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THARROS – CAPO SAN MARCO IN THE PHOENICIAN AND PUNIC AGE. GEOPHYSICAL INVESTIGATIONS AND VIRTUAL REBUILDING

The Phoenician and Punic colony of Tharros in the Gulf of Oristano, in the mid-west of Sardinia, is distinguished by an archaic phase dating back to the beginning of the 7th century BC; it is documented by the *tofet* findings, on the hill of Murru Mannu, and by the incineration and inhumation tombs located in the cemeterial areas in Capo San Marco, to the S, and in the village of San Giovanni di Sinis to the N. The period of maximum development and monumentalization was during the 6th century BC, when Tharros was probably the *Qarthadasht* of Sardinia, the administrative capital of Carthage (Fariselli in press). A few sacred public buildings in the city center and multiple hypogeal funerary structures date back to the Punic phase, which is, therefore, only partially known for the site.

The archaeological evidence in the urban area *intra muros* mainly refers to the Roman and early medieval periods. The city was definitively abandoned around the year 1000 AD due to likely geomorphological problems still to be fully defined, maybe land or mudslides towards the gulf. The Saracens' incursions could also be one of the reasons of the progressive depopulation in favor of the more protected hinterland (Del Vais 2015, 44). The systematic spoliation of the city's buildings, used as a quarry for a long time, make the reconstruction of the population and frequentation's phases very complex.

The Chair for Phoenician-Punic Archaeology at the University of Bologna, under my own direction, has resumed investigations on the field since 2012. Based on a long and multidisciplinary tradition, the research initially focused on the area of Capo San Marco for the diachronic reconstruction of the necropolis (Fariselli 2014) and its ties to the area with the so-called "Rustic Temple", located on the southwestern slope of the promontory, beside the connection between the residential area and the public edifices to which the cemeterial district is connected through the isthmus of Sa Codriola (Fariselli, Boschi, Silani 2014, 2016) (Fig. 1). In this point the Roman Imperial Age tombs are carved into strata probably belonging to a previous Punic workshop area (Secci in press), the presence of which is hypothesized after surveys and investigations and that will undergo an excavation for the next three years. The workshop area could be related to the production of ceramic and/or metallic artifacts maybe connected to operating the funerary district. Within the archaeological park, research is simultaneously looking at the architectonic study of Punic Age temples, also used during subsequent historical phases, and of the Punic and Roman residential district. The

Fig. 1 – Tharros, the gulf, the San Giovanni hill and the isthmus Sa Codriola. Author: A.C. Fariselli.

objective is to gain an overall vision of the city's main historical phases and of its relation to suburbia.

A.C.F.

The Phoenician and Punic necropolis of Capo San Marco has been the focus of integrated topographic and geophysical surveys, with the purpose of reconstructing the ancient funerary landscape. The systematic use of geomatic surveys and geophysical prospections is leading to the registration and detailed documentation of monuments uncovered by excavations and partially accessible, beside giving information on less known and not excavated areas. An integrated approach heading towards the comprehension of the cemeterial area as a whole, of its main characteristics and its distribution in connection to settlements and the natural landscape.

By means of this "total" analysis of the necropolis, which considers both its development "out of the ground" and beneath the soil, new activities established a GIS based informative system to manage different data sets, also useful for the main structural historical phases' reconstruction.

Furthermore, the project began monitoring the modern coastal landscape of the western cliff, where the funerary hypogeal cavities (chambers and pits) are subjected to continuous marine and eolic weathering, beside geological-structural kinematics.

The working strategy for the new survey activities included:

– Gathering and analysis of past topographic documentation;
– Designing and setting a solid basis of topographic benchmarks for new GPS surveys;
– Creating detailed topographic, photogrammetric and laser scanning mappings of whole necropolis' sectors;

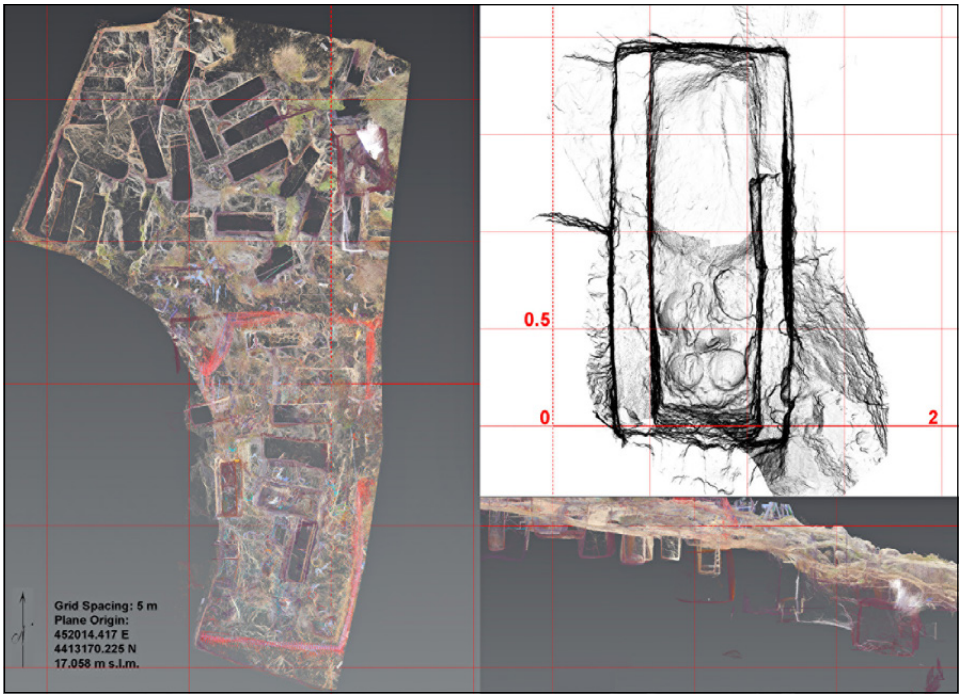

Fig. 2 – Southern necropolis of Capo San Marco: integration of laser scanning data acquired during several archaeological campaigns; synoptic views of the sector A explored between 2013 and 2014 (on the left, and on the lower right); detailed planimetric view of a chamber tomb with contained objects during the archaeological excavation (on the upper right). Data acquisition and processing: M. Silani.

– Integrated geophysical surveys (GPR and geomagnetic methods);
– Archaeological elaboration and interpretation of data;
– Creation of the first 3D renderings.

Within the working strategy adopted by the new surveys, a special place was given to the technology of laser scanner, systematically applied with both documentation and monitoring purposes, also during the excavation's activities.

Topographic mapping instruments and very high precision lasers, integrated with photogrammetric surveys, are ensuring a detailed record with different levels of analysis, regarding the context of the necropolis as a whole, relations with the coastal landscape, every funerary structure and therein eventually contained objects, also mapped in their original location *in situ* prior to being removed and catalogued.

Putting together every laser mapping carried out between the 2012 excavation campaigns and today, an overall model of the funerary context has been

achieved. A mosaic of certain data obtained with the survey of uncovered findings allows a global reading of the plano-altimetric geometry of this sector of the necropolis, as well as of all its informative and constructive elements (materials' characterization, layers, historical and evolutionary phases, etc.) (Fig. 2).

Such data facilitate the computing phase, with the possibility of generating thematic plants which particularly focus on historical phases or rather on typological, architectural and ornamental characteristics of the funerary cavities.

Indeed, the main goal of the ongoing 3D documentation is related to the achievement of a synoptic view for all the attested types of tombs, in order to foster the archaeological analysis, evaluating typologies in structural differences and eventual diversities in the funerary ceremonies and in the deposition practices. This is, in fact, a very partially known aspect of the ancient rituals at Tharros, also due to the episodes of violation that unfortunately the necropolis has been registered since the 19th century.

Apart from historical and archaeological study, the obtained model aims to be useful for the conservation and modern management of the archaeological area, giving a basis for the analysis of the archaeological monuments' structural aspect, their health and therefore intrinsic dangers (like possible subsidence or collapses), the state of cracks, etc., in order to facilitate projects of restoration and securing.

It will also be possible to redirect the model to generate internal, external and detailed views with a higher visual impact, aimed to help reconstruct and understand this important Phoenician-Punic funerary context, its divulgation, valorization and public accessibility.

M.S.

The reconstruction of the ancient funerary landscape is also supported by non-invasive surveying methods. New explorations, by means of geophysical techniques, have the purpose of verifying further extensions of the necropolis, beyond what has been attested from excavations so far, and its relation with other sectors of the settlement, defined by different functional destinations. This particularly concerned the whole isthmus Sa Codriola towards the hill of San Giovanni, with the aim to analyse the northern boundary of the cemetery and its relationship to the city, and the southern sector of the Capo San Marco, near the so-called "Rustic Temple", in order to assess the human presence in the farthest point of the Sinis peninsula.

Tharros is not an easy context for remote sensing techniques, for its physiographic features and for the archaeological target's complexity. The presence of a rough topography and extended areas of Mediterranean vegetation impedes, or at least complicates, using most geophysical techniques and prevents a consistent and complete mapping of the site even in the most accessible areas. Due to such reasons, it was necessary to employ specific solutions both in preparing

the areas to be surveyed and in data acquisition, always favouring a higher sampling rate and high resolution for measures.

Ground penetrating radar and geomagnetic surveys have been in progress since 2012, and notwithstanding imposed conditions, they are giving encouraging results and contributing to the characterization of the non-visible (Boschi, Silani 2014). Generally speaking, both systems have revealed a significant contrast in the physical properties between the sandy subsoil and the buried archaeological structures, thus favouring instrumental detection. The geomagnetic survey had also to face disadvantegeous geopedological and physical conditions for this method, like the sandy soil with low magnetic susceptibility, conspicuous surface asperities and a rocky, irregular and shallow bedrock.

In spite of this, geomagnetic mapping of the land strip between the northern part of the necropolis and the tower of San Giovanni reveals several interesting elements. The analysis of the results confirms what had already emerged during the first experiences in 2012 in the first place, the abundant presence of highly magnetic anomalies (Fig. 3). Such elements were found along the entire extension of the isthmus, and although most of them only seem to be localized phenomena, a few distinguish themselves with a more coherent organization. Such anomalies are defined by a width of ca. 1-2 m and magnetisation around 100-200 nT/m. Overlapping these data with the terrain's digital model also allows to appreciate their correspondence, in more than one case, with the isthmus' sectors defined by low creeks on its slopes, which were very likely to offer major protection from the wind, and the weathering in general, also during ancient times. These are, therefore, clues and indicators that seem to confirm the previously hypothesized presence of a workshop and productive sector in this very area of the Cape, and which could have been organized exactly in correspondence to the groupings of main detected magnetic dipoles, probably referable to productive facilities, maybe kilns and furnaces, and to areas of materials' processing and discarding.

Alongside these considerations, it is necessary to observe how no actual limit to the southern necropolis seems to emerge from the geophysical surveys, therefore neither a separation between necropolis and city, nor a physical demarcation from the adjacent likely workshop sector.

In confirmation to this, in several points of the surveyed area a few shapes and geometries interpretable as inhumations (mostly chamber tombs) are visible. Such piece of information seems to suggest a further extension of the necropolis towards the city, or rather a functional change in this sector of the isthmus, from cemeterial area to workshop, following a scheme already supposed in Tharros, in the tombs located on the Murru Mannu hill (Fariselli 2014, 24).

A few considerations regarding the extension of the Phoenician-Punic necropolis can be made also concerning the southwestern cliff's area, where the only perceived structure seem to be the so-called "Rustic Temple". It's

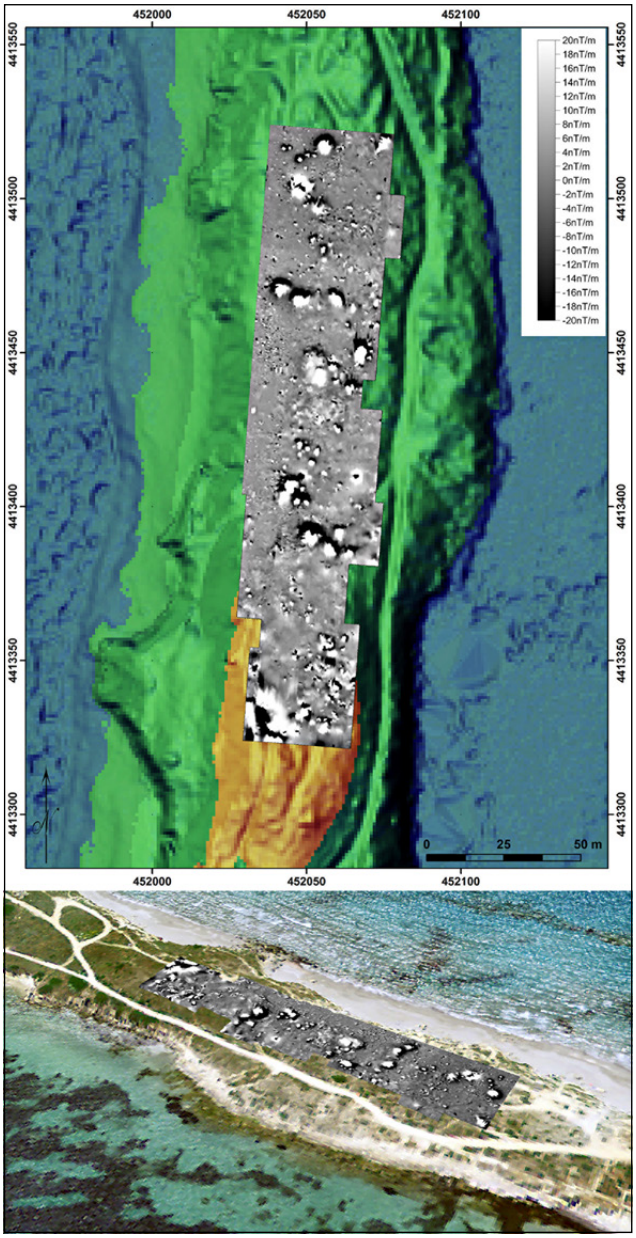

Fig. 3 – Geomagnetic survey of the isthmus Sa Codriola (top) and overlapping with the digital terrain model (bottom). Optically pumped potassium gradiometer, sensors distance 1.30 m. Data acquisition and processing: F. Boschi.

a building dated to the Republican Age and owes its name to the supposed cultic vocation of mobile materials found while uncovering its rough walls, and to the eccentric and isolated dislocation if compared to the city of Tharros (Fariselli 2014, 22-23).

Beside the singular master plan of the structure, rectangular with two rooms with a vestibule, set during the late Punic phase, determining the spatial and functional relationship with the vast necropolis to the N is hard. Alongside 3D mapping of the building by means of laser scanner, geophysical surveys are in progress also in this case, trying to clarify the situation of the pre-republican context and to identify eventual anthropic interventions close to the "temple" (Fariselli, Boschi, Silani 2016).

To this date, geophysical surveys concerned the sector N of the temple, because the widespread presence of Mediterranean vegetation impeded a homogeneous covering of the area around the monument. The Ground Penetrating Radar (GPR) technique revealed a not very good instrumental response within the narrow accessible spaces, nonetheless allowed the detection of some weak, localized radar reflections not easy to interpret. The correspondence of that evidence with the dipolar anomalies defined by high magnetization values detected by the geomagnetic mapping, would seems to confirm the potential archaeological nature of the anomalies' sources, although, judging from the high magnetization values, it is not to be entirely excluded that they're rather due to surfacing of the underneath basalt layer.

New investigations in the surroundings of the Rustic Temple of Capo San Marco are still in a preliminary phase, and therefore do not allow more defined considerations regarding the characterization of the ancient landscape in the area of the promontory. Future more in-depth study will certainly shed new light on the matter, even by means of direct verifications of the few indications given by non-invasive surveys.

We believe anyway that the new research can contribute to the understanding of the "Temple's" functional relation, or autonomy, with the necropolis. An aspect of the Phoenician-Punic topography of Capo San Marco which certainly has to be clarified. At the same time, it is important to better understand the structure in its master plan and functional aspects, and deeply investigate the characteristics of the likely and immediate connection with the nearby sea, by hypothesizing for example, that it could have also been a signaling structure with cultic aspects, just like what has already been documented in the Phoenician East (Fariselli, Boschi, Silani 2016).

F.B.

The third object of the new research is the Punic and Roman settlement (Marano 2014 and in press), where ongoing laser scanner and photogrammetric mapping activities have always the aim of reconstructing the ancient city

and landscape. Beside this general objective, the new surveys were motivated by the need to document the actual status of preservation of many buildings, considering the constant loss of structural information over the centuries caused by the pillaging of building equipment and the continuing erosion due to the wind exposure. The 3D survey was planned in parallel with the new analysis of the residential area started in recent years thanks to the study concession from at the time Soprintendenza Archeologica della Sardegna. The main aim was the clarification of the original houses planning and the domestic use of the spaces in each occupation phase of the site. This point represents another relevant aspect for the comprehension of the ancient urban landscape, considering the lack of specific archaeological research on this topic, which only consist in a first record of the archaeological evidence carried out by Gennaro Pesce after the discovery of the living area between 1956 and 1964 (Pesce 1966), and an attempt to create a typology of the Tharros' houses at the end of last century by Maura Falchi (Falchi 1991, 30-32).

The main problem encountered is an earth layer that does not make a part of walls and floors visible, limiting a complete reading of the ruins and the digital acquisition phase. For this reason, the 3D survey was started with some archaeological contexts where the earth layer did not preclude the archaeological comprehension and where the removal activities would be limited. In addition, the relevant elements for an architectural and typological study and the presence of particular structural and decorative features have been key-points in the choice of the contexts, as the buildings nos. 20 and 58 involved in a 3D relief by laser scanner for documenting the main *in situ* remains of wall-paintings (Fig. 4, a-b) (Marano, Silani in press).

With reference to the houses' typology, the 3D documentation has involved some contexts attributable to a new type not included in the previous recording: this new type is composed of four rooms, two of them placed along the more external part near the street, and two others only accessible from the spaces above-mentioned. Type that in Tharros is documented by two buildings, included in the western quarter (no. 34) and in the area close to the "Semitic Temple" (no. 56), and which seem suggest some relevant analogies with the so-called type no. 3 of the Selinunte's Punic houses (Helas 2009, 300-301).

The field data acquisition aimed at photogrammetric 3D relief of the well-preserved building no. 56, within the western quarter, was accomplished starting from a sequence of photos taken all around the ruins and using a high resolution reflex camera. In addition, some detailed images were taken from a distance under the meter, in order to document in greater detail some characteristic elements in the walls and a well-curb in a room. The relief has been connected to existing local network, previously created during the laser scanner relief activities in the urban centre (Marano, Silani in press) and in southern necropolis of Capo San Marco (Boschi, Silani 2014, 40-51).

Fig. 4 – Archaeological map of Tharros (Pesce 1966, Planimetria generale degli scavi anno 1965) with the contexts involved in 3D relief by laser scanner and photogrammetric method: a) Eastern wall of building no. 20 (photo by M. Marano); b) 3D model of building no. 58 (Marano, Silani in press); c) Point cloud (c1), mesh (c2), NW view of 3D model (c3), SW view of 3D model (c4), SE detail view of 3D model (c5) and reconstruction of the first phase (c6) of building no. 56. Data acquisition and processing: M. Marano.

In the processing phase, the first step has been a specific analysis of the acquired images filtering the 3D point cloud in order to delete the noise elements caused by earth layer and vegetation in the site. The point cloud (Fig. 4, c1) was obtained through the alignment by homologous points, coloured and decimated for modelling process in order to achieve the final 3D texturing restitution (Fig. 4, c3-5).

Also for the urban area, the achieved digital documentation represents a useful support to the archaeological study, which, in this case, aimed to clarify the ancient residential planning with regard to architectural features. Crossing this data with historic information about the previous excavations, some structural features have been identified, which allow to suppose the original presence of a flat roof for this type of house with a courtyard (Fig. 4, c6).

Besides this most common type, the new topographical survey allowed to document also different housing schemes, attested for instance by the building no. 10 where the courtyard was probably only partly covered by a roof, as suggested by the presence of two different paved floors, maybe related to different uses of the spaces.

Even though in a preliminary phase, the collected data show the simultaneous presence at Tharros of different type of houses and building solutions, revealing a wider and more varied record than previously known and hypothesized.

M.M.

Within the urban area, the total view of the main living phases of the site, pursued by the new research, will soon have a new focus on the public monuments area, where a new project that includes also the detailed survey and virtual reconstruction of the main public building is in a start-up phase.

We feel confident that the new season of research recently inaugurated in Tharros can favour not only scientific research, but also the enhancement and public accessibility of this extraordinary heritage, which is not merely historical and cultural, but even natural and scenic. An interweaving of objectives which is pursued by aiming to a complete documentation, technologically advanced, and most of all, conservative of the whole site and in particular of those sectors frequently object to destructive actions, for which the acquired data might represent one day an authentic historical memory of something not recoverable anymore.

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ABSTRACT

The project described in this paper was started in 2012 and concerns the study of the relationship between the urban and suburban districts of the Phoenician and Punic city of Tharros (Cabras, Oristano). The structures of Phoenician and Punic Tharros have been largely cancelled by the Roman occupation. For this reason it is very difficult to determine the original function of many of the neighbourhoods during the Carthaginian period. The archaeological excavation primarily involved the southern necropolis of Capo San Marco. The cemetery must still be fully explored and understood under several aspects, mainly because of the devastation of the site caused by the repeated plundering of the ancient tombs which occurred during the 19th century. In addition to the new dig activities, a 3D topographical survey aimed at the complete documentation of the site and at the virtual rebuilding of the Phoenician and Punic funerary landscape was completed. Another goal of the project is the insertion of this sector of the promontory into the usual tourist route, in order to foster the public fruition of Capo San Marco, while continuing to adopt proper scientific methods and modern techniques. In this direction, geophysical prospecting surveys were carried out in the southern sector of the Capo San Marco, near the so-called "Rustic Temple", in order to assess human presence in the farthest point of the Sinis peninsula (characterised by the presence of the Late Punic ruins of a probable light-house with sacred functions), and across the whole isthmus Sa Codriola towards the hill of San Giovanni, with the aim of analysing the northern boundary of the cemetery and its relationship to the city. The Punic-Roman settlement is now enclosed in the archaeological park, which is a fraction of what was supposed to be the administrative capital of Carthage in Sardinia. 3D modelling and virtual reconstructions were focused also on the residential Punic and Roman area inside the park. The integrated application of the most advanced topographical and geophysical techniques to the site greatly contributed to the recording and understanding of the ancient landscape.