

AS A PIONEER IN THE EMERGING field of archeochemistry, I'm working at the forefront of some of the most exciting inquiries into ancient cultures. By using chemical analysis to extract and identify trace substances present on artifacts – substances that used to be washed away as a routine part of the process – we're gaining unprecedented insights into the way ancient peoples lived.

Looking for direction

Archeochemistry is starting to revolutionize the process of examining and learning about archaeological finds, providing a sharper lens for us to use when explaining material culture. Yet, if it hadn't been for the intervention of the assistant director of admissions at The University of Pennsylvania's School of Medicine – and some other timely breaks – I might never have found myself with this opportunity of a lifetime.

As a junior at the University of Illinois at Urbana-Champaign in 1994, I found myself at a crossroads. Having made enough progress towards my requirements as a biophysics major, I faced the daunting decision of whether to graduate that school year. Like many upperclassmen, I naturally asked myself, "what next?"

My initial thought was that I had not

yet found the correct industry to match my interests. As a result of volunteering at a local hospital for several years, I knew medicine was not for me. A short-term internship at a well-known pharmaceutical company outside Chicago that summer put doubts in my mind whether that route was right for me either.

My solution was a simple one: stay in school for my senior year and use the time to plot a future course. Little did I know how far afield I would actually end up when I concluded my formal education with a Ph.D. in archaeology from the University of Pennsylvania.

Going from a B.S. in biophysics to a Ph.D. program in archaeology is not a common or easy transition. But it wasn't until years later that I learned how narrowly I made it. In fact, the University of Pennsylvania's admissions committee could not quite figure out what to do with my application. My undergraduate grades were quite good for a science major and my GRE scores were very strong. But how does one compare an "A" in organic chemistry lab with an "A" in intermediate Latin?

To help solve its dilemma, the committee unconventionally consulted with the assistant director of admissions of the School of Medicine, who not only

endorsed my undergraduate education, but went so far as to submit a recommendation for my file! Before I knew it, I found myself sitting deep in the Beaux Arts chambers of the University of Pennsylvania Museum of Archaeology and Anthropology, discussing some of the most recent developments and issues in archaeology.

Understanding the tradition

Since the earliest days of archaeology, when an excavator in the field would find a piece of pottery, his or her first step would be to wash off any dirt and substances. Doing so was how they were able to examine the decoration and style of the piece – and thus determine its culture and rough age. This was only the first stage in the process; when the piece went to the conservator, washing with deionized water and acid was also common practice.

Historically, chemistry applications in archaeology were largely methodological in nature, with little concern for the archaeological concerns at hand. Artifacts were sent to distant labs usually many years after excavation, and pulverized for residue analysis, but not before they had been washed, mended, and handled by numerous people.

Transforming Archeological Chemistry

BY ANDREW KOH

The birth of a new approach

Needless to say, destroying artifacts in order to analyze them is not an appetizing option for archeologists. The practice severely slows down the process and also makes excavation directors reluctant to supply objects for analysis.

When I started my research in 2003, I was determined to do things differently. I wanted to devise a process that was archaeologically viable — something that answered archaeological questions — as well as comprehensive, fully-integrated, and non-destructive. The result was the ARCHEM project, a process for extracting residues in the field and identifying them. This also began the transformation of archeological chemistry to archeo-chemistry.

To realize its full potential, archeo-chemistry needed a comprehensive library of organic residues. With it, one could answer questions that were of utmost importance to archaeologists — including the function of certain artifact shapes and the spaces and groups in which they are found; the nature of their use over long periods of time; and the implications these answers hold for understanding the original users' production, consumption, and trade.

Residues also needed to be extracted immediately after excavation, and before washing and mending by conservators. Not only does the conservation process destroy traces of organics, but the further removed in time an object is from its point of excavation, the more likely it is that contaminants have been introduced.

After several summers of refinement that involved the patience, faith, and financial support of numerous colleagues, we have succeeded at seamlessly integrating a process for extraction into the overall conservation process. Its success is due in large part to the purchase of a Büchi Polyevaporator, which allows for the gentle boiling, agitation, and isolation of residues through parallel evaporation, all in a closed system under vacuum pressure. This effectively sped up the extraction process at least five-fold, helping to realize the dream of efficiently extracting residues from every object that enters conservation.

The ARCHEM project has made extracting residues from unmolested artifacts an issue of prime importance and demonstrated that an adequate number of samples can be isolated — without pulverization.



Solving the riddle of the vats...and other mysteries

One of the most exciting discoveries made possible through the ARCHEM project involved two vats located in a Minoan settlement on Mochlos, a small island off the island of Crete. Previously, archaeologists knew only that there were two vats in adjoining, unidentifiable rooms.

Using ARCHEM's revolutionary extraction tools and processes, I have defined one as a vat for making perfumed oil. Moreover, I have shed light onto a complex workshop that produced the finest perfumes and medicines using cistus (a major ingredient today in Chanel No. 5), wormwood, linden flowers, coriander, ferula, and olive oil.

I can confidently state that the other vat was used for wine production, likely at its earliest stages, based on the discovery of tartaric acid without any resins that would signal a later stage of production.

Other mysteries have also been solved. Little juglets long called "creamers" based on their shape, have been shown to have actually contained milk. A triton shell found in a foundation deposit produced resinated wine, demonstrating that it was a practical implement with possible cultic significance when the space was ritually dedicated. These observations are just a glimmer of the kinds of insights into the details and textures of ancient peoples' daily lives that are impossible to gain solely through standard methods of archaeological inquiry.

Integrating science and art

Scholars have been saying for decades that science is the future of archaeology. Yet, my proposal of inserting an extraction process between the excavators and conservators had the potential of threatening a time-honored process. Being intimately familiar with both archeology and the sciences gave me the credibility to convince others to use this new approach.

For those aspiring to jobs as archaeo-chemists, training as both a scientist and archaeologist is of vital importance. In the end, to fully participate in the research dialogue, intense training as an archaeologist is necessary, making a Ph.D. compulsory. Though it is also possible to major in the humanities as an undergraduate and continue on as an archaeological scientist, I am convinced that a holder of a comprehensive B.S. holds a significant advantage, especially as archaeology becomes increasingly multidisciplinary in the 21st century.

But like most disciplines in the humanities, and perhaps even more so, there are numerous pitfalls to intertwining sciences with traditional disciplines. Universities and foundations typically fund and hire based on your attributes as a "fish" or a "fowl" — but rarely as both.

Fortunately, after sticking with my plan and carefully developing a solid methodology, I'm starting to get the kind of feedback that makes it feel very worthwhile. Scholars have told me that the field may not really understand or appreciate what we're doing for another 10 or 20 years. This prediction has inspired me to continue seeking out colleagues, explaining the nature and value of the ARCHEM project. Doing so will help to ensure that this innovative approach is not just a sensation, but also an improvement to the discipline that lasts. **EC**



ANDREW KOH received his B.S. in biophysics from the University of Illinois at Urbana-Champaign and his Ph.D. from the Art and Archaeology of the Mediterranean World program at the University of Pennsylvania. He now teaches

classical studies and material culture to the students at Wayne State University in Detroit, MI and conducts fieldwork in Greece every summer.