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Interpretation and Mapping of Aerial Photographs Using Digital Photogrammetry and GIS

Fig 1. Aerial photograph from June 1986 showing crop-marked walls in one of the fields (Photo: S. Tichy; released by Austrian ministery of defence No: 13088/3-1.4/99) ▷

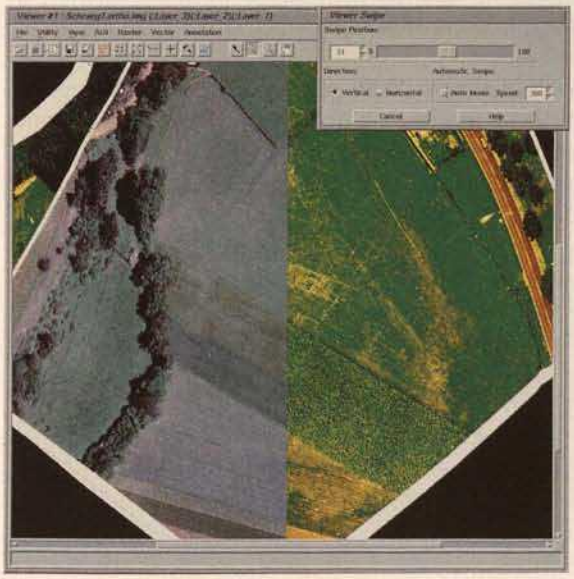

Fig. 2. Screenshot during an ERDAS® session: two orthophotographs from the same area are overlaying each other. To be able to estimate the geometrical correctness, the above orthophotograph is partly swiped away

Fig. 3. Orthophotograph and its variation: the left part is treated with a Wallis filter

Fig. 4. Combination of aerial archaeological interpretation (red) and excavation results (blue) on orthophotograph

The Roman town Teurnia is located in the area of the "Holzerberg" in todays St. Peter im Holz (Carinthia), covering approximately 17 hectares. Since 1845, excavations have been going on, which revealed parts of the towns wall, the forum, residential terraces and several early christian churches. Among them also the episcopal church dating from the 5th and 6th century A.D on top of the Holzerberg. A part of the town at the eastern bottom of the Holzerberg was photographed several times from the air by S. Tichy, a member of Carinthia´s building surveyor´s office between 1978 and 1992. These oblique photographs show the crop-marked town map of an area of 23,000 sqm To be able to integrate the information of these photographs into a complete town map, the aerial archive at the institut for Prehistory in Vienna was consulted.

The area of interest expands over several narrow fields with different crops, each responding differently to the underlying archaeology. This results in a patchwork, where photographs show cropmarks only in single fields. Fortunately, since the photographs were taken over several years, cropmarks could be recorded on each field. Therefore, all of the photographs had to be used for interpretation. Additionally a vertical stereopair (1:10,000) was available, produced by the Austrian air force during summer 1980. It covers the whole area of Teurnia. The oblique photographs were taken using a non-calibrated small format camera with unknown focal length. Unfortunately, some photographs showed a bad distribution of possible control points.

To be able to deal with these problems, we decided to use a bundle adjustment, where control points (= points with ground control) and tie points (= points visible in two or more photographs, but without ground control) are measured on all photographs and all measurements are adjusted to the ground control values in a single solution. The whole procedure was done digitally using the software Softplotter™ on a Silicon Graphics O2 workstation with 256MB RAM. The vertical photographs and the slides were scanned with 2,000 DPI. Ground control was measured using a total station. After the orientation, topographical data (3D-points and breaklines) were measured and a digital terrain model calculated. Consequently, this was used to rectify all of the photographs which were oriented by the bundle adjustment. The resulting orthophotographs have a pixelsize of 0.2 m. The accuracy depends on the quality of the distribution of the control points and lies between 0.5 m in the central part (which contains most of the archaeology) and up to 3 m in the more distant parts.

The interpretation was done using the geographic information system ERDAS Imagine®. Using the provided image enhancment techniques, the orthophotographs were treated with contrast stretch, Wallis filter or crispening. All of the georeferenced orthophotographs and their filtered variations were interpreted on screen. The interpretation drawing was combined with digitized results from the previous excavations which had been done between 1971 and 1978. The combined analysis of the results from the excavation and from aerial interpretation provided archaeologists with new clues to the extent of the settlement area during the 1st to 3rd century A.D. It will also function as basis for future archaeological activities as geophysical prospection.

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3D Reconstruction of Archaeological Sites Based on Prospection Data

The Middle Neolithic circular ditch at Schletz is located in the hilly landscape of northeastern part of Lower Austria and was detected by aerial archaeology in 1981. The interpretation of the aerial photographs was done using analytical photogrammetry. For the whole procedure, an analytical plotter device with a PC 386 was used. This device has a high precision in measuring picture coordinates (at about two mycrons) and therefore produces highly accurate 3D maps of the relevant archaeological information. In that way, the outline of the circular ditch could be drawn which was used later on for setting out the grid used by the geophysical prospection. Additionally, a raster of 3D-points and 3D-breaklines were measured and consequently, the digital terrain model of this site was calculated.

In 1995, a magnetic survey of the site using a high resolution caesium gradiometer was carried out. An area of two hectares was measured in a raster of 0.5 x 0.25 m. The data were visualised as digital images and georeferenced for interpretation. The archaeological interpretation shows a highly eroded single circular ditch with two interruptions, which were used as entrances. Each entrance feature is flanked by two short ditches, which meet the main ditch at a right angle. Using GIS, all the different prospection data were digitally combined to create additional images for subsequent archaeological interpretation.

To derive 3D reconstructions of the archaeological features a magnetic model was constructed. This was done by 3D modelling of the subsurface using dipole spheres of equal size and ho-