Scientific applications in development-led osteoarchaeology: a perspective from Oxford Archaeology

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The application and impact of scientific techniques in development-led osteoarchaeology has grown considerably in recent years. A wide range of imaging modalities (eg computed tomography) and destructive techniques (eg radiocarbon and isotopes) are now available and these have become a relatively routine part of projects. The results of this work can radically change how we interpret archaeological burials and forge fruitful collaborations between organisations. The fact that the work is development driven means that important serendipitous discoveries are made, challenging long-held views about the past, and important lessons provided for the specialists applying and developing the techniques. However, there are particular issues that we face, primarily the extent to which clients should be expected to fund such work, the lack of service providers, the reliability of the results, and ethical issues associated with destructive methods. In addition, the reactive context in which development osteoarchaeologists work presents significant challenges in terms of providing appropriate advice on the use of advanced science on development-funded projects, keeping up to date with rapidly advancing techniques and applying them in a commercial environment in order to achieve the best research outcome.

'Hidden Lives' public exhibition at the Wellcome Genome Campus. Credit: Oxford Archaeology

This article considers some projects undertaken by Oxford Archaeology where advanced science using radiocarbon dating, isotope analysis and ancient DNA has been employed.

Radiocarbon dating of bone is not a new approach, but the technique has recently seen significant changes that have increased its potential and power. Dates can now be realised with less bone, pre-screening techniques have been developed, the 'marine reservoir effect'[1] has become an important consideration and burnt, fully calcined bone can be dated.

Radiocarbon dating can transform our understanding of burials. This was demonstrated during the excavation of Oxford Archaeology's chance discovery of a 10th/11th-century Viking mass grave on the crest of the Ridgeway Hill near Weymouth, Dorset. There was nothing to suggest that the burials dated to the 10th/11th century: they were surrounded by prehistoric archaeology and there were no dateable artefacts with the skeletons. The grave – a disused Roman quarry, with residual Roman pottery found within its fill – was initially believed to be Roman. However, as the mass of jumbled skeletons was exposed, this assumption became less certain. Radiocarbon dates are not typically obtained from human bone during excavation, but in this case the analysis was performed at this stage, on samples taken from three bones (one each from the top, middle and bottom of the deposit). These suggested that the deposits were early medieval rather than prehistoric or Roman. The timing in obtaining this result was crucial, because it was fundamental to subsequent strategies employed on the project. This included isotope analysis, which demonstrated that the individuals in the grave had spent their childhoods in places outside Britain, including Scandinavia, Northern Iceland, the Baltic states and Russia. Further analysis showed that they had lived in the Scandinavian region in later life and had not been in the British Isles for long before their deaths.

Without the radiocarbon dates and the isotope data, the interpretation of the mass grave could have been quite different, and it is interesting to consider that if it had been discovered less than 20 years ago, the science would not have been able to provide this pivotal information. It is a measure of how fast scientific applications in osteoarchaeology have developed. And they are not slowing down. Ancient DNA analysis has advanced considerably over the last decade following the introduction of next generation sequencing, which has presented greater opportunities to, for example, sex skeletons (eg non-adults) that cannot be osteologically sexed, identify 'invisible' diseases and to explore genetic ancestry and relatedness between individuals. Advances have also reduced the cost of DNA analysis, making it an attractive and exciting proposition for archaeologists and bringing it within the reach of development-led practice.

The Viking mass grave discovered on Ridgeway Hill, Dorset. Credit: Oxford Archaeology

The method has also introduced collaborative opportunities, which have advanced techniques and had wide public impact. Oxford Archaeology has worked with scientists on studies of dental calculus taken from post-medieval skeletons excavated at the Oxford Radcliffe hospital burial ground to develop methods that may be applied to future studies (Velsko et al 2017, 2019). In another collaboration, human bone samples from three Cambridgeshire sites were examined to explore the impact of Anglo-Saxon migrations on the genetic composition of the current British population (Schiffels et al 2016). The project was initiated by the Wellcome Trust as a result of their Genome Campus development at Hinxton, near Cambridge. The project also integrated the DNA, osteological and archaeological findings in a highly successful public exhibition about Hinxton, held at the campus.

Who we are and where we came from lie at the heart of public curiosity about the past and DNA analysis magnifies the benefit that development-led archaeology can bring to the public. This aligns very well with archaeology's goal to deliver social value, enshrined in planning guidance (NPPF 2012, 2018). Despite the popularity of DNA analysis and the increasing demand for it in development-led practice, there is a dearth of service providers. Further, the timeframes within which DNA specialists and commercial archaeologists work are often incompatible. This has not been properly acknowledged or appreciated. DNA specialists also seek to collect numerous samples from human skeletons, which is arguably unacceptable compared to other sampling techniques, and yet there has not been the opportunity to agree sensible protocols in response to this.

Historic burial grounds present perhaps the greatest opportunities for DNA applications. Work undertaken to identify 250 Australian and British WWI soldiers who fought and died

[1] Marine samples yield radiocarbon ages substantially older than terrestrial samples that are equivalent in true calendar age; thus individuals who consumed high quantities of seafood will appear older than their true calendar age.

Taking a dental calculus sample from a post-medieval skeleton, excavated at the Radcliffe hospital burial ground, Oxford. Credit: Oxford Archaeology

Recording one of the skeletons from the Ridgeway mass grave. Credit: Oxford Archaeology

in the Battle of Fromelles (1916) represents the largest DNA study of a historic population undertaken to date. The soldiers were found in six unmarked mass graves on the edge of Fromelles village, Northern France and were excavated and analysed by Oxford Archaeology in 2009. The soldiers were reburied in a new Commonwealth War Graves cemetery adjacent to the recovery site in early 2010, and efforts to identify them by name began later that year using archaeological, DNA, historical, genealogical and anthropological evidence. To date, 166 of the soldiers have had their names restored and their families have been informed. This has far exceeded expectations, largely due to the developments in DNA methodologies.

Although not a development-led project, Fromelles highlights some important considerations in the application of DNA analysis to historic populations in this context. Historic burial grounds have the potential to include individuals with living descendants, and/or communities, and this throws a spotlight on how DNA is handled. At Fromelles, the excavation employed scene-of-crime protocols and clear ethical frameworks were established so that, for example, any incidental findings (about an individual's genetic or non-genetic relationships) made through the analysis of the DNA have/will not be made publicly available.

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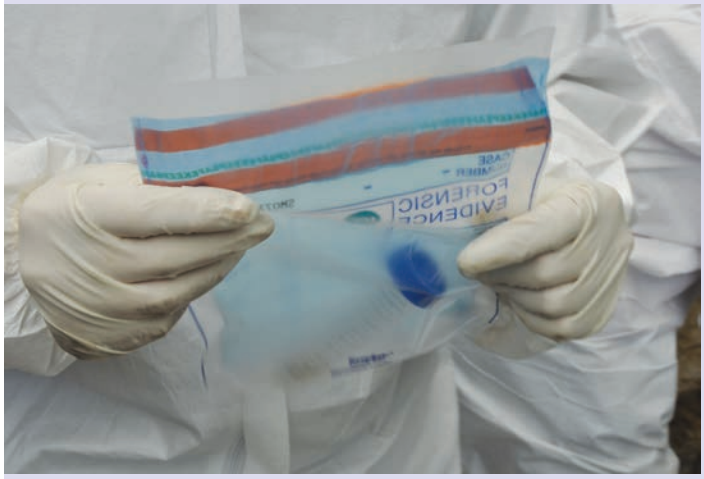
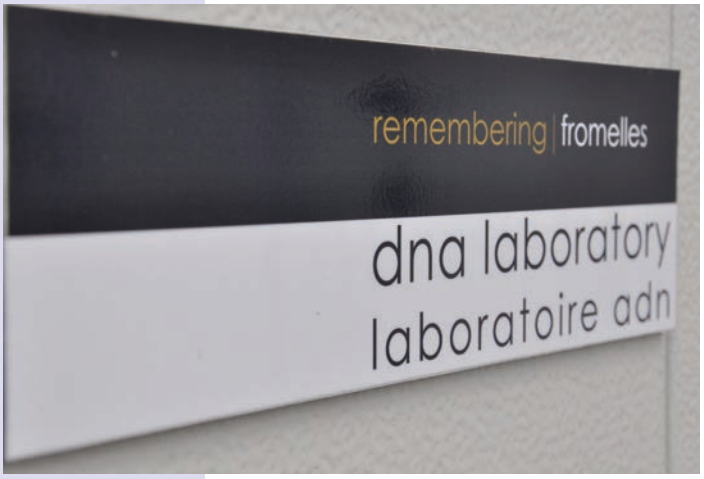
Managing public expectation has been an essential part of the Fromelles project, by clearly communicating the reliability with which identifications can be made and the importance of the historical archaeological context, artefacts, genealogy and anthropology in the process. This is challenging because the science of DNA analysis is complex and continually changing. Despite this, it is widely accepted as 'the silver bullet'. If DNA analysis is to find success in archaeology, re-education and continual updates are needed to understand its potential and its limitations. In addition, DNA studies of past populations can involve a long trajectory, continuing long after a project has finished in the field; planning for the long-term future on projects like this is very important.

Scientific applications in development-led practice have important and powerful contributions to make to understanding our osteoarchaeological heritage. Developments in science such as those described here have, and continue to be, the subject of much discussion. Two of the European Archaeology Association's annual meetings have recently provided a forum to discuss the issues and challenges of scientific developments and archaeology, coined the 'third science revolution' (Kristiansen 2014). Development-led osteoarchaeology has an important contribution to make to these discussions; this, the 'coal face', is where many of the scientific developments are happening and is the laboratory from which everyone can learn.





Fromelles, N. France: Excavating one of the WWI mass graves and sampling for DNA. Credit: Oxford Archaeology

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Louise is Head of Heritage Burial Services at Oxford Archaeology, and leads a team dedicated to the burial archaeology undertaken by three regional offices. Holding a PhD in Biological Anthropology from the University of Bristol, she has over 20 years' experience in the excavation and analysis of human remains from a range of archaeological contexts. She led the excavation and analysis of WWI mass graves in Fromelles, Northern France as well as the detailed analyses of a Viking-age mass grave, discovered on Ridgeway Hill, Weymouth. She currently serves the Australian Army as a subject matter expert for the Fromelles Identification Board.

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