THE APPLICATION OF GEOMATIC SCIENCES AT THE SERVICE OF ARCHAEOLOGICAL RESEARCH

Following the work carried out by Enrique Osset, the systematic excavations began in the summer of 2021. The works combine a set of new methodologies relate to geomatics and digital archaeology for both the identification of possible structures still buried and for the documentation of the excavations.

Did you know... Geomatics include a set of techniques and methodologies that we use for the processes of capture, treatment, analysis, interpretation, dissemination and storage of geographic information (also called spatial or geospatial), in this case, of the archaeological area of Artieda. This set includes, for example: Surveying, Geodesy, Cartography, Photogrammetry and Remote Sensing.

PREVIOUS WORK: USING REMOTE SENSING TO DISCOVER BURIED REMAINS

Before starting the archaeological excavations, a type of prospecting was carried out using remote sensing techniques, with the use of “fixed wing” and “rotary wing” drones with GNSS RTK positioning satellites, with a payload of multispectral and thermographic sensors (works performed by 3D Scanner Patrimonio e Industria, Spin-Off of the University of Zaragoza) and georadar (carried out by SOT). For the development of this previous investigation, it was essential to interpret the differential growth of the vegetation in the area of the archaeological action through the appearance of marks, only visible from the air with multispectral sensors. The differential development of the vegetation is caused by the presence of underground remains such as walls, mosaics, ditches and wells, that prevent growth or phenological behavior similar to that of those plants that grow on a soil without underground remains. These "crop marks" or "soil marks" help archaeologists to identify the archaeological remains still buried and invisible. In this way, the analysis and interpretation carried out by the University of Zaragoza of all the data acquired allowed the selection of several areas likely to contain archaeological structures.

Four archaeological surveys were delimited topographically. Finally two of them were excavated in 2021: survey 1, corresponding to the road junction that endorsed the interpretation of the site as a city; and survey 2, in which the figured black and white mosaic of the thermal building was exhumed. Since the 2022 campaign, the efforts have focused on continuing to bring this monumental structure to light.

Did you know... Remote sensing is a technique for acquiring data from the Earth's surface using passive or active sensors installed on space platforms such as satellites, drones, 3D laser scanners, etc. Currently, it is widely used by archeologists as a non-invasive prospecting and documentation system. In the case of El Forau de la Tuta, the drones allowed us to see the site from the air with a type of camera that can see beyond the range of the human eye.

HANDS ON THE "EARTH": EXCAVATION AND DOCUMENTATION

For the excavation, the so-called Harris system is used, a tool used to describe the temporal succession of archaeological contexts and based on the geological principles established by James Hutton (1726-1797) and Charles Lyell (1797-1875). For this, it is necessary to identify different Stratigraphic Units (SU) and structural units, giving them a number and georeferencing them in the same plane.

In general, they obey four laws or principles:

- The law of overlap, according to which the upper SUs are more recent and the lower ones are older.
- The law of horizontality, which establishes that all SUs tends to be deposited horizontally.
- The law of original continuity.
- The law of stratigraphic succession, according to which all SUs take their place in the sequence.

Thus, all the units must be catalogued and related in a Harris matrix.
Each of the SUs has been georeferenced with GNSS sensors connected to the Active Geodetic Network of the Government of Aragon (ARAGEA). This system allows each survey to be positioned with millimetric precision, in addition to diachronically adding each of the excavated parts to generate a complete view of the site. It is a technique that allows to virtually join in a single model all the excavated areas in a three-dimensional way, documentation acquired by the use of a 3D laser scanner system combined with terrestrial and aerial photogrammetry techniques. Undoubtedly, it is essential for the researchers and for ensuring the conservation of the site. Photogrammetry consists of taking multiple images of the same terrain from various points of view with an overlap between the images, and using them to create high-resolution digitized 2D or 3D models. Based on these data, precise measurements can be made, coordinates can be located, and sections of the site can be exported to help us to understand the site. For the documentation of the final moment of the excavation, for example, the rooms discovered in the 2021 and 2022 campaigns of the thermal building, aerial photogrammetry was also used, in this case, carried out thanks to the combination of a "rotary wing" and a "fixed wing" drone flight.

The environment of the site has also been recorded, by means of a 3D laser scanner system with the purpose of also obtaining a 3D model of the entire complex. The use of this system allows that, although the discovered remains are covered again at the end of each campaign for conservation reasons, the results of the successive campaigns can be joined for generating a "digital twin". This 3D model allows the generation of a physical replica at any scale, like the one visible in the next room, or the generation of a virtual replica, a three-dimensional model, especially of those parts that are covered again and are not visible.

Did you know… In El Forau de la Tuta, every year when we finish the archaeological excavation, we have a great puzzle of new pieces that we have to process and study throughout the year to "virtually" join them with the pieces from previous years and continue with the investigation of the site. Although we still have many pieces to discover, it is very important that we correctly place and store the information to guarantee the study of the site for the next generations of researchers.

DOCUMENTATION AND DISSEMINATION OF ARCHAEOLOGICAL HERITAGE: A DUAL PROPOSAL IN THE 21st CENTURY

One of the objectives of the scientific team and of all the organizations involved in this research project is to bring the results obtained in each archaeological campaign closer to society. This is one of the most complicated parts of the process as the archaeological excavation is covered after each campaign to preserve its conservation. Georeferencing by global positioning satellite sensors (GNSS RTK), mentioned above, has allowed us to analyze the captured data and virtually join each zone and, in this way, start each campaign at the edge of the previous.

In order to promote the enhancement of each of the parts that have currently been covered after excavation, different systems have been used to display them both for the scientific community and for the rest of the interested public. This enhancement is based on the registration, treatment and analysis that have been previously exposed and that have resulted in the high-resolution viewer that you can access via the QR code on the panel.

In addition, using the other QR code you can see some of the Roman archaeological movable property found in the municipality of Artieda and housed in the Virtual Museum of Artieda.

Did you know… The combination of physical and virtual museum that we have constructed in Artieda is already used worldwide by other museums on the Sketchfab platform, such as The British Museum, Harvard Museum of the Ancient Near East and The Smithsonian Institution. The models were made with a structured light 3D scanner. This virtual resource is not intended to replace the physical visit, but it is an excellent complementary idea to promote tourism and education of the Cultural Heritage of Artieda.