THE ROMAN BATH, IN SAGALASSOS (TURKEY): STUDY OF STABILITY USING INTEGRATED GEOPHYSICAL AND LASER SCANNER SURVEYS

Istituto per i Beni Archeologici e Monumentali – CNR, Lecce, Italy

Introduction. The researches carried out by the IBAM-CNR in the area of Roman Bath at the archaeological site of Sagalassos (Ağlasun -Turkey) have led to create an innovative system for the documentation, representation and preservation of archaeological contexts. The scientific rigour and precision of the traditional instrumental mapping together with the use of new technologies and geophysical methods have produced high-definition 3D models of the monument as tools to store and manage scientific information. For geophysical survey two physical parameters were measured, the electrical resistivity and self potential in order to obtain their distribution in a three-dimensional volume. The aim of geophysical survey was to obtain information about the roman bath structure stability.

Results and discussion. With the aim investigate the integrity of the Roman Bath structure, the ERT survey was conducted in an area 78 m x 127 m (Fig. 1a). Fig. 1b shows the electrical resistivity model at six different depths. It is possible to note a low resistivity zone (10-60 Ωm) probably linked to the presence of a flow of water coming from the north. Part of water flow is directed towards the thermal baths and it spreads within them. It is possible also to evidence the fault line that crosses the baths. The 3D images of electrical resistivity can easily be visualized by 3D contouring of iso-resistivity volumes (Fig. 1c).

In Fig. 1c, the ρ data set is displayed with iso-ρ volumes using two threshold values ranging respectively from 1500 to 2000 Ωm and from 10 to 60 ohm m. This kind of visualization allows to emphasize both the bedrock variation depth (ranging from about 5m to about 12m in depth)
and the water flow. In order to better understand the stability condition of Roman Bath the area 1 was subdivided in two sub areas labeled respectively zone 1 and zone 2 (Fig. 2a). Fig. 2b shows the electrical resistivity model at eight different depths. It is possible to note the probable ancient drainage system in the first slices (+9m) posed at about 3m in depth (referring to the current living surface). It is characterized by an high resistivity values ranging from about 4000 Ωm to about 5000 Ωm. These values suggest that the system empty and partially collapsed.

A low resistivity zone (10-60 Ωm) indicate probable water flow coming from the north. Due to the collapsed ancient drainage system the water path is random and therefore the water diffuses randomly along paths that for centuries was opened in the building. Other high resistivity zones (labelled “C”) are visible on the roof. These zones are probably related to a fractures system. It is possible also to evidence the fault line that crosses the baths.

In order to better understand the distribution of the water on the roof a vertical distributions of resistivity are shows in Fig. 2c. Fig. 2c shows the electrical resistivity model at four different vertical sections that crossing the Roman Bath structure. It is possible to note the probable ancient drainage system. It is characterized by an high resistivity values ranging from about 4000 Ωm to about 5000 Ωm. These values suggest that the system empty and partially collapsed.

A low resistivity zone (10-60 Ωm) indicate probable water distribution on the roof. Other high resistivity zones (labelled “C”) are visible on the roof. These zones are probably related to a fractures system.

**Conclusions.** The results of the archaeo-geophysical survey at the archaeological site of Sagalassos are presented in this paper. During the summer of 2015, a geoelectrical survey was conducted using Dipole-Dipole array in two areas.

In the area 1 results indicates the problematic that affect the structure of Roman Bath. First one there is an uncontrolled water flow from the north hits the wall structure of the baths. ERT
Fig. 2 – a) ERT surveyed areas; b) 3D electrical resistivity distribution in the subsoil; c) 3D electrical resistivity distribution crossing the roman bath.

results show zones on the vault where the water stagnates. In these zones, the stability analysis showed a probability of collapse that could occur within 2 years.

Given the low values of the self potentials, the water flow velocity is fairly reduced. The flow velocity likely increases during the rainy season thus increasing the danger of collapse. Another problem linked to the presence of water is related to the formation of ice during the winter. In the zones of water stagnation, this phenomenon leads to an increase in the volume of water and consequently to an increase of the probability of collapse.