ARCL0170: LABORATORY AND INSTRUMENTAL SKILLS IN ARCHAEOLOGICAL SCIENCE

Module Handbook for 2023/2024

Core Module for the MSc Archaeological Science: Technology and Materials
Term I, 15 Credits
Term I: Thursdays 9-11 (410) + lab practicals (TBD).

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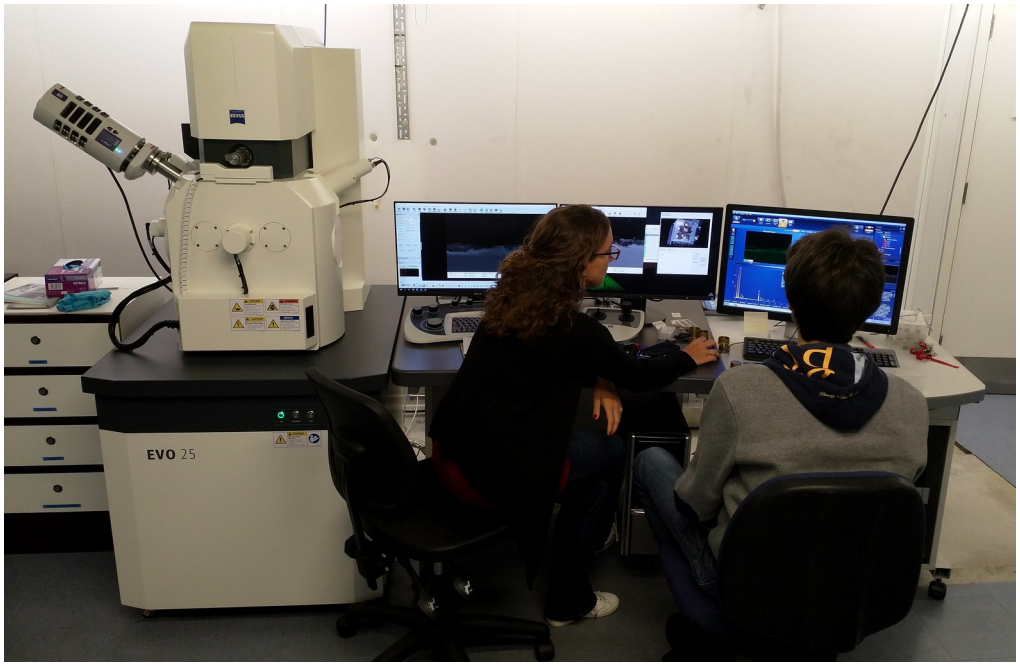

Assessment exams and deadlines for this module:

1. Scientific Report, Term I, 21 November 2023
2. Standard Essay, Term II, 22 April 2024

IMPORTANT INFORMATION REGARDING ASSESSMENTS:

The **coursework coversheet** is available on the course Moodle pages and here: under "Policies, Forms and Guidelines".

Please enter **your five-digit candidate code on the coversheet and *in the subject line*** when you upload your work in Moodle.

Please use **your five-digit candidate code as the name of the file** you submit.

Please refer to the IoA Student Handbook and IoA Study Skills Guide for instructions on coursework submission, IoA referencing guidelines and marking criteria, as well as UCL policies on penalties for late submission, over-length work and academic misconduct.

The use of software to generate content is not allowed for assessments for this course and will be penalised; the use of software for language and writing review and improvement is permitted, and the software and the way it has been used must be indicated in the relevant boxes on the coursework coversheet. UCL defines language and writing review as checking "areas of academic writing such as structure, fluency, presentation, grammar, spelling, punctuation, and language translation".

MODULE OVERVIEW

Module description

Scientific techniques are increasingly used to characterise archaeological materials. Beyond characterisation, this same materials science data may be used to address questions related to technological transfer, trade and exchange, invention and innovation, and cultural identity. It also aids in conservation planning. This module provides students with a critical understanding of some of the main laboratory based techniques used in archaeological research including their potentials, limitations, and protocols of best practice.

Module Aims

This module bridges the gap between archaeology and science by equipping students with the necessary skills to design and carry out lab-based archaeological projects, and to engage critically with the work of others.

More specifically, the module aims to:

- *introduce students to the principles and practice of the instrumental analysis of archaeological materials, including issues of sampling, calibration and data quality, reporting and interpretation, as well as practical training in the use of some of the most common analytical instruments.*
- *provide a wide-ranging and challenging introduction to the role of artefact studies and materials analysis in modern archaeology.*
- *To engage with current debates about the collection, analysis, interpretation, reporting and curation of archaeological materials.*

Learning Outcomes

Upon successful completion of this module, students will:

- *Have the basic skills necessary to acquire, process, report and interpret archaeometric data from at least two analytical techniques, including sample preparation and analysis by Metallography, SEM-EDS, pXRF, XRD, LA-ICP-MS, LIBS, and Micro-Raman.*
- *Have an overview of practical approaches to the study of materials in relation to wider archaeological research questions.*
- *Be able to debate the role of science-based studies in archaeology, including the potential advantages and constraints inherent within different approaches.*
- *Have the ability to critically assess reports and publications deriving from archaeometric work, as well as to propose analytical projects with archaeological relevance.*

Methods of Assessment

Formal assessment is based on the following:

- Scientific investigation report (Assessment 1): Term I, **21 November**. Word limit: 1500. Weighting: 25% of the final mark.

- Lab-based analytical report (Assessment 2): Term II, **22 April**. Word limit: 2000. Weighting: 75% of the final mark.

All work must be fully referenced; your attention is drawn to methods of referencing and to the statements on plagiarism and 'self-plagiarism' available on the website. The topics and deadlines for each assessment are specified below, and further details are given in the last few pages of this handbook. If students are unclear about the nature of an assignment, please contact the Module Co-ordinator. If you wish to discuss essay topics or prepare a brief (single- page maximum) outline of how you intend to approach your assignment, he will be happy to discuss this.

Communications

- **Moodle is the main hub** for this course.
- Important information will be posted by staff in the **Announcements section of the Moodle page** and you will automatically receive an email notification for these.
- Please post any general queries relating to module content, assessments and administration in the MS Teams ARCL0170 General channel (part of the MSc-Technology and Materials 2020/21 Team)
- For personal queries, please contact the co-ordinator by MSTeams or email.

Week-by-week summary

WEEK	Thurs	LECTURES 9.00 – 11.00 in 410	LABORATORY By group
1	5 Oct	Science and Lab-based archaeology: an introduction (MC)	Lab safety modules and local rules (VL, MC)
2	12 Oct	Risk Assessment (RB, VL, MC)	Sample documentation and sampling decisions – nail, slag, and tile (VL, MC)
3	19 Oct	Materials and Methods: practical and ethical considerations (MC)	Preparation of polished sections – start with the nail (VL, MC)
4	26 Oct	The Structure of Matter (MC)	Etching, hardness testing, Continue preparing slag and/or tile sections (VL, MC, PQ)
5	2 Nov	Light and the analysis of materials (MC)	Optical microscopy Continue preparing slag and/or tile sections (PQ, VL, MC)
6	**6-10 November READING WEEK**		
7	16 Nov	Bulk and trace element analysis: an introduction to spectrometry (MC)	LA/LIBS-ICP-MS Continue preparing / analysing remaining sections (MC, VL)
8	23 Nov	Scanning Electron Microscopy and X-ray microanalysis (RB)	SEM-EDS analysis and spectra interrogation (RB, VL, MC)
9	30 Nov	X-ray Fluorescence (MC)	PXRF analysis (RB, VL, MC)
10	7 Dec	Data quality, processing, and presentation (MC)	Assessing data quality / Continue preparing / analysing remaining sections(MC, VL)
11	14 Dec	Review and discussion (RB, VL, MC)	Data analysis: plotting results in excel and R (MC, VL)

Contributors: RB=Russell Bailey; MC=Mike Charlton; VL=Vic Lucas; PQ=Patrick Quinn

Weekly Module Plan

This is a two term module. The first term of the module is taught through a combination of formal lectures, discussion seminars, practical demonstrations and practical exercises. In general, discussion of instrumental and data analysis techniques in lectures will be followed by elevant introductions to the same during practicals. Students will be required to undertake set readings, complete pre-class activities and make (non-examined) short presentations of case study material in order to be able to actively participate in some discussions. In normal years, practical sessions would be in the Wolfson Archaeological Science Laboratories. This year they will take place online but still take advantage of the instruments in remote operation. You will have formative assignments at the end of most

lectures and practicals that are designed to improve your analytical and critical thinking skills while directly engaging with the lessons.

The second term of the module will focus on individualized training in two laboratory techniques appropriate the material chosen for dissertations. Training times will vary and relies on close coordination with the laboratory staff. This will provide the crucial first step in helping students acquire the skills and confidence to carry out individual analytical work with scaffolded support.

Thursday 15.00-16.30: Live lecture/seminar; Mon evening: Lectures for the following week available; Practical sessions: *TBD*; Thurs: deadline to complete formative exercises

Workload
This is a 15-credit module which equates to 150 hours of learning time including session preparation, background reading, and researching and writing your assignments. With that in mind you should expect to organise your time in roughly this way:

20 hours	*Staff-led teaching sessions (lectures, seminars, tutorials, discussion-board sessions)*
20 hours	*Self-guided session preparation*
30 hours	*laboratory work (including practicals and training sessions and work for assessment #2)*
15 hours	*Reading for, analysing data, for, and writing, scientific report*
20 hours	*Preparing formative assessments and non-examined presentations*
45 hours	*Reading for, preparing samples for, acquiring data for, analysing data for and writing, the research essay*

ASSESSMENT

Each assignment and possible approaches to it will be discussed in class, in advance of the submission deadline. If students are unclear about the nature of an assignment, they should discuss this with the Module Co-ordinator in advance (via office hours or class Moodle forum). You will receive feedback on your written coursework via Moodle, and have the opportunity to discuss your marks and feedback with the co-ordinator during office hours.

For more details see the 'Assessment' section on Moodle. The marking criteria and IoA writing guidelines [are useful guides when writing your essay. **Penalties for late submission:** see guidance in UCL Student Handbook.

Assessment 1: Scientific investigation report

Deadline: Term I, 21 November

This assessment requires you to:

- Demonstrate an understanding of a range of different types of analytical information.
- Use the information to make an argument about the history of an object.
- Explain your methods and results in terms that can be understood by an informed lay-person.
- Present your data and arguments in the form of an official scientific report and in an objective, structured and formal manner, suitable for presentation to the Board of Trustees of a Museum.

The word length for your report is 1500 words, plus diagrams and tables. This assessment amounts to 25% of your final module mark.

The scenario

You are a scientist in the laboratory of the National Museum of Transylvania. You have a small laboratory, equipped with a range of equipment for the investigation of archaeological and museum artefacts.

The head curator of the Department of European Art and Archaeology is very excited. The Museum has been offered a rare Renaissance enamelled ewer, believed to have been made in Limoges, France and dating to the sixteenth century. The item has been in a private collection for many decades and hence purchasing it would be legal and bring the artefact to public view. This will fill an important gap in the collections. The curator wishes to buy the object at the price being offered by the dealer, which is slightly below the market value for such an object.

The Director of the Museum, while sympathetic to the enthusiasm of the curator, is more cautious. The cost of the ewer will consume the total funds available for acquisitions in the current financial year. He will have to justify the expenditure to the Museum's Trustees and is ultimately responsible to the Culture Department of the government. If the object is purchased and later turns out to be problematic, his job will be on the line. Therefore he has told the European department to refer it to the scientific laboratory for careful evaluation.

Your job is to examine the object and to produce a report on its condition and authenticity. Your report needs to present the details of your findings, in an objective way. You are not required to comment upon value or cost, and should not do so. Remember that examinations of this type often do not "prove" something, they "suggest" or are "consistent with" with a process or characteristic. This report, particularly if unfavourable in some way to the object, might well be used by the Museum in negotiations with the owner. Therefore it is crucial that it is as objective as possible, and does not leave the Museum liable to legal action.

The Investigation

You are provided with the results of the investigation (via Moodle):

- A picture of the artefact
- Two radiographs of the artefact

- A page from a lab book with a sketch of the appearance of the artefact in ultraviolet light
- The results of an X-Ray Fluorescence examination of the object
- XRF results for a standard
- A radiograph showing the appearance of the central join in a typical 16th century enamelled ewer from Limoges
- A report on something completely different (glass from Cluny), which shows how a report of this type might be organised.

Your Report

Your report should include the following (you should use sub-headings as appropriate). Refer to the example of a report provided via Moodle but use a style and layout that you think looks appropriate (typeface, paragraph spacing, etc.). **YOU MUST USE DOUBLE LINE SPACINGS IN YOUR REPORT**.

- Title of your Institution and Department (Top of page)
- Title of the Report ("Report on .....")
- Department requesting the report (in brackets: "(Requested by Department of.....)".)
- At the beginning a short summary or abstract (up to 4 sentences) of what you have done and what you have found.
- An introduction indicating what you are looking at and why
- A description of the methods used – indicate the methods used and the reasons for using them. You should indicate any limitations that impact the meaning of the results.
- A section outlining the results – what you found/observed. Refer to figures (as fig. 1, 2 etc) and any tables.
- A discussion section – what do the results mean in light of the starting question and methods used? Refer back to previous sections as you develop your argument.
- A concise conclusion – Concise statement on what you have concluded about the object.
- On the left hand side at the bottom of the report, you should sign it, type your name, the date and a file number for this study
- Your report will have referred to previous work in the literature, and references should be provided in the standard way.
- Figures and also tables, if any, should be numbered sequentially and referred to in the text. They should be embedded in the report and always accompanied by captions.

Reading material

Röhrs, S. and Stege, H., (2004). 'Analysing Limoges painted enamels from the 16th to 19th centuries by using a portable micro X-ray fluorescence spectrometer'. X-ray Spectrom. 33, 396-401.

Röhrs, S., Biron, I. and Stege, H. (2006) About Limoges Painted Enamels – Chronological Evolution of the Glass Chemical Composition, Association International pour l'histoire du Verre, Annales du 17e congres, 500-509.

Assessment 2: Practical essay: analytical report

Deadline: Term II, 22 April

This essay comprises practical work in the laboratory (sample preparation and analysis), to give you experience in the preparation of specimens, selection of analytical techniques, and the presentation of the resulting data.

The word count should be 2000: you are expected to write a concise report characterising the sample and the specimen preparation, explaining and justifying the analytical procedures, and reporting your results and primary interpretation in a suitable way.

The emphasis here is on method and characterisation: ideally your report will demonstrate that you can generate useful analytical data and report your results clearly and provide a preliminary technological explanation. You are not expected to perform in-depth bibliographic research, though you may want to survey the literature just to see how others report their analyses).

You will be provided with a unique sample that takes your specific interests into consideration.

Start with an Introduction

Here, you give a brief mention of the material and the task in front: i.e. the characterisation or description of the sample including a photograph or drawing (do not forget the scale bar!), what you know about it (origin, data, nature), and what the task is: Material identification and characterisation. Please include some details about the context (if any) and the archaeological interest in it. This informs what kind of characterisation you intend to conduct and the methods you can use to collect relevant data.

Discuss your methods

Provide a background specifying various techniques for characterisation of materials like yours. Explain what methods you are using (microscopy, SEM-EDS, XRF), all sample preparation this includes / requires. Provide some details about the quality of data the technique generates.

Describe the sample preparation and analysis to the level of documentation necessary for a professional researcher to understand and duplicate what you've done. Could you duplicate the study if you reread the methods section 5 years from now? Here you have to find the balance between over-describing your manual steps of preparation and analysis, and giving the necessary detail for a knowledgeable reader to follow your work.

Report your results

This should be the body of your report, including figures (e.g. micrographs of sections; tables of analysis; graphical presentation of data), enabling the reader to evaluate the results, and possibly compare them with other reports / published evidence from elsewhere. Here, it is important to decide what should be in the text and what in an appendix, to what extent the data can be summarised using tables or figures, etc.

There is no need for a long discussion in this essay, but a concluding paragraph would be sensible, summarising the results with respect to sample identification, characterisation, and the archaeological interest. Is there any advice for developing future projects?

Prepare a neat presentation and proofread your text; if you as the author do not think it is worth this effort, then readers will assume the work described is equally poor.

Submission

The final report should be submitted together with a link to a data repository that includes a digital version of the essay as presented, as well as any further documentation generated (i.e. files and raw data from SEM-EDS, additional micrographs, and other relevant details).

The sample studied and the specimens produced for analyses should all be labelled and returned with the essay.

This essay counts as 75% of your assessed coursework for this course.

Resources and Preparation for Class

Preparation for class

You are expected to read the **essential readings listed below, watch laboratory videos, and complete any online activities on Moodle** each week. Completing the readings is necessary for your effective participation in the activities and discussions that we will do, and it will greatly enhance your understanding of the material. **Further readings are provided via the online-reading list** for you to get a sense of the range of current work on a given topic and for you to draw upon for your assessments.

Recommended basic texts and online resources
Please note that many of the papers and book chapters listed below are available online through UCL Reading Lists. In addition, the Moodle page for this course includes numerous links to useful resources. I will update the online version of the reading list during the year.

There is an increasing number of handbooks of archaeological science. Some are organised in chapters by analytical techniques (e.g. microscopy, elemental analysis, molecular analysis...), and others are organised by material (e.g. metals, ceramics, glass...). Both are useful introductions and starting points. You are strongly encouraged to read some of these as the course progresses, and before you start using the instruments yourself.

In addition to the books listed below, you will find relevant case studies, depending on your material or instrument of interest, by searching in the following essential resources:

Journals (all available online through UCL Library Services):
Archaeometry

Journal of Archaeological Science

Archaeological and Anthropological Sciences

The British Museum Technical Research Bulletin, available on

http://www.britishmuseum.org/research/publications/online_journals/technical_research_bulletin.aspx

Art and Archaeology Technical Abstracts (AATA), available on http://aata.getty.edu/NPS

Published proceedings of the following conferences:
International Symposium on Archaeometry

UK Archaeological Science

Materials Issues in Art and Archaeology

Handbooks, introductory papers, and collections of case studies:
Archaeometry 49/2 (2007). Special issue devoted to Neutron Activation Analysis in Archaeology.
INST ARCH Pers

Archaeometry 50/2 and 50/6 50th anniversary issues with good review papers on a number of topics, including artefact analysis
INST ARCH Pers

Artioli, G. 2010. Scientific Methods and Cultural Heritage: An Introduction to the Application of Materials Science to Archaeometry and Conservation Science. Oxford: Oxford University Press.
INST ARCH LA ART

Brothwell, D. R. and Pollard, A. M. (eds), 2001. Handbook of Archaeological Sciences. Chichester, New York, Weinheim, Brisbane, Singapore, Toronto: John Wiley & Sons, Ltd.
INST ARCH AJ BRO

Demortier, G. and Adriaens, A. (eds), 2000. Ion beam study of art and archaeological objects. A contribution by members of the COST G1 Action. Luxembourg: Office for Official Publications of the European Communities.
INST ARCH LA Qto DEM

Dran J. C. et al, 2004. Ion beam analysis of art works: 14 years of use in the Louvre. Nuclear Instruments and Methods In Physics Research Section B: Beam Interactions with Materials and Atoms, 219, 7-15.

Giumlia-Mair A. et al., 2010. Surface characterisation techniques in the study and conservation of art and archaeological artefacts: a review. Materials technology 25(5), 345-261.

Goffer, Z. 2007. Archaeological chemistry. Hoboken, NJ: Wiley
INST ARCH JD GOF, ISSUE DESK, IOA JD GOF

Martini, A., Milazzo, M. and Piacentini, M. 2004. Physics methods in Archaeometry. Amsterdam; Oxford: IOS Press.
INST ARCH AJ MAR

Martinón-Torres, M. and Rehren, Th. (eds) 2008. Archaeology, History and Science: Integrating Approaches to Ancient Materials. (UCL Institute of Archaeology Publications). Walnut Creek, CA: Left Coast Press
INST ARCH AJ MAR, ISSUE DESK IOA MAR 9

National Academy of Sciences, 2005. Scientific examination of art: modern techniques in conservation and analysis (Arthur M. Sackler Colloquia of the National Academy of Sciences). Washington, DC: National Academies Press.
INST ARCH KN 1 NAT

Pollard, A. M., Heron, C., Armitage, R.A. 2017. Archaeological Chemistry. Cambridge: Royal Society of Chemistry.
INST ARCH JD POL

Pollard, A. M., Batt, C. M., Stern, B. and Young, S. M. M. 2007. Analytical Chemistry in Archaeology. Cambridge: Cambridge University Press
INST ARCH JDD POL

Shackley, M. S. (ed), 2011. X-Ray Flourescence Spectrometry in Archaeology. New York: Springer
[mostly focused on lithic materials, but it also includes a good generic introduction to the basics of XRF in archaeology, available here.]

Torrence, R., Rehren, T., Martinon-Torres, M. (eds.), 2015. Scoping the Future of Archaeological Science: Papers in Honour of Richard Klein. Journal of Archaeological Science 56, special issue. [a recent compilation of papers reviewing recent research, suggesting best practice strategies and outlining future challenges for archaeological science in a wide range of subfields]

Syllabus

Week 1: Science and Lab-based archaeology: an introduction

Mike Charlton

Why are we here? Introduction to the structure, aims and methods of this module. What is science and what's the difference between scientific archaeology and archaeological science? What is characterisation versus explanation versus interpretation? We will strive to answer these questions in this introductory session as well as explore some of the current research topics in archaeomaterials research.

Readings:

Dunnell, R.C., 1982. Science, social science, and common sense: the agonizing dilemma of modern archaeology. J. Anthropol. Res. 38, 1–25.
https://www.jstor.org/stable/3629946?seq=1#metadata_info_tab_contents

Martinón-Torres, M., Killick, D., 2015. Archaeological Theories and Archaeological Sciences. Oxford Handb. Archaeol. Theory 1–17. doi:10.1093/oxfordhb/9780199567942.013.004 https://www.oxfordhandbooks.com/view/10.1093/oxfordhb/9780199567942.001.0001/oxfordhb-9780199567942-e-004

Week 2. Fundamentals of Risk Assessment.

Vic Lucas and Russell Bailey

In this session, Vic and Russell will take you through the fundamentals of risk assessment. Everything we do in working life requires risk assessment, though most of the time we are unaware of it. Field and laboratory work often involves unique problems that require more than a blanket form from above, and need you (as the researcher) to be personally involved in assessing the risks of your activities. You will learn how to distinguish hazards from risks, how to assess risks, how to manage them, and the basic process of working through a risk assessment document. After today, risk assessments will be required for all research projects that you undertake.

Week 3. Materials and analytical techniques. Practical and ethical considerations.

Mike Charlton

In this session we will provide an overview of the main categories of archaeological materials and the most important analytical techniques. We will discuss the suitability of different techniques for different materials and questions.

After this, we will discuss the various aspects that affect sampling and the selection of analytical equipment for specific research questions of archaeological relevance. Practical aspects of science-based analyses. Invasive vs non-invasive. Destructive vs non-destructive. Research agenda vs equipment availability. Ethics.

You are encouraged to consider issues that will continue to arise throughout the course of the degree and your entire career, namely, balancing research objectives with the management of cultural/heritage resources.

Readings:

Tite, M.S., 2002. Archaeological Collections: Invasive Sampling versus Object Integrity. Pap. from Inst. Archaeol. 13, 1. doi:10.5334/pia.189 [see replies in the same volume] https://pia-journal.co.uk/articles/abstract/10.5334/pia.189/

Tubb, K.W., 2007. Irreconcilable differences ? Problems with Unprovenanced Antiquities. Pap. from Inst. Archaeol. 18, 3–11. [see replies in the same volume] https://pia-journal.co.uk/articles/10.5334/pia.294/

Week 4. The structure of matter

Mike Charlton

We will be looking at the fundamental structures of materials, using simple, descriptive models. This will include a look at individual atoms and their various components; isotopes; the periodic table of elements; different bonding models to form molecules; valencies and stoichiometry; alloys and solid solutions; from molecules to crystal structures; and how various aspects of these are being exploited for analytical purposes.

Learning objectives:
The amount of physics and chemistry that you need for this module and degree is limited. However, it is crucial that you understand these very basics so that we have a solid foundation to build on. If any of the above terms is unclear, please seek clarification.

Readings:

Any basic textbook on inorganic chemistry can provided you with a sound knowledge-base for this degree. And you can also try the Internet!

Morgenstein, M., 2006. Geochemical and petrographic approaches to chert tool provenance studies: Evidence from two western USA Holocene archaeological sites. Geol. Soc. Spec. Publ. 257, 307–321. doi:10.1144/GSL.SP.2006.257.01.23
https://sp.lyellcollection.org/content/257/1/307.short

Week 5. Light and the analysis of materials.

Mike Charlton

Almost every analytical technique we use involves the electromagnetic spectrum, or light. This session will provide you with a basic introduction to the role light plays in characterising materials at macroscopic and microscopic scales.

X-rays play an especially important role in materials characterisation. This session will emphasise the most common applications of X-rays in materials science. It will be important to gain a good understanding of X-ray behaviour in order to understand the results you obtain from the various instruments in our lab that make use of these energetic photons, including our X-ray cabinet, SEM-EDS, XRD, pXRF, and the EPMA (incorporating 3 WDS detectors)

Readings: *Please read one of the following and provide a short response on the moodle forum*

Berranger, M., Bauvais, S., Boukezzoula, M., Leroy, S., Disser, A., Vega, E., Aubert, M., Dillmann, P., Fluzin, P., 2017. Analyse technologique, étude de provenance et datation par le radiocarbone du dépôt de demi-produits ferreux de Durrenentzen (Haut-Rhin, France) :

une vision renouvelée de l'économie du fer au premier âge du Fer. ArcheoSciences 41, 45–67. https://doi.org/10.4000/archeosciences.4883

Eekelers, K., Degryse, P., Muchez, P., 2016. Petrographic investigation of smithing slag of the Hellenistic to Byzantine city of Sagalassos (SW-Turkey). Am. Mineral. 101, 1072–1083. https://doi.org/10.2138/am-2016-5390

McCrone, W.C., 1990. The Shroud of Turin: blood or artist's pigment? Acc. Chem. Res. 23, 77–83. https://doi.org/10.1021/ar00171a004
http://www.mccroneinstitute.org/uploads/the_microscope__shroud_small-1422560933.pdf

Ting, C., Humphris, J., 2017. The technology and craft organisation of Kushite technical ceramic production at Meroe and Hamadab, Sudan. J. Archaeol. Sci. Reports 16, 34–43. https://www.sciencedirect.com/science/article/pii/S2352409X17302900

Shizuma, K., Kajimoto, T., Endo, S., Matsugi, K., Arimatsu, Y., Nojima, H., 2017. Non-destructive analysis of ancient bimetal swords from western Asia by γ-ray radiography and X-ray fluorescence. Nucl. Instruments Methods Phys. Res. Sect. B Beam Interact. with Mater. Atoms 407, 244–255. doi:10.1016/j.nimb.2017.07.014
https://www-sciencedirect-com.libproxy.ucl.ac.uk/science/article/pii/S0168583X17307504

Simpson, S.J., La Niece, S., 2010. New light on old swords from Iran. Br. Museum Tech. Res. Bull. 4, 95–101.
https://webarchive.nationalarchives.gov.uk/ukgwa/20170208015019mp_/https://www.britishmuseum.org/pdf/BMTRB4%20Simpson.pdf

Week 6. Reading week

Independent study – Scientific report due Thursday

Week 7: Bulk and Trace element analysis: an introduction to spectrometry

Mike Charlton

Microanalysis is a incredibly useful tool for understanding an object's phase structure and chemistry, but is biased by its small analytical areas and sample inhomogeneity. Bulk analytical techniques such as NAA, ICP, and XRF are superior when the goal is measuring the overall composition of an object. These techniques also have sensitivity and are capable of measuring trace elements at ppm and smaller concentrations. This session builds on your knowledge of the electromagnetic spectrum and provides a first introduction to spectroscopy and spectrometry.

Readings:

Dussubieux, L., Robertshaw, P., Glascock, M.D., 2009. LA-ICP-MS analysis of African glass beads: Laboratory inter-comparison with an emphasis on the impact of corrosion on data interpretation. Int. J. Mass Spectrom. 284, 152–161. doi:10.1016/j.ijms.2008.11.003 https://www-sciencedirect-com.libproxy.ucl.ac.uk/science/article/pii/S1387380608004405

Liu, S., Li, Q. F., Gan, F., Zhang, P. and Lankton, J. W. 2012. Silk Road glass in Xinjiang, China: chemical compositional analysis and interpretation using a high-resolution portable XRF spectrometer. Journal of Archaeological Science 39, 7: 2128-2142. https://www-sciencedirect-com.libproxy.ucl.ac.uk/science/article/pii/S0305440312001008#!

Week 8: Scanning electron microscopy and X-ray microanalysis

Russell Bailey

The SEM is a versatile tool for imaging given its superior magnification potential and depth of field in comparison to optical microscopes. Electron interactions with the sample also lend themselves to phase identification and elemental characterisation. As such, it has become an indispensable instrument for many sciences. This session will provide you with an introduction to the principles of scanning electron microscopy and X-ray microanalysis as well as prepare you for the practicalities of using it for research.

Readings:

Ingo, G.M. et al., 2006. Combined use of SEM-EDS, OM and XRD for the characterization of corrosion products grown on silver Roman coins. Applied Physics A, 83(4), 493-497. https://link-springer-com.libproxy.ucl.ac.uk/article/10.1007/s00339-006-3533-0

Martinón-Torres, M. and Uribe-Villegas, M.A. 2016. The prehistoric individual, connoisseurship and archaeological science: the Muisca goldwork of Colombia. Journal of Archaeological Science 63: 136-155. https://www-sciencedirect-com.libproxy.ucl.ac.uk/science/article/pii/S0305440315002514

Week 9: X-ray Fluorescence

Mike Charlton

X-ray Fluorescence (XRF) is both the most celebrated and maligned chemical characterisation technique used in the analysis of archaeological materials. The physical foundation of the technique will be summarised, building on discussions from previous sessions. We will explore why it is so powerful, on the one hand, and so easily abused on the other. Data complexities will be discussed drawing on examples generated by pXRF.

Week 10: Data quality, reporting, and processing

Mike Charlton

Just because a machine goes 'ping' and generates some numbers does not guarantee that the measurement was a success or that the numbers have any meaning at all. We have to assess data quality every time we make a measurement. And if the data are acceptable, then what? First, we have to report the data in way that effectively communicates our results (providing neither too little nor too much detail. Then we still have the task of bridging the the data with our starting questions via graphs and statistics. This lecture will describe some of the ways we ensure our data are valid, how we report them (including accuracy, precision, and transformation), and then what we do with them.

It is impossible to learn statistics and data visualisation from a single lecture. However, after this session you should be familiar with the potential applications of a range of data processing and presentation techniques, so that you can assess whether they are useful for your particular dataset. If you choose to use them, be prepared to invest a lot more time…

Readings:

You can find brief and useful introductions to many relevant issues in the AMC Technical Briefs of the Royal Society of Chemistry. We have included some of these in the Moodle page but you're encouraged to explore for more.
http://www.rsc.org/Membership/Networking/InterestGroups/Analytical/AMC/TechnicalBriefs.asp

Charlton, M., Humphris, J., 2019. Exploring ironmaking practices at Meroe, Sudan—a comparative analysis of archaeological and experimental data. Archaeol. Anthropol. Sci. 11. doi:10.1007/s12520-017-0578-2
https://link.springer.com/article/10.1007/s12520-017-0578-2

Week 11: Review and concluding discussion

Mike Charlton

Making our data and interpretation available to others to use, discuss and enjoy is an ethical responsibility. After all, we often work with public heritage and funded by public resources. What is the best way of doing so? We will use this session to discuss general practical aspects of research design, as well as any other relevant subject that you may wish to talk about. In addition, we will also be handing out your materials for assessment 2.

Student activity BEFORE the class:

Read the two papers listed below. What's good and what's not? How would you structure it to reach a scientific audience, a general archaeology audience, or a general public audience? Can you suggest more attractive titles for them?

Charlton, M. F., Crew, P., Rehren, Th. & Shennan, S. J. 2010. Explaining the evolution of ironmaking recipes - an example from northwest Wales. *Journal of Anthropological Archaeology* 29: 352-367. https://www-sciencedirect-com.libproxy.ucl.ac.uk/science/article/pii/S0278416510000309

Radivojević, M. & Rehren, Th. 2016. Paint It Black: The Rise of Metallurgy in the Balkans. *Journal of Archaeological Method and Theory* 23: 200-237. https://link-springer-com.libproxy.ucl.ac.uk/article/10.1007/s10816-014-9238-3