WHEN ARCHAEOLOGY BECAME DIGITAL - DOCUMENTATION OF TRENCH 3 AT SCHWARZENBACH-BURG

Klaus Löcker

In 1998 and 1999 an excavation project was carried out by VIAS in the central part of the prehistoric settlement Schwarzenbach-Burg to clarify Bronze and Iron Age habitation. The excavation area trench 3 measured 400 square meters. Beside the mentioned main objective the trench was also used to test new documentation methods such as digital and photogrammetric recording. To do so, the trench was cut in half and the southern half was excavated during the 1998 campaign while the northern half was dug the following year. During each campaign different documentation methods have been used in order to be able to compare efficiency and speed of the applied methods.

Stratigraphic Documentation

The used excavation method for trench 3 was – like at all other excavation areas in Schwarzenbach – the stratigraphic method developed by E.C. Harris. This method is based on uncovering deposits and feature interfaces - the units of stratification (SU) - of an archaeological site in reversed order of their original deposition and the documentation of these units individually and three-dimensionally, as proposed by Harris 1989 by single layer planning.

Generally, the working steps of the stratigraphic documentation in trench 3 were as follows. After uncovering a unit of stratification the situation was discussed in the team and a sketch was drawn showing all information concerning this unit of stratification and its context. This sketch was used in all following steps as a basis of documentation regarding numeration, sequence and workflow. Then the situation was photographed and the unit of stratification was recorded geodetically three-dimensionally or as a drawing by hand. All observations and information regarding this particular unit of stratification were recorded in a so-called SU-sheet, a protocol for all possible data concerning a unit of stratification. After the documentation various samples were taken (sediment samples, palaeobotanical samples, susceptibility samples, radiocarbon samples etc.). These samples also were recorded three-dimensionally. Possible finds out of this unit of stratification were bagged or – if the unit of stratification was large enough – assigned to sectors inside the unit of stratification and then bagged in order to be able to locate these finds more easily later on during analysis. Important single finds were recorded

DEM of Schwarzenbach-Burg with the excavation trenches 1992 - 2007 and the areas of the geophysical prospection highlighted in light brown. Trench 3 is highlighted in red. The aerial photo of trench 3 was taken during the excavation in 1998.

geodetically three-dimensionally. All these finds were given a particular number and were bagged along with a find sheet containing all important information about this find. Then the finds were washed and labelled. All the information regarding the units of stratification was collected in a database and then illustrated as a sequential diagram. This so-called Harris Matrix is a diagram illustrating a stratigraphic sequence. A stratigraphic sequence is defined as "the order of the deposition of layers and the creation of feature interfaces on an

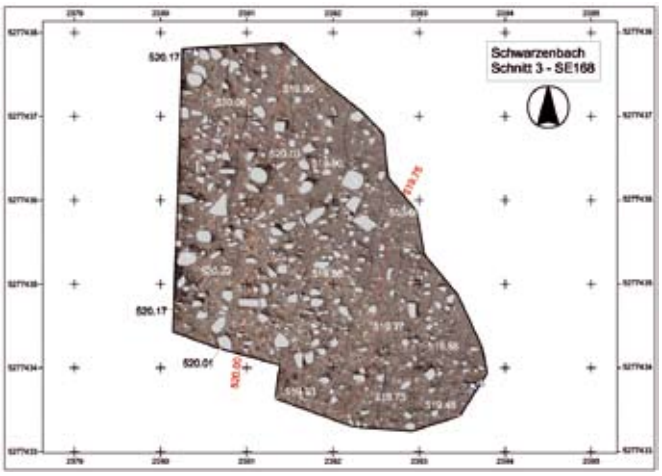
Using the digital total-station in Schwarzenbach.

archaeological site through the course of time" (Harris 1989, 159, see page 36). A stratigraphic sequence is determined by interpretation of the stratification of the site according to the axioms defined by Harris. The detected stratigraphic relations in this connexion are translated into a diagram. The aim of stratigraphy as being the description of the stratification is to set the units of stratification in a relative order (i.e. the stratigraphic sequence).

Documentation 1998

In 1998 the documentation of the units of stratification of trench 3 was carried out by using a digital total-station in terms of single layer plans. Details and layers with a large number of stones were drawn by hand. The outlines of the units of stratification were precisely recorded in three dimensions with the total-station. In addition, each surface of a unit of stratification – also of those drawn by hand - was recorded topographically in a particular raster. The measuring data were buffered in the total-station and read out onto a PC on site. We were able to convert these raw data into AutoCAD DXF-files on the spot using a program developed specially for this purpose. The plans drawn by hand were digitised using a digitiser tablet. These and the converted data from the total-station were put together in AutoCAD to produce a digital plan of the site as the excavation proceeded.
The topographical data were processed using the program Surfer, spot heights were added to the digital CAD plan and the layer surfaces were visualised by means of contour lines. These contour lines were produced in Surfer interpolating the measured values using the Kriging method and then converted to the DXF-format.
We were able to carry out all these working steps -

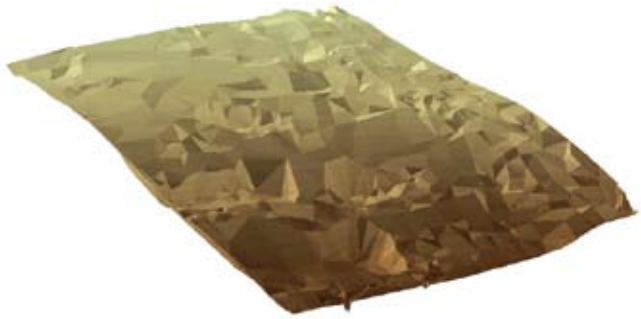
Measuring photogrammetrical control points in Schwarzenbach 1999.



Digital single layer plan of SU 168 produced using GIS in ArcView: Rectified photo clipped to the recorded outline of SU 168 with digitised stones, levelling values and contour lines.

Oblique photo taken of SU 168 during the excavation in 1999.

Rectified and georeferenced photo of SU 168 for import to GIS.



The last step of the excavation process: using the total-station for the documentation of the geological surface.

measuring the units of stratification on site to the point of producing and printing the digital plans on the PC – within a very short time enabling us to control and if necessary to correct the plans on the basis of the units of stratification during excavation. Furthermore, it was also possible to produce and print general layouts of large layer contexts which proved to be very helpful in recognising these contexts on the excavation.

Documentation 1999

In 1999 the northern half of the site was excavated. The funding of the excavation was cut to a third of the original amount, so it was necessary to develop new and efficient methods of documentation, which would supersede the time-consuming and partly unsatisfactory (because of being just two-dimensional) drawing by hand as we documented parts of the site in 1998. The aim was to implement the excavation process in an efficient and simple way by means of the development of a quick and cost-saving documentation procedure. Additionally we switched from AutoCAD to the GIS program ArcView 3.1 which suited the needs of stratigraphic documentation far better.

The system that emerged out of this situation consists of a digital total-station and a digital camera for documenting the units of stratification. The total station was used for recording the boundaries of the units of stratification point by point which were then imported into ArcView as a 3D-polygon. Additionally, the surfaces of the deposits and the feature interfaces were documented three-dimensionally by the means of surface points and break-lines to compute a digital elevation model (DEM). Instead of the conventional drawing by hand each stratigraphic unit was photographed with a digital camera and rectified on the computer. For the rectification process we used the program Asrix which was written by Steve Nickerson based on a special algorithm for plane rectification and was freeware at that time.
The rectification required a minimum of four control points which were surrounding the unit of stratification. Because Asrix was only able to perform plane rectification we had to heed that the plane which was formed by the control points did not diverge too much from the topography of the unit of stratification's surface. In case that this was impossible, more control points had to be added in order to produce multiple smaller planes which formed a rough approximation of the units topography. Each of these planes was rectified apart and put together again in the GIS. Thus, we were able to rectify even complex units of stratification with a sufficient accuracy

of less than 5 centimetres. The entire process from the digital photo to the production of the rectified unit of stratification in the GIS took an average of approximately 10 minutes. The mapped stones, layers of bones, skeletons and such could be drawn later on by means of the rectified and georeferenced images using the GIS environment (especially during rainy days). Thus, this work did not slow down the excavation process anymore.

Conclusion

During the excavation campaign in 1999 the entire site documentation was done by only two people. By implementing the new method of documentation using digital photos the expenditure of time for the documentation could be decreased by 70 percent compared to 1998. The duration of the 1998 excavation of the southern half of trench 3 was 6 weeks, in 1999 we excavated the northern half in only 3 weeks. So we were able to decrease the expenditure of time for the excavation by 50 percent simply by adopting new documentation methods and were simultaneously able to improve the quality of the stratigraphic documentation. The further adaptation of this primary developments showed major short-comings of the single layer planning as defined by E.C. Harris that could be solved by theoretical improvements of the stratigraphic method in 2001 (see page 31-36).

References

Doneus M., Neubauer W. (2004): *Digital Recording of Stratigraphic Excavations*. In: Ausserer, K.F., Börner, w., Goriany, M. & Karlhuber-Vöckl, L. (eds). *Enter the Past. The E-way into the four Dimensions of Cultural Heritage. CAA 2003, Computer Applications and Quantitative Methods in Archaeology.* BAR International Series 1227, Archaeopress, Oxford.

Zusammenfassung

Schnitt 3 der Grabungskampagnen 1998 und 1999 auf der urgeschichtlichen Siedlung Schwarzenbach-Burg diente neben der Erforschung der bronze- und eisenzeitlichen Siedlungsstrukturen auch der Einführung neuer, zeitsparender Dokumentationsmethoden basierend auf digitaler Tachymetrie, digitaler Photogrammetrie und dem Einsatz von GIS Software.
Während der Ausgrabungskampagne 1999 wurde die gesamte Grabungsdokumentation nur von zwei Personen durchgeführt. Durch die Einführung einer neuen Dokumentationsmethode mit der Verwendung von digitalen Fotos konnte die Zeitdauer der Dokumentation im Vergleich zu 1998 um 70 Prozent verringert werden. 1998 wurde die südliche Hälfte des Schnittes 3 in sechs Wochen gegraben, 1999 benötigten wir für die nördliche Hälfte nur drei Wochen. Damit konnte die Gesamtdauer der Grabung lediglich durch die Einführung neuer Dokumentationsmethoden um 50 Prozent verringert und gleichzeitig die Qualität der Dokumentation erhöht werden. Die weitere Bearbeitung dieser ersten Entwicklungen zeigte größere Mängel der von E. C. Harris definierten single layer Pläne. Diese konnten 2001 durch Verbesserungen der Theorie der stratigraphischen Methode gelöst werden (siehe Seite 31-36).

Klaus Löcker is senior researcher at the Central Institute for Meteorology and Geodynamics working in the field of geophysical prospection in Archaeology in close cooperation with VIAS. He acted as technical director of the excavation trench 3 at Schwarzenbach-Burg. His main interests are Iron Age archaeology, mining archaeology, experimental archaeology, GIS and theory of archaeology in general and of excavation and stratigraphic methods in particular.
klaus.loecker@univie.ac.at