ISOTOPE ANALYSIS OF ARCHAEOLOGICAL MATERIALS AT THE BIOARCHAEOLOGY LABORATORY, CARDIFF UNIVERSITY (UK)

Course ID: HIS 489

Summer Session: Jul 20-31, 2026

Winter Session: Jan 4-15, 2027

Academic Credits: 4 Semester Credit Units (Equivalent to 6 Quarter Units)

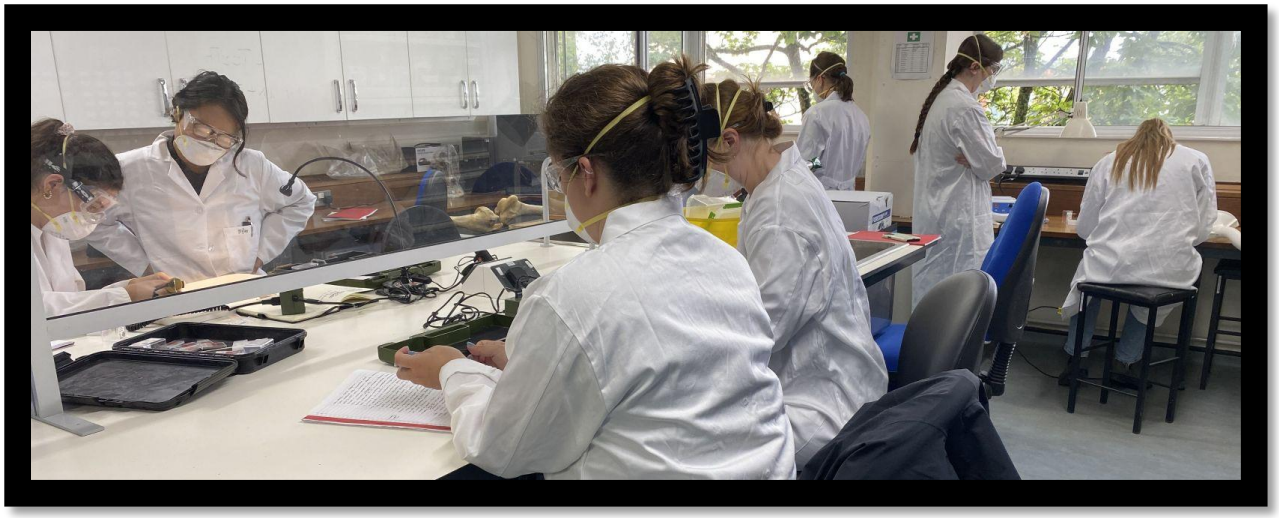
School of Record: Culver Stockton College

This program does not provide accommodation or meals. Cardiff is the capital and largest city of Wales (UK), with many hotels, short term rentals grocery store and restaurants for all price ranges. Collegiate offers various student housing at three different location around the university, starting at £135 (ca. $175) per week.

DIRECTORS:

Dr. Emily Holt – Archaeological Science Project Officer, Cardiff University BioArchaeology Lab, UK (holte@cardiff.ac.uk)

Dr. Richard Madgwick – Professor of Archaeological Science, School of History at Cardiff University, UK (madgwickrd3@cardiff.ac.uk)



PROGRAM DESCRIPTION

Isotope analysis of ancient materials has become a key component of the archaeologist's toolkit. Strontium and sulfur isotopes help document ancient mobility patterns. Carbon and nitrogen isotopes provide insights into animal and human diets. Oxygen isotopes help reconstruct environmental change. The list of relevant isotopes is long, and all provides important archaeological data about life and choices humans made in the past. Understanding how isotope analysis works, therefore, is an essential skill for archaeologists, whether as

archaeological scientists pursuing isotope analysis for their own research or as critical consumers of their colleagues' conclusions.

This program provides a hands-on introduction to the basics of archaeological isotope analysis. Students will work with the semi-commercial unit Cardiff University BioArchaeology (C•U•BA), learning the theoretical foundations of isotope analysis and gaining practical experience with sample selection, physical and chemical sample preparation, sample analysis and laboratory safety. Students will work with materials from a variety of sites and time periods. Students should expect to analyze materials coming from animal and human remains found in archaeological contexts.

IMPORTANT DISCLAIMER

The Anthropocene Research Center was established to support field training in a range of sciences at sites within the U.S. & across the world. Traveling and conducting field work involves risk. Students interested in participating in any ARC program must weigh the potential risk against the value of education provided by the program of their choosing.

Risk is inherent in everything we do, and the ARC takes risks seriously. A committee of leading scholars review each field school location prior to approval. Once a program is accepted, the ARC continually monitors conditions at the program's site and so we can provide an experience that is as safe as possible.

The ARC does not provide trip or travel cancellation insurance. Students are encouraged to explore such insurance policies on their own. Post Covid 19, most basic policies do not cover trip cancelation due to pandemics. If you wish to purchase an insurance policy that covers such contingencies, explore Cancel for Any Reason (CFAR) plans. Insuremytrip.com, Squaremouth.com or Travelguard.com are possible websites where students may explore different insurance policies.

Students should be aware that conditions in the field are different than those experienced at home, dorms or college towns. Students will be exposed to the elements, live in rustic accommodation, and expect to engage in daily physical activity.

We do our best to follow schedule and activities as outlined in this syllabus. Yet local permitting agencies, political, environmental, personal, and/or weather conditions may force changes. This syllabus, therefore, is only a general commitment. Students should allow flexibility and adaptability as research work is frequently subject to modification.

All students must consult medical professionals to ensure they are fit to participate in an ARC field program. ARC is not qualified to provide medical advice. For all other concerns, please consult with ARC staff members or program director(s) – as appropriate.

COURSE OBJECTIVES

The main objective of this program is to introduce students to the theory and practice of archaeological isotope analysis.

To achieve this objective, the program will (a) engage students in developing a practical working knowledge of **laboratory methods for isotope analysis** through hands-on participation in all aspects of physical and chemical sample preparation; (b) introduce students to the **intellectual challenges presented by archaeological isotope analysis**, including research design and the interpretation of data; and (c) introduce students to the **ethical complexities of sampling archaeological collections and working with human remains** through lectures, critical reading, and discussion.

Students will participate in the following research activities:

Sample preparation: Students will use drills, scalpels, and ultrasonicators to prepare enamel, dentine, and bone specimens for carbon/nitrogen/sulfur, oxygen, and strontium/lead analysis.

Collagen extraction: Students will use fume hoods, acids, hot blocks, filters, freezers, and freeze dryers to extract collagen from dentine and bone specimens and prepare it for analysis.

Record keeping: Students will lab notebooks and record sheets to correctly document all processes and samples.

LEARNT SKILLS

We are aware and strongly support students who seek employment in the Cultural Resource Management sector – whether with private CRM companies on in government compliance agencies. CRM employers seek to understand the skills students learn at the field school, so listing (and ranking) those should help students secure CRM employment. To that end, we are listing all the skills students will learn during this program. At the end of the field school, students will get a Certificate of Completion, where each skill will be ranked at one of three levels:

- ✓ **Basic**: Can perform the skill/task with some supervision.
- ✓ **Competent**: Can perform the skill/task without any supervision.
- ✓ **Advanced**: Can perform the skill/task and teach others how to do it.

Students will be trained in the following skills:

Skill	Skill Definition
Sample prep	Ability to use tools such as drills, scalpels, and ultrasonicators to clean and prepare enamel, dentine, and bone specimens
Collagen extraction	Ability to use fume hoods, acids, hot blocks, filters, freezers, and freeze dryers to extract archaeological collagen and prepare it for analysis
Record keeping	Ability to use lab notebooks and recording sheets to correctly document samples and procedures for isotope analysis
Lab Safety	Knowledge of correct safety procedures and PPE to physically and chemically prepare specimens for isotope analysis
Theory and applications	Knowledge of the scientific foundations of isotope analysis and the potential applications of isotope analysis to archaeological research questions
Bioarchaeology	Knowledge of how isotope analysis can be applied to human remains
Zooarchaeology	Knowledge of how isotope analysis can be applied to faunal remains

ACADEMIC GRADING MATRIX

Students will be graded based on their work as follows.

50%: Attend and participate each scheduled day, including lectures, practicals, and discussions

50%: Record keeping: includes sampling sheets and lab notebooks that will be submitted and evaluated at the end of the course

COURSE SCHEDULE

Week 1		Readings
Monday	**Morning:** • Introductions; lab tours; introduction to lab safety and signing of risk assessments; issuing PPE; introduction to record keeping • Lecture: Isotope Analysis in Archaeology: Principles and Methods	**Required**: • Britton and Richards, "Introducing Archaeological Science" • Somerville and Beasley, "Exploring Human Behavior Through Isotopic Analyses"

	Afternoon: • Practicals: introduction to drills; introduction to sample selection; introduction to collagen weighing • Discussion: questions and first impressions	• Cardiff University SHARE, "Policy for the Care, Treatment and Storage of Archaeological Human Remains"
Tuesday	**Morning:** • Practicals: drill setup and drilling practice; practice sample selection; practice collagen weighing • Lecture: Isotopes and Human Diet **Afternoon:** • Practicals: drill setup and drilling practice; practice sample selection; practice collagen weighing • Discussion	**Required**: • Richards, "Isotope Analysis for Diet Studies"
Wednesday	**Morning:** • Practicals: introduction to sampling for strontium, oxygen, and carbon/nitrogen/sulfur • Lecture: Isotope Approaches to Mobility **Afternoon:** • Practical: continue drill sampling practice • Discussion	**Required**: • Britton, "Isotope Analysis for Mobility and Climate Studies" **Recommended**: • Evans *et al.*, "Applying lead (Pb) isotopes to explore mobility in humans and animals" • Holt *et al.*, "Strontium ($^{87}Sr/^{86}Sr$) mapping: A critical review of methods and approaches
Thursday	**Morning:** • Practical: begin collagen extraction chemistry • Lecture: Isotopes and Animal Management **Afternoon:** • Practical: work on projects (sampling or chemistry) • Discussion	**Required**: • Madgwick *et al.*, "Multi-isotope analysis demonstrates long distance movement of people and animals for feasts in the Stonehenge landscape" **Recommended**: • Kinaston, "Isotopes, Domestication, and Past Animal Husbandry Practices" • Messana *et al.*, "Between valleys, plateaus, and mountains"
Friday	**Morning:** • Practical: introduction to ultrasonicator, then work on projects (sampling or chemistry) **Afternoon:** • Practical: continue project work • Discussion	**Required**: • Madgwick *et al.*, "Farming and feasting during the Bronze Age-Iron Age transition in Britain" **Recommended**: • Ventresca Miller et al., "Subsistence and social change in central Eurasia"
Week 2		**Readings**
Monday	**Morning:** • Practical: introduction to collagen filtering and freezing, then work on projects • Computer practical: Presenting and Interrogating Isotope Data **Afternoon:** • Practical: continue project work • Discussion	**Required**: • Scorrer *et al.*, "Diversity aboard a Tudor warship: Investigating the origins of the Mary Rose crew using multi-isotope analysis" **Recommended**: • Suzuki *et al.*, "Isotopic proveniencing at Classic Copan and in the southern periphery of the Maya area"
Tuesday	**Morning:**	

	• Practical: continue project work • Lecture: Plant Isotope Analysis: Problems and Potential **Afternoon:** • Practical: continue project work • Discussion	
Wednesday	**Morning:** • Practical: introduction to freeze dryer, then continue project work • Lecture: Novel Isotope Approaches **Afternoon:** • Practical: continue project work • Discussion	
Thursday	**Morning:** • Practical: continue project work • Lecture: Research Showcase **Afternoon:** • Practical: begin project work wrap-up • Discussion	
Friday	**Morning:** • Practical: finalize project work and recording, tidy lab spaces • (No lecture today) **Afternoon:** • Turn in lab notebooks and record sheets • Discussion: Takeaways and Future Directions • Course evaluation	**Required**: • Szpak, "Stable Isotope Analysis in Archaeology – Current Perspectives and Future Directions"

- Course structure may be subject to change upon directors' discretion. The course meets on weekdays only.

A TYPICAL WORKDAY

Time	Activity
8:00am-12:00pm	Morning practical and lecture
12:00-1:00pm	Break for lunch
1:00-5:00pm	Afternoon practical and discussion

ATTENDANCE POLICY

The required minimum attendance for the successful completion of the field school is 85% of the course hours. Any significant delay or early departure from an activity will be calculated as an absence from the activity. An acceptable number of absences for medical or other personal reasons will not be considered if the student catches up on the program study plan through additional readings, homework or tutorials with program staff members.

PREREQUISITES

There are no prerequisites. This is hands-on, experiential learning, and students will study on-site how to conduct archaeological isotope analysis. The work requires patience, discipline, manual dexterity, and attention to detail.

TRAVEL & MEETING POINT/TIME

We suggest you hold purchasing your airline ticket until six (6) weeks prior to departure date. Natural disasters, political changes, weather conditions and a range of other factors may

require the cancelation of a program. The CFS typically takes a close look at local conditions 6-7 weeks prior to program beginning and makes a Go/No Go decision by then. Such time frame still allows for the purchase of deeply discounted airline tickets while protecting students from potential loss of airline ticket costs if CFS is forced to cancel a program.

Students will meet the program directors in the reception area of Cardiff University's John Percival Building, Colum Drive, at 8:00am on Monday, first day of the program (Fig 1).

If you missed your connection or your flight is delayed, please call, text or email project director immediately. A local emergency cell phone number will be provided to all enrolled students.

Figure 1: Cardiff University's John Percival Building

PROGRAM ETIQUETTE

Cultural norms in Cardiff are similar to cultural norms in many cities in North America. Cardiff is quite international, and students should be prepared to encounter and respect people from a wide variety of cultures and backgrounds. Students should also be aware and respectful of the Welsh national heritage. Welsh is an official language in Wales, and signs throughout the university and city are bilingual.

EQUIPMENT LIST

No specific equipment is needed for this course. Students are required to wear closed-toe shoes and socks in the lab.

VISA REQUIREMENTS

US citizens and most other visitors travelling to the UK need an Electronic Travel Authorisation (ETA) to visit the UK. An ETA costs £16. Students must obtain ETA on their own and the cost is not covered by the program's tuition.

Citizens of other countries are asked to check the UK Embassy website at their home country for specific visa requirements.

MEALS & ACCOMMODATION

Students are responsible for finding their own accommodations and supplying their own food. There are many options for affordable temporary housing in Cardiff. There are many AirBnBs in the city. Sublets and short-term leases are available and are particularly common during the summer when many students leave town. There are also low-cost hostels and hotels in the city

center. Collegiate offers various student housing at three different locations around the university, starting at £135 (ca. $175) per week.

Inexpensive meal options can be found in grocery stores and restaurants around Cardiff. A meal deal from any of the major grocery stores (Tesco, Sainsbury's, Coop) includes choice of a main dish (sandwich, salad, pasta), a snack, and a drink, and can be purchased for approximately $6.00. Many of the small eateries and fast-food restaurants around campus offer meal deals costing approximately $8.00-$13.00. There are also pubs and restaurants near the program site that offer hot meals for approximately $13.00-$20.00.

Cardiff's public transportation is excellent, connecting the city with efficient & affordable bus & train systems. Cardiff also has efficient train system, connecting it to destinations across the United Kingdom.

PRACTICAL INFORMATION

International dialing code: +44

Money/Banks/Credit Cards: Great British Pound. For current exchange rate, see https://www.xe.com/currencyconverter. Credit cards, debit cards, and payment apps are widely accepted, and some restaurants and businesses are cashless.

ATM Availability: ATMs are widely available

Local Language: Wales is a bilingual country; both English and Welsh are spoken in Cardiff. Students can expect that speaking English is an option in all shops, restaurants, medical facilities, etc.

Measure units: degree Celsius (ºC), meter (m.), gram (gr.), liter (l)

ACADEMIC CREDITS & TRANSCRIPT

Attending students will be awarded 4 semester credit units (equivalent to 6 quarter credit units). Students will receive a letter grade for attending this field school based on the assessment matrix (above). This program provides a minimum of 80 direct instructional hours. Students are encouraged to discuss the transferability of credit units with faculty and the registrar at their home institutions prior to attending this program.

Students will be able to access their transcripts through our School of Record – Culver-Stockton College. C-SC has authorized the National Student Clearinghouse to provide enrollment and degree verification (at https://tsorder.studentclearinghouse.org/school/select). Upon completion of a program, students will get an email from C-SC with a student ID that may be used to retrieve transcripts. The first set of transcripts will be provided at no cost; additional transcripts may require payment. If you have questions about ordering a transcript, contact the C-SC office of the registrar at registrar@culver.edu.

REQUIRED READINGS

PDF files of all mandatory readings will be provided to enrolled students via a shared Dropbox folder.

- Britton K, and Richards M. Introducing Archaeological Science. In K Britton and M Richards (eds) *Archaeological Science: An Introduction*, pp. 3-10. Cambridge University Press: Cambridge.
- Somerville A, Beasley M. 2023. Exploring Human Behavior Through Isotopic Analyses: Tools, Scales, and Questions. In M Beasley and A Somerville (eds) *Exploring Human Behavior Through Isotope Analysis. Applications in Archaeological Research*, pp. 9-32. Springer: Cham, Switzerland.

- Cardiff University SHARE. Nd. Policy for the Care, Treatment and Storage of Archaeological Human Remains. Internal document.
- Richards M. 2020. Isotope Analysis for Diet Studies. In K Britton and M Richards (eds) *Archaeological Science: An Introduction*, pp. 125-143. Cambridge University Press: Cambridge.
- Britton K. 2020. Isotope Analysis for Mobility and Climate Studies. In K Britton and M Richards (eds) *Archaeological Science: An Introduction*, pp. 99-124. Cambridge University Press: Cambridge.
- Scorrer J, Faillace, K, Hildred A, Nederbragt A, Andersen M, Millet M-A, Lamb A, Madgwick R. 2021. Diversity aboard a Tudor warship: Investigating the origins of the Mary Rose crew using multi-isotope analysis. *Royal Society Open Science* 8: 202106.
- Madgwick R, Lamb A, Sloane H, Nederbragt A, Albarella U, Parker Pearson M, Evans J. 2019. Multi-isotope analysis demonstrates long distance movement of people and animals for feasts in the Stonehenge landscape. *Science Advances* 5: eaau6078.
- Madgwick, R, Esposito C, Lamb A 2023. Farming and feasting during the Bronze Age–Iron Age transition in Britain (ca. 900–500 bce): multi-isotope evidence for societal change. *Frontiers in Environmental Archaeology* 2: 122158.
- Szpak P. 2023. Stable Isotope Analysis in Archaeology – Current Perspectives and Future Directions. In M Beasley and A Somerville (eds) *Exploring Human Behavior Through Isotope Analysis*. *Applications in Archaeological Research*, pp. 295-303. Springer: Cham, Switzerland.

RECOMMENDED READINGS

- Evans J, Pashley V, Mee D, Wagner D, Parker Pearson M, Fremondeau D, Albarella U, Madgwick R 2022. Applying lead (Pb) isotopes to explore mobility in humans and animals. *PLoS ONE* 17: e0274831.
- Holt E, Evans J, Madgwick R. 2021. Strontium ($^{87}Sr/^{86}Sr$) mapping: A critical review of methods and approaches. *Earth Science Reviews* 216: 103593.
- Kinaston R. 2023. Isotopes, Domestication, and Past Animal Husbandry Practices: A Review of the Formative Studies. In M Beasley and A Somerville (eds) *Exploring Human Behavior Through Isotope Analysis*. *Applications in Archaeological Research*, pp. 155-180. Springer: Cham, Switzerland.
- Suzuki S, Nakamura S, Price TD. 2020. Isotopic proveniencing at Classic Copan and in the southern periphery of the Maya area. *Journal of Anthropological Archaeology* 60: 101228.
- Messana C, Tornero C, Madgwick R, Lamb A, Evans J, Colominas L. 2023. Between valleys, plateaus, and mountains: unveiling livestock altitudinal mobility in the Iron Age Iberian Peninsula (3rd c. BC) through a multi-isotope approach. *Frontiers in Environmental Archaeology* 2: 1245725.
- Ventresca Miller A, Usmanova E, Logvin V, Kalieva S, Shevnina I, Logvin A, Kolbina A, Suslov A, Privat K, Haas K, Rosenmeier M. 2014. Subsistence and social change in central Eurasia. *Journal of Archaeological Science* 42: 525-538.