

THE VIRTUAL RECONSTRUCTION OF THE “TITANE” ARCHAEOLOGICAL SITE (GREECE) BY AIMS OF PHOTOGRAMMETRY

Timothy Nuttens^a, Rudi Goossens^a, Christiane Tytgat^b, Alain De Wulf^a, Daniël Van Damme^a, Marc Hennau^a, Dennis Devriendt^a

^aGeography Department, University of Gent, Krijgslaan 281, 9000 Gent Belgium, rudi.goossens@ugent.be

^bRoyal Museums of Art and History – Jubelpark 1000 Brussels – Belgium

KEY WORDS: Photogrammetry, Archaeology, Surveying, Management, Orthorectification

ABSTRACT:

This paper is mainly dealing with the production of ortho-photo maps of the remnants of the walls of the ancient acropolis of the archaeological site of Titane. This is done by using a Canon 11 Mbyte camera. The stereo-couples are processed in a non-metric way. The aim is to produce DEM's and ortho-photo maps of the acropolis walls, in order to have documents for monitoring and managing the historical site of Titane. This seems to be necessary since recently (2007) a small part of the walls collapsed.

1. INTRODUCTION

The site of ancient Titane in Korinthia was identified in 1840 by Ludwig Ross. It is located about 50 km SW of Corinth, just to the North-East of the small contemporary village of Titane, the former Voivonda. In antiquity, after Sikyon, it was probably the most important site in the Sikyonia region. However, it has remained, so far, a mostly unexplored site.

Titane was renowned in antiquity for its sanctuary of Asclepius. The sanctuary was described in detail by Pausanias who considered the cult of the god practiced on the site as ancient already at the time. None of the buildings and the monuments mentioned by the ancient traveller has been located. Fundamental research and mapping of the site was carried out by Ernst Meyer in 1937 (Meyer E., 1937). The map he produced was, and still is, used by all scholars researching on ancient Titane.

The aim of the five year program conducted by the Belgian School at Athens is:

- a) To locate the sanctuary of Asclepius and to establish the extent of the city in the course of the centuries;
- b) To produce a digital terrain model and a new topographic map of the site and its surrounding area that can be used as a basis for drawing up the results of future archaeological survey and excavations;
- c) To produce a series of digital relief models and orthophoto maps of the acropolis and city wall in order to re-create a virtual reality of these walls;
- d) To study the use of the land in the area surrounding the site.
- e) Finally, this multidisciplinary research program, in combination with archaeological excavations, will help to clarify the historical, political and religious role played by Titane, a locality situated midway between two major ancient centres, Nemea and Sikyon.

The remnants of the walls surrounding the acropolis of Titane are until now still in a relative good conservation stage. But as in spring 2007 was shown, when a small part of the walls collapsed, they are in a need for conservation actions and a photogrammetric documentation.

The walls are composed out of stabled stones, while the towers are built up by rectangular shaped blocks.

The walls are endangered by different factors, normal erosion, roots of trees pushing the stones aside and uncontrolled grazing by goats and sheep. Therefore it was decided in 2005 to document the walls by close range photogrammetry.

2. FIELD WORK

The field work was done in the period end September – beginning of October 2005.

In a first stage, a visual inspection was made around the remnants of the acropolis walls, in order to find the optimal viewing points, the position of the base stations for the topographic base station, the recording and restitution scale of the final ortho-photo products, etc...

It was decided to create a polygon around the remnants of the acropolis wall. This polygon was attached to a geodetic point which is installed at the edge of the acropolis. From this polygon the skeleton of the acropolis walls could be measured. This result is represented in figure 1.

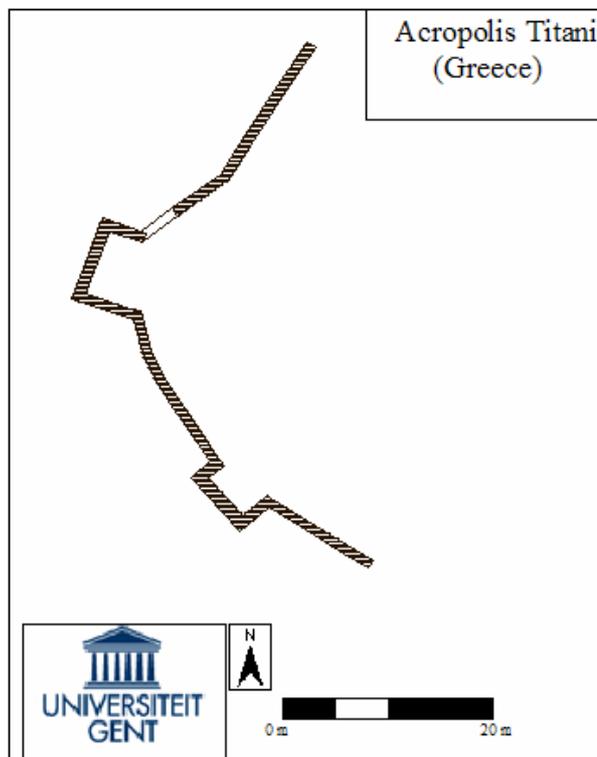


Figure 1. The ground plan of the acropolis walls at Titane.

In a second phase signals were prepared to stick on the walls, functioning as controlled points. These signals were prepared out of a light carton material, so that after a while the cartons would erode and disappear, leaving the monument without any traces. The cartons were stuck on the walls in such a way

that during the image recording always a minimum of 6 points would be visible on each stereo pair. The points were measured with a total station (without reflector) from the base stations of the polygon.

In a third phase, the photographs were taken using a Canon EOS1D (11 mega pixel). The photographs were taken with a 60% overlap, in a progressive way along the acropolis walls, taken into account that each couple should include a minimum of 6 control points. The pictures were taken in such conditions that the walls were not lighted by direct sunlight. In total 13 stereo-pairs were recorded in order to cover the total extend of the acropolis walls.

3. PREPARATION OF THE COORDINATES

As shown in figure 1, all the walls have a different position towards the north. Therefore, for each stereo couple, it was needed to transfer the co-ordinates of each of the control points contribution to the restitution of a stereo-couple, in a new axe-system, parallel to the image base. This was done for each stereo couple.

After the creation of the surface model and the ortho photo plans, the transfer has to be done in the reverse way in order to bring the ortho photos back into their original position.

4. THE RESTITUTION OF THE IMAGES.

The images were processed using *VirtuoZo 3.3* software. The images were processed in a non-metric way, since the internal calibration of the camera was not known at that moment. The relative orientation process was done in an automatic way. The control points were given in, in a manual way. The best results were obtained on the towers of the acropolis wall; somewhat less accurate results were obtained on the rest of the walls. This is believed to be due the fact that the towers are build on by rather big rectangular shaped blocks, while the rest of the walls are constructed out of stapled stones, giving more internal shadows.

Results of the absolute orientation are given in table 1.

Errors in mm.	Wall of the towers	Ordinary wall
RMS in x	0.9	8.3
RMS in y	1.3	3.2
RMS in z	2.3	7.0

Table 1: Results of the absolute orientation of the best results (photo pair 7, tower walls) and the worst result (photo pair 1, ordinary acropolis wall), in mm.

The DEM as well as the ortho photos were created with a GSD (Ground Spacing Distance) every 5mm. in order to keep the detail of the original images. Most of the times this automatic generation of DEM as well as ortho photo were satisfactory, excepted in the upper limits of the acropolis walls. Since in that zone, most of the times, the automatic image matching was difficult. This was caused by the fact that the software could not find matching points in the open air. This was creating strong deformations at the upper edge of the acropolis walls. Therefore the operator intervened manually to introduce break lines at the top of the acropolis walls. By editing the stereo model the software will only consider the matching point within the break lines. This is illustrated in figure 2 and figure 3. In total the 13 stereo pairs were processed in a similar way.



Figure 2: Result on the ortho photo before editing



Figure 3: Result on the ortho photo after editing.

5. RESULTS AND DISCUSSION.

The restitution of all the 13 DEM's and ortho photos stayed in an acceptable error range. The errors are ranging between 1 and 9 mm for x, y and z. this error range was obtained in a non-metric way. In a present stage the lenses are calibrated, so in a future stage these errors are expected to be lower. Anyhow the obtained results are considered as sufficient for the documentation of the acropolis walls at Titani. The importance of such documentation became clear in the spring of 2007 when a small part of the acropolis walls at the south side, has collapsed. This is illustrated in figure 4 and figure 5.

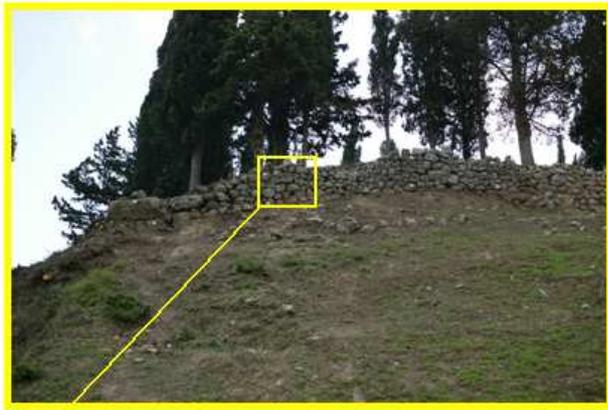


Figure 4. : Original remains of the wall as photographed in 2005



Figure 5. Part of the same wall for figure 4 that has collapsed in 2007



In any case there is now a metric documentation available how this wall was once looking. More over in case one wants to reconstruct this part of the wall, the DEM and the ortho-photo can be of a great help to reconstruct the side.

In such a way this type of rather easy documentation of historical monuments can help in managing archaeological sites, without that it brings excessive expenditures to the management of the monuments.

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