

## Integrated Geophysical Surveys for Archaeological Prospecting – New Results

The working group for archaeological prospecting at the department for geophysics at Kiel University (Germany) has undertaken several geophysical surveys on archaeological sites in northern Germany, Luxembourg, Italy and Turkey during the last years. Magnetic, electric, ground penetrating radar (GPR) measurements and shallow shear wave seismic were used for the investigation of Hittite, Greek, Roman and Viking age settlements, fortifications and temple constructions.

Primarily magnetic prospecting was applied for fast data acquisition in order to get a general idea of the subsurface remains of the archaeological site. Five Fluxgate gradiometer probes (Förster;  $dz = 40$  cm), mounted on a portable rack, are carried by two persons along 50 meter survey profiles with a sampling interval of 5 centimetres inline and 20 or 40 centimetres crossline. The datasets were processed with the software Mar Plot and presented as grayscale images. Striking anomalies are further investigated with geoelectric and GPR measurements. Therefore a multielectrode array and different GPR antennas (120, 200, 500 and 900 MHz) are available. Subsequent processing algorithms perform a 3 D view of the subsurface structures.

Prominent magnetic anomalies were found at the site of the Hittite town Sarissa in Central Anatolia, Turkey. Here 3,000 year old ruins, located on a remarkable mound, were excavated. With the exception of few steep slopes the entire acropolis (150,000 sqm) was investigated in the course of several survey campaigns (Fig. 1). The foundation of the 1.5 km long interior town wall surrounding the town centre was discovered and a distinct symmetric conception of the four ancient city gates was prospected. High uniform magnetic anomalies of the gate buildings insinuate a destruction by conflagration. The geomagnetic measurements were compared with geoelectric and GPR investigations at several locations. Our results show that the extension of the residential area is much larger than previously thought. The surveying of a sanctuary, found on a nearby mountain skid, revealed northward aligned buildings and the enclosure of an adjoining lake.

Magnetic and seismic measurements were applied for the investigation of the archaic fortification wall of Milet, located on a former peninsula at the west coast of Turkey. Nowadays the archaeological site is situated in the alluvium of the Menderes river. Milet's urban area included several ports and was enclosed by a town wall. Early settlements were found on a hill, called Kalabak tepe, in the south of the peninsula. We investigated the extent of the archaic city wall with geomagnetic measurements in order to examine the connection between Kalabak tepe and the lower part of the town. The rectangular street system, adopted by the Milesian Hippodamus, was detected and its orientation and size were proved to correspond with the excavated structures. The western coastline representing the border of the settlement was determined by the results of the magnetic survey. Some magnetic anomalies close to the ancient shoreline can possibly be identified as fortification or harbour constructions. Shear wave seismic was used to explore the structure of a harbour ba-

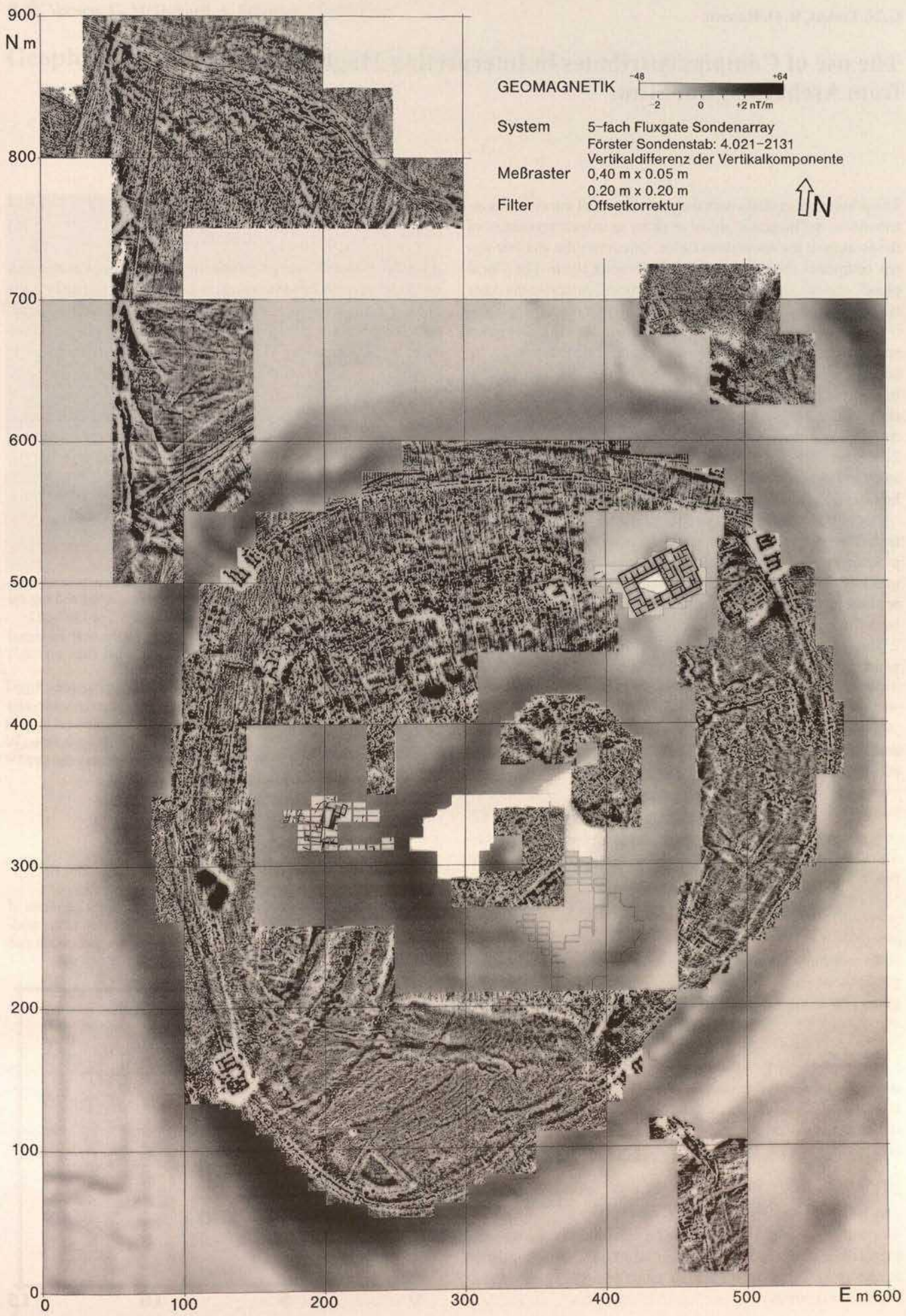
sin while magnetic investigations revealed the layout of the quay walls.

A recent feasibility study in the archaeological park of Selinunte, Italy, showed weak structures of buildings, street systems and the town wall, due to a low contrast between the used building materials and the surrounding subsoil. Further examples of the Viking age settlement Rerik at the Baltic coast and the Gallo-Roman settlement Wallendorf, close to the border to Luxembourg, will be presented in order to discuss the limits of geophysical prospection methods.

Future improvements may be possible with quick and precise positioning systems. Differential GPS promises an accuracy in the order of centimetres and is suited for the presented sites.

Fig. 1. Result of the magnetic prospecting using the Fluxgate array on the archaeological site of the Hittite town Sarissa





**GEOMAGNETIK**



System 5-fach Fluxgate Sondenarray  
 Förster Sondenstab: 4.021-2131  
 Vertikaldifferenz der Vertikalkomponente

MeBraster 0,40 m x 0,05 m  
 0,20 m x 0,20 m

Filter Offsetkorrektur

