SEM–EDS and chemical–archaeological soil analysis: a synergistic interpretation of data

Poster · May 2016

DOI: 10.13140/RG.2.1.4393.8163

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41st International Symposium on Archaeometry (ISA)
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SEM-EDS and chemical-archaeological soil analysis: a synergistic interpretation of data

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Scanning Electron Microscopy - Energy Dispersive Spectrometry (SEM-EDS) is one of the most versatile analytical techniques in archaeology, applicable to the study of a wide range of artifacts and archaeological materials. SEM imaging and analysis is experiencing a renaissance in all field of archaeological studies: many researchers use these techniques to analyze rocks, minerals and sub-millimeter-sized fragmented samples with only minimal damage. Layers of mineral-based pigments and plasters can also be studied with an electron beam that can be focused to microscopic sizes as also a wide variety of biological materials e.g., pollen (Pilcher, 1968). SEM-EDS remains a popular application, especially to reconstruct the vegetation history and/or the paleo-climate of a region.
Traditional soil analyses are very important in the archeological context and help to the characterization of soil profile features.
Results of chemical tests sometimes are unexpected and may yield new information on the soil properties, including those related to the natural processes of soil formation as well as those occurred throughout the history of humanity. Many researchers have recognized the need of a plain interaction between different disciplines "If you collect the soil samples during an excavation and pose the right questions from the beginning, you can avoid the arising of uncorrected interpretation of the whole context".
In this optic a multidisciplinary approach was accomplished to perform a correct analysis of soil samples and finds collected from different archeological sites.


Analysis of soil particle size

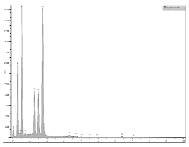

Calcimeter


Stereomicroscopy


pHmeter


Scanning Electron Microscopy


sieve


EDS Spectrum


X-ray diffractometer

IMAGE SOIL ANALYSES

❖**PETROGRAPHIC ANALYSIS: Thin sections of finds pre-consolidated by resin impregnation under vacuum were examined with a microscope "ZEISS Axioskop 40 POL" by using polarizing transmitted light (Fig.1a).**
❖**SEM/EDX: Soil and thin sections were observed by using LEO 50XVP Scanning Electronic Microscope (SEM), equipped with a PentaFET detector having a Si (Li) operated at 25 KV for microanalysis in Energy Dispersive X-ray analytical system (EDX) (Fig.1b).**

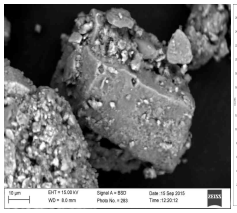
CHEMICAL SOIL ANALYSES

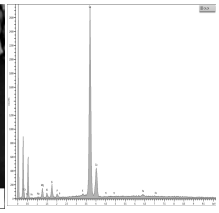
- pH
- Conductivity
- Total Limestone
- Organic Carbon
- Phosphorus
- Soil particles' size

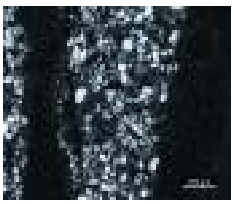
STUDY CASES

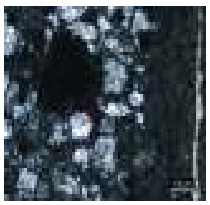
AIM : Study and comparison of archaeological and outside soil; evaluation of the find composition collected in this soil to understand past local human activities

N.	Analyses	Unità di misura	Risultati analisi	
1	colour	YR	10YR 4/2 4/3	
2	weight	g	660	
3	pH	%	7,21	
4	total Limestone		71,86	
5	organic matter	g·kg⁻¹	64,55	
6	soil particle size	%	SG7	49,3
			A7	4,1
			LF7	0,6
			LG7	19,3
			SF7	26,8









In the order: the fortified settlement of Satrianum, soil chemical analysis, SEM image and related microdata of soil sample, Stereomicroscoy images of find collected on the soil sample analyzed

RESULTS. The soil is classified as sandy-loamy and SEM analysis confirms analytical result. The find characterized by a glassy surface was initially considered as a part of an oven, but actually it shows only a partial melting of quartz-arenite in a site characterized by the presence of Fe-oxi-hydroxides, which are able to reduce the eutectic temperature of the material, confirming its exposition to very high temperature. XRPD analysis showed as well the disorderly presence of alpha-cristobalite, which is formed at a temperature higher than 1000 °C as substitute of quartz. Due to the absence of microstructures of reaction into the mortar surface or on its contact plane with quartz-arenite, it can be assumed that the glassy surface was formed as melted material leached accidentally during the glass production.

AIM: Quality evaluation of two different layers of plaster in Bagnoli Termae Tepidarium

Bagnoli Termae : General view and particular aspect of the plaster, petrographic details

RESULTS. Two layered plasters were found: two overlapped mortar bodies characterized by different composition and texture . The outer layer (A) shows an arenaceous weaving with a particle size predominantly between 0.5 and 1 mm, while the inner layer is constituted by particles having a maximum dimensions of 2.3 mm. A stratigraphic contact between the two layers is well recognizable, but not well defined, suggesting a short time of contact application.

Acknowledgements: Soprintendenza Beni Culturali ed Ambientali of Messina for Bagnoli Termae samples

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