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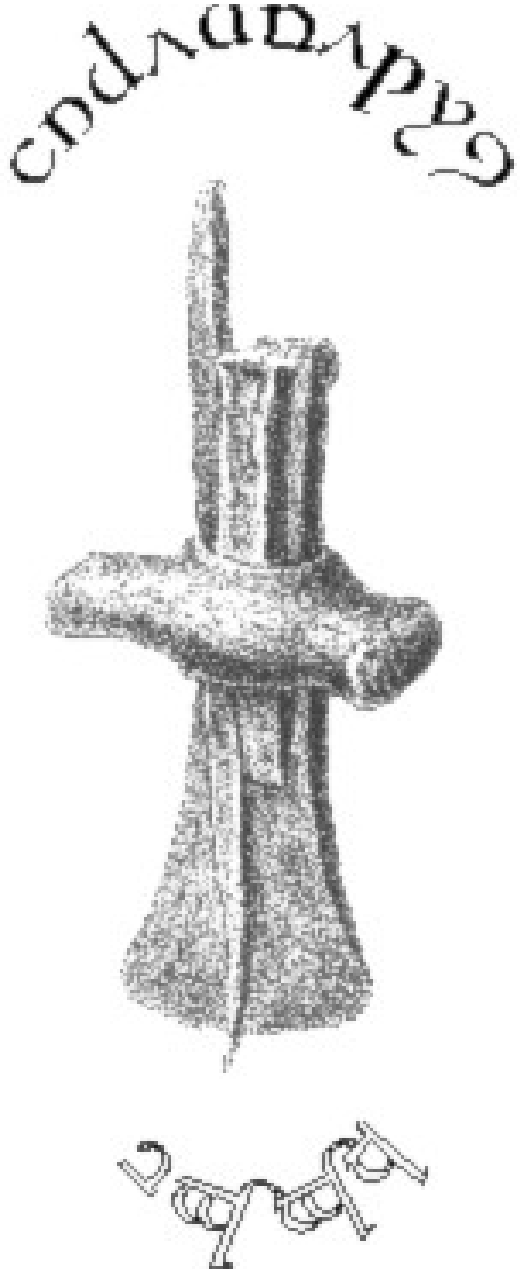

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" A DETAILED STUDY OF THE ARCHAEOLOGICAL SITE OF KITROS (N. GREECE) BY COMBINED MAGNETIC AND SPECTROMETRY METHODS"

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Abstract

In the present study the archaeological site of "Louloudies – Kitros" (N. Greece) is investigated by the use of magnetic and spectrometry geophysical methods. For this reason soil samples were collected from several trenches within the archaeological site, as well as radial traverses around kilns, which were used for glass production. Moreover, samples were collected from a long traverse, starting from the middle of the archaeological site and extending outside of the site, in order to identify the limits of the archaeological settlement.

The performed measurements were successful in identifying the different occupation levels and the boundaries of the archaeological site. High values of magnetic susceptibility and iron oxide content were well correlated with the periods of intense human activity. Around the kilns, the mean values of the magnetic susceptibility indicated the effect of the fire mechanism in the surrounding area and also gave some first evidence concerning the use of the kilns. Comparison of the magnetic and chemical properties of the anthropogenic soils suggests that their enhancement may be used as an index for locating areas and features of archaeological interest.

Keywords: *magnetic susceptibility, spectrometry methods.*

Introduction

The archaeological site "Louloudia - Kitros" was established in 479 AD when the Bishop of Pydna moved there after the Goths' occupation of his former seat. The complex (80x90 meters) consisted of a Basilica, the Bishop's residence and installations for the production of wine and olive oil. The settlement was destroyed by an earthquake around the middle 6th century AD, which forced the Bishop to move in another area. The rest of the complex kept its productive character by the creation of new storages. Some years later a second earthquake destroyed the complex and the residents abandoned it. Later on it was used as the locus of workshop activity and especially the production of vessels, glass items and iron instruments. Finally the complex was abandoned without any other destruction. The reasons for this abandon were possible due to the incursions, as the general picture of findings suggests that workers left unfinished their jobs (Marki 1997).

The purpose of this study is to distinguish the different occupation levels by using magnetic susceptibility measurements and spectrometry methods.

Method

The magnetic susceptibility was measured for all samples in two frequencies (0,47 and 4,7 kHz) using the Bartington MS2 Meter. The frequency dependent susceptibility X_{FD} and the mean value of the susceptibility were calculated. Also LeBorgne Contrast (LBC) and its normalization (NLBC) were calculated in order to emphasize the ancient layer and to confirm the stratigraphy of the area.

In addition spectrometry analysis (ESR) was also carried out in selected samples in order to estimate the amounts of iron oxides and others magnetic contains. Moreover, Mossbauer spectrometry analysis was applied for several samples in order to define the percentage content in iron oxides.

Finally IRM measurements have been performed in order to refine the distinction of the samples from different areas of activity.

Data Collection

From the archaeological complex 110 soil samples were collected. 68 soil samples were taken from cross-sections (S1-S6) into the archaeological trenches and the rest were taken from the surface. The depth of the studied trenches range from 0.8 to 2 meters. Samples also were taken around the kilns (F1-F3). Finally, samples were collected from a long traverse (T1), starting from the middle of the archaeological site and extending outside of the site, in order to identify the limits of the archaeological settlement. The archaeological site as well as the distribution of the collection sites is shown in figure 1.

Results

Archaeological trenches

The diagrams of the magnetic susceptibility values for the samples taken from the archaeological trenches are shown in figure 2. As it is observed in these diagrams some layers exhibit enhanced magnetic susceptibility levels. These layers correspond to the brown clay and are in a good agreement with the intervals where the complex has been inhabited. Hence, it is possible to distinguish the levels of intense human activity from those where the complex was abandoned on the basis of these measurements.

Surface Traverse

The results from the measurements of the magnetic susceptibility inside and outside of the archaeological site are shown in fig. 3. A gradual reduction of the values as we move away from the complex is obvious. Nevertheless at a certain point outside the complex, there is an increase of the magnetic susceptibility values, which reach the mean values of the archaeological site. After a better observation we noticed that at that area the archaeologists elaborate the potsherds which they extract from the site. Hence, that place is somehow "polluted" from the soil of the archaeological complex.

Kilns

Several samples were taken around the kilns, in order to define the variation of the magnetic susceptibility from the center towards the outer part of the kiln. For the kilns F1 and F2, (fig. 4) the values of the magnetic susceptibility have a significant reduction as we move away from the center of the kiln. After 1,5-2m the values increase again, reaching the mean values, which are estimated for the complex. Therefore, it is clear that the influence of the fire is significant only up to distances 1,5-2m away from the center of the kiln. In the third studied kiln (F3) the values of the magnetic susceptibility are reduced towards the center of the kiln (fig. 5). This result conflicts to the mechanism of magnetic 'enhancement' and the results from the other two kilns. For this reason we make two assumptions. According to the first one this behavior is due to a contaminated sample, which we collected and which influenced the result. According to the second hypothesis this kiln has not been in use of a long time and so the necessary contents of the iron oxide have not been created and they did not give increased magnetic susceptibility values.

Spectrometry analysis

In an effort to investigate to chemical composition of the samples, we performed ESR measurements in the Nuclear Research Center "Demokritos". 10 samples were studied which came from the archaeological trenches (S1-S4), from a kiln (F3) and from the surface traverse (T1).

ESR analysis for these samples (fig. 6) indicates that for the samples with low magnetic susceptibility values the spectrum referred to iron oxides is much weaker that the spectra referred to Mn^{2+} and Fe^{3+}. Hence, we can consider that the main contribution to the magnetization is due to iron oxides. Also it is shown from these spectra that in the samples, which have remains of fire (S4-F3) the content of Mn^{2+}, is greater than in the other samples, in which no remains of fire appear to be present.

In order to make a qualitative analysis to the samples, Mossbauer measurements were applied to some pilot samples. From the shape and the

symmetry of the Mossabauer spectrum the percentage contribution of the iron oxides contained in the samples was found and is shown in Table 1.

Sample	α-Fe_2O_3
T1-8 (surface traverse)	*24%*
S1-12 (Cross-section /gray horizon)	*9%*
F3-1 (Center of the kiln)	*7%*

The sample F3-1 that was collected from the center of the kiln has the smallest content of iron oxides. This fact confirm the second assumption we made for the kiln (F3), namely that this kiln was not in use for a long time.

Conclusions

The results obtained in the study of the archaeological site "Louloudies Kitros" can be summarized as follows:

By using the magnetic susceptibility method the occupation levels of the archaeological site were determined and separated. These measurements show that the main occupation level belongs to the brown clays just below the gray horizon, which is visible in all studied cross-sections.

The study of the magnetic susceptibility of the soils, along the section (T1), indicated that it is possible to identify the limits of the archeological site from its neighboring area.

Both the magnetic susceptibility and spectrometry measurements, demonstrated that the main contribution to the magnetization of the soil is mainly due to the iron oxides and secondly to Fe^{+3} Mn^{+2} ions.

Finally, ESR measurements gave us some first evidence on the correlation between the presence of the Mn^{+2} and the areas with remains of fire.

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