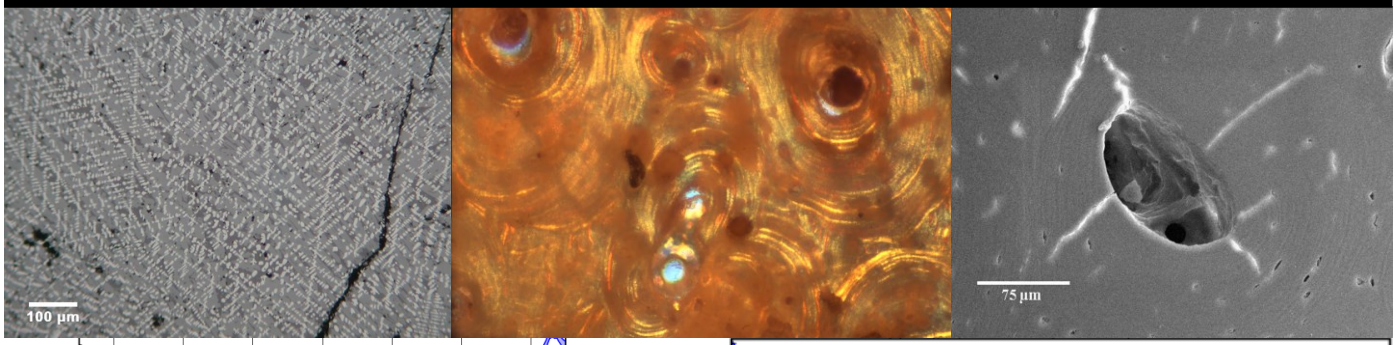
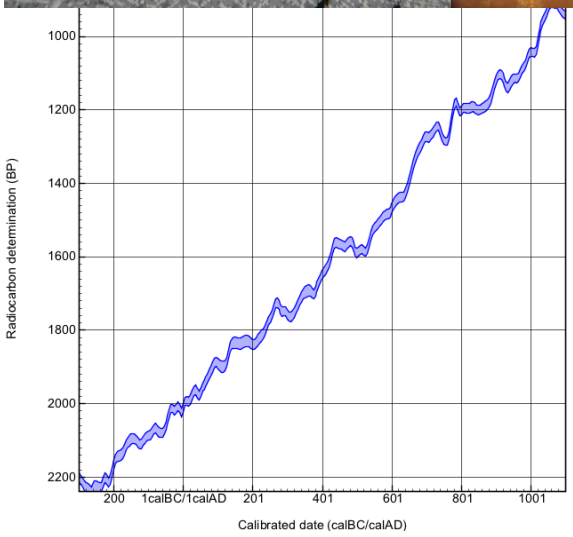
LONDON'S GLOBAL UNIVERSITY

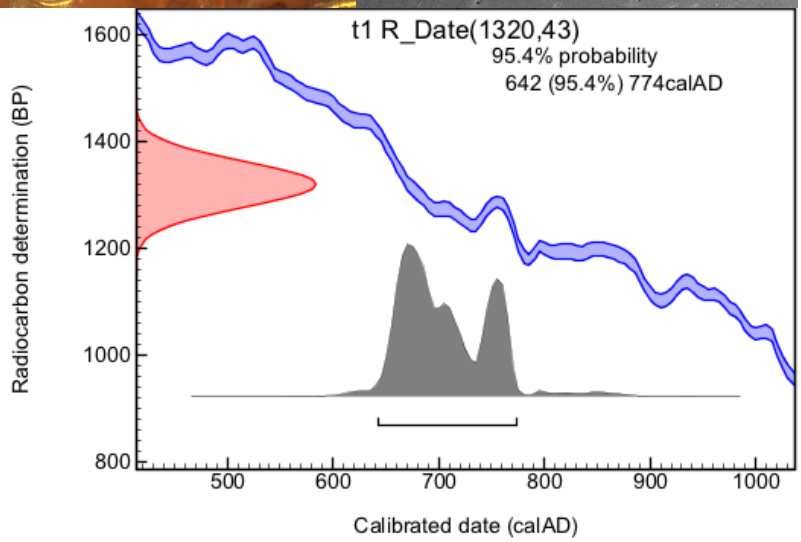
UCL

UCL INSTITUTE OF ARCHAEOLOGY

ARCL3093: MICROSCOPY AND DATING OF ARCHAEOLOGICAL MATERIALS







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IoA 613 and 020 7679 8872

2015-16

Year 2/3 Option, 0.5 unit

Turnitin Class ID: 2970240
Turnitin Password IoA1516

Please see the last page of this document for important information about submission and marking procedures, or links to the relevant webpages.

1 OVERVIEW

Short description

This course will introduce students to the principles and practice of applying light and electron microscopy to the investigation of archaeological materials. These will include practical demonstrations and experience. The course will also provide an overview of dating methods based on radioactive decay, accumulation of radiation damage, seasonal events and chemical processes. There will be more detailed coverage of radiocarbon and dendrochronological dating, the latter including practical experience.

Week-by-week summary

Lectures will be held 9-11am on Mondays at UCL Earth Sciences Room 44, South Wing. Demonstration sessions may be held in other places and at other times as necessary and agreed by student consensus.

	Week	Lecturer	Title
1	5 October 2015	MC	Introduction: Course organisation and objectives Overview: microscopy and dating
2	12 October 2015	MC	Introduction to optical and electron microscopy.
3	19 October 2015	PQ	Introduction to ceramic petrography
4	26 October 2015	JM	Metallography of archaeological metals
5	2 November 2015	MAK	Micromorphology of archaeologically related sediments
	9 November 2015	**READING WEEK—NO LECTURES**	
6	16 November 2015	MG	Microscopy of archaeological fibres and textiles
7	23 November 2015	MC	Science based dating in archaeology
8	30 November 2015	EKB ME	Phytoliths and Pollen Microscopy of teeth—use-wear and life history
9	7 December 2015	MB	Dendrochronology and wood identification
10	14 December 2015	KE	Recent research in radiocarbon dating

Basic texts

Bell, S., & Morris, Keith. (2010). An introduction to microscopy. Boca Raton ; London: CRC Press.
MEDICAL SCIENCES BB 50 BE

Brothwell D. and Pollard A. M (2001) Handbook of Archaeological Sciences. John Wiley
INST ARCH AJ BRO
ISSUE DESK IOA BRO 15

Goldstein, J., & Goldstein, J. (2003). Scanning electron microscopy and x-ray microanalysis (3rd ed.). New York ; London: Kluwer Academic/Plenum.
INST ARCH JKA GOL

Olsen, S. (1988). Scanning electron microscopy in archaeology (BAR international series; 452). Oxford: B.A.R.
INST ARCH AJ 10 Qto OLS

Renfrew, C., & Bahn, P. G. (2012). Archaeology: Theories, methods, and practice. Thames and Hudson.
INST ARCH AH REN

R. E. Taylor and Martin J. Aitken (1997). Chronometric dating in archaeology. Plenum Press.
ISSUE DESK IOA TAY 4

Methods of assessment

The course will be assessed by two items of coursework: a series of short questions weighted at 40% of the total and a standard essay weighted at 60% of the total mark for the course.

Teaching methods

The course is taught through lectures and a small number of seminars and practical sessions/demonstrations. All practical activities and laboratory visits have been incorporated into the scheduled sessions for the course. Pending interest, class consensus and resource availability, additional laboratory sessions and practicals may be arranged to give students greater familiarity with the methods and techniques covered in the course.

Workload

There will be 20 hours of lectures and practical sessions for this course. Students will be expected to undertake around 80 hours of reading for the course, plus 88 hours preparing for and producing the assessed work. This adds up to a total workload of 188 hours for the course.

Prerequisites

There are no formal prerequisites for this course.

2 AIMS, OBJECTIVES AND ASSESSMENT

Aims

- To introduce the principles of microscopy and scientific dating techniques as widely used in archaeology
- To demonstrate and encourage good practice in the application of microscopy and scientific dating techniques to archaeological problems through case studies from ongoing research
- To provide practical experience with microscopes to observe and characterize diverse archaeological materials
- To provide practical experience with quantitative methods and software packages used in scientific dating

Objectives

On successful completion of this course a student should:

- Understand the principles and applicability of microscopy to specific archaeological questions
- Understand the principles and applicability of the main archaeological dating techniques
- Recognize and discern reporting practices in archaeological microscopy and dating
- Be familiar with the design and operation of light and electron microscopes
- Be familiar with basic sample preparation techniques for microscopy and scientific dating
- Be familiar with standard software packages for analysis of micrographs and radiocarbon dating
- Be able to design a research project involving the application of microscopy or scientific dating in archaeology

Learning Outcomes

On successful completion of the course students should have developed and be able to demonstrate*:*

- detailed observation and critical reflection skills
- some basic laboratory knowledge and skills
- the ability to conduct problem-based research
- the ability to apply acquired knowledge to specific archaeological problems

Coursework

Assessment tasks

The course will be assessed by two items of coursework: 1) a short series of questions weighted at 40% of the total mark; and 2) a literature review or standard essay of 2850 – 3150 words weighted at 60% of the total mark for the course

Set of questions (40%; submission date: 17 Dec 2015)
A short series of questions will be distributed in the second half of the term. Answering these questions will require students to have a good working knowledge of microscopy, scientific dating techniques and their application in archaeology. There is no word limit for this piece of coursework but students will obtain credit for identifying the most important aspect and expressing their answers clearly and concisely. For guidance, the total word count for the short questions is expected to be 2,375 - 2,625 words.

Standard essay (60%; 2850 – 3150 words, submission date: 14 January 2016)
The second item of coursework is a standard essay. Please choose one of the options below or discuss an idea with me.

Standard Essay questions:

1. Formulate a research strategy to explore the impact of metal production on the environment from prehistory to the present. Indicate the specific microscopic and dating techniques you might use to determine the relative impacts of different metals at different times and why you selected them.

2. Can dates be used for more than just telling time? Critically assess the ways archaeologists have begun to use temporal data to infer other parameters and processes of past human existence.

3. How does microscopy aid in the characterization of artefact production and use? How do we combine these characterizations with archaeological theory to help explain or interpret the past? You may select either a single or multiple materials for your essay.

4. Can microscopic analysis be quantified? Critically discuss the ways researchers try to quantify microscopic observations of different archaeological phenomena. What role, if any, do validation procedures play? What role, if any, does computational image analysis play?

5. What can microscopy tell us about the life history of people from their teeth and bones? When is it appropriate to use scanning electron or light microscopy? What special sample preparation procedures need to be considered?

6. Ferrous archaeometallurgy in Africa is plagued by the “old wood” problem—referring to the use of old trees to produce charcoal and yielding ^{14}C dates that are too early. Are there any alternatives to dating production sites in Africa?

7. Can artefacts be directly dated? Critically examine some proposed methods to date artefacts. What do the results of successful efforts tell us that dating by association did not?

8. How do microscopy and dating methods combine to inform archaeologists about past environments?

9. What good is charcoal to an archaeologist? Describe the various microscopic and chronometric approaches one might apply to charcoal in the archaeological record and what information might be gained about time and human ecological footprints. How does this compare to the analysis of other biological remnants such as pollen, phytoliths and bone?

10. What microscopic and dating techniques can be applied to pigments and what do they tell us? How do they compare with other methods of analysis?

11. Dating techniques are often characterized as absolute or relative. What are some examples of relative scientific dating techniques and what role do they play in archaeological enquiries. Can they be combined with absolute dating methods to offer greater insights into the archaeological record?

12. Formulate a strategy to investigate the origins and spread of agriculture in some specified region of the world. What microscopic and dating techniques will you use in your project? Explain how the region you choose might constrain your choice of methods. Include a critical evaluation of existing research in the area.

If students are unclear about the nature of an assignment, they should discuss this with the Course Co-ordinator.

Students are not permitted to re-write and re-submit essays in order to try to improve their marks. However, students may be permitted, in advance of the deadline for a given assignment, to submit for comment a brief outline of the assignment.

The Course Co-ordinator is willing to discuss an outline of the student's approach to the assignment, provided this is planned suitably in advance of the submission date.

Word counts

The following should not be included in the word-count: title page, contents pages, lists of figure and tables, abstract, preface, acknowledgements, bibliography, lists of references, captions and contents of tables and figures, appendices.

Penalties will only be imposed if you exceed the upper figure in the range. There is no penalty for using fewer words than the lower figure in the range: the lower figure is simply for your guidance to indicate the sort of length that is expected.

3 SCHEDULE AND SYLLABUS

Teaching schedule

Lectures will be held 09.00-11.00 on Mondays at UCL Earth Sciences Room 44, South Wing. Demonstration sessions may be held in other laboratories through the term and arranged in discussion with the class. Further details will be announced closer to the date.

Lecturers: Mike Charlton, Patrick Quinn, John Merkel, Manuel Arroyo-Kalin, Margarita Gleba, Eleanor Kingwell-Banham, Marija Edinborough, Martin Bridge and Kevan Edinborough.

Practicals

Practical/seminar groups

All practical activities and laboratory visits have been incorporated into the scheduled sessions for the course. Pending interest, class consensus and resource availability, additional laboratory sessions and practicals may be arranged to give students greater familiarity with the methods and techniques covered in the course.

Because laboratory space is limited, it is essential that students attend the practical group to which they have been assigned. If they need to attend a different group for a particular session, they should arrange to swap with another student from that group, and confirm this arrangement with the Course Co-ordinator.

Syllabus

The following is an outline for the course as a whole, and identifies essential and supplementary readings relevant to each session. Information is provided as to where in the UCL library system individual readings are available; their location and Teaching Collection (TC) number, and status (whether out on loan) can also be accessed on the eUCLid computer catalogue system. Readings marked with an * are considered essential to keep up with the topics covered in the course. Copies of individual articles and chapters identified as essential reading are in the Teaching Collection in the Institute Library (where permitted by copyright) or are available online.

Session 1: Introduction to the Course
Mike Charlton

This session will provide you with an overview of the course—its structure, aims, objectives and requirements. Following these preliminaries, it will turn toward the main subject matter of the course—microscopy and scientific dating in archaeology. Though it might seem a strange pairing, these two vital components of the archaeological science toolkit intersect at research areas such as dendrochronology, varve chronology, obsidian hydration, fission track dating and biostratigraphy.

This first lecture will survey the many ways microscopic examination of archaeological materials have informed our knowledge of the past and the numerous methods that have helped put those elements of the past into a temporal sequence.

AITKEN, M.J., 1990, Science-based dating in Archaeology, London: Longman.
INST ARCH AJ 10 AIT
ISSUE DESK IoA AIT

BOUSFIELD, B., 1992, Surface preparation and microscopy of materials, Chichester: John Wiley.
INST ARCH JKA BOU

BRANDON,D. & KAPLAN,W.D., 1999, Microstructural characterization of materials, Chichester: John Wiley.
INST ARCH JKA BRA
http://onlinelibrary.wiley.com/book/10.1002/9780470727133 **(2008 edition)**

GOFFER, Z., 2007, Archaeological chemistry, Chichester, John Wiley
INST ARCH JD GOF
http://onlinelibrary.wiley.com/book/10.1002/0471915254

GUINIER, A., 1984, The structure of matter, London: Edward Arnold.
PHYSICS J 5 GUI

HENDERSON, J., 2000, The science and archaeology of materials, London: Routledge.
INST ARCH JDA HEN
ISSUE DESK IOA HEN 11

JONES,M.P., 1987, Applied mineralogy: a quantitative approach, London: Graham & Trotman.
INST ARCH BA 11 JON

LEUTE, U., 1987, Archaeometry, Weinheim & New York: VCH. AJ LEU.
INST ARCH AJ LEU

McCRONE,W.C., McCRONE,L.B. & DELLY,J.G., 1978, Polarized light microscopy, Ann Arbor, Michigan: Ann Arbor Science.
INST ARCH JKA Qto MAC

SMART, P.L. & FRANCES, P.D., 1991, Quaternary dating methods – a user's guide, Cambridge, Quaternary Research Association.
INST ARCH AJ 10 SMA
GEOLOGY A 9 SMA
STORE 00-05888

TUCKER, M., 1988, Techniques in sedimentology, Oxford: Blackwell.
GEOLOGY E 57 TUC

Session 2: Introduction to optical and electron microscopy
Mike Charlton

This session will introduce the basic design and operation of the two most commonly used microscope types in archaeology. Some practical experience will be acquired using optical microscopes and a demonstration will be given of the scanning electron microscope (time and space permitting). We will also explore aspects of what is probably the single most important aspect of microscopy—sample preparation.

Barton, H., Torrence, R., 2015. Cooking up recipes for ancient starch: assessing current methodologies and looking to the future. J. Archaeol. Sci. 56, 194–201. doi:10.1016/j.jas.2015.02.031
http://www.sciencedirect.com/science/journal/03054403

Bell, S., & Morris, Keith. (2010). An introduction to microscopy. Boca Raton; London: CRC Press.
MEDICAL SCIENCES BB 50 BE

Davidson, M.W., Abramowitz, M., 2002. Optical microscopy. Encycl. imaging Sci. Technol., Wiley online library.
http://www.olympusmicro.com/primer/opticalmicroscopy.html

Edwards, K.J., Fyfe, R.M., Hunt, C.O., Schofield, J.E., 2015. Moving forwards? Palynology and the human dimension. J. Archaeol. Sci. 56, 117–132. doi:10.1016/j.jas.2015.02.010
http://www.sciencedirect.com/science/journal/03054403

FLEGER, S.L., HECKMAN, J.W., and KLOMPARENS, K.L., 1993, Scanning and transmission electron microscopy, New York: W.H.Freeman & Co.
MEDICAL SCIENCES BB 55 FLE

Goldstein, J., & Goldstein, J. (2003). Scanning electron microscopy and x-ray microanalysis (3rd ed.). New York ; London: Kluwer Academic/Plenum.
INST ARCH JKA GOL

Hunt, C.O., Rushworth, G., Dykes, A.P., 2007. UV-fluorescence microscopy and the coherence of pollen assemblages in environmental archaeology and Quaternary geology. J. Archaeol. Sci. 34, 562–571. doi:10.1016/j.jas.2006.06.011
http://www.sciencedirect.com/science/journal/03054403

JONES,M.P., 1987, Applied mineralogy: a quantitative approach, London: Graham & Trotman.
INST ARCH BA 11 JON

*McCrone, W.C., 1990. The Shroud of Turin: blood or artist's pigment? Acc. Chem. Res. 23, 77–83. doi:10.1021/ar00171a004
http://www.mcri.org.php53-15.dfw1-1.websitetestlink.com/uploads/the_microscope__shroud_small-1422560933.pdf
http://pubs.acs.org/toc/achre4/23/3

Olsen, S. (1988). Scanning electron microscopy in archaeology (BAR international series; 452). Oxford: B.A.R.
INST ARCH AJ 10 Qto OLS

POTTS, P.J., 1987, A handbook of silicate rock analysis, Glasgow & London: Blackie & Son.
INST ARCH JKA POT

REED, S.J.B., 1996, Electron microprobe analysis and scanning electron microscopy in geology, Cambridge: Cambridge University Press.
INST ARCH BA 10 REE
GEOLOGY A 9 REE

*Towe, K.M., 1990. The Vinland Map: still a forgery. Acc. Chem. Res. 23, 84–87. doi:10.1021/ar00171a005
http://pubs.acs.org/toc/achre4/23/3

WATT, I.M., 1997, (2nd ed.) The principles and practice of electron microscopy, Cambridge: CUP.
PHYSICS L30 WAT
IoA library JKA WAT

Session 3: Introduction to Ceramic Petrography
Patrick Quinn

This session will cover the application of the geological technique of thin section petrography to the study of ancient ceramics and related materials. Following a short introduction to the principles of optical mineralogy and petrography, we will consider, with the use of case studies, how 'ceramic petrography' can reveal information on the manufacturing technology of pottery and thus the cultural traditions of the people who made them. We will also examine how the geological information within sherds can inform us about their place of manufacture and detect the movement of ceramics via processes such trade, exchange and migration. The application of petrographic techniques to related artefacts such as plaster and stone will also be introduced. A hands-on practical session will provide the opportunity to observe ceramics in thin section under the microscope.

Day, P. M., Oren E. D., Joyner, L. and Quinn, P. S. 1999. Petrographic analysis of the Tel Haror inscribed sherd: Seeking provenance within Crete. In: (P. P. Betancourt, V. Karageorghis, R. Laffineur and W-D Neimeiee, eds.) Meletemata, Vol. 1, Aegaeum 20, Annales d'archéologie égéene de l'Université de Liège et UT-Pasp.

*Freestone, I. (1995). CERAMIC PETROGRAPHY. *American Journal of Archaeology*, 99(1), 111-115.
http://www.jstor.org/openurl?volume=99&date=1995&spage=111&issn=00029114&issue=1

Quinn, P. S. 2009. Interpreting Silent Artefacts: Petrographic Approaches to Archaeological Ceramics. Archaeopress, Oxford.
INST ARCH KD 3 QUI
ISSUE DESK IOA QUI 2

Quinn, P. S. 2013. *Ceramic Petrography: The Interpretation of Archaeological Pottery & Related Artefacts in Thin Section*. Archaeopress, Oxford.
INST ARCH KD 3 QUI
ISSUE DESK IOA QUI 1

Quinn, P. S. and Burton, M. 2009. Ceramic Petrography and the Reconstruction of Hunter-Gatherer Craft Technology in Late Prehistoric Southern California. In: Quinn, P. S. (Ed.) *Interpreting Silent Artefacts: Petrographic Approaches to Archaeological Ceramics.* Archaeopress: 267-295.
INST ARCH KD 3 QUI
ISSUE DESK IOA QUI 2

*Quinn, P. S., Day, P. M. and Kilikoglou, V. 2010. Keeping An Eye on Your Pots: The Provenance of Neolithic Ceramics from Cyclops Cave on the Island of Youra, Greece. *Journal of Archaeological Science*. 37: 1042-1052.
http://www.sciencedirect.com/science/journal/03054403

MACKENZIE, W.S. & ADAMS, A.E., 1994, A colour atlas of rocks and minerals in thin section, London, Manson Publishing.
INST ARCH BA 11 MAC
GEOLOGY D 32 MAC

Peacock, D. P. S. 1969. Neolithic Pottery Production in Cornwall. Antiquity, 43: 145-149.
http://journals.cambridge.org.libproxy.ucl.ac.uk/action/displayJournal?jid=AQY

REEDY, C.L., 2008, Thin-section petrography of stone and ceramic cultural materials, London, Archetype Publications.
INST ARCH BA 10 Qto REE
ISSUE DESK IOA REE 7

Whitbread, I. K. 1995 Greek Transport Amphorae: A Petrological and Archaeological Study. Fitch Laboratory Occasional Paper, 4. British School at Athens.
YATES P 70 WHI

Whitbread, I K. 2001. Ceramic Petrology, Clay Geochemistry and Ceramic Production – from Technology to the Mind of the Potter. In: (Brothwell, D. R. and Pollard, A. M.) Handbook of Archaeological Sciences, Wiley: 449–458.
INST ARCH AJ BRO
ISSUE DESK IOA BRO 15

Session 4: Metallography of archaeological metals
John Merkel

In this session, John Merkel will introduce you to metallography—the scientific study of metal microstructures. Metallic alloys are solids composed of a vast number of small crystals, or grains. Observations of the shape, size and color of these grains, usually exposed by chemical etching, can shed light on alloy composition and properties as well as the manufacturing processes they underwent. More importantly, these observations offer insights on past technological knowledge and appropriate conservation procedures.

SCOTT, D.A., 1991, *Metallography and microstructure of ancient and historic metals*, London: Archetype & J. Paul Getty Trust.
INST ARCH KEB Qto SCO

Session 5: Micromorphology of archaeologically related sediments
Manuel Arroyo-Kalin

Soil micromorphology involves the microscopic investigation of soil constituents, especially their structure and character. These relationships provide detailed information about soil development, including diagnostic anthropogenic signatures. In this session, Manuel Arroyo-Kalin introduces some of the key methods and models used in the application of micromorphology to archaeological problems.

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* Goldberg, P. and Berna, F., 2010. Micromorphology and context Quaternary International 214 (1-2), 56-62.
http://www.sciencedirect.com/science/journal/10406182

Goldberg, P., & Macphail, R. (2006). *Practical and Theoretical Geoarchaeology* . Oxford: Blackwell. Ch. 16
http://onlinelibrary.wiley.com/book/10.1002/9781118688182
INST ARCH BA 10 GOL
ISSUE DESK IOA GOL 2

* Macphail, R. I.; Goldberg, P. Archaeological Materials. In: Stoops, G.;Marcelino, V., et al (Ed.). Interpretation of Micromorphological Features of Soils and Regoliths. Amsterdam: Elsevier, 2010.p.589-621.
http://www.sciencedirect.com/science/book/9780444531568
INST ARCH BA 23 STO

Reference works on micromorphological analysis:
Bullock, P., Fedoroff, N., Jongerius, A., Stoops, G., &Tursina, T. (1986). /Handbook for Soil Thin Section Description/ (1st ed.). Wolverhampton, UK: Waine Research Publications.
INST ARCH BA 23 Qto BUL

Courty, M.-A., Macphail, R., & Goldberg, P. (1989). *Soils and Micromorphology in Archaeology*. Cambridge: Cambridge University Press.
INST ARCH BA 23 COU

Kemp, RA. Soil Micromorphology and the Quaternary. Cambridge: Quaternary Research Association Technical Guide No. 2, 1985.
INST ARCH BA 23 KEM

Stoops, G. (2003). Guidelines for Analysis and Description of Soil and Regolith Thin Sections. Madison, Wisconsin, Soil Science Society of America.
INST ARCH BA 23 STO

Session 6: Microscopy of archaeological fibres and textiles
Margarita Gleba

The generic term 'textile' covers a wide variety of raw materials which have in common only their ultimate product. Throughout history resources for making textiles included a variety of wild and domesticated plant and animal fibres, as well metals. Identifying these materials is crucial for our understanding of textile uses and fibre preferences. It also provides us with important data about ancient agriculture (flax and cotton cultivation), animal husbandry (sheep keeping, silkworm rearing) and exploitation of environmental resources (nettle, tree bast, sea silk). In this session we will look at the various microscopic methods for identifying the principal textile raw materials focusing in particular on sheep wool, plant fibres (flax, hemp, tree bast, cotton), silk, metal thread, as well as wool fibre quality analysis. We will also consider how preservation conditions influence our ability to identify textile fibres.

Appleyard, J.M. (1978) *Guide to the Identification of Animal Fibres*. Leeds.
INST ARCH KJ APP

*Bergfjord, C. and Holst, B. (2010) A procedure for identifying textile bast fibres using microscopy: flax, nettle/ramie, hemp and jute, *Ultramicroscopy*, **110** 1192
http://www.sciencedirect.com/science/journal/03043991

Bischoff, J.J. and Murray A. (2005) Digital microscopy and applications of digital image analysis for the study of textile fibres. In R. Janaway and P. Wyeth (eds), Scientific Analysis of Ancient and Historic Textiles: Informing Preservation, Display and Interpretation. London, 95-101.
INST ARCH KJ Qto JAN

Catling, D., and Grayson, J. (2004) *Identification of Vegetable Fibres*. London.
INST ARCH KH CAT

*Fischer, A. 2010, "Current Examinations of Organic Remains using Variable Pressure Scanning Electron Microscopy [VP-SEM]," in *North European Symposium for Archaeological Textiles X*, vol. 5 E. Andersson Strand et al., eds., Oxbow, Oxford and Oakville, pp. 57-62.
INST ARCH KJ Qto STR

Gale, R. and Cutler, D. (2000) *Plants in archaeology: identification manual of vegetative plant materials used in Europe and the southern Mediterranean to c. 1500*. Westbury and Royal Botanic Gardens, Kew, Otley.
INST ARCH BB 51 Qto GAL

*Gleba, M. (2012) From textiles to sheep: investigating wool fibre development in pre-Roman Italy using scanning electron microscopy (SEM). *Journal of Archaeological Science* 39, 3643-3661. http://www.sciencedirect.com/science/journal/03054403

Greaves, P.H. and Saville, B.P. (1995) *Microscopy of Textile Fibres*. Oxford
INST ARCH KJ GRE

Haugan, E. and Holst, E. (2013) Determining the fibrillar orientation of bast fibres with polarized light microscopy: the modified Herzog test (red plate test) explained., *Journal of Microscopy,* Vol. 252, Issue 2, pp. 159–168
http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291365-2818

Rast-Eicher, A. and Bender Jørgensen, L. (2013) Sheep wool in Bronze Age and Iron Age Europe. *Journal of Archaeological Science* 40, 1224-1241.
http://www.sciencedirect.com/science/journal/03054403

Ryder, M. and Gabra-Sanders, T. (1985) The Application of Microscopy to Textile History. *Textile History* 16(2), 123-140.
http://www.maneyonline.com/loi/tex

Ryder, M. and Gabra-Sanders, T. (1987) A microscopic study of remains of textiles made from plant fibres. *Oxford Journal of Archaeology* 6 (1), 91-108.
http://onlinelibrary.wiley.com/journal/10.1111/%28ISSN%291468-0092

Wang, H. M. and Wang, X. (2005) Surface Morphologies and Internal Fine Structure of Bast Fibers. *Fibers and Polymers* 6(1), 6-12.
http://www.springer.com/chemistry/polymer+science/journal/12221

Session 7: Science based dating in archaeology
Michael Charlton

This session will explore various approaches to measuring time in archaeology. Traditional archaeological approaches to building chronologies using seriation and superposition of artefact types are discussed and contrasted with chronometers based on natural phenomena such as sediment deposition, annular growth cycles of trees, non-human biological development and evolution and radioactive decay.

*Clark, A.J., Tarling, D.H., Noël, M., 1988. Developments in archaeomagnetic dating in Britain. J. Archaeol. Sci. 15, 645–667. doi:10.1016/0305-4403(88)90058-1
http://www.sciencedirect.com/science/journal/03054403

Crew, P., 2002. Magnetic mapping and dating of prehistoric and medieval iron-working sites in northwest Wales. Archaeol. Prospect. 9, 163–182. doi:10.1002/arp.191
http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291099-0763

Damon, P.E., Donahue, D.J., Gore, B.H., Hatheway, A.L., Jull, A.J.T., Linick, T.W., Sercel, P.J., Toolin, L.J., Bronk, C.R., Hall, E.T., Hedges, R.E.M., Housley, R., Law, I.A., Perry, C., Bonani, G., Trumbore, S., Woelfli, W., Ambers, J.C., Bowman, S.G.E., Leese, M.N., Tite, M.S., 1989. Radiocarbon dating of the Shroud of Turin. Nature 337, 611–615.
http://www.nature.com/nature/archive/index.html

*Hellstrom, J., Pickering, R., 2015. Recent advances and future prospects of the U-Th and U-Pb chronometers applicable to archaeology. J. Archaeol. Sci. 56, 32–40.
http://www.sciencedirect.com/science/journal/03054403

Hunt, C.O., Gilbertson, D.D., Hill, E.A., Simpson, D., 2015. Sedimentation, re-sedimentation and chronologies in archaeologically-important caves: problems and prospects. J. Archaeol. Sci. 56, 109–116. doi:10.1016/j.jas.2015.02.030
http://www.sciencedirect.com/science/journal/03054403

Leroy, S., Héritier, M.L., Delqué-kolic, E., 2014. Consolidation or initial design? Radiocarbon dating of ancient iron alloys sheds light on the reinforcements of French gothic cathedrals. doi:10.1016/j.jas.2014.10.016.
http://www.sciencedirect.com/science/journal/03054403

Phillips, T.J., 1989. Shroud irradiated with neutrons? Nature 337, 594–594. doi:10.1038/337594a0
http://www.nature.com/nature/archive/index.html

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Session 8a: Phytoliths and Pollen
Eleanor Kingwell-Banham

During this session, Eleanor Kingwell-Banham will lead you through a basic introduction to microenvironmental analyses. What are pollen and phytoliths? How do you identify them? How do they contribute to understanding past land use, paleoenvironments and agricultural strategies?

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*PIPERNO, D. R. (2006) Phytoliths : a comprehensive guide for archaeologists and paleoecologists. AltaMira Press, Lanham, MD.
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INST ARCH BB 5 PIP

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*Shillito, L.-M., 2013. Grains of truth or transparent blindfolds? A review of current debates in archaeological phytolith analysis. Veg. Hist. Archaeobot. 22, 71–82. doi:10.1007/s00334-011-0341-z
http://link.springer.com/journal/334

Session 8b: Microscopy of teeth—use-wear and life history
Marija Edinborough

The session will explore application of microscopic analyses in the study of human teeth. Food mastication is a primary function of teeth, but in archaeological contexts teeth can also be considered as artefacts of human behaviour and/or as archive of life history events. On the basis of case studies it will be shown how specific task-related activities involving teeth-as-tools can be detected using SEM analyses. Marija Edinborough will also demonstrate importance of microscopy and micro-imaging in reconstructing age and life history parameters from teeth.

Bonfiglioli, B., Mariotti, V., Facchini, F., Belcastro, M. G., & Condemi, S. (2004). Masticatory and non-masticatory dental modifications in the epipalaeolithic necropolis of Taforalt (Morocco). *International Journal of Osteoarchaeology*,*14*(6), 448-456.
http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291099-1212

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Minozzi, S., Manzi, G., Ricci, F., di Lernia, S., & Borgognini Tarli, S. M. (2003). Nonalimentary tooth use in prehistory: an example from early Holocene in Central Sahara (Uan Muhuggiag, Tadrart Acacus, Libya). *American journal of physical anthropology*, *120*(3), 225-232.
http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291096-8644

Radović, M. B. (2012). Ageing in the Danube gorges population (9500-5500 BC): Tooth cementum annulation method.*Starinar*, (62), 9-18.
http://www.doiserbia.nb.rs/Article.aspx?ID=0350-02411262009R#.VhOmXPmqqkp

Wittwer-Backofen, U., Gampe, J., & Vaupel, J. W. (2004). Tooth cementum annulation for age estimation: Results from a large known-age validation study. *American Journal of Physical Anthropology*, *123*(2), 119-129.
http://onlinelibrary.wiley.com/doi/10.1002/ajpa.10303/pdf

Session 9: Dendrochronology and wood identification
Martin Bridge

This session examines what is arguably the single most important material in the archaeological record—wood. Important for crafting structures, building fires and making charcoal, it provides a log of human choices, ecological structure and time. Martin Bridge will guide us through the process of identifying wood and building absolute dating sequences from tree-rings (dendrochronology). Examples will be provided from his own research.

An atlas of end-grain photomicrographs for the identification of hardwoods. (1953) HMSO
STORE 13-0904

Baillie, M. G. L. (1982) Tree-Ring Dating and Archaeology, London
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Baillie, M. G. L. (1995) A slice through time - dendrochronology and precision dating, London
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Baillie, M.G.L. and Pilcher, J.R. (1973) A simple cross-dating program for tree-ring research. *Tree Ring Bulletin*, 33, 7-14.
http://www.treeringsociety.org/TRBTRR/TRBTRR.htm

Brazier, J.D. and Franklin, G.L. (1961) Identification of Hardwoods: a microscopic key. HMSO
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Bridge, M. C. (1988) The dendrochronological dating of buildings in southern England, *Medieval Archaeology*, 32, 166-174.
http://www.maneyonline.com/loi/med

*Bridge, M. C. (2000) Can dendrochronology be used to indicate the source of oak within Britain? *Vernacular Architecture*, 31, 67-72
http://www.maneyonline.com/loi/vea

*Bridge, M.C. (2011) Resource exploitation and wood mobility in Northern European oak: dendroprovenancing individual timbers from the Mary Rose (1510/11-1545), International Journal of Nautical Archaeology, 40, 417-423.
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*Bridge, M. C. (2012) Locating the origins of wood resources: a review of dendroprovenancing, Journal of Archaeological Science, 39, 2828-34.
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Edlin, H.L. (1977) What wood is that? A manual of wood identification. Stobart Davies.
INST ARCH KC EDL
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Hoadley, R.B. (1990) Identifying Wood: accurate results with simple tools. Taunton Press.
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Miles, D. (1997) The interpretation, presentation, and use of tree-ring dates, *Vernacular Architecture*, 28, 40-56.
http://www.maneyonline.com/loi/vea

Schweingruber, F.H. (1988) Tree Rings: basics and applications of dendrochronology. Dorcrecht, Reidel.
INST ARCH AJ 10 SCH

Wilson, K. and White, D.J.B. (1986) The Anatomy of Wood: its diversity and variability. Stobart.
INST ARCH KC WIL
BOTANY 84 h WIL

Session 10: Recent research in radiocarbon dating
Kevan Edinborough

This session will offer a detailed overview of radiocarbon dating—the most widely used scientific dating method in archaeology. It will explore the many issues involved in sampling, calibration and date generation, highlighting areas of potential trouble. Kevan Edinborough will also demonstrate how these dates can be used as data to help build and test a wide range of hypotheses related to human populations and their behaviour.

Buchanan, B., Collard, M., Edinborough, K. 2008. Paleoindian demography and the extraterrestrial impact hypothesis. Proceedings of the National Academy of Science USA (PNAS), 105: 11651-11654.
http://www.pnas.org/

*Burley, D.V., Edinborough, K., 2013. Discontinuity in the Fijian Archaeological Record Supported by a Bayesian Radiocarbon Model. Radiocarbon 56, 295–303.
https://journals.uair.arizona.edu/index.php/radiocarbon/index

*Collard, M., Edinborough, K., Shennan, S., Thomas, M.G., 2010. Radiocarbon evidence indicates that migrants introduced farming to Britain. J. Archaeol. Sci. 37, 866–870.
doi:10.1016/j.jas.2009.11.016
http://www.sciencedirect.com/science/journal/03054403

Riede, F., Edinborough, K., 2012. Bayesian radiocarbon models for the cultural transition during the Allerød in southern Scandinavia. J. Archaeol. Sci. 39, 744–756. doi:10.1016/j.jas.2011.11.008
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*Shennan, S.J., Downey, S., Timpson, A., Edinborough, K., Colledge, S., Kerig, T., Manning. K., Thomas. M. 2013. Regional population collapse followed initial agriculture booms in mid-Holocene Europe. In, Nature Communications: 2041-1723.
http://www.nature.com/ncomms/2013/131001/ncomms3486/full/ncomms3486.html

Timpson, A., Colledge, S., Crema, E., Edinborough, K., Kerig, T., Manning, K., Thomas, M.G., Shennan, S., 2014. Reconstructing regional population fluctuations in the European Neolithic using radiocarbon dates: a new case-study using an improved method. J. Archaeol. Sci. 52, 549–557. doi:10.1016/j.jas.2014.08.011
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*Whittle, A., Bayliss, A., Healy, F., 2008. The Timing and Tempo of Change: Examples from the Fourth Millennium cal. BC in Southern England. Cambridge Archaeol. J. 18, 65–70.
http://journals.cambridge.org/action/displayJournal?jid=CAJ

Woodbridge, J., Fyfe, R.M., Roberts, N., Downey, S., Edinborough, K., Shennan, S., 2014. The impact of the Neolithic agricultural transition in Britain: a comparison of pollen-based land-cover and archaeological 14C date-inferred population change. J. Archaeol. Sci. 51, 216–224. doi:10.1016/j.jas.2012.10.025
http://www.sciencedirect.com/science/journal/03054403

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4 ONLINE RESOURCES

http://zeiss-campus.magnet.fsu.edu/

http://www.olympusmicro.com/

http://www.microscope-microscope.org

http://www.ammrf.org.au/myscope/

http://mcri.org/v/64/the-shroud-of-turin

https://www.historicengland.org.uk/advice/technical-advice/archaeological-science/scientific-dating/

https://c14.arch.ox.ac.uk/embed.php?File=oxcal.html

http://intcal.qub.ac.uk/intcal13/

5 ADDITIONAL INFORMATION

Libraries and other resources

In addition to the Library of the Institute of Archaeology, other libraries in UCL with holdings of particular relevance to this degree are: the UCL Science Library and UCL Bartlett Library.

Information for intercollegiate and interdepartmental students

Students enrolled in Departments outside the Institute should obtain the Institute's coursework guidelines from Judy Medrington (email j.medrington@ucl.ac.uk), which will also be available on the IoA website.

Health and safety

The Institute has a Health and Safety policy and code of practice which provides guidance on laboratory work, etc. This is revised annually and the new edition will be issued in due course. All work undertaken in the Institute is governed by these guidelines and students have a duty to be aware of them and to adhere to them at all times. This is particularly important in the context of the laboratory work which will be undertaken as part of this course.

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INSTITUTE OF ARCHAELOGY COURSEWORK PROCEDURES

General policies and procedures concerning courses and coursework, including submission procedures, assessment criteria, and general resources, are available in your Degree Handbook and on the following website: http://wiki.ucl.ac.uk/display/archadmin. It is essential that you read and comply with these. Note that some of the policies and procedures will be different depending on your status (e.g. undergraduate, postgraduate taught, affiliate, graduate diploma, intercollegiate, interdepartmental). If in doubt, please consult your course co-ordinator.

GRANTING OF EXTENSIONS:

New UCL-wide regulations with regard to the granting of extensions for coursework have been introduced with effect from the 2015-16 session. Full details will be circulated to all students and will be made available on the IoA intranet. Note that Course Coordinators are no longer permitted to grant extensions. All requests for extensions must be submitted on a new UCL form, together with supporting documentation, via Judy Medrington's office and will then be referred on for consideration. Please be aware that the grounds that are now acceptable are limited. Those with long-term difficulties should contact UCL Student Disability Services to make special arrangements.