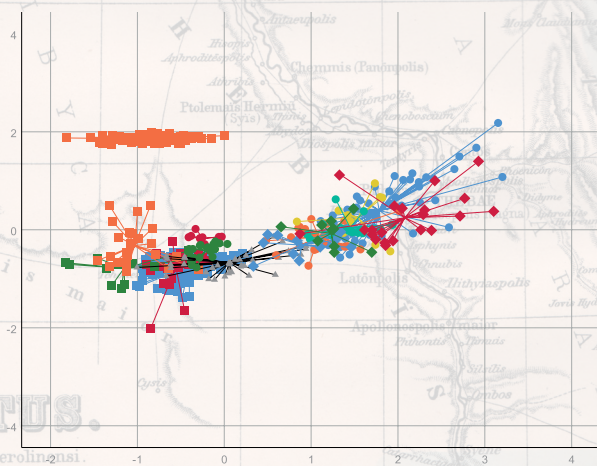


Portable XRF for Heritage and Archaeology in Egypt

Conference organised by

Nadia Cantin, Mai Abdelgawad and Thomas Faucher

CEAalex, CNRS/Ifao, UAR3134



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October 8th, 2025
Bibliotheca Alexandrina
Alexandria, Egypt


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CENTRE D'ÉTUDES ALEXANDRINES
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Programme

October 8th, 2025, Bibliotheca Alexandrina, Alexandria, Egypt

- 9:00 Welcome and opening of the day by the Director of the Manuscript Center and Museum of the Bibliotheca Alexandrina
Dr. Medhat Issa
- 9:10 Welcome by the Director of CEAlex
Thomas Faucher
- 9:15 The pXRF Ceramic Users Network: network, results and next steps
Nadia Cantin
- 9:35 Comparing pXRF to WDXRF data for Ceramic Provenance Studies: Analysing Chian Amphorae from the Whitbread Collection
Mai Abdelgawad, Noémi Müller
- 10:00 Causes of inter-instrumental error
Lee Drake et al.

10:30 Coffee break

- 11:00 Tracing Alloys and Inlays: Non-Destructive pXRF Investigation of Bronze Osiris Statues from the 1st Millennium BC
Eid Mertah
- 11:30 Chemical characterisation of Roman and Medieval metal objects from Kom el-Dikka, Alexandria
Michał Krueger, Grzegorz Majcherek, Agnieszka Szulc-Kajak

12:00 On-site metallurgical studies at Ayn Soukhna: the role of portable XRF analysis
Frederik W. Rademakers, Georges Verly

12:30 P-XRF on Egyptian Coins: From corpus analysis to a methodological critique
Thomas Faucher, Bruno Sozza

13:00 Visiting Bibliotheca Alexandrina Restoration Laboratory

13:30 lunch break

14:30 Tales of pigments: XRF Analyses of Colour Remains on Aswan Rock Inscriptions
Elisabeth Wegner

15:00 Mapping the dead: the role of portable scanning X-ray fluorescence spectroscopy for the analysis of ancient Egyptian funerary portraits
Giovanni Verri

15:30 Three years of CeramEgypt: aims, methods, results and lessons learned
Lars Heinze, Rabea Reimann

16:00 Tracing ceramic production with pXRF analysis of Fatimid and Mamluk periods (12-14 c.) in Alexandria, Egypt: A comparative study (pXRF, WDXRF) with Egyptian ceramics from the Royal Museums of Art and History (Brussels)
Adamantia Panagopoulou, Jaume Buxeda i Garrigós, Anno Hein, Delphine Dixneuf, Julie Marchand

16:30 Discussion

The pXRF Ceramic Users Network: network, results and next steps

The CEALex has initiated, since 2021, an International Research Network dedicated to pXRF analyses for archaeological ceramic studies. Initially focused on the Mediterranean region, this network project has gradually expanded and currently comprises 13 laboratories from 8 countries.

The issue of equipment interoperability and the subsequent challenges of integrating data from different laboratories are a recurring concern in the study of ancient materials. Specialists studying ancient ceramics have adopted a similar approach, comparing laboratory data with data acquired using portable equipment. Here, the intercomparison of ten portable XRF systems provides critical insights into data quality and methodological standardisation, supporting ongoing efforts to enhance the reliability and interoperability of pXRF in ceramic studies. Its primary aim is to compare the validity and repeatability of results obtained using various pXRF devices.

For that, the network has developed a common intercomparison kit that offers possibilities for intercalibration between research teams. A second approach is currently ongoing, focusing on the integration of spectral data as resources for intercalibration.

Nadia Cantin¹ & the IRN “pXRF Ceramic Users Network” members

1. Centre d'Études Alexandrines (CEALex), CNRS/Ifao, UAR 3134, Alexandria, Egypt.

Comparing pXRF to WDXRF data for Ceramic Provenance Studies: Analysing Chian Amphorae from the Whitbread Collection

Within the framework pXRF-CUN (Ceramic Users Network) programme (2021-2025), led by the CEALex, various partners are collaborating to compare and share the data obtained using their portable XRF equipment on ceramic materials. For this purpose, a ceramic kit comprising 18 fired ceramic discs was prepared and analysed using WD-XRF at the Fitch Laboratory to provide reference values. For each portable analyser, the deviations from the reference values were calculated in the form of slope and intercept, and these were discussed as intercalibration curve during this research programme.

As a case study, Chian amphorae samples from the Fitch Laboratory collection, studied by Ian Whitbread in 1995, were analysed using one of the network's portable analysers (CEALex - Niton XI3t GOLDD+), as well as by WD-XRF, and the two datasets were compared to each other.

The results of the comparison are presented here. They highlighted the strengths and limitations of each approach, and their implications were discussed for future applications of portable analytical technologies.

Mai Abdelgawad¹, Noémi Müller²

1. Centre d'Études Alexandrines (CEALex), CNRS/Ifao, UAR 3134, Alexandria, Egypt.

2. Fitch Laboratory, British School of Athens, Athens, Greece.

Causes of inter-instrumental error

A key challenge in XRF instrumentation is inter-instrumental differences; spectra from one instrument is different from another even if they are from the same manufacturer. This is the reason for device-specific calibrations; if components were the same, there would be no need to calibrate each instrument individually. This talk will provide an overview on the main sources of spectral variance, from photon flux to attenuators, and highlight configurations which will be most robust to it. We will also cover spectral normalisation, and how this can reduce variation between instruments even if calibration standards are not available.

Lee Drake¹ et al.

1. Decision Tree, LLC, University of New Mexico, Department of Anthropology.

Tracing Alloys and Inlays: Non-Destructive pXRF Investigation of Bronze Osiris Statues from the 1st Millennium BC

This paper presents a non-destructive analytical study using portable X-ray fluorescence (pXRF) to examine a selection of bronze Osiris statues from the Egyptian Museum in Cairo, dating to the 1st millennium BC. The study aims to characterise the bronze alloys and identify the diverse inlay materials applied during their manufacture. pXRF has proven particularly effective in detecting remains of precious inlay materials such as gold, silver, and electrum, as well as inserts made of glass and lapis lazuli. The analysis also extends to pigments, including Egyptian blue ($\text{CaCuSi}_4\text{O}_{10}$), hematite (Fe_2O_3), and calcium carbonate (CaCO_3), which were used as paste beneath the inlays, as decorative accents, or as preparation layers. By providing compositional data without requiring sampling, this approach offers valuable insights into technological choices and artistic conventions. This research highlights the significance of pXRF in archaeological science, contributing to a broader understanding of ancient manufacturing practices while supporting future efforts in conservation, authentication, and cultural heritage interpretation.

Eid Mertah¹

1. Egyptian Museum, Cairo.

Chemical characterisation of Roman and Medieval metal objects from Kom el-Dikka, Alexandria

The aim of the paper is to present the results of spectrometric analyses of over 200 metal artifacts from Kom el-Dikka, Alexandria, obtained during Polish-Egyptian archaeological and conservation research conducted between 1960 and 2022 by the Polish Centre of Mediterranean Archaeology, University of Warsaw. The analyses were performed on-site using a handheld XRF device.

The results obtained allow several categories of alloys to be distinguished based on the proportions of elements or the presence of specific components. When considered in conjunction with archaeological data, this allows technological differences to be identified and their significance determined. Furthermore, it provides data for inferring the provenance of certain metals, the practice of secondary recycling through remelting, and permits the identification of specific aspects of the production processes of individual objects.

Michał Krueger¹, Grzegorz Majcherek², Agnieszka Szulc-Kajak²

1. Faculty of Archaeology, Adam Mickiewicz University in Poznań.

2. Polish Centre of Mediterranean Archaeology, University of Warsaw.

On-site metallurgical studies at Ayn Soukhna: The role of portable XRF analysis

Ayn Soukhna is among the richest metallurgical sites in Egypt, with evidence for major smelting activity primarily dated to the Middle Kingdom. This is demonstrated by the abundant finds of metallurgical workshops, with copper ore, smelting furnaces, melting structures, raw copper, crucibles and finished objects.

To understand all possible production chains attested, the composition of the different metallurgical products encountered on-site must be characterised. The only way to achieve this for a broad selection of finds is by portable XRF, which was taken to the field for three seasons.

C. 2800 pXRF analyses were carried out at Ayn Soukhna. Together, they illuminate different copper ore types smelted on-site, the nature of raw copper produced, and the different crucible operations which include raw and arsenical copper processing. This research illustrates the crucial role pXRF plays in reconstructing metallurgical production chains in the field at unprecedented detail.

Frederik W. Rademakers¹, Georges Verly²

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1. British Museum, Department of Scientific Research, London (UK).
KU Leuven, Department of Earth and Environmental Sciences, Leuven (BE).
 2. Sorbonne University, UMR 8167, Paris (FR).
Iramat UMR 7065 – Institut de Recherche sur les Archéomatériaux (FR).
KU Leuven, Department of Archaeology, Leuven (BE).

P-XRF on Egyptian Coins: From corpus analysis to a methodological critique

Portable X-ray fluorescence (p-XRF) spectrometry is a valuable tool for studying large corpora of copper-alloy coins from excavations in Egypt, such as those from the Centre d'Études Alexandrines. When applied to Ptolemaic coinage, this technique allows for rapid sorting and can help resolve identification issues, despite the known biases of surface analysis.

However, the comparability of data between different instruments remains a major challenge. Our study focuses on a critical methodological approach, based on comparative analyses of certified standards conducted with two different p-XRF spectrometers. The results reveal significant and problematic discrepancies, not only with the certified values but also between the two instruments themselves. This presentation will detail these discrepancies and discuss their implications for building reliable databases.

Thomas Faucher¹ and Bruno Sozza²

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1. Centre d'Études Alexandrines (CEAlex), CNRS/Ifao, UAR 3134, Alexandria, Egypt.
 2. SIGMA Clermont, Spécialité Matériaux Hautes Performances, 2nd year student.

Tales of pigments: XRF Analyses of Colour Remains on Aswan Rock Inscriptions

Traces of colour on rock inscriptions, despite often being severely eroded, attest that these media were subject to colour application, as was common for other types of objects and architectural features in Ancient Egypt.

But what was their original appearance? Was there a decorum defining the extent of colour application and the range of pigments used? And what purpose did colouring serve, both individually and within the context of inscription clusters and their surrounding landscape, apart from enhancing the visibility of the inscriptions? It was these and other questions that inspired a PhD topic and, along with it, sparked the idea for a research project investigating colour remains on rock inscriptions on Sehel Island in the Aswan area using non invasive methods, including XRF analysis. Although conducting on site measurements with the handheld XRF device proved challenging, the results have contributed to furthering our understanding of pigment composition and even application techniques.

Elisabeth Wegner¹

1. German Archaeological Institute Cairo.

Mapping the dead: the role of portable scanning X-ray fluorescence spectroscopy for the analysis of ancient Egyptian funerary portraits

Recent applications of scanning X-ray fluorescence spectroscopy (MA-XRF), have revealed increasingly detailed information on the materials and techniques used by artists. The development by Northwestern University of a portable MA-XRF unit has allowed for the study of otherwise inaccessible works of art.

The making of five funerary portraits from Egypt—now at the Art Institute of Chicago, the Institute for the Study of Ancient Cultures and the Field Museum, Chicago—was investigated using MA-XRF, hyperspectral and multiband imaging. Portable instrumentation was essential for this research since the fragile nature of the portraits necessitated in-situ analysis. The synergy of these techniques allowed to elucidate the artists' material choices and the methods of paint application for the creation of distinctive visual effects. The insights gained can help to provide an enhanced understanding of artistic and workshop practices, traditions and innovations, and to draw parallels across different historical, cultural, chronological and geographical production.

Giovanni Verri¹

1. The Art Institute of Chicago.

Three years of CeramEgypt: aims, methods, results and lessons learned

The *CeramEgypt* project (2017-2020) was a Franco-German initiative funded by the ANR and DFG to study Hellenistic and Roman pottery from Egypt and the role this material can play in our understanding of Egypt's economy. Combining archaeological and scientific methods, it focused on ceramics from verified production sites while developing an open-access database in *Arachne*, building upon the earlier *CeramAlex* project (2011-2014).

The project employed portable XRF (pXRF) for non-destructive analysis and selected thin-section petrography to chemically and mineralogically characterise fabrics. While pXRF proved useful for initial "fingerprinting," significant limitations emerged, as was expected, when analysing Nile Valley and Delta clays due to their geochemical homogeneity. Thin-section analysis also only provided limited insights as it was constrained by severe logistical problems.

However, over three years, CeramEgypt compiled data from multiple Egyptian sites, with particular attention to workshop contexts. Results demonstrated the potential to differentiate some production centers across the Nile Delta, even with pXRF's limitations. This gives hope that certain high-quality productions, like those from Bouto, may in the future be identified as having supplied regional and supra-regional markets with Hellenistic gloss wares and Egyptian Red Slip Wares (ERSW).

The presentation will also cover the problems, pitfalls and deficits that, at its time, prevented the project from significantly contributing to many of the archaeological questions and research objectives it had. Our hope is, that it can thus provide valuable lessons for future approaches to this important topic and how to better design and execute such an archaeological and archaeometric investigation via a collaborative, multi-disciplinary and data-driven research.

Lars Heinze¹, Rabea Reimann¹

1. University of Cologne

Tracing ceramic production with pXRF analysis of Fatimid and Mamluk periods (12-14c.) in Alexandria, Egypt

Fustat (al-Fusṭāṭ) was the first capital of Muslim Egypt, founded by ‘Amr ibn al-‘Āṣ in 641. The Fatimid family conquered Egypt and they established their capital as al-Qahira (Cairo) in 969. By the end of the Fatimid era and under the Ayyubids and Mamluks, al-Qahira became a grand city. Little evidence exists for ceramic production though no kiln has been found. Waste sherds indicated multiple production sites such as a workshop in Fustat, in Nile Valley center and in Alexandria. In this study, a ceramic assemblage from Fatimid and Mamluk periods (12th-14th c.) in Alexandria was analysed through portable X-ray fluorescence (pXRF) identifying compositional groups and variability associated with clay sources, glazes, and production centers. Further analyses have already been applied, such as WDXRF for provenance, complemented by SEM-EDS, XRD, and Raman spectroscopy, for production technologies, on Egyptian ceramics from the Royal Museums of Art and History (Brussels). A comparative study (pXRF, WDXRF) between ceramics from Alexandria and Brussels will then assess group correlations and advance knowledge of production practices.

Adamantia P.Panagopoulou¹, Jaume Buxeda i Garrigósa¹, Anno Hein², Delphine Dixneuf³, Julie Marchand⁴

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 3. Laboratoire d’Archéologie médiévale et moderne en Méditerranée (UMR 7298), Université Aix-Marseille, CNRS.
 4. FED-tWIN researcher, KMKG-MRAH & Université Libre de Bruxelles

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