemetery lies a site that was characterised during fieldwalking as having "extensive earthworks, including terracing and walls, dense tile and artefact scatter, as well as marble". These earthworks are clearly visible on current aerial photographs and show linear as well as circular shapes.
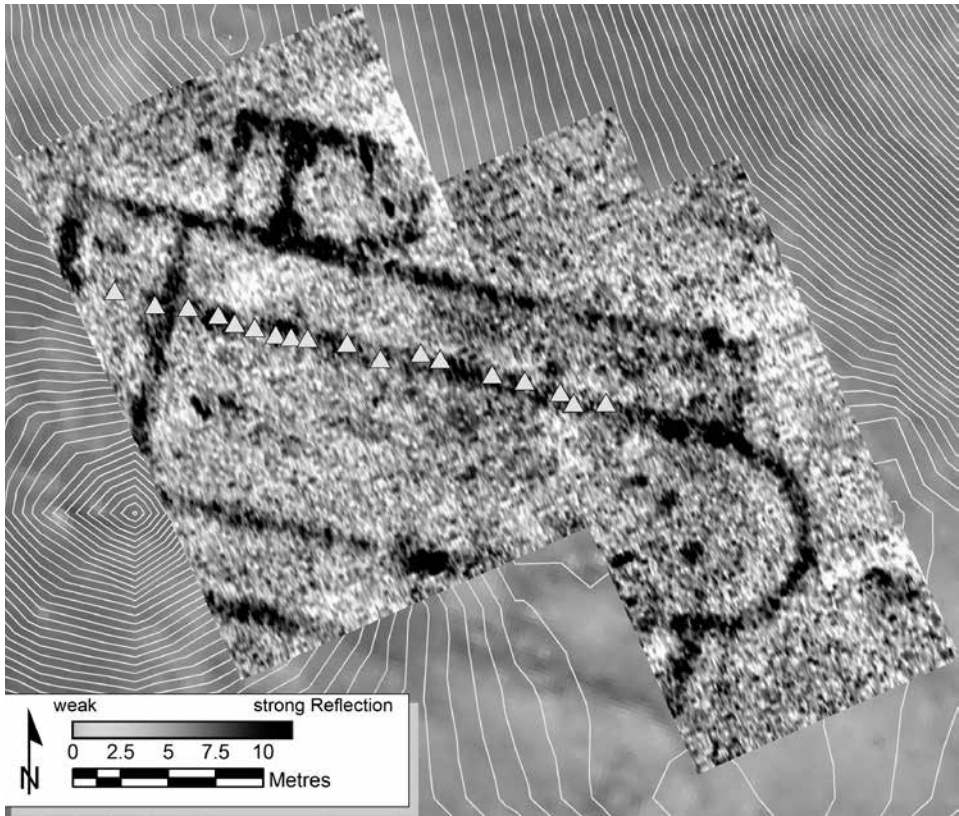
[a] GeodataWIZ Ltd, Thornton, United Kingdom

Fig. 1. Time slice at 1.2 m depth, showing the GPR data and the shallow soil heaps (triangles)

A ground-penetrating radar (GPR) survey was therefore undertaken over this site, using a 500 MHz Malå system with 0.25 m line spacing.

The processed time slices (Fig. 1) clearly show the foundations of a Byzantine basilica, oriented east-southeast, with linear wall foundations and an apse at the eastern end of the nave. The morphological interpretation of the data is supported by surface finds, which include many fragments of thin polished marble panels, presumably from wall revetment. When the survey area was tied into the project using a Total Station, a line of 18 shallow soil heaps was noticed (Fig. 2) that appeared to be similar to the spill that is often found around auger holes. By plotting these in the project's GIS together with the GPR data, it became clear that they were exactly aligned over the northern wall of the central nave, following exactly a GPR anomaly. Who had marked out this foundation wall for augering and how? Unfortunately, Pessinus and its environs are frequently targeted by looters as the expanses of the various cemeteries are very hard to protect and even the core area of the city is frequently

Fig. 2. Total station survey of the site in low light, showing the line of shallow soil heaps to the right

targeted by illicit diggers. The first few weeks of every field season are spent recording and cleaning the crudely dug pits and smashed marble pieces. The majority of these extractions seem to target underground chambers that were constructed as sometimes elaborate burial houses (Schmidt and Tsetskhladze 2013). It was noticed that some of these looted sites were unknown before and it must hence be assumed that some sort of detection equipment was used by the grave robbers to locate them. We were passed information from an anonymous informer explaining that criminal gangs are operating in separate teams for detection and extraction, pointing to a considerable level of sophistication of organised heritage-crime. But what equipment do they use and can they detect buried wall foundations like the one of the Byzantine basilica? Underground cavities can be found with low-frequency electromagnetic (LFEM) devices in the form of metal-detectors with large coincident coils, or separate transmitter and receiver coils (Slingram devices, e.g. White's TM808). It is conceivable that similar equipment was used on this site and allowed to trace the course of the foundation wall, which was then probed further with an auger. According to the GIS results the westernmost auger hole went beyond the foundation and appears to have been the last one dug (triangles in Fig. 1).

To understand better how this foundation may have been detected, advanced vector processing was applied to the GPR data to visualise the anomaly. The transects were first processed using gain adjustment, bandpass filtering and background removal. A soil velocity of 0.078 m/ns was estimated from migration tests and used to migrate all 2D transects, before the data were combined into a 3D cube, from which time-slices were derived. These raster data were then converted to polygons by applying a threshold, so that a sequence of vector processing steps could be used (Schmidt and Tsetskhladze 2013). A newly developed overlap analysis allowed the separation of these vector features into individual structural bodies.
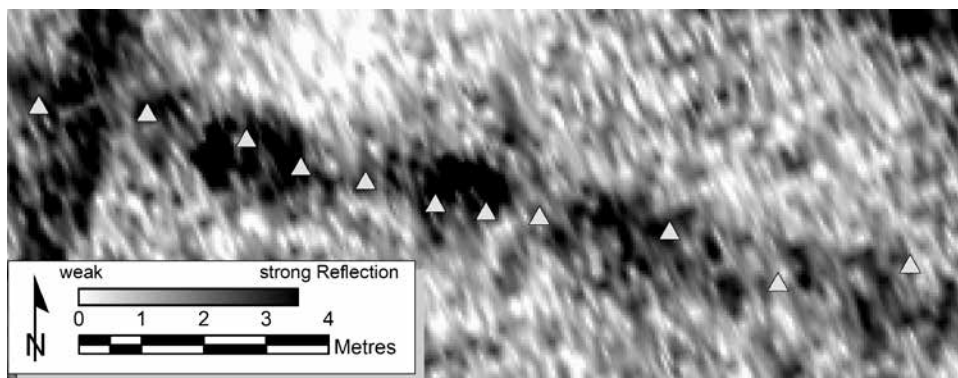
Fig. 3. Enlarged time slice at 1.2 m depth, showing the GPR data and the shallow soil heaps (triangles), which are denser over the presumed pillar bases that reach closer to the surface

The results show that the densest augering (Fig. 3) is located over two presumed pillar bases (0.8 m wide), which are preserved up to 0.6 m below the surface. The rest of the foundation is preserved at 0.9–1.4 m below surface and attracted fewer auger holes. It must hence be concluded that the detection equipment used by the looters provides some degree of depth discrimination and a fairly sophisticated metal-detector is most likely.

The combination of detailed geophysical measurements, advanced data processing and GIS analysis allowed some glimpses into the operations of the looters on this site. It would be desirable to develop cheap active or passive EM devices that could scramble the signals of the metal-detectors so that this and other sites could be protected better.

REFERENCES

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