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Ancient Sanctuary at Kalapodi, Fthiotis, Central Greece. Presentation of Restoration Works and the Implementation of Triquetra Programme

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1 The site

Fig. 1. Kalapodi. Fthiotis Greece (2023). The ruins of the site after presentation works. Photo: M. Papanikolau, DAI Athen.

In central Greece, in today's Fthiotis, where in antiquity Phokis bordered eastern Lokris and Boeotia, there is a sanctuary that is one of the most important of ancient Phokis [1]. The sanctuary was in the same region of the famous pan-Hellenic oracle of Apollo of Delphi. According to the excavators the sanctuary too was possibly an oracle of Apollo,

the famous one of Abae. Systematic excavations were carried out again in the sanctuary only in the second half of the 20th century, under the direction of the German Archaeological Institute; they continue to this day [2] (see The pilot sites are: Kalapodi, Greece, Ventotene, Italy, Aegina Island, Greece, Choirokoitia, Cyprus, Epidaurus, Greece, Roseninsel, Germany, Argilliez, Switzerland, Smuszewo, Poland.

According to the project in Kalapodi, data collection, data evaluation, documentation, implementation, monitoring and publicity activities will take place.
In more detail, the following activities will take place:
1. Analysis of materials (sample collection, petrographic and petrographic analyses from the Kalapodi monuments) / in order to create a comprehensive database / archive of analyses
2. Collection of data such as meteorological data - Collection of satellite images of the wider area -Collection of data on the seismicity of the area - Assessment through modelling of climate change impacts - Risk assessment. Testing of geophysical techniques consisting in passive seismic measurements to output effect related to stratigraphy as well as geo-structural setting on local seismic response
3. Application through the digital twin technology project in the archaeological site with detailed documentation of the existing state of the monuments. Creation of a GIS of the archaeological site
4. Construction of infrastructure for the implementation of the programme on the archaeological site
4.1 Preliminary earthworks
4.2 Installation of underground power line to the project site
4.3 Construction of a base/plate of lightly reinforced compatible mortar for the project implementation within the archaeological site at a location at a distance from the monuments
5. Construction of an exact replica of the steps and stylobate of the Northern Tempel (exact copy with the application of CNC - Computerized Numerical Control). The replica will be made with similar material to the original
6. Placing on the implementation base of different types of stones that have been used in the monuments of the site and which have no archaeological traces
7. Application of nanotechnology with a coating product to protect the materials (stones) from water on stones that do not bear archaeological traces
8. Application of active protection of materials against frost. Installation on the stones of the pilot project of a net of heated electrodes which will be activated when the temperature in the archaeological site approaches 3° C. The temperature of the materials will be recorded and the behavior of the system during snowfalls will be recorded by camera on a 24-hour basis. The technique has been applied experimentally on stones with the same quality of the stones of site in the settlement of Kalapodi in 2019, with data recording.
9. A permanent exhibition of information material about the archaeological site is to be set up in the old school in the modern village of Kalapodi. There, the contribution of the Triquetra project to the issue of protecting the monuments from the effects of climate change could be mentioned through posters. It is proposed that information material on the programme can be placed in the context of the project.). The results of

the excavations were impressive, especially on the issue of the continuity of worship from prehistoric times to the Roman era. The architectural remains were also significant for the evolution of ancient Greek architecture. Temples of different periods, with various types of structure and materials, testify to the gradual development of ancient Greek temple architecture over time, from the humble brick structures of prehistory to the intention of monumentality of the Geometric period, later to the transitional character of the Archaic period and finally to the systematic mode of expression based on the rules of the Classical period. The ruins of these cult buildings are arranged in two parallel monumental units: north and south. The ruins had for years been protected either under embankments (northern monumental unit) or under a low and temporary roof (southern monumental unit). Many excavated sections were backfilled. Even the ruins that were under the protective canopy were virtually inaccessible, partly because they were under geotextiles, and partly because the canopy itself was particularly low and dangerous to the personnel and the scientists (see Fig. 2).

Fig. 2. Kalapodi. Fthiotis Greece (2017). The ruins of the site before presentation works. Orhophoto: DAI Athen.

2 Presentation Works

In 2017 German Archaeological Institute had started working on a plan for the cultural heritage management and the presentation of the southern temple complex. From the autumn of 2018, the maintenance and presentation works are almost completed. In 2023 the temporary presentation of the northern temple was also completed. The shape of the soil was restored, and the ruin of the archaic temple now emerges naturally from the soil, just as it was the case in Greek archaic architecture [2].

Going beyond the narrow limits of the archaeological site, the architectural study proposed the idea of linking the monument with its wider environment in an interdependent relationship, so that they form an indivisible unity. In this way the monument marks equally its rare scientific content and its aesthetic value as a ruin which is projected in the sunlight against the background of the natural environment. The older and deeper layers which consisted of delicate materials (raw bricks, stonework made of small-sized crude stones) were decided to be backfilled. In addition, the maintenance of large pits in the ground for the sake of viewing, even within a canopy, would in the long term cause issues of continuous maintenance of the soft limestones of the archaic temple, as the study of these stones showed, since rising damp would constantly undermine the cohesiveness of these materials. The loss of the view of the geometric adyton due to the backfilling of this particular level was compensated by the restoration of the classical adyton directly above the geometric one in its original position, which, in any case, was a condition imposed by the Ministry of Culture for the approval of the dismantling, for the sake of excavations which took place in 2009 (see Fig. 3). It should be pointed out that the architectural significance of the classical adyton constructed purely by reusing architectural parts of an archaic building is superior to that of the simple brick geometric sanctuary. According to the study, four phases remain visible and intertwine with each other, shedding considerable light on the historical evolution of the sanctuary from Geometric times to the Roman era. Indeed, with the work of marking the Geometric temple proposed with replicas of raw bricks, for the first time the scale of this great temple is so well understood. The pediment was proposed, after its systematic research, to be exhibited as an exhibit of major importance at the place where it was found. The stones of the pediment on the ground at the place where they fell are a valuable historical document of the burning of the archaic temple by the Persians, as ancient resources testifies. The passage from the initial idea, to the preparation of the specific studies, to their approval by the competent authorities and finally to their implementation was not a simple process. It required the timely management of the funds credited by the German Archaeological Institute and the Pestalozzi Foundation, and the cooperation with the Ministry of Culture of Greece, especially with the local Ephorate, and the director E. Karantzali. The restoration project was a request of the local community for years [3], and its implementation is the result of the vision of the director of the German Archaeological Institute, K. Sporn [4].

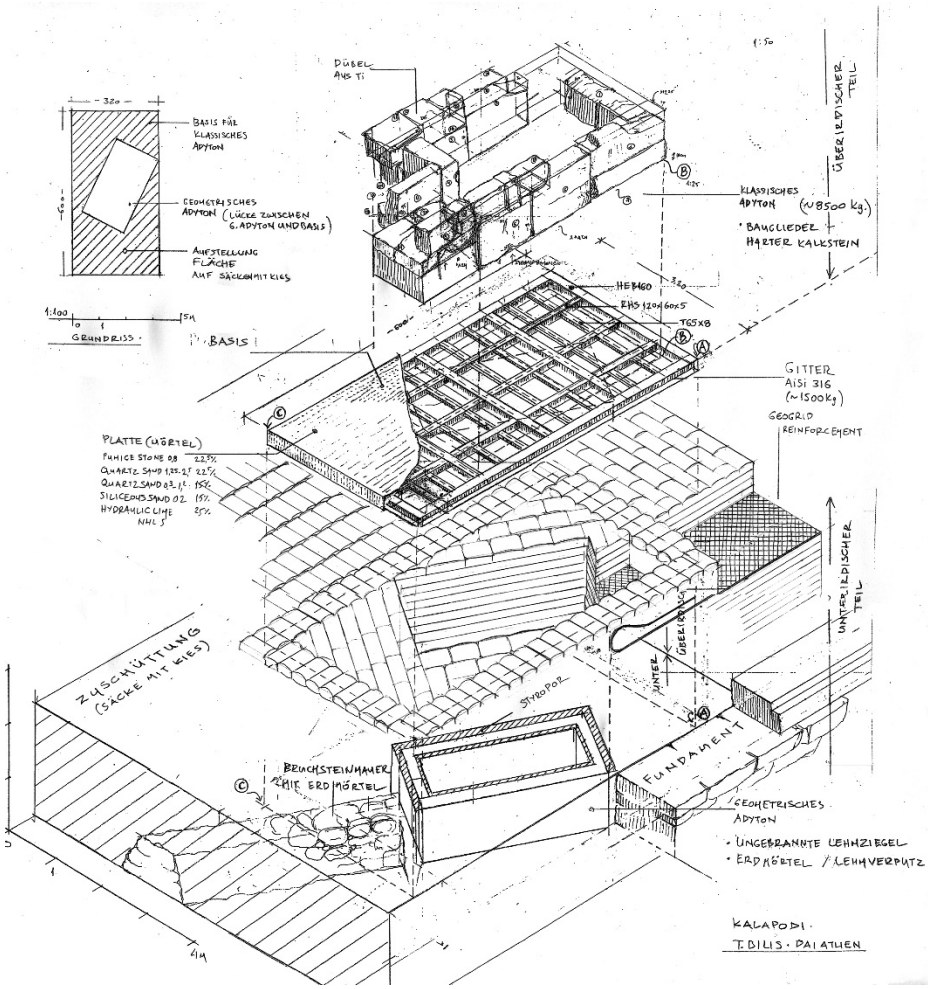

Fig. 3. Kalapodi. Fthiotis Greece. Structural analysis of the proposal of the restoration of the classical adyton directly above the geometric one, in its original position. The restoration of the classical adyton was a condition imposed by the Ministry of Culture of Greece for the approval of the dismantling, for the sake of excavations which took place in 2009. Sketch: Th, Bilis, DAI Athen.

3 Triquetra Programme

Fig. 4. Kalapodi. Fthiotis Greece (2021). The ruins of the site are protected during winter by seasonal covering with geotextile and insulation panels. Photo: Ch. Vaporakis, DAI Athen.

Phenomena of frost pose a constant danger to the site's materials which, in combination with the vulnerable structural materials, causes decay problems. Currently this is solved by seasonal covering with geotextile and insulation panels. Due to climate change, in the future all these problems will become intense. The site participates as case study for TRIQUETRA program that started on 01/01/2023 and will last for 3 years. As part of the program TRIQUETRA an integrated methodological model to protect archaeological remains at Kalapodi from frost is proposed.

According to the official website of the programme: «...The TRIQUETRA project aims at creating an evidence-based assessment platform that allows precise risk stratification, and also creates a database of available mitigation measures and strategies, acting as a Decision Support Tool towards efficient risk mitigation and site remediation. The overall approach of Triquetra is based on three distinct steps: 1. Risk Identification 2. Risk Quantification 3. Risk Mitigation. This "trifecta" approach (hence the name Triquetra) creates a framework of risk assessment and risk mitigation so as to tackle as many of these risks as possible, in the most efficient way available. A total of 21 organizations from 7 countries participate in the project, including 8 Universities and Research Organizations and 6 Cultural Heritage Authorities. The project started on

01/01/2023 and will last for 3 years. TRIQUETRA project is funded from the EU HE research and innovation programme under GA No. 101094818...» The TRIQUETRA project (EU HE research and innovation programme under GA No. 101094818)...»[5]. The sites participating in Triquetra reflect a wide variety covering almost all cases from natural environments such as Continental - rural areas , submarine sites, coastal areas. The pilot sites are: Kalapodi, Greece, Ventotene, Italy, Aegina Island, Greece, Choirokoitia, Cyprus, Epidaurus, Greece, Roseninsel, Germany, Argilliez, Switzerland, Smuszewo, Poland.

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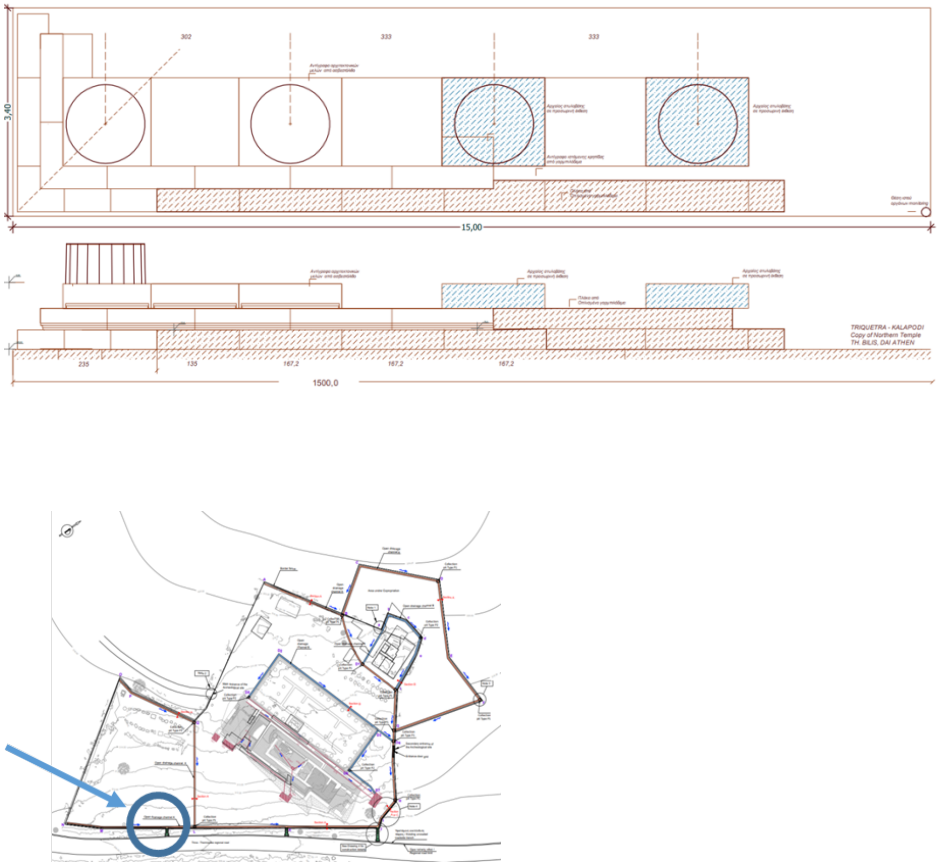

Fig. 5. Kalapodi. Fthiotis Greece. Implementation of Triquetra programme at the site of Kalapodi. Drawing of the construction of an exact replica of the steps and stylobate of the Northern Tempel (Above). Position of the structure at the plan of the site (Below). The replica will be made with similar material to the original for the application of nanotechnology with a coating product to protect the materials (stones) from water on stones. Drawings: Th, Bilis, DAI Athen.

Fig. 6. Kalapodi. Fthiotis Greece. Photo: K. Sporn, DAI Athen.

4 Conservation works and analyses of building materials

Along with the restoration and presentation of the southern temple complex of Kalapodi, systematic conservation works were carried out on the building materials of the monuments. This was prior to the approval of a conservation study, by the Greek Ministry of Culture [6]. The study included physico-chemical analyses of the structural materials of the temples and proposals for new compatible restoration mortars. A total of 15 samples were studied which included, limestones from the classical and archaic temples, mudbricks and building mortars, while the new mortars designed (10 in total) had hydraulic lime as binder and aggregates in appropriate grades. In addition, accelerated ageing experiments on frost and soluble salts were carried out on the limestone samples. From the results of the analyses, important conclusions were drawn for the building materials, such as the low frost resistance of the limestone used in the archaic temple.
The systematic conservation works were aimed at the structural strengthening of the various materials, and included cleaning of members, welding, sealing, grouting, consolidation and aesthetic restoration works. They were carried out in different phases from 2018 to 2021 by both conservation firms as contractors and DAI's specialized staff (see Fig. 7, 8).
From observations of the conservation interventions and maintenance work so far, we can conclude that the materials used withstand the harsh conditions successfully. The annual covering of the temple from October to mid-April with ground cover fabric and

insulation materials has contributed to this, as well as the frequent monitoring of the site by DAI staff who acts with small-scale conservation works where necessary.

Fig. 7. Kalapodi. Fthiotis Greece. During conservation works. Photo: T. Bilis, DAI Athen.

Fig. 8. Kalapodi. Fthiotis Greece. During conservation works (left), before and after conservation of a limestone from the archaic temple (right). Photo: E. Stamou (left) A. Sotiropoulos (right), DAI Athen.

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