Strontium isotope analysis of the Mesolithic cremation from Langford, Essex, England

Rick J. Schulting
School of Archaeology, University of Oxford, Oxford, UK
rick.schulting@arch.ox.ac.uk

Christophe Snoeck
Analytical, Environmental & Geo-Chemistry, Dept. of Chemistry
Vrije Universiteit Brussel, Brussels, Belgium

Louise Loe and Nick Gilmour
louise.loe@oxfordarch.co.uk
nick.gilmour@oxfordarch.co.uk
Oxford Archaeology
Janus House, Osney Mead, Oxford, OX2 0ES

Introduction

As reported in MM 23.2, a site in Langford, Essex, has yielded the first cremation deposit dated to the Mesolithic in Britain (Gilmour and Loe 2015). Directly dated to 5657–5561 cal BC (95.4% probability, based on two separate dates on calcined bone successfully combined in OxCal 4.2: 6692 ± 21 BP, χ^2, T = 0.0(5%3.8)), the deposit contained what appear to be the partial cremated remains of a single adult. While the loss of the organic fraction precludes stable isotope analyses for dietary reconstruction, recent experimental studies have shown that it is possible to obtain reliable in vivo strontium isotope ($^{87}Sr/^{86}Sr$) values on calcined bone, due to the high crystallinity resulting from the cremation process (Snoeck *et al*. 2015; see also Harbeck *et al*. 2011; Harvig *et al*. 2014). Here, we present the results of the strontium isotope analysis of the Langford cremation, and discuss what this means for the mobility of this individual. This is the first time the method has been applied to cremated bone from the Mesolithic period.

Methods

Two cremated bone fragments were pretreated with 1M acetic acid (1 mL per 10 mg of sample) for 3 min in an ultrasonic bath, followed by three rinses with milliQ water and 10 min ultrasonication. The entire acid digestion process and subsequent Sr purification were achieved under a class 100 laminar flow hood in a class 1000 clean room (Université Libre de Bruxelles, Belgium, hereafter ULB). Fifty mg of sample were digested in subboiled concentrated HNO_3 at 120˚C for 24h, before purification of the Sr analyte by a chromatographic technique on ion-exchange resins (see Snoeck *et al*. (2015) for more details). The isotope ratios of the purified strontium samples were then measured on a Nu Plasma MC-ICP mass spectrometer (from Nu Instruments) at ULB.

Results

The results of the analysis are presented in Table 1. The $^{87}Sr/^{86}Sr$ values for the two calcined bone fragments differ slightly, though not enough to justify their representing two separate individuals (nor was there any osteological evidence for this in the remains). The small difference may relate to different bone turnover rates for the two samples, so that they represent some real variation in the foods consumed over the periods represented. The two values average to 0.70944 ± 6.01^{-5}. For comparison, duplicate measurements on different calcined bone samples from what should represent single individuals in funerary urns at the early Middle Bronze Age site of Ballymacaldrack, Co. Antrim, Northern Ireland, varied by up to 0.0002 (Snoeck *et al*. 2016). It should be noted that a major difference between $^{87}Sr/^{86}Sr$ measurements on calcined bone compared to the more usual analysis of tooth enamel, is that bone refers to an average intake of strontium over the last decade or more of life, rather than the childhood signals obtained through enamel.

Catalogue no.	*Element*	*$^{87}Sr/^{86}Sr$*	*2σ**
CMEP14:7-1	long bone frag	0.709395	0.000011
CMEP14:7-2	cranial frag	0.709480	0.000008

Table 1: $^{87}Sr/^{86}Sr$ results for two calcined bone fragments from the Langford cremation. (*2σ error is the absolute error value of the individual sample analysis – internal error)

Discussion

Crucial to the interpretation of strontium isotope results is the availability of baseline data for the various geologies represented in the surrounding region. Langford is located on the London Clay, dating to the Eocene epoch (56 – 33.9 mya) of the Palaeogene. No $^{87}Sr/^{86}Sr$ measurements are available for the immediate vicinity, but values from sampling locations to the west on what should be the same geology (isotopically speaking) suggest that biologically available strontium isotope values will be in the range 0.7090 to 0.7100 (Figure 1). This fits well with the value of ca. 0.7094 for the Langford cremation, and taken at face value suggests that this individual was 'local'.

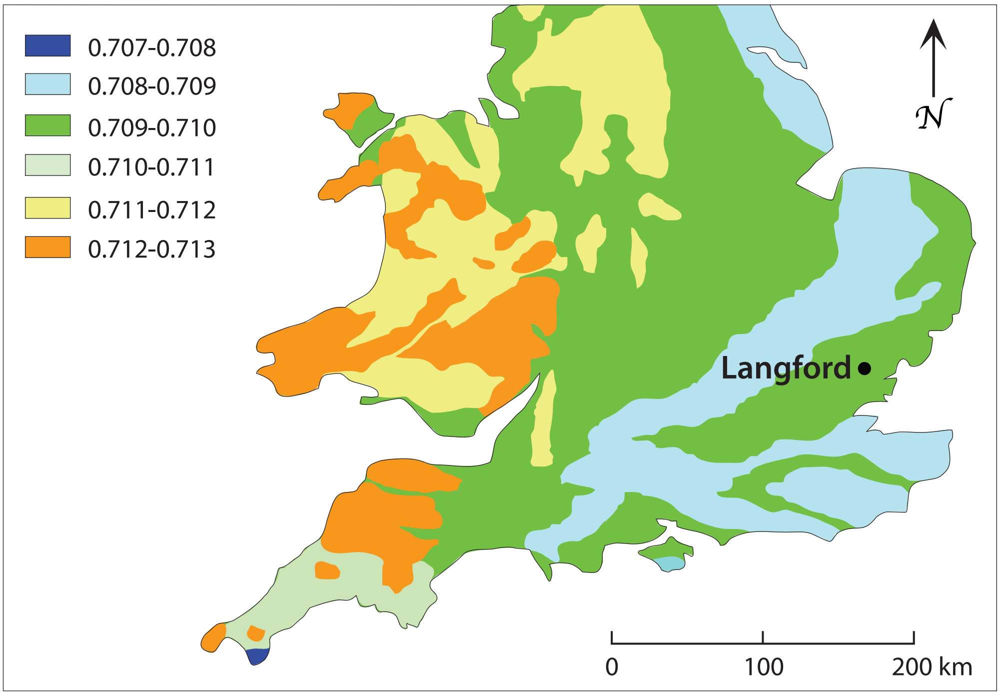

Figure 1. Southern Britain showing the location of Langford cremation, with broad $^{87}Sr/^{86}Sr$ value ranges based on Evans *et al*. 2010, fig. 1B.

But what exactly does this mean? Unfortunately, at this stage we come up against the coarse resolution of the available baseline data. Values in the same band extend over large swathes of England, and so even if the Langford individual were consuming foods from a wide territory, their $^{87}Sr/^{86}Sr$ result would still appear 'local'. The nearest clearly different geology is the Sussex White Chalk Formation found some 25-35 km to both the north and south of Langford, with values in the range 0.708–0.709 (Figure 1) (Evans *et al*. 2010, fig. 1B). Such distances would probably be entirely with the local group territories as usually envisaged for European Mesolithic hunter-gatherers, though it is possible that we have overstated the case for mobility in this period (Price 2015; Schulting 2010). The $^{87}Sr/^{86}Sr$ results provide no clear evidence for systematic exploitation of foods on the Chalk, though with the coarse resolution of the baseline data this cannot be ruled out (it should be noted that strontium concentrations are much higher in plants than in animals, so we are essentially talking about the use of plant foods). The modern coast is even closer (ca. 17 km). While the sea would have been slightly further away, the tidal estuary of the River Blackwater would have brought estuarine and marine resources within easy reach of the site. But since the ocean $^{87}Sr/^{86}Sr$ value of 0.7092 lies within the presumed range of the London Clay, it is not possible to determine whether or not estuarine/marine foods were contributing to the diet, though this would certainly be expected.

With further sampling and strontium isotope analysis of modern plants growing in the Langford region and its surrounding environs, it may be possible to fine-tune the interpretation, but that would depend entirely on the observed range and scale of variation. Further analysis is also underway on $\delta^{13}C$ and $\delta^{18}O$ isotopes on the calcined bone fragments, which should provide some information on the conditions under which the cremation took place (size of the pyre, ventilation, etc.) (Snoek *et al*. 2014; 2016).

References

- Evans, J.A., Montgomery, J., Wildman, G. and Boulton, N. 2010. Spatial variations in biosphere 87Sr/86Sr in Britain. *Journal of the Geological Society, London* 167: 1-4.
- Gilmour, N. and Loe, L. 2015. A Mesolithic cremation-related deposit from Langford, Essex, England: a first for the British Mesolithic. *Mesolithic Miscellany* 23(2): 55-57.
- Harbeck, M., Schleuder, R., Schneider, J., Wiechmann, I., Schmahl, W.W. and Grupe, G. 2011. Research potential and limitations of trace analyses of cremated remains. *Forensic Science International* 204(1): 191-200.
- Harvig, L., Frei, K.M., Price, T.D. and Lynnerup, N. 2014. Strontium isotope signals in cremated petrous portions as indicator for childhood origin. *PLoS ONE* 9(7): e101603.
- Price, T.D. 2015. Tracing past human movement: an example from the Muge middens. In: N. Bicho, C. Detry, T.D. Price and E. Cunha (eds.), *Muge 150th: the 150th Anniversary of the Discovery of Mesolithic Shellmiddens – Vol. 2*: pp. 225-237. Cambridge: Cambridge Scholars.
- Schulting, R.J. 2010. Staying home for dinner: an isotopic approach to regionality in Mesolithic Atlantic Europe. In: R. Barndon, A. Engevik and I. Øye (eds.), *The Archaeology of Regional Technologies: Case Studies from the Palaeolithic to the Age of the Vikings*: pp. 69-88. Lewiston: Edwin Mellen Press.
- Snoeck, C., Brock, F. and Schulting, R.J. 2014. Carbon exchanges between bone apatite and fuels during cremation: impact on radiocarbon dates. *Radiocarbon* 56(2): 591-602.
- Snoeck, C., Lee-Thorp, J., Schulting, R.J., Mattielli, N., deJong, J. and Debouge, W. 2015. Calcined bone provides a reliable substrate for strontium isotope ratios as shown by an enrichment experiment. *Rapid Communications in Mass Spectrometry* 29(1): 107-114.
- Snoeck, C., Pouncett, J., Ramsey, G., Meighan, I.G., Mattielli, N., Lee-Thorp, J.A. and Schulting, R.J. 2016. Mobility during the Neolithic and Bronze Age in Northern Ireland explored using strontium isotope analysis of cremated human bone. *American Journal of Physical Anthropology*: 10.1002/ajpa.22977.
- Snoeck, C., Schulting, R.J., Lee-Thorp, J.A., Lebon, M. and Zazzo, A. 2016. Impact of heating conditions on the carbon and oxygen isotope composition of calcined bone. *Journal of Archaeological Science* 65(1): 32–43.