1.14.19. DIAGNOSTIC STUDY AT THE ACROPOLIS OF SARANTAPICHO AND THE ACROPOLIS OF ERIMOKASTRO, RHODES

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This work presents the use of non-destructive techniques as testing tools for the diagnostic study of structural materials which is essential for a successful design of conservation interventions on monuments.

The non-destructive techniques used as part of this work include Ultrasonics (US), Ground Penetrating Radar (GPR), Infra-Red Thermography (IRT) and Fibre Optics Microscopy (FOM), which were utilized on the diagnostic study of the structural materials of the walls at the Ialyssos Acropolis (Sarantapichos) and the Acropolis of Erimokastro, Rhodes.

These were supported by an array of instrumental characterization techniques which included polarized optical microscopy (OM), X-ray Diffraction (XRD), Scanning Electron Microscopy combined with Energy Dispersive X-ray (SEM-EDX), Mercury Porosimetry (POR), conductivity measurements and mechanical testing.

The Acropolis of Ialyssos (Sarantapicho) consists of Cyclopean Walls of the Mycenaean period and is located at the northeastern part of the island of Rhodes. It's name stems from a legend that the Acropolis was guarded by a giant 40 "πήχες" high, whereas his alleged tomb is the almost equally long water supply tunnel nearby. The Acropolis of Erimokastro (Deserted Castle) is a confirmed archaeological site, located at the northeastern part of the island of Rhodes at a natural hill between Kallithea and Afantou bays. Its wall is multifaceted and cyclopean, 2 – 4 m high and 1.7 – 2 m wide built from rubble stones.

The compact limestone from which the walls of both Acropoles are built reveal significant biological decay, alveolar disease, cracks and loss of authentic material. The in-situ application of the above mentioned non-destructive characterization methods in conjunction with instrumental characterization techniques can lead to the mapping of the structural materials, the assessment of the environmental impact on them, the diagnosis of their decay, that support an integrated design of the proposed conservation interventions. This information can be utilized by geographical information systems that can present the current decay status of the monuments and correlate it with architectural data. The instrumental techniques are used to assess the mineralogical and chemical composition, the microstructure and the mechanical properties of the materials examined and aid in the understanding of the prevailing decay phenomena.

More specifically, the results from optical microscopy, XRD and mercury porosimetry reveal that at Erimokastro, the abundant grey limestone is of high purity and low porosity (~1%), and in particular high percentage of small pores. The occasional dark-brown inclusions (possibly of siliceous composition) have an even smaller porosity (0.3 – 0.5%) whereas the off-white fossiliferous limestone with aluminosilicate inclusions presents much higher porosity ~6 – 6.5% mostly of large pores which is detrimental for the absorption of soluble salts. Regarding the structural materials present at Sarantapicho, these are grey dolomite and grey compact limestone with aluminosiliceous inclusions both with low porosity values (~1%). The pore size distribution is shifted towards the smaller pores.

The microscopic observation with scanning electron microscopy reveal the biological decay, in particular an extensive development of fungi due to which the exterior surface of the stones is colored dark black-grey. In addition, conglomerates of dust are observed that consist of pollen earth.

The average value of the mechanical strength of the samples is ~112 MPa, which is within the range of 88 – 147 MPa that is indicated in the international literature for this type of stones, and is representative for their characterization. The measurement of the ultrasonic velocities of the limestones at the Ialyssos Acropolis reveal that their value are similar (from 1992 m/s to 2222 m/s) indicating their homogeneity, low porosity and common provenance. The respective values for the stones at Erimokastro show a higher variance (ranging from 1099m/s to 3704m/s), with the off-white fossiliferous limestones corresponding to the lower values, indicating the presence of various lithotypes.

The systematic scanning with ground penetrating radar over the water supply tunnel at Ialyssos Acropolis, revealed that the tunnel is open up to approximately 3meters from its entrance, whereas the remaining portion of it, has either collapsed or filled with earth. GPR was also employed to detect internal cracks, discontinuities and surface defects at selected stones at both sites internal crack that extends to the stone's surface is revealed at a stone at the entrance of the Ialyssos Acropolis. Similar results were obtained from Erimokastro samples.

The application of infra-red thermography at the Ialyssos Acropolis stones revealed higher temperatures at the areas where biological decay is active and thermal anisotropies of the stone augment the mechanical strains, leading to fracture and crack propagation. It should be noted, that the off-white fossiliferous limestone have increased temperatures as observed by IRT compared to the grey limestone. At Erimokastro, the dark-brown inclusions appear at the IR-thermographs with higher temperatures due to their higher thermal conductivity and surface roughness.

In-situ microstructure observations with FOM revealed the presence of extensive biological decay with shell-like stone lichens, white grey colored and carpic structure leading to color alterations of the stone and the development of surfacial microcracks and microcavities.

Concluding, the use of non-destructive techniques in conjunction with instrumental characterization methods, allowed the assessment of the decay status and the mapping of the decay phenomena on the structural stones of the walls of the Acropolis at Ialyssos, and the Acropolis at Erimokastro.