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Combining data of different GPR systems of surveys of the roman fort Qreiye-ᶜAyyash, Syria

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Key words: GPR, Data processing, Image enhancement, Roman Fort

Introduction

The Roman fort of Qreiye-ᶜAyyash was founded in the late 2nd or early 3rd century AD and was abandoned in the mid-third of the 3rd century AD. It is situated immediately north of the modern village of ᶜAyyash, 12 km upstream from Deir ez-Zor in Syria, on the edge of a plateau overlooking the valley of the river Euphrates. The Roman fort comprises 220 x 220 m and was discovered in 1929 by A. Poidebard in the course of an aerial photographic reconnaissance (Poidebard, 1934, 87-88, pls 86-87).

In spring 2002, the German Archaeological Institute Damascus and the Direction General of Antiquities and Museums of Syria established a joint project to investigate the site by carrying out systematic topographical and archaeological surveys, magnetic and geoelectric prospection and archaeological excavations (Gschwind-Hassan, 2008; Gschwind, 2003-2007).

GPR prospection

In November 2002, a GPR test survey of 9700 m² was carried out successfully by Archeo Prospections® in the central area of the fort (Seren *et al.*, 2007), using a PulseEKKO 1000 with 900 and 450 MHz antennas. The GPR prospection of the entire area of the fort was possible thanks to generous support from the Gerda Henkel Foundation. It was completed in September 2004, using a PulseEKKO 1000 system with 900 MHz antennas and a GSSI SIR-3000 system with 400 MHz antennas. Further GPR prospection inside and outside the Roman fort was carried out in October 2005 using a Noggin system with 500 MHz antennas (Fig. 1). In total, an area of more than 75 000 m² was prospected using GPR.

Data Processing

For computing depth slices, a mean velocity of 12.5 cm/ns is used, the GPR traces are suitably band-pass filtered and a background removal filter is applied (Fig 2). The partly overlapping single GPR grids are put together in one 3D data block with 10 cm depth slices by averaging overlapping areas.

The prospection results are very different depending on the location and the GPR-System (Fig. 2). Due to the rough surface the PulseEKKO 1000 system produces a very

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Figure 1: GPR prospection at the edge of the plateau immediately north of the Roman fort of Qreiye using a Sensor&Software Noggin System with 500 MHz antennas.

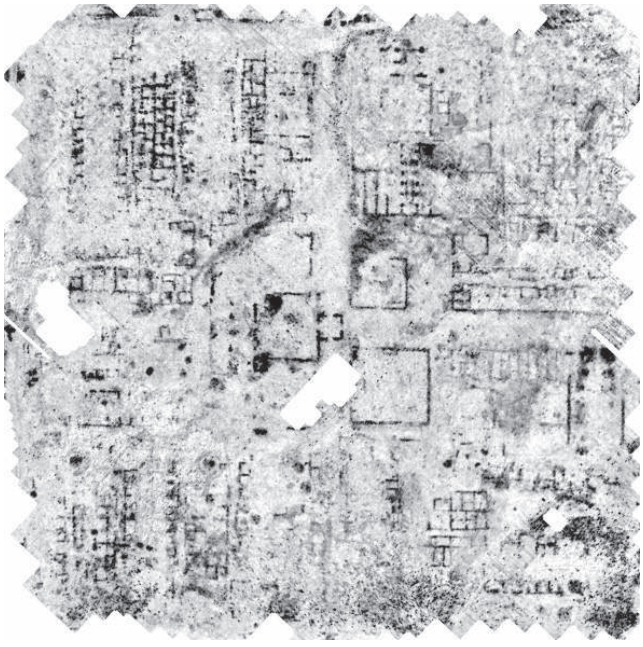

Figure 3: GPR depth slice 0.20-0.40 m. The striping patterns disappear with the use of an average trace removal filter with only 1 m length.

distracting striping pattern in the measuring direction on visualisations of depth slices. The geophysical contrast of archaeological structures seems to be insignificant in some areas and substantial in others. Therefore, certain archaeological structures are visible very clearly, while others are hardly recognisable and some areas are entirely devoid of visible archaeological features. The expected archaeological structures (walls) are generally composed of mud-brick resting on foundations of magnetic quarrystone. The fort of Qreiye is situated on a plateau formed of a basalt layer 2-3 m thick and overlaid by natural clay and debris from collapsed mud-brick (Kiss 2006). The basalt is strongly and variably magnetic. Therefore, only the most solid archaeological structures could be detected by magnetic prospection.

The GPR profiles were carried out at an angle of 45 degrees to the expected rectangular archaeological structures to get equally good response for all directions of the structures, although this leads to a much higher effort in the field. Since it is necessary to apply an average trace removal filter with a filter-length of only 1 m, the linear archaeological structures would also be removed, if they were oriented in the direction of GPR profiles. The 1 m average trace removal filter leads to depth slices with significantly less noise and nearly no disturbing linear patterns in the GPR profile direction (Fig. 3).

To enhance archaeological structures with very small geophysical contrast a Wallis-filter (Wallis, 1977) with 12 x 12 m window size has been applied (Fig. 4). The Wallis-filter changes the statistical parameters mean and standard deviation so that they are the same for the applied window size at any location in the image. Therefore, archaeological structures with small geophysical contrast are statistically enhanced. Because a very dense cover of buildings can be anticipated inside a Roman fort, a 12 x 12 m window is used. The Wallis–filtered visualization is helpful as an additional source for archaeological interpretation.

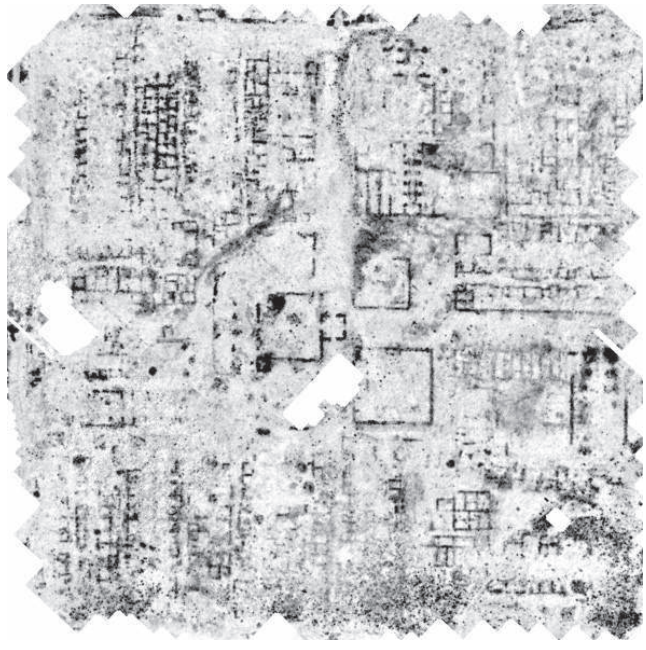

Figure 2: GPR depth slice 0.20-0.40 m. Archaeological structures show partly very good and partly very small contrast and are overlaid by striping patterns in the measuring direction.

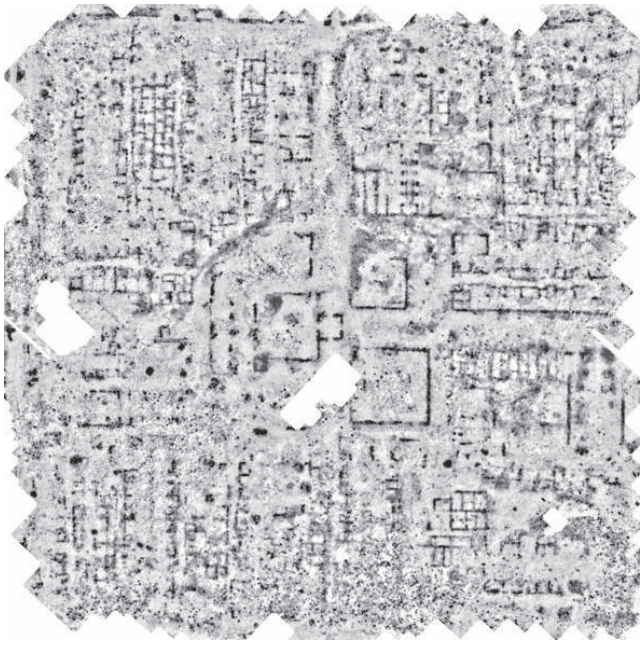

Figure 4: GPR depth slice 0.20-0.40 m. A Wallis-Filter with a 12 x 12 m window enhances archaeological structures with very small geophysical contrast.

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