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Geophysical Prospection of Archaeological Structures in a Noisy Area in Shayzar, Syria

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Site

The roman town “Caesarea”, which was named “Sezer” and used as a citadel in middle ages, is located within the modern town “Shayzar” in the north-west of Syria. The modern buildings, power lines and the streets with a lot of cars cause a very noisy environment for geophysical prospection. A football ground of about 50x90 m was chosen for testing both methods, magnetic and ground penetrating radar (GPR), to detect archaeological structures.

Instruments and survey area

The magnetic survey was carried out using a fluxgate magnetic acquisition system with 4 sensors in gradient array from the manufacturer FÖRSTER® mounted on a one wheel cart. The cart was developed in our institute and allows to record high quality data in areas with difficult field conditions. An optical distance measurement system on the wheel ensures an exact positioning of the magnetic data. The measurement grid was 50x10 cm.
GPR survey was carried out using a NOGGIN system with 250 MHz antenna from the manufacturer Sensors & Software. A new base plate was mounted on the antenna for the easy moving at rough surface conditions. The measurement grid was 50x5 cm.

Data processing

The magnetic data are processed using the self developed software ApMag. The main steps of the processing are filtering, removing of the line pattern, interpolation to a grid of 10x10 cm, geo-referencing and producing of a grey scale magnetogramm for visualizing in a geographical information system (GIS).
The GPR data are automatically processed using the self developed software package ApRadar. Several preprocessing steps were carried out including removing of constant shifts, automatic detection of the starting point (time zero), frequency dependent high-pass filtering and a background removal filter to get the best results for each measurement. There is no gain control algorithm applied to the traces of a section but a statistical correction of each depth-slice for each section. This is equal to an automatic gain control (AGC) algorithm applied to the whole section where the window length of the AGC algorithm is equal to the time range added for the depth slice. Therefore a data dependent gain control is applied to the data.
NOGGIN systems deliver better results after applying a filter to remove low frequencies (frequencies below the half centre frequency). Varying the cut-off frequency between one quarter and three quarters of the centre frequency is hardly visibly in the depth slices because the frequencies to be removed are very low.
For depth slices calculation a mean velocity of the radar wave of 0.13 m/ns is used and a geometric correction of the antenna separation is considered. The velocity is estimated by adjusting diffraction hyperbolas. Depth slices of 10 cm thickness are calculated and interpolated to a regularly spatial grid of 10 cm. The depth slice are geo-referenced and visualised as grey scale images in a GIS.

Results

Both methods deliver very good results of the roman structures and show advantages and disadvantages of

the magnetic and GPR prospection. The magnetic prospection data suffer from big noise caused by the modern sources, but as the archaeological structures have a good magnetic contrast to the ground, these structures are very well visible. Applying low-pass filtering und a Wallis-filter even shows the archaeological structure in the disturbed areas.
In the GPR depth slices the walls are already partly visible in the first depth slice and are very sharp between 0.60m to 1.5m. But not all archaeological structures visible in the magnetogramm are visible in the GPR depth slices due to different geophysical contrasts of the archaeological structures to the surrounding ground. Therefore the magnetic and GPR prospection results complement one another and more archaeological information can be gathered from the combination of both methods than with only one.