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Prospection of the Early Islamic residence Rusafat Hisam (Syria) by Caesium Magnetometry and Resistivity Surveying 1997–1999

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Around the end of the 5th or beginning of the 6th century the city Resafa-Sergiupolis had been fortified. The reliquary of Holy Sergius held in the chappel beside the basilica was not only a centre for pilgrimage of Christians but also of Muslims. One of them was Hisam b. Abd al-Malik, who built at the northern side of the reliquary chappel with an direct entrance to the sanctuary the Great Mosque. Hisam already as prince loved this place in the desert, when the valley of the Euphrates became more and more contaminated by pestilence. It was also here in the desert, when Hisam got the news of his appointment to be caliph (reign from 105/724 to 125/743), and he decided to built south of Resafa-Sergiupolis his new residence Resafa-Rusafat Hisam, which became the new name for the city too. In this huge area (about 3 square kilometres) 1977 a basic survey by fieldwalking and a topographical survey were made, followed 20 years later by a first geophysical prospection, which will be described here. From the first survey in 1977 a rather extensive idea about the charakter of Hisam's residence could be drawn as a loose agglomeration of six palaces with farmhouses and public utilities. The archaeological investigations of the city and the surrounding landscape resulted in a rather precise dating of the place by numismatic evidence from the early Abbasid period to the second half of the 8th century (136/753-54 or 146/763-64). This means that in the seconde quarter of the 8th century there existed besides the fortified byzantine city, which still was a centre for pilgrimage until the 13th century, the Islamic residence, which was never fortified. Nowadays in the whole area of this residence many relicts of mudbrick-buildings still can be seen by their sunken walls, which form features like dikes. In the extremly wet spring in 1997 and 1998 many details of the architecture could be observed as damp marks on the ground. These marks were not stable at all and vanished few hours later. Therefore it was impossible to document these phantom features. But for some cases when the magnetization contrast of the mudbrick buildings against their surrounding becomes negligible this would be the only method of tracing theses houses, because there is almost no contrast in resistivity too.

After the test measurement in 1997, there were two prospection campaigns in 1998 and 1999 using the successfully tested combination of caesium magnetometry and resistivity surveying. In this huge residence area of 3 km^2 magnetics was applied for large scale prospection, but resistivity on specific buildings to learn more about architectural details. All houses and palaces of the residence were built by sun-dried mudbricks, but with different techniques. But all walls have also a foundation made out of stone. For these foundations the local anhydrite was used. The walls of the more important buildings were plastered with stuccowork (also anhydrite). The magnetization contrast was found to be extremly low being positive for mudbrick wall in their surrounding debris, but also negative for the stone foundations. These two effects in magnetic contrast can cancel and a structure becomes non detectable with magnetics even if one could see the walls at the surface, which may be very frustrating. But there were also some buildings with burning, which show up in the magnetogram quite nicely. The situation for resistivity was found to be little better, but only in a wet ground condition making the electrical contact possible and showing a good contrast for the stone foundations. But also a mudbrick wall in its debris shows a very slight positive anomaly (better conductivity). This effect was also given for extreme dryness, because the dense mudbricks are holding the moisture for a long time. All campains took place early in the year around Easter, when heavy rains allow good electrical contact to the ground. It was only in 1999, when it was almost impossible to work with resistivity because of an extreme aridity (when the sheep are dying resistivity surveying in the desert becomes impossible). One would wish an instrument with capacitive coupling to the ground.

This combination of magnetics and resistivity for prospecting mudbrick architecture in the desert may be demonstrated best with the complex of palaces III/IV, which was prospected almost complete in the two days campaign in 1997. The palace IV is also well visible at the surface, so there will be a good possibility adding the terrain model to the geophysics. The instruments used for magnetic prospection was the Scintrex SMARTMAG SM4G-Special with duo-sensor configuration (in 1998 and 1999 two instruments were put into action). For resistivity survey, which was run by our Syrian colleagues from Damascus University, a Geoscan RM15 with twin-electrode was used. Unfortunately it was impossible using the multiplexed double-twin configuration because of the contact problems to the ground.

The question was to decide which non destructive technique would be suitable for archaeological prospection for mudbrick architecture. Therefore caesium magnetometry and resistivity survey were applied on the same area (FP 143), where strong evidence for a palace could be seen on the surface by topographical reason. It is known, that resistivity survey should be the best method for prospecting archaeological structures made from stone, but magnetometry would be about 5 times faster in fieldwork. Therefore caesium-magnetometry was covering an area of more than 1.5 hectares after two days (300,000 measurements with 0.1/0.5 m intervalls). Resistivity only covered a quarter of hectare.

A main survey line was chosen from the southeast corner of the inner wall of the palace IV leading to the southwest corner

Fig. 1. Rusafat-Hisam 1997/98, palace complex III/IV. Magnetogram as digital image, caesium magnetometer Scintrex SMARTMAG SM4G-Special with duo-sensor configuration, sensitivity 0.01 nT, raster 0.5/0.25 m after resampling, reduction to the line-mean, dynamics –3.2/+3.2 nT in 256 grayscale (white/black), 40 m grid

Fig. 2a. Rusafat-Hisam 1997, palace complex III/IV. Magnetogram (detail) as digital image. Same technical data as Fig. 1, but 20 m grid

Fig. 2b. Rusafat-Hisam 1997, palace complex III/IV. Compilation of magnetics and resisitivity survey. Resistivity with Geoscan RM15-Advanved with twin-electrode, raster 0.5/0.5 m, dynamics of the original data 30/40 Ohm m, highpass-filtering 8 x 8 pixel, dynamics ± 1.5 Ohm m in 256 grayscale (white=high resistivity, black=good conductivity), 20 m grid

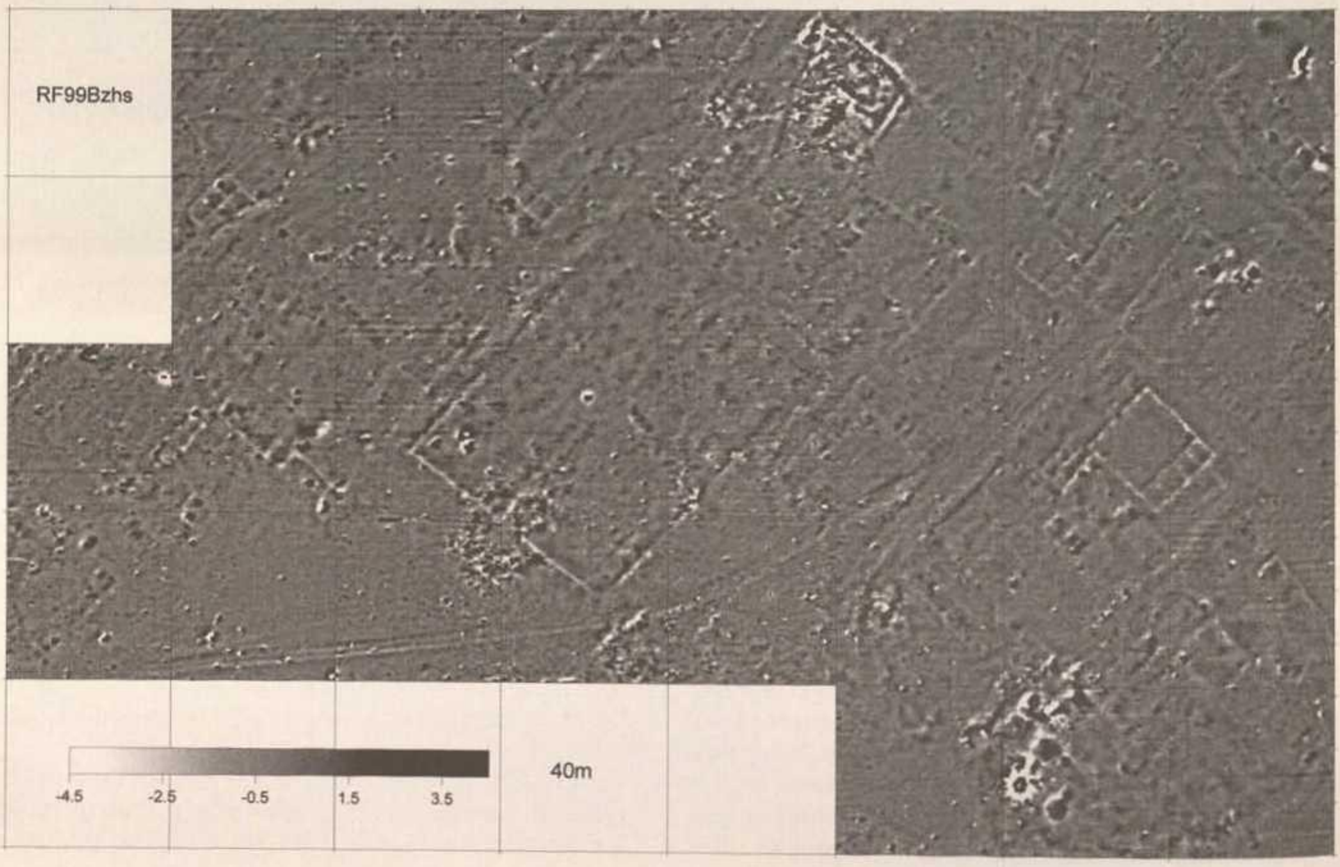
of the city wall of Byzantine Resafa. A 40 m grid was marked by wooden stacks for magnetometry and a 20 m grid was fixed covering the eastern half of the palace for resistivity.

1. For caesium magnetometry a Scintrex Smartmag SM4G-Special was used in the socalled duo-sensor configuration which doubles the speed of fieldwork. This magnetometer has a sensitivity of 0.01 Nanotesla at 0.1 sec cycle. Time mode sampling at 0.2 sec was chosen which gives a spacial resolution on the traverse better than 20 cm. High frequency external geomagnetic disturbances were eliminated by a bandpass filtering at 1 Hz. The diurnal geomagnetic variation was corrected by the reduction of the data after resampling on the line-mean and on the square-mean. Data processing and visualization was made in the same night on a notebook computer using special software packages. Greyshade plotting was made on the screen and a hardcopy was printed in the German Archaeological Institute at Damascus (Fig. 1).
2. For resistivity survey a Geoscan RM15 Advanced resistivity-meter and multiplexer MPX15 was applied with parallel double twin electrodes (3 probes) at 0.5 m separation. Automatic

Fig. 3a. Rusafat-Hisam 1999. Magnetogram of the middle area of the residence site with several buildings of different type. Technical details as Fig. 1, but dynamics ± 6,5

Fig. 4 and 5. Rusafat-Hisam 1999. Aerial views of Resafa-Sergioupolis ▷ and of the area of the residence of Rusafa-Hisam with a secondary building (FP 148) being surveyed by resistivity taken at the helicopter flight (photograph C. Schweitzer)

Fig. 3b. Rusafat-Hisam 1999. Same as Fig. 3a, but highpass filtering 10 x 5 nT, dynamics ± 3.5 nT



sampling allowed fast measurement at 0.5/0.5 m intervalls. The resistivity survey was done by my geophysicist collegues Kaldun Kotaisch and Bassam Al-Shmali from the Geophysical Institute of Damascus. Data processing after dumping to the notebook computer was undertaken by GEOPLOT V2.2 software package (Fig. 2b).

Both methods resulted in a rather clear image of the archaeological structures. For magnetometry a suitable contrast was found between mudbricks, stone foundations and cultural debris. Resistivity gave an somehow clearer image of the construction of the walls showing also the anhydrite-plaster of the mudbrick walls. By this effect even the interior of the building becomes visible. In palace IV the corridors inside the walls may be seen. However direct measurements of the resisitivity of the plaster exposed to the surface gave no clear evidence for this effect. The rim of both sides of a wall with high resistivity could also be caused by a stone foundation on both sides of a wall, but this is not very likely from architectural reasons.

By this experience magnetometry should be applied for fast and large area coverage first, whereas resistivity survey may be used only for detailled work on specific buildings. The combination of caesium magnetometry and resistivity survey at the Islamic site of Resafa gives a powerful method for nondestructive archaeological prospecting.

In 1998 the palace complex III/IV was completed with caesium magnetometry (operated by H.Becker and J. W. E. Fassbinder). The palace III, which was never clearly visible at the surface, also gave no clear traces in magnetics (Fig. 1). Possibly one should search for the double palace III/IV in another context. The resistivity survey of palace IV was also completed, but only with 1.0 m traverse intervals and 0.5 m sample interval because of time problems, which gave a rather coarse image of the architectural structures. A remeasurement with resistivity in 1999 with an raster 0.5/0.5 m did not realy improve this result because of the contact problems under extremly dry conditions. But the main project in 1998 was the magnetic propection of palace VI and its surroundings. The palace is situated very exposed at an elevation towards the main wadi, but there are only some of the architectural structures visible in the magnetogram. In contrast to palace IV there seems to be almost no magnetic contrast of the mudbrick architecture. But in palace VI some buildings and part of the fortifiction is made from burnt bricks which allow a clear tracing in the magnetometry. The area tested for resistivity surveying at the rampart and the interior of palac VI was not big enough viewing any architectural details. The result of the magnetic prospecting of the surrounding buildings (farm houses ?) looks much better identifying some complete layout plans of houses.

In March 1999 the combined prospection was continued for the 2^{nd} campaign. With two complete caesium magnetometer systems with duo-sensor configuration (operated by H.Becker and C. Schweitzer) a large and representative area (about 18 ha) could be measured giving a comprehensive impression about the architectural structure of many secondary buildings of Hisam's residence. Because of the extremly dry ground resistivity survey was concentrated on two buildings only. A remeasurement of palace IV with 0.5/0.5 m raster and a secondary building (FP Nr. 148) were surveyed, which gave important additional results of architectural details. But also in the magnetograms the architecture of various types of buildings can be identified mainly by a negative magnetic contrast of the stone foundations of the walls. But there are also some burnt down ruins or rooms with higher magnetization visible (Fig. 3a, 3b).

Also in 1999 the topographic survey was continued for detailed digital terrain models (M. Stephani). The Syrian Air Force undertook an extensive helicopter flight over Rusafa-Hisam and Resafa-Sergioupolis for photogrametric aerial photos taken as oblique views (with control points on the ground) out of the open door of the aircraft (M. Stephani, see also Fig. 4 and 5). The combination of the terrestrial and the aerial survey will result in detailed models of most buildings, which are visible at the surface, and will give the ideal base for the compilation of the geophysics.

With the support of these terrestrial-aerial terrain models of the site, the ground geophysics will be finished within one more campaign. A detailed plan of a representative area (the whole area in aerial photo) of the residence of Rusafa-Hisam will be produced as a combined work with geophysical prospection, air- and ground photogrammetry and archaeological survey.

References

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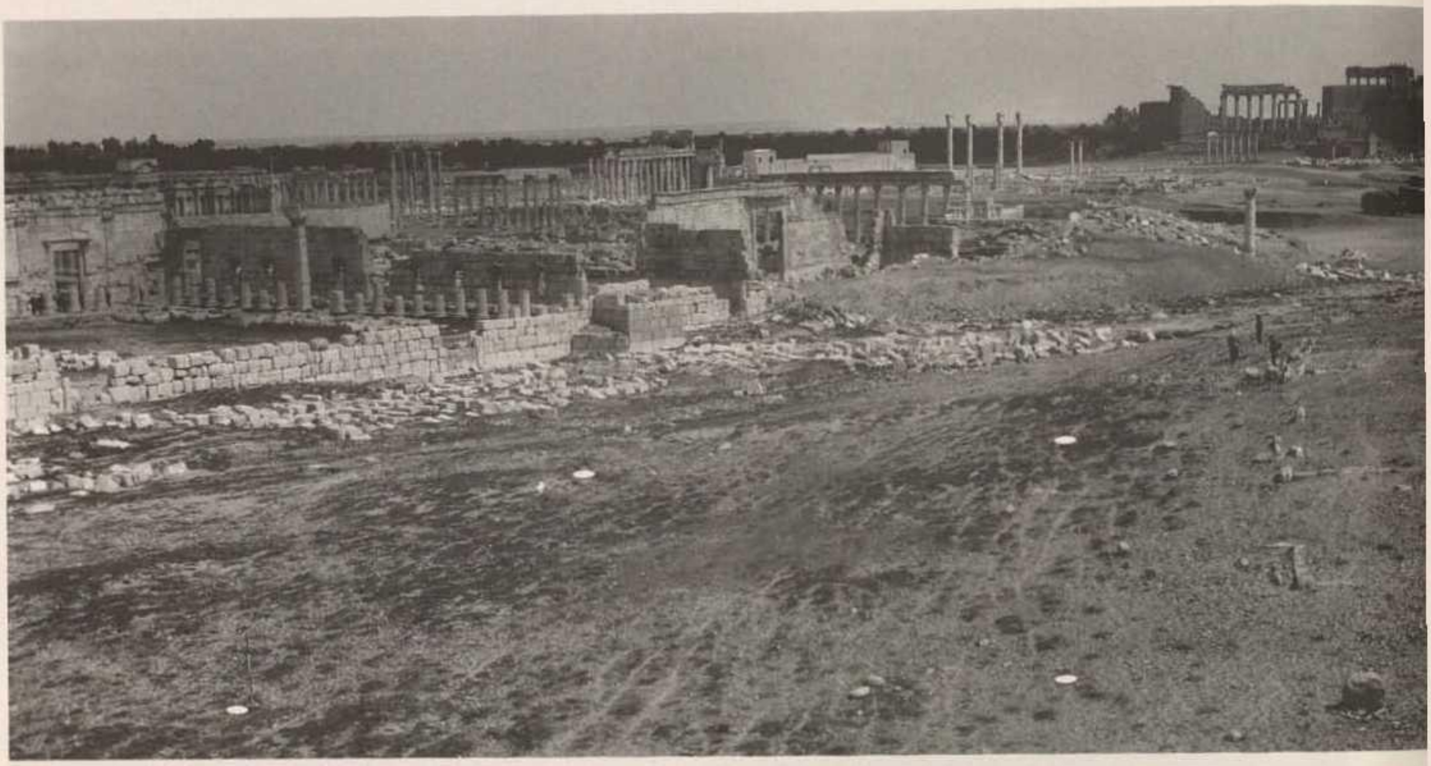

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Combined Caesium Magnetometry and Resistivity Survey in Palmyra (Syria) 1997 and 1998

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"In Hellenistic times, the caravan city of Palmyra, situated in the Syrian desert, had almost no direct contact with the great centres in the west such as Pergamon in Asia Minor or Rome. During this early period, the politics, economy and culture of Palmyra were all oriented towards the east, to the recently founded cities on the Euphrates and Tigris, such as Seleucia or Dura-Europos, and later to Parthian cities such as Hatra. It was only later, after the peace treaty between Rome and the Partians (20 B. C.), that Palmyra developed closer relations to western centres – to Emesa and Antioch, to the cities in Asia Minor and to Rome – in a periode when, especially through the unifying power of normative Augustan politics, a Hellenistic-Roman 'koine', a common language also in the arts were established. At that period, the first monumental buildings were also built in Palmyra, including sanctuaries, such as the temple of Bel dedicated in A.D. 32, and funerary monuments, such as the tower of Atenatan built in 9 B.C." (Schmidt-Colinet, 1997). This rather clear view of the political and cultural situation of Palmyra stands in contrast to the actual knowledge of the city of Palmyra in Hellenistic times, which is completely unknown except of the above mentioned temple of Bel.

Following the ideas of Schmidt-Colinet the Hellenistic city of Palmyra may be situated in the south of the Roman city wall of Diocletianus which is still an upstanding monument like many other buildings in the Roman city. Nowadays this area is a vast field of ruins but without any architectural structures to be seen above ground. Only after careful fieldwalking some buildings eroded to the foundations appear, but their dating is almost uncertain. In spring 1997 after a long period of heavy rainfalls some building near the surface showed up as vegetation marks, but they vanished within several hours and could not been mapped before.

In March 1997 and 1998 nondestructive geophysical methods were tested in the "Hellenistic city" of Palmyra for archaeological prospecting. A 700 m long main line (azimuth = 100/280°) was fixed by stable architectural elements in the field and a 40 m grid was marked by wooden stacks. Two geophysical techniques were applied for this project: