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# SYNCHROTRON LIGHT APPLICATIONS IN ARCHAEOLOGY: HEAVY METALS AND HUMAN HEALTH IN THE PAST.

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## Abstract

Health is a critical factor for individuals, societies, and economies to thrive. Human heavy metal exposure is topical today, and has affected humanity since the first exploitation of metals, at the core of our civilization. This presentation highlights how synchrotron light, and X-ray Fluorescence (SR-XRF) and X-ray absorption fine structure (XAFS) in particular, can be used to explore not only the presence, but crucially in the context of human health, the speciation of heavy metals in ancient human tissues, including bone, dental tissues, hair and skin. Metals such as lead (Pb), arsenic (As), and copper (Cu), were mined, manufactured, and used at ancient archaeological sites, enabling technological advances. Cultural aesthetics led to the use of heavy metals in pigments decorating artefacts, and in cosmetics for enhancing personal appearance. In my first case study, the ID21 scanning X-ray microscope optimized for 2D μXRF (elemental maps) was used at the ESRF (European Synchrotron Radiation Facility) to obtain detailed elemental maps, including Cu, in ancient human hair sections. Only a handful of studies using synchrotron radiation enabled approaches to ancient human hair have been undertaken to date, few studies explore metal element distribution within ancient hair, and none Cu in particular. Key archaeological questions, such as effects of intensive metal and craft work on human health, can be investigated using synchrotron radiation micro X-Ray Fluorescence (SR-μXRF) in exploring biogenic versus diagenetic/environmental uptake of metals, and copper in particular, in ancient human hair. Through the second case study within this talk I showcase the use of extended X-ray absorption fine structure (EXAFS) to explore heavy metal speciation (Pb) in ancient human tissues in the context of exploring past human health in ancient Iran, using the SESAME (Synchrotron-light for Experimental Science and Applications in the Middle East) XAFS/XRF beamline. Metals allowed humanity to become what it is today, but not without a cost. Synchrotron light enables us to explore human health in the deep past, as well as in the present.

## About

Kirsi received her PhD from University of Cambridge (Trinity College) in 2004, with focus on human bioarchaeology. Prior to joining the Cyprus Institute (Cyl) and its Science and Technology in Archaeology and Culture Research Center (STARC) in 2008, Kirsi was the Director of the Wolfson Bioarchaeology Laboratory and tenured Faculty at Newcastle University. At Cyl she served as the Chair of the Faculty Council of the Science and Technology in Archaeology and Culture Research Center. She was the Scientific Coordinator of the EU FP7 project STACHEM (Science and Technology for Archaeology and Cultural Heritage in the Eastern Mediterranean). Kirsi's current research focuses on synchrotron radiation enabled bioarchaeology, as well as other scientific and technological means to approach key questions about the human past through archaeological human

tissues, ranging from bone and teeth to hair and skin remains. She currently leads analyses of human remains from the wider Eastern Mediterranean and Middle East (EMME) region and beyond, including Cyprus, Iraq, Syria, Turkey, Iran, and Egypt. Her particular research interests include heavy metal exposure in the past through focus on microstructures of ancient human tissues, using synchrotron radiation techniques. Kirsi currently supervises five PhD students, engaging them in regular beamtimes at synchrotron radiation facilities at ESRF, SESAME, and PSI (Swiss Light Source). Kirsi led the first official user group at the newly opened SESAME synchrotron, including two of her PhD students.

**Primary author(s) :** Dr. LORENTZ, Kirsi (The Cyprus Institute)

**Presenter(s) :** Dr. LORENTZ, Kirsi (The Cyprus Institute)

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