

## **A stable relationship: isotopes and bioarchaeology are in it for the long haul**

Kate Britton\*

\* *Department of Archaeology, University of Aberdeen, Meston Building, Aberdeen AB24 3UE, UK; Department of Human Evolution, Max Planck Institute for Evolutionary Anthropology, Deutscher Platz 6, 04103 Leipzig, Germany (Email: k.britton@abdn.ac.uk)*

### **RECOMMENDED FURTHER READING**

#### **SECTION I: ISOTOPES & BIOARCHAEOLOGY**

1. Introductory Papers, Reviews & Overviews
2. Bone & Tooth Diagenesis
3. Protein Preservation in Bone & Assessing Collagen Quality
4. Isotopic Impacts of Pretreatment Techniques on Bioapatite
5. Controlled Dietary/Feeding Studies
6. Compound-Specific Isotopes
7. 'Non-Traditional' Isotopes
8. Micro Sampling & Incremental Approaches
9. Mixing Models & Statistical Approaches to Isotope Data

#### **SECTION II: CASE STUDIES IN ARCHAEOLOGICAL HUMAN DIET & MOBILITY**

10. Early Hominin Diet & Mobility
11. Late Pleistocene (Neanderthal) Diet and Mobility
12. Mesolithic-Neolithic Transition in North-West Europe
13. Changes in Mobility Patterns with the Transition to Agriculture
14. Maize Agriculture in North America
15. Isotopes, Individuals & Socio-Cultural Identities
16. Dietary Transitions in Britain from the late Iron Age to the High Medieval Period
17. Breastfeeding in Britain's Past

**SECTION III: ARCHAEOLOGICAL ANIMALS & ISOTOPES**

18. Birth Seasonality & Dairying
19. Movement of Domestic Animals
20. Foddering Regimes & Resource Management
21. Late Pleistocene Faunal Ecology & Environment
22. Late Pleistocene Faunal Mobility
23. Reconstructing Palaeoclimate from Faunal Bioapatite

## SECTION I: ISOTOPES & BIOARCHAEOLOGY

### 1. Introductory Papers, Reviews & Overviews

- BENTLEY, R.A. 2006. Strontium isotopes from the earth to the archaeological skeleton: a review. *Journal of Archaeological Method and Theory* 13:135-187.
- BOGAARD, A. & OUTRAM, A. K. 2013. Palaeodiet and beyond: stable isotopes in bioarchaeology. *World Archaeology* 45: 333-337.
- DENIRO, M.J. 1987. Stable isotopy and archaeology. *American Scientist* 75:182-191.
- FAURE, G. & MENSING, T.M. 2005. *Isotopes: principles and applications*. Hoboken, N.J: Wiley.
- FRY, B. 2006. *Stable isotope ecology*. New York: Springer.
- HEDGES, R.E.M., STEVENS, R.E. & KOCH, P.L. 2006. ISOTOPES IN BONES AND TEETH. In: LENG, M.J. (ed.) *Isotopes in Palaeoenvironmental Research*. Dordrecht: Springer Netherlands.
- LAMB, A.L. 2016. Stable isotope analysis of soft tissues from mummified human remains. *Environmental Archaeology* 21:271-284.
- LEE-THORP, J.A. 2008. On isotopes and old bones. *Archaeometry* 50:925-950.
- KATZENBERG, M.A. 2000. Stable Isotopic Analysis: A tool for studying past diet, demography and life history. In: KATZENBERG, M.A. & SAUNDERS, S.R. (eds.) *Biological Anthropology of the Human Skeletal*. New York: Wiley-Liss.
- KATZENBERG, M.A. & HARRISON, R.G. 1997. What's in a bone? Recent advances in archaeological bone chemistry. *Journal of Archaeological Research* 5:265-293.
- MAKAREWICZ, C.A. & SEALY, J. 2015. Dietary reconstruction, mobility, and the analysis of ancient skeletal tissues: Expanding the prospects of stable isotope research in archaeology. *Journal of Archaeological Science* 56:146-158.
- MAKAREWICZ, C.A. 2016. Toward an Integrated Isotope Zooarchaeology. In: GRUPE, G. & MCGLYNN, C.G. (eds.) *Isotopic Landscapes in Bioarchaeology*. Berlin, Heidelberg: Springer Berlin Heidelberg.
- MAYS, S. 2000. New Directions in the Analysis of Stable Isotopes In excavated Bones and Teeth. In: COX, M. & MAYS, S. (eds.) *Human Osteology in Archaeology and Forensic Science*. London: Greenwich Medical Media.
- NEHLICH, O. 2015. The application of sulphur isotope analyses in archaeological research: A review. *Earth-Science Reviews* 142:1-17.
- PATE, F.D. 1994. Bone chemistry and paleodiet. *Journal of Archaeological Method and Theory* 1:161-209.
- PILAAAR BIRCH, S.E. 2013. Stable isotopes in zooarchaeology: an introduction. *Archaeological and Anthropological Sciences* 5:81-83.
- REITSEMA, L.J. 2013. Beyond diet reconstruction: Stable isotope applications to human physiology, health, and nutrition. *American Journal of Human Biology* 25:445-456.
- SCHOENINGER, M. J. & MOORE, K. 1992. Bone Stable Isotope Studies in Archaeology. *Journal of World Prehistory* 6: 247-296.

- SCHWARCZ, H.P. 1991. Some theoretical aspects of isotope paleodiet studies. *Journal of Archaeological Science* 18:261-275.
- SCHWARCZ, H.P. & SCHOENINGER, M.J. 1991. Stable Isotope Analyses in Human Nutritional Ecology. *Yearbook of Physical Anthropology* 34:283-321.
- SCHWARCZ, H.P. & SCHOENINGER, M.J. 2012. Stable Isotopes of Carbon and Nitrogen as Tracers for Paleo-Diet Reconstruction. In: BASKARAN, M. (ed.) *Handbook of Environmental Isotope Geochemistry: Vol I*. Berlin, Heidelberg: Springer Berlin Heidelberg.
- SEALY, J. 2001. Body tissue chemistry and palaeodiet. In: BROTHWELL, D.R. & POLLARD, A.M. (eds.) *Handbook of Archaeological Sciences*. Chichester: Wiley.
- SILLEN, A., SEALY, J.C. & VAN DER MERWE, N.J. 1989. Chemistry and paleodietary research: no more easy answers. *American Antiquity*:504-512.
- TSUTAYA, T. & YONEDA, M. 2015. Reconstruction of breastfeeding and weaning practices using stable isotope and trace element analyses: A review. *American Journal of Physical Anthropology* 156:2-21.
- WHITE, C.D. & LONGSTAFFE, F.J. 2016. Stable isotopes and selective forces: examples in biocultural and environmental anthropology. In: ZUCKERMAN, M.K. & MARTIN, D.L. (eds.) *New Directions in Biocultural Anthropology*. New Jersey: Wiley Blackwell.

## 2. Bone & Tooth Diagenesis

- AYLIFFE, L.K., CHIVAS, A.R. & LEAKEY, M.G. 1994. The retention of primary oxygen isotope compositions of fossil elephant skeletal phosphate. *Geochimica et Cosmochimica Acta* 58:5291-5298.
- BERNA, F., MATTHEWS, A. & WEINER, S. 2004. Solubilities of bone mineral from archaeological sites: the recrystallization window. *Journal of Archaeological Science* 31:867-882.
- BLAKE, R.E., O'NEIL, J. & GARCIA, G.A. 1997. Oxygen isotope systematics of biologically mediated reactions of phosphate: I. Microbial degradation of organophosphorus compounds. *Geochimica et Cosmochimica Acta* 61:4411-4422.
- BUDD, P., MONTGOMERY, J., BARREIRO, B. & THOMAS, R.G. 2000. Differential diagenesis of strontium in archaeological human dental tissues. *Applied Geochemistry* 15:687-694.
- HEDGES, R.E. 2002. Bone diagenesis: an overview of processes. *Archaeometry* 44:319-328.
- HEDGES, R.E.M., MILLARD, A.R. & PIKE, A.W.G. 1995. Measurements and relationships of diagenetic alteration of bone from three archaeological sites. *Journal of Archaeological Science* 22:201-209.
- HEDGES, R.E. & MILLARD, A.R. 1995. Bones and groundwater: towards the modelling of diagenetic processes. *Journal of Archaeological Science* 22:155-164.
- HOPPE, K.A., KOCH, P.L. & FURUTANI, T.T. 2003. Assessing the preservation of biogenic strontium in fossil bones and tooth enamel. *International Journal of Osteoarchaeology* 13:20-28.

- IACUMIN, P., BOCHERENS, H., MARIOTTI, A. & LONGINELLI, A. 1996. Oxygen isotope analyses of co-existing carbonate and phosphate in biogenic apatite: a way to monitor diagenetic alteration of bone phosphate? *Earth and Planetary Science Letters* 142:1-6.
- KEENAN, S.W. 2016. From bone to fossil: A review of the diagenesis of bioapatite. *American Mineralogist* 101:1943-1951.
- KOCH, P.L., HALLIDAY, A.N., WALTER, L.M., STEARLEY, R.F., HUSTON, T.J. & SMITH, G.R. 1992. Sr isotopic composition of hydroxyapatite from recent and fossil salmon: the record of lifetime migration and diagenesis. *Earth and Planetary Science Letters* 108:277-287.
- KOCH, P.L., TUROSS, N. & FOGEL, M.L. 1997. The effects of sample treatment and diagenesis on the isotopic integrity of carbonate in biogenic hydroxylapatite. *Journal of Archaeological Science* 24:417-429.
- KOHN, M.J., SCHOENINGER, M.J. & BARKER, W.W. 1999. Altered states: Effects of diagenesis on fossil tooth chemistry. *Geochimica et Cosmochimica Acta* 63:2737-2747.
- LEE-THORP, J. & VAN DER MERWE, N.J. 1987. Carbon isotope analysis of fossil bone apatite. *South African Journal of Science* 83:712-715.
- LEE-THORP, J. & SPONHEIMER, M. 2003. Three case studies used to reassess the reliability of fossil bone and enamel isotope signals for paleodietary studies. *Journal of Anthropological Archaeology* 22:208-216.
- MADGWICK, R., MULVILLE, J. & EVANS, J., 2012. Investigating diagenesis and the suitability of porcine enamel for strontium ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) isotope analysis. *Journal of Analytical Atomic Spectrometry* 27: 733-742.
- MONTGOMERY, J. 2002. *Lead and strontium isotope compositions of human dental tissues as an indicator of ancient exposure and population dynamics: The application of isotope source-tracing methods to identify migrants among British archaeological burials and a consideration of ante-mortem uptake, tissue stability and post-mortem diagenesis*. Doctoral Thesis, The University of Bradford.
- NELSON, D.E., DENIRO, M.J., SCHOENINGER, M.J., DEPAOLO, D.J. & HARE, P.E. 1986. Effects of diagenesis on strontium, carbon, nitrogen, and oxygen concentration and isotopic composition of bone. *Geochimica et Cosmochimica Acta* 50:1941-1949.
- NIELSEN-MARSH, C.M. & HEDGES, R.E.M. 2000. Patterns of diagenesis in bone I: The effects of site environments. *Journal of Archaeological Science* 27:1139-1150.
- NIELSEN-MARSH, C.M., SMITH, C.I., JANS, M., NORD, A., KARS, H. & COLLINS, M.J. 2007. Bone Diagenesis in the European Holocene II: Taphonomic and Environmental Considerations. *Journal of Archaeological Science* 34:1523-1531.
- PRICE, T.D., BLITZ, J., BURTON, J.H. & EZZO, J.A. 1992. Diagenesis in prehistoric bone: Problems and solutions. *Journal of Archaeological Science* 19:513-529.
- SHARP, Z.D., ATUDOREI, V. & FURRER, H. 2000. The effect of diagenesis on oxygen isotope ratios of biogenic phosphate. *American Journal of Science* 300:222-237.
- SCHOENINGER, M.J., MOORE, K.M., MURRAY, M.L. & KINGSTON, J.D. 1989. Detection of bone preservation in archaeological and fossil samples. *Applied Geochemistry* 4:281-292.

- SCHOENINGER, M.J., HALLIN, K., REESER, H., VALLEY, J.W. & FOURNELLE, J. 2003. Isotopic alteration of mammalian tooth enamel. *International Journal of Osteoarchaeology* 13:11-19.
- SNOECK, C., LEE-THORP, J., SCHULTING, R., JONG, J., DEBOUGE, W. & MATTIELLI, N., 2015. Calcined bone provides a reliable substrate for strontium isotope ratios as shown by an enrichment experiment. *Rapid Communications in Mass Spectrometry* 29: 107-114.
- SMITH, C.I., NIELSEN-MARSH, C.M., JANS, M.M.E. & COLLINS, M.J. 2007. Bone diagenesis in the European Holocene I: Patterns and Mechanisms. *Journal of Archaeological Science* 34:1485-1493.
- STUART-WILLIAMS, H.L.Q., SCHWARCZ, H.P., WHITE, C.D. & SPENCE, M.W. 1996. The isotopic composition and diagenesis of human bone from Teotihuacan and Oaxaca, Mexico. *Palaeogeography, Palaeoclimatology, Palaeoecology* 126:1-14.
- TRICKETT, M.A., BUDD, P., MONTGOMERY, J. & EVANS, J. 2003. An assessment of solubility profiling as a decontamination procedure for the  $^{87}\text{Sr}/^{86}\text{Sr}$  analysis of archaeological human skeletal tissue. *Applied Geochemistry* 18:653-658.
- TRUEMAN, C.N., BEHRENSMEYER, A.K., TUROSS, N. & WEINER, S. 2004. Mineralogical and compositional changes in bones exposed on soil surfaces in Amboseli National Park, Kenya: diagenetic mechanisms and the role of sediment pore fluids. *Journal of Archaeological Science* 31:721-739.
- WANG, Y. & CERLING, T.E. 1994. A model of fossil tooth and bone diagenesis: implications for paleodiet reconstruction from stable isotopes. *Palaeogeography, Palaeoclimatology, Palaeoecology* 107:281-289.
- ZAZZO, A., LÉCUYER, C., SHEPPARD, S.M.F., GRANDJEAN, P. & MARIOTTI, A. 2004. Diagenesis and the reconstruction of palaeoenvironments: A method to restore original  $\delta^{18}\text{O}$  values of carbonate and phosphate from fossil tooth enamel. *Geochimica et Cosmochimica Acta* 68:2245-2258.

### 3. Protein Preservation in Bone & Assessing Collagen Quality

- AMBROSE, S.H. 1990. Preparation and characterization of bone and tooth collagen for isotopic analysis. *Journal of Archaeological Science* 17:431-451.
- COLLINS, M.J., NIELSEN-MARSH, C.M., HILLER, J., SMITH, C.I., ROBERTS, J.P., PRIGODICH, R.V., WESS, T.J., CSAPÒ, J., MILLARD, A.R. & TURNER-WALKER, G. 2002. The survival of organic matter in bone: a review. *Archaeometry* 44:383-394.
- DENIRO, M.J. 1985. Postmortem preservation and alteration of in vivo bone collagen isotope ratios in relation to palaeodietary reconstruction. *Nature* 317:806-809.
- DENIRO, M. J. and WEINER, S., 1988. Chemical, enzymatic and spectroscopic characterization of “collagen” and other organic fractions from prehistoric bones. *Geochimica et Cosmochimica Acta* 52: 2197-2206.
- DOBBERSTEIN, R.C., COLLINS, M.J., CRAIG, O.E., TAYLOR, G., PENKMAN, K.E.H. & RITZ-TIMME, S. 2009. Archaeological collagen: Why worry about collagen diagenesis? *Archaeological and Anthropological Sciences* 1:31-42.

GRUPE, G., BALZER, A. & TURBAN-JUST, S. 2002. Modelling protein diagenesis in ancient bone: towards a validation of stable isotope data. *Biogeochemical Approaches to Paleodietary Analysis*. Springer.

MASTERS, P.M. 1987. Preferential preservation of noncollagenous protein during bone diagenesis: implications for chronometric and stable isotope measurements. *Geochimica et Cosmochimica Acta* 51:3209-3214.

SMITH, C.I., CRAIG, O.E., PRIGODICH, R.V., NIELSEN-MARSH, C.M., JANS, M.M.E., VERMEER, C. & COLLINS, M.J. 2005. Diagenesis and survival of osteocalcin in archaeological bone. *Journal of Archaeological Science* 32:105-113.

TUROSS, N., FOGEL, M.L. & HARE, P.E. 1988. Variability in the preservation of the isotopic composition of collagen from fossil bone. *Geochimica et Cosmochimica Acta* 52:929-935.

VAN KLINKEN, G.J. 1999. Bone collagen quality indicators for palaeodietary and radiocarbon measurements. *Journal of Archaeological Science* 26:687-695.

#### 4. Isotopic Impacts of Pretreatment Techniques on Bioapatite

CROWLEY, B.E. & WHEATLEY, P.V. 2014. To bleach or not to bleach? Comparing treatment methods for isolating biogenic carbonate. *Chemical Geology* 381:234-242.

GARVIE-LOK, S.J., VARNEY, T. & KATZENBERG, M.A. 2004. Preparation of bone carbonate for stable isotope analysis: the effects of treatment time and acid concentration. *Journal of Archaeological Science* 31:763-776.

GRIMES, V. & PELLEGRINI, M. 2013. A comparison of pretreatment methods for the analysis of phosphate oxygen isotope ratios in bioapatite. *Rapid Communications in Mass Spectrometry* 27:375-390.

HOPPE, K.A., KOCH, P.L. & FURUTANI, T.T. 2003. Assessing the preservation of biogenic strontium in fossil bones and tooth enamel. *International Journal of Osteoarchaeology* 13:20-28.

KOCH, P.L., TUROSS, N. & FOGEL, M.L. 1997. The effects of sample treatment and diagenesis on the isotopic integrity of carbonate in biogenic hydroxylapatite. *Journal of Archaeological Science* 24:417-429.

NIELSEN-MARSH, C.M. & HEDGES, R.E.M. 2000. Patterns of diagenesis in bone II: Effects of acetic acid treatment and removal of diagenetic CO<sub>3</sub>. *Journal of Archaeological Science* 27:1151-1159.

PELLEGRINI, M. & SNOECK, C. 2016. Comparing bioapatite carbonate pre-treatments for isotopic measurements: Part 2 — Impact on carbon and oxygen isotope compositions. *Chemical Geology* 420:88-96.

PESTLE, W.J., CROWLEY, B.E. & WEIRAUCH, M.T. 2014. Quantifying Inter-Laboratory Variability in Stable Isotope Analysis of Ancient Skeletal Remains. *PLoS ONE* 9:e102844.

#### 5. Controlled Dietary/Feeding Studies

AMBROSE, S.H. & NORR, L. 1993. Experimental evidence for the relationship of the carbon isotope ratios of whole diet and dietary protein to those of bone collagen and

carbonate. In: LAMBERT, J.B. & GRUPE, G. (eds.) *Prehistoric Human Bone: Archaeology at the Molecular Level*. New York: Springer-Verlag.

AMBROSE, S.H. 2000. Controlled diet and climate experiments on nitrogen isotope ratios of rats. In: AMBROSE, S.H. & KATZENBERG, M.A. (eds.) *Biogeochemical Approaches to Palaeodietary Analysis*. New York: Kluwer Academic/Plenum Press.

AYLIFFE, L., CERLING, T.E., ROBINSON, T., WEST, A., SPONHEIMER, M., PASSEY, B., HAMMER, J., ROEDER, B., DEARING, M.-D. & EHLERINGER, J.R. 2004. Turnover of carbon isotopes in tail hair and breath CO<sub>2</sub> of horses fed an isotopically varied diet. *Oecologia* 139:11-22.

BALASSE, M., BOCHERENS, H., MARIOTTI, A. & AMBROSE, S.H. 2001. Detection of dietary changes by intra-tooth carbon and nitrogen isotopic analysis: an experimental study of dentine collagen of cattle (*Bos taurus*). *Journal of Archaeological Science* 28:235-245.

DENIRO, M.J. & EPSTEIN, S. 1978. Influence of diet on the distribution of carbon isotopes in animals. *Geochimica et Cosmochimica Acta* 42:495-506.

DENIRO, M.J. & EPSTEIN, S. 1981. Influence of diet on the distribution of nitrogen isotopes in animals. *Geochimica et Cosmochimica Acta* 45:341-351.

DENIRO, M.J. & SCHOENIGER, M.J. 1983. Stable carbon and nitrogen isotope ratios of bone collagen: variations within individuals, between sexes, and within populations raised on monotonous diets. *Journal of Archaeological Science* 10:199-203.

HOWLAND, M.R., CORR, L.T., YOUNG, S.M.M., JONES, V., JIM, S., VAN DER MERWE, N.J., MITCHELL, A.D. & EVERSLED, R.P. 2003. Expression of the dietary isotope signal in the compound-specific  $\delta^{13}\text{C}$  values of pig bone lipids and amino acids. *International Journal of Osteoarchaeology* 13:54-65.

HUELSEMANN, F., FLENKER, U., KOEHLER, K. & SCHAENZER, W. 2009. Effect of a controlled dietary change on carbon and nitrogen stable isotope ratios of human hair. *Rapid Communications in Mass Spectrometry* 23:2448-2454.

O'CONNELL, T.C. & HEDGES, R.E.M. 2017. Chicken and Egg: Testing the Carbon Isotopic Effects of Carnivory and Herbivory. *Archaeometry* 59:302-315.

O'CONNELL, T.C., KNEALE, C.J., TASEVSKA, N. & KUHNLE, G.G.C. 2012. The diet-body offset in human nitrogen isotopic values: A controlled dietary study. *American Journal of Physical Anthropology* 149:426-434.

PASSEY, B.H., ROBINSON, T.F., AYLIFFE, L.K., CERLING, T.E., SPONHEIMER, M., DEARING, M.D., ROEDER, B.L. & EHLERINGER, J.R. 2005. Carbon isotope fractionation between diet, breath CO<sub>2</sub>, and bioapatite in different mammals. *Journal of Archaeological Science* 32:1459-1470.

RICHARDS, M.P., FULLER, B.T., SPONHEIMER, M., ROBINSON, T. & AYLIFFE, L. 2003. Sulphur isotopes in palaeodietary studies: a review and results from a controlled feeding experiment. *International Journal of Osteoarchaeology* 13:37-45.

SPONHEIMER, M., ROBINSON, T.F., ROEDER, B.L., PASSEY, B.H., AYLIFFE, L.K., CERLING, C.E., DEARING, M.D. & EHLERINGER, J.R. 2003. An experimental study of nitrogen flux in llamas: is <sup>14</sup>N preferentially excreted? *Journal of Archaeological Science* 30:1649-1655.

SPONHEIMER, M., ROBINSON, T., AYLIFFE, L., ROEDER, B., HAMMER, J., PASSEY, B., WEST, A., CERLING, T., DEARING, D. & EHLERINGER, J. 2003. Nitrogen Isotopes



in Mammalian Herbivores: Hair  $\delta^{15}\text{N}$  Values from a Controlled Feeding Study. *International Journal of Osteoarchaeology* 13:80-87.

TIESZEN, L.L., BOUTTON, T.W., TESDAHL, K.G. & SLADE, N.A. 1983. Fractionation and turnover of stable carbon isotopes in animal tissues: Implications for  $\delta^{13}\text{C}$  analysis of diet. *Oecologia* 57:32-37.

TIESZEN, L.L. & FAGRE, T. 1993. Effect of diet quality and composition on the isotopic composition of respiratory  $\text{CO}_2$ , bone collagen, bioapatite and soft tissues. In: LAMBERT, J. & GRUPE, G. (eds.) *Prehistoric Human Bone: Archaeology at the Molecular Level*. New York: Springer-Verlag.

TUROSS, N., WARINNER, C., KIRSANOW, K. & KESTER, C. 2008. Organic oxygen and hydrogen isotopes in a porcine controlled dietary study. *Rapid Communications in Mass Spectrometry* 22:1741-1745.

WEBB, E.C., STEWART, A., MILLER, B., TARLTON, J. & EVERSLED, R.P. 2016. Age effects and the influence of varying proportions of terrestrial and marine dietary protein on the stable nitrogen-isotope compositions of pig bone collagen and soft tissues from a controlled feeding experiment. *STAR: Science & Technology of Archaeological Research* 2:54-66.

ZAZZO, A., BALASSE, M., PASSEY, B.H., MOLONEY, A.P., MONAHAN, F.J. & SCHMIDT, O. 2010. The isotope record of short- and long-term dietary changes in sheep tooth enamel: implications for quantitative reconstruction of paleodiets. *Geochimica et Cosmochimica Acta* 74:3571-3586.

ZAZZO, A., CERLING, T.E., EHLERINGER, J.R., MOLONEY, A., MONAHAN, F. & SCHMIDT, O. 2015. Isotopic composition of sheep wool records seasonality of climate and diet. *Rapid Communications in Mass Spectrometry* 29:1357-1369.

## 6. Compound-Specific Isotopes

CHOY, K., SMITH, C.I., FULLER, B.T. & RICHARDS, M.P. 2010. Investigation of amino acid  $\delta^{13}\text{C}$  signatures in bone collagen to reconstruct human palaeodiets using liquid chromatography–isotope ratio mass spectrometry. *Geochimica et Cosmochimica Acta* 74:6093-6111.

COLONESE, A. C., FARRELL, T., LUCQUIN, A., FIRTH, D., CHARLTON, S., ROBSON, H. K., ALEXANDER, M. & CRAIG, O. E. 2015. Archaeological bone lipids as palaeodietary markers. *Rapid Communications in Mass Spectrometry* 29: 611-618.

CORR, L.T., SEALY, J.C., HORTON, M.C. & EVERSLED, R.P. 2005. A novel marine dietary indicator utilising compound-specific bone collagen amino acid  $\delta^{13}\text{C}$  values of ancient humans. *Journal of Archaeological Science* 32:321-330.

CORR, L.T., RICHARDS, M.P., GRIER, C., MACKIE, A., BEATTIE, O. & EVERSLED, R.P. 2009. Probing dietary change of the Kwäday Dän Ts'inchí individual, an ancient glacier body from British Columbia: II. Deconvoluting whole skin and bone collagen  $\delta^{13}\text{C}$  values via carbon isotope analysis of individual amino acids. *Journal of Archaeological Science* 36:12-18.

- FOGEL, M.L. & TUROSS, N. 2003. Extending the limits of paleodietary studies of humans with compound specific carbon isotope analysis of amino acids. *Journal of Archaeological Science* 30:535-545.
- HARE, P.E., FOGEL, M.L., STAFFORD, T.W., MITCHELL, A.D. & HOERING, T.C. 1991. The isotopic composition of carbon and nitrogen in individual amino acids isolated from modern and fossil proteins. *Journal of Archaeological Science* 18:277-292.
- HOWLAND, M.R., CORR, L.T., YOUNG, S.M.M., JONES, V., JIM, S., VAN DER MERWE, N.J., MITCHELL, A.D. & EVERSLED, R.P. 2003. Expression of the dietary isotope signal in the compound-specific  $\delta^{13}\text{C}$  values of pig bone lipids and amino acids. *International Journal of Osteoarchaeology* 13:54-65.
- JIM, S., AMBROSE, S. H. & EVERSLED, R. P. 2004. Stable carbon isotopic evidence for differences in the dietary origin of bone cholesterol, collagen and apatite: Implications for their use in palaeodietary reconstruction. *Geochimica et Cosmochimica Acta* 68: 61-72.
- JIM, S., JONES, V., AMBROSE, S.H. & EVERSLED, R.P. 2006. Quantifying dietary macronutrient sources of carbon for bone collagen biosynthesis using natural abundance stable carbon isotope analysis. *British Journal of Nutrition* 95:1055-1062.
- MCCULLAGH, J. S., TRIPP, J. A. & HEDGES, R. E. 2005. Carbon isotope analysis of bulk keratin and single amino acids from British and North American hair. *Rapid Communications in Mass Spectrometry* 19: 3227-3231.
- MCCULLAGH, J.S., JUCHELKA, D. & HEDGES, R.E. 2006. Analysis of amino acid  $^{13}\text{C}$  abundance from human and faunal bone collagen using liquid chromatography/isotope ratio mass spectrometry. *Rapid Communications in Mass Spectrometry* 20:2761-2768.
- MORA, A., ARRIAZA, B.T., STANDEN, V.G., VALDIOSERA, C., SALIM, A. & SMITH, C. 2017. High-resolution palaeodietary reconstruction: Amino acid  $\delta^{13}\text{C}$  analysis of keratin from single hairs of mummified human individuals. *Quaternary International*. (in press)
- NAITO, Y.I., BOCHERENS, H., CHIKARAISHI, Y., DRUCKER, D.G., WIBING, C., YONEDA, M. & OHKOUCHI, N. 2016. An overview of methods used for the detection of aquatic resource consumption by humans: Compound-specific delta N-15 analysis of amino acids in archaeological materials. *Journal of Archaeological Science: Reports* 6:720-732.
- RAGHAVAN, M., MCCULLAGH, J.S.O., LYNNERUP, N. & HEDGES, R.E.M. 2010. Amino acid  $\delta^{13}\text{C}$  analysis of hair proteins and bone collagen using liquid chromatography/isotope ratio mass spectrometry: paleodietary implications from intra-individual comparisons. *Rapid Communications in Mass Spectrometry* 24:541-548.
- SMITH, C.I., FULLER, B.T., CHOY, K. & RICHARDS, M.P. 2009. A three-phase liquid chromatographic method for  $\delta^{13}\text{C}$  analysis of amino acids from biological protein hydrolysates using liquid chromatography–isotope ratio mass spectrometry. *Analytical Biochemistry* 390:165-172.
- STOTT, A.W., EVERSLED, R.P. & TUROSS, N. 1997. Compound-specific approach to the  $\delta^{13}\text{C}$  analysis of cholesterol in fossil bones. *Organic Geochemistry* 26:99-103.
- STOTT, A.W., EVERSLED, R.P., JIM, S., JONES, V., ROGERS, J., TUROSS, N. & AMBROSE, S. 1999. Cholesterol as a new source of palaeodietary information: experimental approaches and archaeological applications. *Journal of Archaeological Science* 26:705-716.

STYRING, A.K., SEALY, J.C. & EVERSHED, R.P. 2010. Resolving the bulk  $\delta^{15}\text{N}$  values of ancient human and animal bone collagen via compound-specific nitrogen isotope analysis of constituent amino acids. *Geochimica et Cosmochimica Acta* 74:241-251.

TRIPP, J.A., MCCULLAGH, J.S. & HEDGES, R.E. 2006. Preparative separation of underivatized amino acids for compound-specific stable isotope analysis and radiocarbon dating of hydrolyzed bone collagen. *Journal of Separation Science* 29:41-48.

WEBB, E.C., HONCH, N.V., DUNN, P.J.H., ERIKSSON, G., LIDÉN, K. & EVERSHED, R.P. 2015. Compound-specific amino acid isotopic proxies for detecting freshwater resource consumption. *Journal of Archaeological Science* 63:104-114.

## 7. 'Non-Traditional' Isotopes

ALBARÈDE, F., DESAULTY, A.M. & BLICHERT-TOFT, J. 2012. A geological perspective on the use of Pb isotopes in archaeometry. *Archaeometry* 54:853-867.

CHU, N.-C., HENDERSON, G.M., BELSHAW, N.S. & HEDGES, R.E.M. 2006. Establishing the potential of Ca isotopes as proxy for consumption of dairy products. *Applied Geochemistry* 21:1656-1667.

CLEMENTZ, M., HOLDEN, P. & KOCH, P. 2003. Are calcium isotopes a reliable monitor of trophic level in marine settings? *International Journal of Osteoarchaeology* 13:29-36.

HEUSER, A., TÜTKEN, T., GUSSONE, N. & GALER, S.J. 2011. Calcium isotopes in fossil bones and teeth—diagenetic versus biogenic origin. *Geochimica et Cosmochimica Acta* 75:3419-3433.

JAOUEN, K., SZPAK, P. & RICHARDS, M. P. 2016. Zinc Isotope Ratios as Indicators of Diet and Trophic Level in Arctic Marine Mammals. *PLoS ONE* 11: e0152299.

JAOUEN, K. & PONS, M.-L. 2016. Potential of non-traditional isotope studies for bioarchaeology. *Archaeological and Anthropological Sciences*:1-16.

KNUDSON, K.J., WILLIAMS, H.M., BUIKSTRA, J.E., TOMCZAK, P.D., GORDON, G.W. & ANBAR, A.D. 2010. Introducing  $\delta^{88/86}\text{Sr}$  analysis in archaeology: a demonstration of the utility of strontium isotope fractionation in paleodietary studies. *Journal of Archaeological Science* 37:2352-2364.

MARTIN, J.E., VANCE, D. & BALTER, V. 2014. Natural variation of magnesium isotopes in mammal bones and teeth from two South African trophic chains. *Geochimica et Cosmochimica Acta* 130:12-20.

MARTIN, J.E., VANCE, D. & BALTER, V. 2015. Magnesium stable isotope ecology using mammal tooth enamel. *Proceedings of the National Academy of Sciences of the United States of America* 112:430-435.

MELIN, A.D., CROWLEY, B.E., BROWN, S.T., WHEATLEY, P.V., MORITZ, G.L., YIT YU, F.T., BERNARD, H., DEPAOLO, D.J., JACOBSON, A.D. & DOMINY, N.J. 2014. Technical Note: Calcium and carbon stable isotope ratios as paleodietary indicators. *American Journal of Physical Anthropology* 154:633-643.

REYNARD, L.M., HENDERSON, G.M. & HEDGES, R.E.M. 2011. Calcium isotopes in archaeological bones and their relationship to dairy consumption. *Journal of Archaeological Science* 38:657-664.

REYNARD, L.M., PEARSON, J.A., HENDERSON, G.M. & HEDGES, R.E.M. 2013. Calcium isotopes in juvenile milk-consumers. *Archaeometry* 55:946-957.

TÜTKEN, T., VENNEMANN, T. W. & PFRETZSCHNER, H.-U. 2011. Nd and Sr isotope compositions in modern and fossil bones – Proxies for vertebrate provenance and taphonomy. *Geochimica et Cosmochimica Acta* 75: 5951-5970.

## 8. Micro Sampling & Incremental Approaches

BALASSE, M. 2002. Reconstructing dietary and environmental history from enamel isotopic analysis: Time resolution of intra-tooth sequential sampling. *International Journal of Osteoarchaeology* 12: 155-165.

BALASSE, M. 2003. Potential biases in sampling design and interpretation of intra-tooth isotope analysis. *International Journal of Osteoarchaeology* 13: 3-10.

BEAUMONT, J. & MONTGOMERY, J. 2015. Oral histories: a simple method of assigning chronological age to isotopic values from human dentine collagen. *Annals of Human Biology* 42:407-414.

BENDREY, R., VELLA, D., ZAZZO, A., BALASSE, M. & LEPETZ, S. 2015. Exponentially decreasing tooth growth rate in horse teeth: implications for isotopic analyses. *Archaeometry* 57:1104-1124.

BRITTON, K., GRIMES, V., DAU, J. & RICHARDS, M.P. 2009. Reconstructing faunal migrations using intra-tooth sampling and strontium and oxygen isotope analyses: a case study of modern caribou (*Rangifer tarandus granti*). *Journal of Archaeological Science* 36:1163-1172.

DOLPHIN, A.E., TEETER, M.A., WHITE, C.D. & LONGSTAFFE, F.J. 2016. Limiting the impact of destructive analytical techniques through sequential microspatial sampling of the enamel from single teeth. *Journal of Archaeological Science: Reports* 5:537-541.

EERKENS, J.W., BERGET, A.G. & BARTELINK, E.J. 2011. Estimating weaning and early childhood diet from serial micro-samples of dentin collagen. *Journal of Archaeological Science* 38:3101-3111.

GUIRY, E.J., HEPBURN, J.C. & RICHARDS, M.P. 2016. High-resolution serial sampling for nitrogen stable isotope analysis of archaeological mammal teeth. *Journal of Archaeological Science* 69:21-28.

KOHN, M.J. 1996. Predicting animal  $\delta^{18}\text{O}$ : Accounting for diet and physiological adaptation. *Geochimica et Cosmochimica Acta* 60:4811-4829.

KOHN, M.J., SCHOENINGER, M.J. & VALLEY, J.W. 1996. Herbivore tooth oxygen isotope compositions: effects of diet and physiology. *Geochimica et Cosmochimica Acta* 60:3889-3896.

KOHN, M.J., SCHOENINGER, M.J. & VALLEY, J.W. 1998. Variability in oxygen isotope compositions of herbivore teeth: reflections of seasonality or developmental physiology? *Chemical Geology* 152:97-112.

PASSEY, B.H., CERLING, T.E., SCHUSTER, G.T., ROBINSON, T.F., ROEDER, B.L. & KRUEGER, S.K. 2005. Inverse methods for estimating primary input signals from time-averaged isotope profiles. *Geochimica et Cosmochimica Acta* 69:4101-4116.

- READE, H., STEVENS, R.E., BARKER, G. & O'CONNELL, T.C. 2015. Tooth enamel sampling strategies for stable isotope analysis: Potential problems in cross-method data comparisons. *Chemical Geology* 404:126-135.
- SANDBERG, P.A., SPONHEIMER, M., LEE-THORP, J. & VAN GERVEN, D. 2014. Intra-tooth stable isotope analysis of dentine: A step toward addressing selective mortality in the reconstruction of life history in the archaeological record. *American Journal of Physical Anthropology* 155:281-293.
- TRAYLER, R.B. & KOHN, M.J. 2017. Tooth enamel maturation reequilibrates oxygen isotope compositions and supports simple sampling methods. *Geochimica et Cosmochimica Acta* 198:32-47.
- WILLMES, M., KINSLEY, L., MONCEL, M.H., ARMSTRONG, R.A., AUBERT, M., EGGINS, S. & GRÜN, R. 2016. Improvement of laser ablation in situ micro-analysis to identify diagenetic alteration and measure strontium isotope ratios in fossil human teeth. *Journal of Archaeological Science* 70:102-116.
- ZAZZO, A., BALASSE, M. & PATTERSON, W.P. 2005. High-resolution d13C intratooth profiles in bovine enamel: Implications for mineralization pattern and isotopic attenuation. *Geochimica et Cosmochimica Acta* 69:3631-3642.
- ZAZZO, A., BALASSE, M. & PATTERSON, W.P. 2006. The reconstruction of mammal individual history: refining high-resolution isotope record in bovine tooth dentine. *Journal of Archaeological Science* 33:1177-1187.
- ZAZZO, A., BALASSE, M., PASSEY, B.H., MOLONEY, A.P., MONAHAN, F.J. & SCHMIDT, O. 2010. The isotope record of short- and long-term dietary changes in sheep tooth enamel: implications for quantitative reconstruction of paleodiets. *Geochimica et Cosmochimica Acta* 74:3571-3586.
- ZAZZO, A., BENDREY, R., VELLA, D., MOLONEY, A.P., MONAHAN, F.J. & SCHMIDT, O. 2012. A refined sampling strategy for intra-tooth stable isotope analysis of mammalian enamel. *Geochimica Et Cosmochimica Acta* 84:1-13.

## 9. Mixing Models & Statistical Approaches to Isotope Data

- BOWEN, G.J., HOOGEWERFF, J. & WEST, J.B. 2009. Isoscapes: Isotope mapping and its applications. *Journal of Geochemical Exploration* 102:V-VII.
- FERNANDES, R., NADEAU, M.-J. & GROOTES, P.M. 2012. Macronutrient-based model for dietary carbon routing in bone collagen and bioapatite. *Archaeological and Anthropological Sciences* 4:291-301.
- FERNANDES, R., MILLARD, A.R., BRABEC, M., NADEAU, M.J. & GROOTES, P. 2014. Food Reconstruction Using Isotopic Transferred Signals (FRUITS): a Bayesian model for diet reconstruction. *PLOS ONE* 9: e87436.
- HEDGES, R.E.M. & VAN KLINKEN, G.J. 2000. "Consider a Spherical Cow..." - on Modelling and Diet. In: AMBROSE, S.H. & KATZENBERG, M.A. (eds.) *Biogeochemical Approaches to Paleodietary Analysis*. New York: Kluwer Academic/Plenum.
- KELLNER, C.M. & SCHOENINGER, M.J. 2007. A simple carbon isotope model for reconstructing prehistoric human diet. *American Journal of Physical Anthropology* 133:1112-1127.

LIGHTFOOT, E. & O'CONNELL, T.C. 2016. On the Use of Biomineral Oxygen Isotope Data to Identify Human Migrants in the Archaeological Record: Intra-Sample Variation, Statistical Methods and Geographical Considerations. *PLoS ONE* 11:e0153850.

MONTGOMERY, J., EVANS, J. & COOPER, R.E. 2007. Resolving archaeological populations with Sr-isotope mixing models. *Applied Geochemistry* 22:1502-1514.

PHILLIPS, D.L. 2012. Converting isotope values to diet composition: the use of mixing models. *Journal of Mammalogy* 93:342-352.

PHILLIPS, D.L., INGER, R., BEARHOP, S., JACKSON, A.L., MOORE, J.W., PARNELL, A.C., SEMMENS, B.X. & WARD, E.J. 2014. Best practices for use of stable isotope mixing models in food-web studies. *Canadian Journal of Zoology* 92:823-835.

PHILLIPS, D.L. & KOCH, P.L. 2002. Incorporating concentration dependence in stable isotope mixing models. *Oecologia* 130:114-125.

TSUTAYA, T. & YONEDA, M. 2013. Quantitative Reconstruction of Weaning Ages in Archaeological Human Populations Using Bone Collagen Nitrogen Isotope Ratios and Approximate Bayesian Computation. *PLoS ONE* 8:e72327.

WILLMES, M., MCMORROW, L., KINSLEY, L., ARMSTRONG, R., AUBERT, M., EGGINS, S., FALGUÈRES, C., MAUREILLE, B., MOFFAT, I. & GRÜN, R. 2014. The IRHUM (Isotopic Reconstruction of Human Migration) database: bioavailable strontium isotope ratios for geochemical fingerprinting in France. *Earth Syst. Sci. Data* 6:117-122.

**SECTION II: Case Studies in Archaeological Human Diet & Mobility****10. Early Hominin Diet & Mobility**

BALTER, V., BRAGA, J., TÉLOUK, P. & THACKERAY, J.F. 2012. Evidence for dietary change but not landscape use in South African early hominins. *Nature* 489:558-560.

COPELAND, S.R., SPONHEIMER, M., DE RUITER, D.J., LEE-THORP, J.A., CODRON, D., LE ROUX, P.J., GRIMES, V. & RICHARDS, M.P. 2011. Strontium isotope evidence for landscape use by early hominins. *Nature* 474:76-78.

LEE-THORP, J.A., VAN DER MERWE, N.J. & BRAIN, C. 1994. Diet of *Australopithecus robustus* at Swartkrans from stable carbon isotopic analysis. *Journal of Human Evolution* 27:361-372.

LEE-THORP, J.A., SPONHEIMER, M. & VAN DER MERWE, N.J. 2003. What do stable isotopes tell us about hominid dietary and ecological niches in the Pliocene? *International Journal of Osteoarchaeology* 13:104-113.

LEE-THORP, J. & SPONHEIMER, M. 2006. Contributions of biogeochemistry to understanding hominin dietary ecology. *Yearbook of Physical Anthropology, Vol. 49 2006*. New York: Wiley-Liss, Inc.

LEE-THORP, J.A., SPONHEIMER, M., PASSEY, B.H., DE RUITER, D.J. & CERLING, T.E. 2010. Stable isotopes in fossil hominin tooth enamel suggest a fundamental dietary shift in the Pliocene. *Philosophical Transactions of the Royal Society B: Biological Sciences* 365:3389-3396.

LEE-THORP, J., LIKIUS, A., MACKAYE, H.T., VIGNAUD, P., SPONHEIMER, M. & BRUNET, M. 2012. Isotopic evidence for an early shift to C4 resources by Pliocene hominins in Chad. *Proceedings of the National Academy of Sciences of the United States of America* 109:20369-20372.

SCHOENINGER, M. J. 2014. Stable Isotope Analyses and the Evolution of Human Diets. *Annual Review of Anthropology* 43: 413-430.

SPONHEIMER, M. & LEE-THORP, J.A. 1999. Isotopic evidence for the diet of an early hominid, *Australopithecus africanus*. *Science* 283:368-370.

SPONHEIMER, M., LEE-THORP, J., DE RUITER, D., CODRON, D., CODRON, J., BAUGH, A.T. & THACKERAY, F. 2005. Hominins, sedges, and termites: new carbon isotope data from the Sterkfontein valley and Kruger National Park. *Journal of Human Evolution* 48:301-312.

SPONHEIMER, M., DE RUITER, D., LEE-THORP, J. & SPÄTH, A. 2005. Sr/Ca and early hominin diets revisited: new data from modern and fossil tooth enamel. *Journal of Human Evolution* 48:147-156.

SPONHEIMER, M., ALEMSEGED, Z., CERLING, T.E., GRINE, F.E., KIMBEL, W.H., LEAKEY, M.G., LEE-THORP, J.A., MANTHI, F.K., REED, K.E. & WOOD, B.A. 2013. Isotopic evidence of early hominin diets. *Proceedings of the National Academy of Sciences of the United States of America* 110:10513-10518.

SPONHEIMER, M. & LEE-THORP, J. 2015. Hominin Paleodiets: The Contribution of Stable Isotopes. In: HENKE, W. & TATTERSALL, I. (eds.) *Handbook of Paleoanthropology*. Berlin, Heidelberg: Springer Berlin Heidelberg.

VAN DER MERWE, N.J., THACKERAY, J.F., LEE-THORP, J.A. & LUYT, J. 2003. The carbon isotope ecology and diet of *Australopithecus africanus* at Sterkfontein, South Africa. *Journal of Human Evolution* 44:581-597.

WYNN, J.G., SPONHEIMER, M., KIMBEL, W.H., ALEMSEGED, Z., REED, K., BEDASO, Z.K. & WILSON, J.N. 2013. Diet of *Australopithecus afarensis* from the Pliocene Hadar formation, Ethiopia. *Proceedings of the National Academy of Sciences of the United States of America* 110:10495-10500.

## 11. Late Pleistocene (Neanderthal) Diet and Mobility

AMBROSE, S.H. 1998. Prospects for stable isotopic analysis of later Pleistocene hominid diets in West Asia and Europe. In: AKAZAWA, T., AOKI, K. & BAR-YOSEF, O. (eds.) *Neandertals and modern humans in western Asia*. New York: Plenum Press.

BALTER, V. & SIMON, L. 2006. Diet and behavior of the Saint-Cesaire Neanderthal inferred from biogeochemical data inversion. *Journal of Human Evolution* 51:329-338.

BOCHERENS, H., FIZET, M., MARIOTTI, A., LANGE-BADRE, B., VANDERMEERSCH, B., BOREL, J.P. & BELLON, G. 1991. Isotopic biogeochemistry ( $^{13}\text{C}$ ,  $^{15}\text{N}$ ) of fossil vertebrate collagen: application to the study of a past food web including Neanderthal man. *Journal of Human Evolution* 20:481-492.

BOCHERENS, H., BILLIOU, D., MARIOTTI, A., PATOU-MATHIS, M., OTTE, M., BONJEAN, D. & TOUSSAINT, M. 1999. Palaeoenvironmental and palaeodietary implications of isotopic biogeochemistry of last interglacial Neanderthal and mammal bones in Scladina Cave (Belgium). *Journal of Archaeological Science* 26:599-607.

BOCHERENS, H., BILLIOU, D., MARIOTTI, A., TOUSSAINT, M., PATOU-MATHIS, M., BONJEAN, D. & OTTE, M. 2001. New isotopic evidence for dietary habits of Neandertals from Belgium. *Journal of Human Evolution* 40:497-505.

BOCHERENS, H., DRUCKER, D.G., BILLIOU, D., PATOU-MATHIS, M. & VANDERMEERSCH, B. 2005. Isotopic evidence for diet and subsistence pattern of the Saint-Césaire I Neanderthal: review and use of a multi-source mixing model. *Journal of Human Evolution* 49:71-87.

RICHARDS, M.P. & TRINKAUS, E. 2009. Isotopic evidence for the diets of European Neanderthals and early modern humans. *Proceedings of the National Academy of Sciences of the United States of America* 106:16034-16039.

RICHARDS, M.P., PETTITT, P.B., TRINKAUS, E., SMITH, F.H., PAUNOVIC, M. & KARAVANIC, I. 2000. Neanderthal diet at Vindija and Neanderthal predation: The evidence from stable isotopes. *Proceedings of the National Academy of Sciences of the United States of America* 97:7663-7666.

RICHARDS, M.P., HARVATI, K., GRIMES, V., SMITH, C., SMITH, T., HUBLIN, J.J., KARKANAS, P. & PANAGOPOULOU, E. 2008. Strontium isotope evidence of Neanderthal mobility at the site of Lakonis, Greece using laser-ablation PIMMS. *Journal of Archaeological Science* 35:1251-1256.

RICHARDS, M.P., TAYLOR, G., STEELE, T., MCPHERRON, S.P., SORESSI, M., JAUBERT, J., ORSCHIEDT, J., MALLYE, J.B., RENDU, W. & HUBLIN, J.J. 2008. Isotopic dietary analysis of a Neanderthal and associated fauna from the site of Jonzac (Charente-Maritime), France. *Journal of Human Evolution* 55:179-185.



RICHARDS, M. P. & TRINKAUS, E. 2009. Isotopic evidence for the diets of European Neanderthals and early modern humans. *Proceedings of the National Academy of Sciences of the United States of America* 106: 16034-16039.

RICHARDS, M. P., HARVATI, K., GRIMES, V., SMITH, C., SMITH, T., HUBLIN, J. J., KARKANAS, P. & PANAGOPOULOU, E. 2008. Strontium isotope evidence of Neanderthal mobility at the site of Lakonis, Greece using laser-ablation PIMMS. *Journal of Archaeological Science* 35: 1251-1256.

NAITO, Y.I., CHIKARAISHI, Y., DRUCKER, D.G., OHKOUCHI, N., SEMAL, P., WIBING, C. & BOCHERENS, H. 2016. Ecological niche of Neanderthals from Spy Cave revealed by nitrogen isotopes of individual amino acids in collagen. *Journal of Human Evolution* 93:82-90.

WIBING, C., ROUGIER, H., CREVECOEUR, I., GERMONPRÉ, M., NAITO, Y.I., SEMAL, P. & BOCHERENS, H. 2016. Isotopic evidence for dietary ecology of late Neandertals in North-Western Europe. *Quaternary International* 411, Part A:327-345.

GARCIA, N., FERANEC, R.S., PASSEY, B.H., CERLING, T.E. & ARSUAGA, J.L. 2015. Exploring the potential of laser ablation carbon isotope analysis for examining ecology during the ontogeny of middle Pleistocene hominins from Sima de los Huesos (northern Spain). *PLoS One* 10:e0142895.

## 12. Mesolithic-Neolithic Transition in North-West Europe

FISCHER, A., OLSEN, J., RICHARDS, M., HEINEMEIER, J., SVEINBJORNSDOTTIR, A.E. & BENNIKE, P. 2007. Coast-inland mobility and diet in the Danish Mesolithic and Neolithic: evidence from stable isotope values of humans and dogs. *Journal of Archaeological Science* 34:2125-2150.

GIGLEUX, C., RICHARDS, M.P., CURTIS, N., HUTCHISON, M. & BRITTON, K. 2017. Reconstructing diet at the Neolithic stalled cairn of the Knowe of Rowiegar, Rousay, Orkney, using stable isotope analysis. *Journal of Archaeological Science: Reports* 13:272-280.

MILNER, N., CRAIG, O. E., BAILEY, G. N., PEDERSEN, K. & ANDERSEN, S. H. 2004. Something fishy in the Neolithic? A re-evaluation of stable isotope analysis of Mesolithic and Neolithic coastal populations. *Antiquity* 78: 9-22.

MONTGOMERY, J., BEAUMONT, J., JAY, M., KEEFE, K., GLEDHILL, A. R., COOK, G. T., DOCKRILL, S. J. & MELTON, N. D. 2013. Strategic and sporadic marine consumption at the onset of the Neolithic: increasing temporal resolution in the isotope evidence. *Antiquity* 87: 1060-1072.

PRICE, T.D., AMBROSE, S.H., BENNIKE, P., HEINEMEIER, J., NOE-NYGAARD, N., PETERSEN, E.B., PETERSEN, P.V. & RICHARDS, M.P. 2007. New information on the Stone Age graves at Dragsholm, Denmark. *Acta Archaeologica* 78:193-219.

RICHARDS, M. & HEDGES, R. 1999. A Neolithic revolution? New evidence of diet in the British Neolithic. *Antiquity* 73:891-897.

RICHARDS, M.P. & HEDGES, R.E.M. 1999. Stable isotope evidence for similarities in the types of marine foods used by late Mesolithic humans at sites along the Atlantic coast of Europe. *Journal of Archaeological Science* 26:717-722.

- RICHARDS, M.P. 2000. Human consumption of plant foods in the British Neolithic: Direct evidence from bone stable isotopes. *In: FAIRBAIRN, A.S. (ed.) Plants in the Neolithic Britain and beyond.* Oxford: Oxbow Books.
- RICHARDS, M.P. & SCHULTING, R. 2000. Stable isotopes from human remains from the Severn Estuary. *In: BELL, M., CASELDINE, A. & NEUMANN, H. (eds.) Prehistoric Intertidal Archaeology in the Welsh Severn Estuary.* York: Council for British Archaeology, CBA Research Report 120.
- RICHARDS, M. P., SCHULTING, R. J. & HEDGES, R. E. M. 2003. Sharp shift in diet at onset of Neolithic. *Nature* 425: 366.
- RICHARDS, M. P., PRICE, T. D. & KOCH, E. 2003. Mesolithic and Neolithic subsistence in Denmark: New stable isotope data. *Current Anthropology* 44: 288-U4.
- RICHARDS, M. P. & SCHULTING, R. J. 2006. Against the grain? A response to Milner et al. (2004). *Antiquity* 80: 444-456.
- SCHULTING, R.J. & RICHARDS, M.P. 2001. Dating women and becoming farmers: new palaeodietary and AMS dating evidence from the Breton Mesolithic cemeteries of Tévéc and Hoëdic. *Journal of Anthropological Archaeology* 20:314-344.
- SCHULTING, R.J. & RICHARDS, M.P. 2002. Dogs, ducks, deer and diet: New stable isotope evidence on Early Mesolithic dogs from the Vale of Pickering, North-East England. *Journal of Archaeological Science* 29:327-333.
- SCHULTING, R. & RICHARDS, M.P. 2002. Finding the coastal Mesolithic in southwest Britain: AMS dates and stable isotope results on human remains from Caldey Island, south Wales. *Antiquity* 76:1011-1125.
- SCHULTING, R. J. & RICHARDS, M. P. 2002. The wet, the wild and the domesticated: The Mesolithic-Neolithic transition on the West coast of Scotland. *European Journal of Archaeology* 5: 147-189.
- TAUBER, H. 1981. <sup>13</sup>C evidence for dietary habits of prehistoric man in Denmark. *Nature* 292: 332-333.

### **13. Changes in Mobility Patterns with the Transition to Agriculture**

- BENTLEY, R. A. 2013. Mobility and the diversity of Early Neolithic lives: Isotopic evidence from skeletons. *Journal of Anthropological Archaeology* 32: 303-312.
- BENTLEY, R.A., KRAUSE, R., PRICE, T.D. & KAUFMANN, B. 2003. Human mobility at the early Neolithic settlement of Vaihingen, Germany: evidence from strontium isotope analysis. *Archaeometry* 45:471-486.
- BENTLEY, R. A., PIETRUSEWSKY, M., DOUGLAS, M. T. & ATKINSON, T. C. 2005. Matrilocality during the prehistoric transition to agriculture in Thailand? *Antiquity* 79: 865-881.
- BENTLEY, R., XA, ALEXANDER, TAYLES, N., HIGHAM, C., MACPHERSON, C., ATKINSON, T., XA & C 2007. Shifting Gender Relations at Khok Phanom Di, Thailand: Isotopic Evidence from the Skeletons. *Current Anthropology* 48: 301-314.

- BENTLEY, R.A., WAHL, J., PRICE, T.D. & ATKINSON, T.C. 2008. Isotopic signatures and hereditary traits: snapshot of a Neolithic community. *Antiquity* 82:290-304.
- BORIĆ, D. & PRICE, T.D. 2013. Strontium isotopes document greater human mobility at the start of the Balkan Neolithic. *Proceedings of the National Academy of Sciences of the United States of America* 110:3298-3303.
- ERIKSSON, G., FREI, K.M., HOWCROFT, R., GUMMESSON, S., MOLIN, F., LIDÉN, K., FREI, R. & HALLGREN, F. 2016. Diet and mobility among Mesolithic hunter-gatherers in Motala (Sweden)-The isotope perspective. *Journal of Archaeological Science: Reports*.
- FREI, K.M. & PRICE, T.D. 2012. Strontium isotopes and human mobility in prehistoric Denmark. *Archaeological and Anthropological Sciences* 4:103-114.
- GIBLIN, J.I., KNUDSON, K.J., BERECZKI, Z., PÁLFI, G. & PAP, I. 2013. Strontium isotope analysis and human mobility during the Neolithic and Copper Age: a case study from the Great Hungarian Plain. *Journal of Archaeological Science* 40:227-239.
- GOUDE, G., CASTORINA, F., HERRSCHER, E., CABUT, S. & TAFURI, M.A. 2012. First strontium isotope evidence of mobility in the Neolithic of Southern France. *European Journal of Archaeology* 15:421-439.
- HAAK, W., BRANDT, G., DE JONG, H. N., MEYER, C., GANSLMEIER, R., HEYD, V., HAWKESWORTH, C., PIKE, A. W. G., MELLER, H. & ALT, K. W. 2008. Ancient DNA, Strontium isotopes, and osteological analyses shed light on social and kinship organization of the Later Stone Age. *Proceedings of the National Academy of Sciences of the United States of America* 105: 18226-18231.
- MONTGOMERY, J., BUDD, P. & EVANS, J. 2000. Reconstructing the lifetime movements of ancient people: a Neolithic case study from southern England. *European Journal of Archaeology* 3:370-385.
- NEHLICH, O., MONTGOMERY, J., EVANS, J., SCHADE-LINDIG, S., PICHLER, S.L., RICHARDS, M.P. & ALT, K.W. 2009. Mobility or migration: a case study from the Neolithic settlement of Nieder-Mörlen (Hessen, Germany). *Journal of Archaeological Science* 36:1791-1799.
- NEIL, S., EVANS, J., MONTGOMERY, J. & SCARRE, C. 2016. Isotopic evidence for residential mobility of farming communities during the transition to agriculture in Britain. *Royal Society Open Science* 3:150522.
- PRICE, T.D., WAHL, J. & BENTLEY, R.A. 2006. Isotopic evidence for mobility and group organization among Neolithic farmers at Talheim, Germany, 5000 BC. *European Journal of Archaeology* 9:259-284.
- SJÖGREN, K.-G., PRICE, T.D. & AHLSTRÖM, T. 2009. Megaliths and mobility in southwestern Sweden. Investigating relationships between a local society and its neighbours using strontium isotopes. *Journal of Anthropological Archaeology* 28:85-101.
- SMITS, E., MILLARD, A.R., NOWELL, G. & GRAHAM PEARSON, D. 2010. Isotopic investigation of diet and residential mobility in the Neolithic of the Lower Rhine Basin. *European Journal of Archaeology* 13:5-31.

#### 14. Maize Agriculture in North America

BENDER, M.M., BAERREIS, D.A. & STEVENTON, R.L. 1981. Further light on carbon isotopes and Hopewell agriculture. *American Antiquity*:346-353.

KATZENBERG, M.A., SCHWARCZ, H.P., KNYF, M. & MELBYE, F.J. 1995. Stable isotope evidence for maize horticulture and paleodiet in southern Ontario, Canada. *American Antiquity*:335-350.

LYNOTT, M.J., BOUTTON, T.W., PRICE, J.E. & NELSON, D.E. 1986. Stable carbon isotopic evidence for maize agriculture in southeast Missouri and northeast Arkansas. *American Antiquity*:51-65.

SCHOENINGER, M.J. 2009. Stable isotope evidence for the adoption of maize agriculture. *Current Anthropology* 50:633-640.

SCHWARCZ, H.P., MELBYE, J., KATZENBERG, M.A. & KNYF, M. 1985. Stable isotopes in human skeletons of southern Ontario: reconstructing palaeodiet. *Journal of Archaeological Science* 12:187-206.

TYKOT, R.H. 2006. Isotope Analyses and the Histories of Maize. In: STALLER, J.E., TYKOT, R.H. & BENZE, B.F. (eds.) *Histories of Maize: Multidisciplinary approaches to the prehistory, linguistics, biogeography, domestication, and evolution of maize*. San Diego: Elsevier.

VAN DER MERWE, N.J. & VOGEL, J.C. 1978. C-13 Content of Human Collagen as a Measure of Prehistoric Diet in Woodland North-America. *Nature* 276:815-816.

VOGEL, J.C. & VAN DER MERWE, N.J. 1977. Isotopic evidence for early maize cultivation in New York State. *American Antiquity* 42:238-242.

## 15. Isotopes, Individuals & Socio-Cultural Identities

ALEXANDER, M.M., GERRARD, C.M., GUTIÉRREZ, A. & MILLARD, A.R. 2015. Diet, society, and economy in late medieval Spain: Stable isotope evidence from Muslims and Christians from Gandía, Valencia. *American Journal of Physical Anthropology* 156:263-273.

BASTOS, M.Q.R., SANTOS, R.V., M. DE SOUZA, S.M.F., RODRIGUES-CARVALHO, C., TYKOT, R.H., COOK, D.C. & SANTOS, R.V. 2016. Isotopic study of geographic origins and diet of enslaved Africans buried in two Brazilian cemeteries. *Journal of Archaeological Science* 70:82-90.

BEAUMONT, J., GEBER, J., POWERS, N., WILSON, A., LEE-THORP, J. & MONTGOMERY, J. 2013. Victims and survivors: Stable isotopes used to identify migrants from the Great Irish Famine to 19th century London. *American Journal of Physical Anthropology* 150:87-98.

CHEUNG, C., JING, Z., TANG, J., YUE, Z. & RICHARDS, M.P. 2015. Examining social and cultural differentiation in early Bronze Age China using stable isotope analysis and mortuary patterning of human remains at Xin'an Zhuang, Yin Xu. *Archaeological and Anthropological Sciences*:1-18.

DONG, Y., MORGAN, C., CHINENOV, Y., ZHOU, L., FAN, W., MA, X. & PECHENKINA, K. 2017. Shifting diets and the rise of male-biased inequality on the Central Plains of China during Eastern Zhou. *Proceedings of the National Academy of Sciences of the United States of America* 114:932-937.

- ERIKSSON, G. & LIDÉN, K. 2013. Dietary life histories in Stone Age Northern Europe. *Journal of Anthropological Archaeology* 32:288-302.
- EVANS, J.A., CHENERY, C.A. & FITZPATRICK, A.P. 2006. Bronze Age childhood migration of individuals near Stonehenge, revealed by strontium and oxygen isotope tooth enamel analysis. *Archaeometry* 48:309-321.
- FRANCE, C.A.M., OWSLEY, D.W. & HAYEK, L.-A.C. 2014. Stable isotope indicators of provenance and demographics in 18th and 19th century North Americans. *Journal of Archaeological Science* 42:356-366.
- JØRKOV, M.L.S. & GRÖCKE, D.R. 2016. Investigating adult diet during Industrialization in Copenhagen based on stable isotope analysis of bone collagen and hair keratin. *Archaeological and Anthropological Sciences*:1-15.
- KILLGROVE, K. & MONTGOMERY, J. 2016. All Roads Lead to Rome: Exploring Human Migration to the Eternal City through Biochemistry of Skeletons from Two Imperial-Era Cemeteries (1st-3rd c AD). *PLoS ONE* 11:e0147585.
- KOOTKER, L.M., MBEKI, L., MORRIS, A.G., KARS, H. & DAVIES, G.R. 2016. Dynamics of Indian Ocean Slavery Revealed through Isotopic Data from the Colonial Era Cobern Street Burial Site, Cape Town, South Africa (1750-1827). *PLoS ONE* 11:e0157750.
- LAMB, A.L., EVANS, J.E., BUCKLEY, R. & APPLEBY, J. 2014. Multi-isotope analysis demonstrates significant lifestyle changes in King Richard III. *Journal of Archaeological Science* 50:559-565.
- MARTÍNEZ-JARRETA, B., SOSA, C., LALIENA, C., BUDOWLE, B. & HEDGES, R.E.M. 2017. Stable Isotope and Radiocarbon Dating of the Remains of the Medieval Royal House of Aragon (Spain) Shed Light on Their Diets, Life Histories and Identities. *Archaeometry* (in press).
- MÜLDNER, G., MONTGOMERY, J., COOK, G., ELLAM, R., GLEDHILL, A. & LOWE, C. 2009. Isotopes and individuals: diet and mobility among the medieval Bishops of Whithorn. *Antiquity* 83: 1119-1133.
- PEARSON, J. & MESKELL, L. 2015. Isotopes and Images: Fleshing out Bodies at Çatalhöyük. *Journal of Archaeological Method and Theory* 22:461-482.
- PEARSON, J.A., HADDOW, S.D., HILLSON, S.W., KNÜSEL, C.J., LARSEN, C.S. & SADVARI, J.W. 2015. Stable carbon and nitrogen isotope analysis and dietary reconstruction through the life course at Neolithic Çatalhöyük, Turkey. *Journal of Social Archaeology* 15:210-232.
- QUINTELIER, K., ERVYNCK, A., MÜLDNER, G., NEER, W., RICHARDS, M.P. & FULLER, B.T. 2014. Isotopic examination of links between diet, social differentiation, and DISH at the post-medieval Carmelite Friary of Aalst, Belgium. *American Journal of Physical Anthropology* 153:203-213.
- SHAW, H., MONTGOMERY, J., REDFERN, R., GOWLAND, R. & EVANS, J. 2016. Identifying migrants in Roman London using lead and strontium stable isotopes. *Journal of Archaeological Science* 66:57-68.

SHERIDAN, S.G. & GREGORICKA, L.A. 2015. Monks on the move: Evaluating pilgrimage to byzantine St. Stephen's monastery using strontium isotopes. *American Journal of Physical Anthropology* 158:581-591.

SOMERVILLE, A.D., FAUVELLE, M. & FROEHLE, A.W. 2013. Applying new approaches to modeling diet and status: isotopic evidence for commoner resiliency and elite variability in the Classic Maya lowlands. *Journal of Archaeological Science* 40:1539-1553.

TORRES-ROUFF, C., KNUDSON, K.J., PESTLE, W.J. & STOVEL, E.M. 2015. Tiwanaku influence and social inequality: A bioarchaeological, biogeochemical, and contextual analysis of the Larache cemetery, San Pedro de Atacama, Northern Chile. *American Journal of Physical Anthropology* 158:592-606.

WILSON, A.S., TAYLOR, T., CERUTI, M.C., CHAVEZ, J.A., REINHARD, J., GRIMES, V., MEIER-AUGENSTEIN, W., CARTMELL, L., STERN, B., RICHARDS, M.P., WOROBEY, M., BARNES, I. & GILBERT, M.T.P. 2007. Stable isotope and DNA evidence for ritual sequences in Inca child sacrifice. *Proceedings of the National Academy of Sciences of the United States of America* 104:16456-16461.

## **16. Dietary Transitions in Britain from the late Iron Age to the High Medieval Period**

BARRETT, J. H., BEUKENS, R. P. & NICHOLSON, R. A. 2001. Diet and ethnicity during the Viking colonization of northern Scotland: Evidence from fish bones and stable carbon isotopes. *Antiquity* 75: 145-154.

BONSALL, L.A. & PICKARD, C. 2015. Stable isotope and dental pathology evidence for diet in late Roman Winchester, England. *Journal of Archaeological Science: Reports* 2:128-140.

CHEUNG, C., SCHROEDER, H. & HEDGES, R. E. M. 2012. Diet, social differentiation and cultural change in Roman Britain: new isotopic evidence from Gloucestershire. *Archaeological and Anthropological Sciences* 4: 61-73.

CURTIS-SUMMERS, S., MONTGOMERY, J. & CARVER, M. 2014. Stable Isotope Evidence for Dietary Contrast Between Pictish and Medieval Populations at Portmahomack, Scotland. *Medieval Archaeology* 58:21-43.

HEMER, K.A., LAMB, A.L., CHENERY, C.A. & EVANS, J.A. 2017. A multi-isotope investigation of diet and subsistence amongst island and mainland populations from early medieval western Britain. *American Journal of Physical Anthropology* 162:423-440.

MAYS, S. & BEAVAN, N. 2012. An investigation of diet in early Anglo-Saxon England using carbon and nitrogen stable isotope analysis of human bone collagen. *Journal of Archaeological Science* 39:867-874.

MÜLDNER, G. 2013. Stable isotopes and diet: their contribution to Romano-British research. *Antiquity* 87: 137-149.

MÜLDNER, G. & RICHARDS, M. P. 2005. Fast or feast: reconstructing diet in later medieval England by stable isotope analysis. *Journal of Archaeological Science* 32: 39-48.

- MÜLDNER, G. & RICHARDS, M. P. 2007. Stable isotope evidence for 1500 years of human diet at the city of York, UK. *American Journal of Physical Anthropology* 133: 682-697.
- MÜLDNER, G., MONTGOMERY, J., COOK, G., ELLAM, R., GLEDHILL, A. & LOWE, C. 2009. Isotopes and individuals: diet and mobility among the medieval Bishops of Whithorn. *Antiquity* 83: 1119-1133.
- PRIVAT, K. L., O'CONNELL, T. C. & RICHARDS, M. P. 2002. Stable isotope analysis of human and faunal remains from the Anglo-Saxon cemetery at Berinsfield, Oxfordshire: Dietary and social implications. *Journal of Archaeological Science* 29: 779-790.
- REDFERN, R. C., HAMLIN, C. & ATHFIELD, N. B. 2010. Temporal changes in diet: a stable isotope analysis of late Iron Age and Roman Dorset, Britain. *Journal of Archaeological Science* 37: 1149-1160.
- RICHARDS, M. P., FULLER, B. T. & MOLLESON, T. I. 2006. Stable isotope palaeodietary study of humans and fauna from the multi-period (Iron Age, Viking and Late Medieval) site of Newark Bay, Orkney. *Journal of Archaeological Science* 33: 122-131.
- RICHARDS, M. P., HEDGES, R. E. M., MOLLESON, T. I. & VOGEL, J. C. 1998. Stable isotope analysis reveals variations in human diet at the Poundbury Camp cemetery site. *Journal of Archaeological Science* 25: 1247-1252.
- STEVENS, R. E., LIGHTFOOT, E., HAMILTON, J., CUNLIFFE, B. & HEDGES, R. E. M. 2013. Investigating Dietary Variation With Burial Ritual in Iron Age Hampshire: An Isotopic Comparison of Suddern Farm Cemetery and Danebury Hillfort Pit Burials. *Oxford Journal of Archaeology* 32: 257-273.

### **17. Breastfeeding in Britain's Past**

- BEAUMONT, J., GLEDHILL, A., LEE-THORP, J. & MONTGOMERY, J. 2013. Childhood diet: A closer examination of the evidence from dental tissues using stable isotope analysis of segmental human dentine. *Archaeometry* 55:277-295.
- BEAUMONT, J., MONTGOMERY, J., BUCKBERRY, J. & JAY, M. 2015. Infant mortality and isotopic complexity: New approaches to stress, maternal health, and weaning. *American Journal of Physical Anthropology* 157:441-457.
- BRITTON, K., FULLER, B.T., TUTKEN, T., MAYS, S. & RICHARDS, M.P. 2015. Oxygen isotope analysis of human bone phosphate evidences weaning age in archaeological populations. *American Journal of Physical Anthropology* 157:226-241.
- BURT, N.M. 2013. Stable isotope ratio analysis of breastfeeding and weaning practices of children from medieval Fishergate House York, UK. *American journal of physical anthropology* 152:407-416.
- FULLER, B.T., RICHARDS, M.P. & MAYS, S.A. 2003. Stable carbon and nitrogen isotope variations in tooth dentine serial sections from Wharram Percy. *Journal of Archaeological Science* 30:1673-1684.
- FULLER, B.T., MOLLESON, T.I., HARRIS, D.A., GILMOUR, L.T. & HEDGES, R.E.M. 2006. Isotopic Evidence for Breastfeeding and Possible Adult Dietary Differences from Late/Sub-Roman Britain. *American Journal of Physical Anthropology* 129:45-54.

- HAYDOCK, H., CLARKE, L., CRAIG-ATKINS, E., HOWCROFT, R. & BUCKBERRY, J. 2013. Weaning at Anglo-Saxon Raunds: Implications for changing breastfeeding practice in Britain over two millennia. *American Journal of Physical Anthropology* 151:604-612.
- HENDERSON, R.C., LEE-THORP, J. & LOE, L. 2014. Early life histories of the London poor using  $\delta^{13}\text{C}$  and  $\delta^{15}\text{N}$  stable isotope incremental dentine sampling. *American Journal of Physical Anthropology* 154:585-593.
- JAY, M., FULLER, B.T., RICHARDS, M.P., KNUSEL, C.J. & KING, S.S. 2008. Iron age breastfeeding practices in Britain: Isotopic evidence from Wetwang Slack, East Yorkshire. *American Journal of Physical Anthropology* 136:327-337.
- JAY, M. 2009. Breastfeeding and weaning behaviour in archaeological populations: evidence from the isotopic analysis of skeletal materials. *Childhood in the Past* 2:163-178.
- MAYS, S.A., RICHARDS, M.P. & FULLER, B.T. 2002. Bone stable isotope evidence for infant feeding in mediaeval England. *Antiquity* 76:654-656.
- MAYS, S. 2003. Bone strontium: calcium ratios and duration of breastfeeding in a Mediaeval skeletal population. *Journal of Archaeological Science* 30:731-741.
- NEHLICH, O., FULLER, B.T., JAY, M., MORA, A., NICHOLSON, R.A., SMITH, C.I. & RICHARDS, M.P. 2011. Application of sulphur isotope ratios to examine weaning patterns and freshwater fish consumption in Roman Oxfordshire, UK. *Geochimica et Cosmochimica Acta* 75:4963-4977.
- NITSCH, E.K., HUMPHREY, L.T. & HEDGES, R.E.M. 2006. Using stable isotope analysis to examine the effect of economic change on breastfeeding practices in Spitalfields, London, UK. *American Journal of Physical Anthropology* 146:619-628.
- POWELL, L.A., REDFERN, R.C. & MILLARD, A.R. 2014. Infant feeding practices in Roman London: the isotopic evidence. In: CARROLL, P.M. & GRAHAM, E.-J. (eds.) *Infant health and death in Roman Italy and beyond*. *Journal of Roman Archaeology* Suppl. 96.
- PRIVAT, K.L., O'CONNELL, T.C. & RICHARDS, M.P. 2002. Stable isotope analysis of human and faunal remains from the Anglo-Saxon cemetery at Berinsfield, Oxfordshire: Dietary and social implications. *Journal of Archaeological Science* 29:779-790.
- REDFERN, R.C., MILLARD, A.R. & HAMLIN, C. 2012. A regional investigation of subadult dietary patterns and health in late Iron Age and Roman Dorset, England. *Journal of Archaeological Science* 39:1249-1259.
- RICHARDS, M.P., MAYS, S. & FULLER, B.T. 2002. Stable carbon and nitrogen isotope values of bone and teeth reflect weaning age at the Medieval Wharram Percy site, Yorkshire, UK. *American Journal of Physical Anthropology* 119:205-210.

### **SECTION III: ARCHAEOLOGICAL ANIMALS & ISOTOPES**

#### **18. Birth Seasonality & Dairying**

- BALASSE, M. & TRESSET, A. 2002. Early weaning of Neolithic domestic cattle (Bercy, France) revealed by intra-tooth variation in nitrogen isotope ratios. *Journal of Archaeological Science* 29: 853-859.



- BALASSE, M., SMITH, A.B., AMBROSE, S.H. & LEIGH, S.R. 2003. Determining sheep birth seasonality by analysis of tooth enamel oxygen isotope ratios. The Late Stone Age site of Kasteelberg (South Africa). *Journal of Archaeological Science* 30:205-215.
- BALASSE, M., OBEIN, G., UGHETTO-MONFRIN, J. & MAINLAND, I. 2012. Investigating seasonality and season of birth in past herds: a reference set of sheep enamel stable oxygen isotope ratios. *Archaeometry* 54:349-368.
- BALASSE, M., BOURY, L., UGHETTO-MONFRIN, J. & TRESSET, A. 2012. Stable isotope insights ( $\delta^{18}\text{O}$ ,  $\delta^{13}\text{C}$ ) into cattle and sheep husbandry at Bercy (Paris, France, 4th millennium BC): birth seasonality and winter leaf foddering. *Environmental Archaeology* 17:30-44.
- BLAISE, E. & BALASSE, M. 2011. Seasonality and season of birth of modern and late Neolithic sheep from south-eastern France using tooth enamel  $\delta^{18}\text{O}$  analysis. *Journal of Archaeological Science* 38:3085-3093.
- BUCHAN, M., MÜLDNER, G., ERVYNCK, A. & BRITTON, K. 2016. Season of birth and sheep husbandry in late Roman and Medieval coastal Flanders: A pilot study using tooth enamel  $\delta^{18}\text{O}$  analysis. *Environmental Archaeology* 21:260-270.
- FRÉMONDEAU, D., CUCCHI, T., CASABIANCA, F., UGHETTO-MONFRIN, J., HORARD-HERBIN, M.-P. & BALASSE, M. 2012. Seasonality of birth and diet of pigs from stable isotope analyses of tooth enamel ( $\delta^{18}\text{O}$ ,  $\delta^{13}\text{C}$ ): a modern reference data set from Corsica, France. *Journal of Archaeological Science* 39:2023-2035.
- GRON, K. J., MONTGOMERY, J. & ROWLEY-CONWY, P. 2015. Cattle Management for Dairying in Scandinavia's Earliest Neolithic. *PLoS ONE* 10: e0131267.
- HAMILTON, J., HEDGES, ROBERT E. M. & ROBINSON, M. 2009. Rooting for pigfruit: pig feeding in Neolithic and Iron Age Britain compared. *Antiquity* 83: 998-1011.
- HAMMOND, C. & O'CONNOR, T. 2013. Pig diet in medieval York: carbon and nitrogen stable isotopes. *Archaeological and Anthropological Sciences* 5:123-127.
- TOWERS, J., JAY, M., MAINLAND, I., NEHLICH, O. & MONTGOMERY, J. 2011. A calf for all seasons? The potential of stable isotope analysis to investigate prehistoric husbandry practices. *Journal of Archaeological Science* 38:1858-1868.
- TOWERS, J., GLEDHILL, A., BOND, J. & MONTGOMERY, J. 2014. An Investigation of Cattle Birth Seasonality using  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  Profiles within First Molar Enamel. *Archaeometry* 56:208-236.
- TOWERS, J., MAINLAND, I., MONTGOMERY, J. & BOND, J. 2016. Calving seasonality at Pool, Orkney during the first millennium AD: an investigation using intra-tooth isotope ratio analysis of cattle molar enamel. *Environmental Archaeology*:1-16.

## 19. Movement of Domestic Animals

- BENDREY, R., HAYES, T.E. & PALMER, M.R. 2009. Patterns of Iron Age Horse Supply: An Analysis of Strontium Isotope Ratios in Teeth. *Archaeometry* 51:140-150.
- BENTLEY, R. A. & KNIPPER, C. 2005. Transhumance at the early Neolithic settlement at Vaihingen (Germany). *Antiquity* 79 (December. "Online Project Gallery").

BENTLEY, R. A. & KNIPPER, C. 2005. Geographic patterns in biologically available strontium, carbon and oxygen isotope signatures in prehistoric SW Germany. *Archaeometry* 47: 629-644.

EVANS, J.A., TATHAM, S., CHENERY, S.R. & CHENERY, C.A. 2007. Anglo-Saxon animal husbandry techniques revealed through isotope and chemical variations in cattle teeth. *Applied Geochemistry* 22:1994-2005.

LAFFOON, J.E., PLOMP, E., DAVIES, G.R., HOOGLAND, M.L.P. & HOFMAN, C.L. 2013. The Movement and Exchange of Dogs in the Prehistoric Caribbean: An Isotopic Investigation. *International Journal of Osteoarchaeology* 25:454-465.

SJÖGREN, K.G. & PRICE, T.D. 2013. A complex Neolithic economy: isotope evidence for the circulation of cattle and sheep in the TRB of western Sweden. *Journal of Archaeological Science* 40:690-704.

SYKES, N.J., WHITE, J., HAYES, T.E. & PALMER, M.R. 2006. Tracking animals using strontium isotopes in teeth: the role of fallow deer (*Dama dama*) in Roman Britain. *Antiquity* 80:948-959.

THORNTON, E. K. 2011. Reconstructing ancient Maya animal trade through strontium isotope ( $^{87}\text{Sr}/^{86}\text{Sr}$ ) analysis. *Journal of Archaeological Science* 38: 3254-3263.

VALENZUELA-LAMAS, S., JIMÉNEZ-MANCHÓN, S., EVANS, J., LÓPEZ, D., JORNET, R. & ALBARELLA, U. 2016. Analysis of seasonal mobility of sheep in Iron Age Catalonia (north-eastern Spain) based on strontium and oxygen isotope analysis from tooth enamel: First results. *Journal of Archaeological Science: Reports* 6: 828-836.

VINER, S., EVANS, J., ALBARELLA, U. & PEARSON, M.P. 2010. Cattle mobility in prehistoric Britain: strontium isotope analysis of cattle teeth from Durrington Walls (Wiltshire, Britain). *Journal of Archaeological Science* 37:2812-2820.

## 20. Foddering Regimes & Resource Management

BRITTON, K., MULDER, G. & BELL, M. 2008. Stable isotope evidence for salt-marsh grazing in the Bronze Age Severn Estuary, UK: implications for palaeodietary analysis at coastal sites. *Journal of Archaeological Science* 35:2111-2118.

BALASSE, M., TRESSET, A., DOBNEY, K. & AMBROSE, S. H. 2005. The use of isotope ratios to test for seaweed eating in sheep. *Journal of Zoology* 266: 283-291.

BALASSE, M., TRESSET, A. & AMBROSE, S.H. 2006. Stable isotope evidence ( $^{13}\text{C}$ ,  $^{18}\text{O}$ ) for winter feeding on seaweed by Neolithic sheep of Scotland. *Journal of Zoology* 270:170-176.

BALASSE, M., MAINLAND, I. & RICHARDS, M. 2009. Stable isotope evidence for seasonal consumption of marine seaweed by modern and archaeological sheep in the Orkney archipelago (Scotland). *Environmental Archaeology* 14:1-14.

COPLEY, M.S., JIM, S., JONES, V., ROSE, P., CLAPHAM, A., EDWARDS, D.N., HORTON, M., ROWLEY-CONWY, P. & EVERSLED, R.P. 2004. Short- and long-term foraging and foddering strategies of domesticated animals from Qasr Ibrim, Egypt. *Journal of Archaeological Science* 31:1273-1286.

- FINUCANE, B., AGURTO, P.M. & ISBELL, W.H. 2006. Human and animal diet at Conchopata, Peru: stable isotope evidence for maize agriculture and animal management practices during the Middle Horizon. *Journal of Archaeological Science* 33:1766-1776.
- JONES, J. R. & MULVILLE, J. 2016. Isotopic and zooarchaeological approaches towards understanding aquatic resource use in human economies and animal management in the prehistoric Scottish North Atlantic Islands. *Journal of Archaeological Science: Reports* 6: 665-677.
- LOSEY, R. J., GARVIE-LOK, S., LEONARD, J. A., KATZENBERG, M. A., GERMONPRÉ, M., NOMOKONOVA, T., SABLIN, M. V., GORIUNOVA, O. I., BERDNIKOVA, N. E. & SAVEL'EV, N. A. 2013. Burying Dogs in Ancient Cis-Baikal, Siberia: Temporal Trends and Relationships with Human Diet and Subsistence Practices. *PLoS ONE* 8: e63740.
- MADGWICK, R., MULVILLE, J. & STEVENS, R. E. 2012. Diversity in foddering strategy and herd management in late Bronze Age Britain: An isotopic investigation of pigs and other fauna from two midden sites. *Environmental Archaeology* 17: 126-140.
- MAKAREWICZ, C. & TUROSS, N. 2005. Foddering by Mongolian pastoralists is recorded in the stable carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotopes of caprine dentinal collagen. *Journal of Archaeological Science* 33: 862-870.
- MAKAREWICZ, C. A. 2015. Winter is coming: seasonality of ancient pastoral nomadic practices revealed in the carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotopic record of Xiongnu caprines. *Archaeological and Anthropological Sciences*: 1-14.
- MCMANUS-FRY, E., KNECHT, R., DOBNEY, K., RICHARDS, M. P. & BRITTON, K. 2016. Dog-human dietary relationships in Yup'ik western Alaska: The stable isotope and zooarchaeological evidence from pre-contact Nunalleq. *Journal of Archaeological Science: Reports* (in press).
- MÜLDNER, G., BRITTON, K. & ERVYNCK, A. 2014. Inferring Animal Husbandry Strategies in Coastal Zones through Stable Isotope Analysis: New Evidence from the Flemish Coastal Plain (Belgium, 1st - 15th century AD). *Journal of Archaeological Science* 41: 322-332.
- NOE-NYGAARD, N., PRICE, T.D. & HEDE, S.U. 2005. Diet of aurochs and early cattle in southern Scandinavia: evidence from  $^{15}\text{N}$  and  $^{13}\text{C}$  stable isotopes. *Journal of Archaeological Science* 32:855-871.
- PECHENKINA, E.A., AMBROSE, S.H., XIAOLIN, M. & BENFER, R.A. 2005. Reconstructing northern Chinese Neolithic subsistence practices by isotopic analysis. *Journal of Archaeological Science* 32:1176-1189.
- THORNTON, E.K., DEFRANCE, S.D., KRIGBAUM, J. & WILLIAMS, P.R. 2011. Isotopic evidence for Middle Horizon to 16th century camelid herding in the Osmore Valley, Peru. *International Journal of Osteoarchaeology* 21:544-567.

## 21. Late Pleistocene Faunal Ecology & Environment

- BOCHERENS, H. 2003. Isotopic biogeochemistry and the palaeoecology of the mammoth steppe fauna. *DEINSEA - Annual of the Natural History Museum Rotterdam* 9: 57-76.

- BOCHERENS, H. 2015. Isotopic tracking of large carnivore palaeoecology in the mammoth steppe. *Quaternary Science Reviews* 117:42-71.
- BOCHERENS, H., FOGEL, M.L., TUROSS, N. & ZEDER, M. 1995. Trophic Structure and Climatic Information From Isotopic Signatures in Pleistocene Cave Fauna of Southern England. *Journal of Archaeological Science* 22:327-340.
- BOCHERENS, H., KOCH, P.L., MARIOTTI, A., GERAADS, D. & JAEGER, J.-J. 1996. Isotopic biogeochemistry ( $^{13}\text{C}$ ,  $^{18}\text{O}$ ) of mammalian enamel from African Pleistocene hominid sites. *PALAIOS* 11:306-318.
- BOCHERENS, H., BILLIOU, D., PATOU-MATHIS, M., BONJEAN, D., OTTE, M. & MARIOTTI, A. 1997. Paleobiological implications of the isotopic signatures (C-13, N-15) of fossil mammal collagen in Scladina cave (Sclayn, Belgium). *Quaternary Research* 48:370-380.
- BOCHERENS, H., HOFMAN-KAMIŃSKA, E., DRUCKER, D.G., SCHMÖLCKE, U. & KOWALCZYK, R. 2015. European Bison as a Refugee Species? Evidence from Isotopic Data on Early Holocene Bison and Other Large Herbivores in Northern Europe. *PLoS ONE* 10:e0115090.
- BRITTON, K., GAUDZINSKI-WINDHEUSER, S., ROEBROEKS, W., KINDLER, L. & RICHARDS, M.P. 2012. Stable isotope analysis of well-preserved 120,000-year-old herbivore bone collagen from the Middle Palaeolithic site of Neumark-Nord 2, Germany reveals niche separation between bovids and equids. *Palaeogeography, Palaeoclimatology, Palaeoecology* 333-334:168-177.
- CHISHOLM, B., DRIVER, J., DUBE, S. & SCHWARCZ, H.P. 1986. Assessment of prehistoric bison foraging and movement patterns via stable-carbon isotope analysis. *Plains Anthropologist* 31:193-205.
- CHRITZ, K.L., DYKE, G.J., ZAZZO, A., LISTER, A.M., MONAGHAN, N.T. & SIGWART, J.D. 2009. Palaeobiology of an extinct Ice Age mammal: Stable isotope and cementum analysis of giant deer teeth. *Palaeogeography, Palaeoclimatology, Palaeoecology* 282:133-144.
- COLTRAIN, J.B., HARRIS, J.M., CERLING, T.E., EHLERINGER, J.R., DEARING, M.-D., WARD, J. & ALLEN, J. 2004. Rancho La Brea stable isotope biogeochemistry and its implications for the palaeoecology of late Pleistocene, coastal southern California. *Palaeogeography, Palaeoclimatology, Palaeoecology* 205:199-219.
- FERANEC, R., GARCIA GARCIA, N., DIEZ, J. C. & ARSUAGA, J. L. 2010. Understanding the ecology of mammalian carnivores and herbivores from Valdegoba cave (Burgos, northern Spain) through stable isotope analysis. *Palaeogeography, Palaeoclimatology, Palaeoecology* 297: 263-272.
- FIZET, M., MARIOTTI, A., BOCHERENS, H., LANGEBADRE, B., VANDERMEERSCH, B., BOREL, J.P. & BELLON, G. 1995. Effect of diet, physiology and climate on carbon and nitrogen stable isotopes of collagen in a late Pleistocene anthropic palaeoecosystem - Marillac, Charente, France. *Journal of Archaeological Science* 22:67-79.
- GARCIA GARCIA, N., FERANEC, R.S., ARSUAGA, J.L., DE CASTRO, J.M.B. & CARBONELL, E. 2009. Isotopic analysis of the ecology of herbivores and carnivores from the Middle Pleistocene deposits of the Sierra De Atapuerca, northern Spain. *Journal of Archaeological Science* 36:1142-1151.

- KOCH, P.L., HOPPE, K.A. & WEBB, D.S. 1998. The isotopic ecology of late Pleistocene mammals in North America. Part 1: Florida. *Chemical Geology* 152:119-138.
- KUITENS, M., VAN DER PLICHT, J., DRUCKER, D.G., VAN KOLFSCHOTEN, T., PALSTRA, S.W.L. & BOCHERENS, H. 2015. Carbon and nitrogen stable isotopes of well-preserved Middle Pleistocene bone collagen from Schöningen (Germany) and their paleoecological implications. *Journal of Human Evolution* 89:105-113.
- MACFADDEN, B.J., CERLING, T.E., HARRIS, J.M. & PRADO, J. 1999. Ancient latitudinal gradients of C-3/C-4 grasses interpreted from stable isotopes of New World Pleistocene horse (*Equus*) teeth. *Global Ecology and Biogeography* 8:137-149.
- RICHARDS, M. P. & HEDGES, R. E. M. 2003. Variations in bone collagen delta C-13 and delta N-15 values of fauna from Northwest Europe over the last 40 000 years. *Palaeogeography, Palaeoclimatology, Palaeoecology* 193: 261-267.
- STEVENS, R.E. & HEDGES, R.E.M. 2004. Carbon and nitrogen stable isotope analysis of northwest European horse bone and tooth collagen, 40,000 BP-present: Palaeoclimatic interpretations. *Quaternary Science Reviews* 23:977-991.
- STEVENS, R. E., JACOBI, R., STREET, M., GERMONPRE, M., CONARD, N. J., MUNZEL, S. C. & HEDGES, R. E. M. 2008. Nitrogen isotope analyses of reindeer (*Rangifer tarandus*), 45,000 BP to 900 BP: Palaeoenvironmental reconstructions. *Palaeogeography, Palaeoclimatology, Palaeoecology* 262: 32-45.
- STEVENS, R.E., HERMOSO-BUXÁN, X.L., MARÍN-ARROYO, A.B., GONZÁLEZ-MORALES, M.R. & STRAUS, L.G. 2014. Investigation of Late Pleistocene and Early Holocene palaeoenvironmental change at El Mirón cave (Cantabria, Spain): Insights from carbon and nitrogen isotope analyses of red deer. *Palaeogeography, Palaeoclimatology, Palaeoecology* 414: 46-60.

## 22. Late Pleistocene Faunal Mobility

- BIRCH, S.E.P., MIRACLE, P.T., STEVENS, R.E. & O'CONNELL, T.C. 2016. Late Pleistocene/Early Holocene migratory behavior of ungulates using isotopic analysis of tooth enamel and its effects on forager mobility. *PloS One* 11:e0155714.
- BRITTON, K., GRIMES, V., NIVEN, L., STEELE, T., MCPHERRON, S., SORESSI, M., KELLY, T. E., JAUBERT, J., HUBLIN, J.-J. & RICHARDS, M. P. 2011. Strontium isotope evidence for migration in late Pleistocene *Rangifer*: Implications for Neanderthal hunting strategies at the Middle Palaeolithic site of Jonzac, France. *Journal of Human Evolution* 61:176-185.
- COPELAND, S.R., CAWTHRA, H.C., FISHER, E.C., LEE-THORP, J.A., COWLING, R.M., LE ROUX, P.J., HODGKINS, J. & MAREAN, C.W. 2016. Strontium isotope investigation of ungulate movement patterns on the Pleistocene Paleo-Agulhas plain of the Greater Cape floristic region, South Africa. *Quaternary Science Reviews* 141:65-84.
- HOPPE, K.A., KOCH, P.L., CARLSON, R.W. & WEBB, D.S. 1999. Tracking mammoths and mastodons: Reconstruction of migratory behaviour using strontium isotope ratios. *Geology* 27:439-442.
- JULIEN, M.-A., BOCHERENS, H., BURKE, A., DRUCKER, D., PATOU-MATHIS, M., KROTOVA, O. & PÉAN, S. 2012. Were European steppe bison migratory? <sup>18</sup>O, <sup>13</sup>C and Sr

intra-tooth isotopic variations applied to a palaeoethological reconstruction. *Quaternary International* 271:106-119.

LUGLI, F., CIPRIANI, A., PERETTO, C., MAZZUCHELLI, M. & BRUNELLI, D. 2016. In situ high spatial resolution  $^{87}\text{Sr}/^{86}\text{Sr}$  ratio determination of two Middle Pleistocene (ca 580 ka) *Stephanorhinus hundsheimensis* teeth by LA–MC–ICP–MS. *International Journal of Mass Spectrometry*.

PELLEGRINI, M., DONAHUE, R. E., CHENERY, C., EVANS, J., LEE-THORP, J., MONTGOMERY, J. & MUSSI, M. 2008. Faunal migration in late-glacial central Italy: implications for human resource exploitation. *Rapid Communications in Mass Spectrometry* 22:1714-1726.

PÉREZ-CRESPO, V.A., SCHAAF, P., SOLIS-PICHARDO, G., ARROYO-CABRALES, J., ALVA-VALDIVIA, L.M. & TORRES-HERNÁNDEZ, J.R. 2016. Strontium isotopes and mobility of a Columbian mammoth (*Mammuthus columbi*) population, Laguna de las Cruces, San Luis Potosí, México. *Geological Magazine* 153:743-749.

PRICE, T.D., MEIGGS, D., WEBER, M.-J. & PIKE-TAY, A. 2017. The migration of Late Pleistocene reindeer: isotopic evidence from northern Europe. *Archaeological and Anthropological Sciences* 9:371-394.

### 23. Reconstructing Palaeoclimate from Faunal Bioapatite

ARPPE, L. & KARHU, J.A. 2010. Oxygen isotope values of precipitation and the thermal climate in Europe during the middle to late Weichselian ice age. *Quaternary Science Reviews* 29:1263-1275.

AYLIFFE, L. & CHIVAS, A.R. 1990. Oxygen isotope composition of bone phosphate of Australian kangaroos: Potential as a palaeoenvironmental recorder. *Geochimica et Cosmochimica Acta* 54:2603-2609.

AYLIFFE, L.K., LISTER, A.M. & CHIVAS, A.R. 1992. The preservation of glacial-interglacial climatic signatures in the oxygen isotopes of elephant skeletal phosphate. *Palaeogeography, Palaeoclimatology, Palaeoecology* 99:179-191.

BERNARD, A., DAUX, V., LÉCUYER, C., BRUGAL, J.-P., GENTY, D., WAINER, K., GARDIEN, V., FOUREL, F. & JAUBERT, J. 2009. Pleistocene seasonal temperature variations recorded in the  $\delta^{18}\text{O}$  of *Bison priscus* teeth. *Earth and Planetary Science Letters* 283:133-143.

BRYANT, J.D., LUZ, B. & FROELICH, P.N. 1994. Oxygen isotopic composition of fossil horse tooth phosphate as a record of continental paleoclimate. *Palaeogeography, Palaeoclimatology, Palaeoecology* 107:303-316.

BRYANT, J.D., FROELICH, P.N., SHOWERS, W.J. & GENNA, B.J. 1996. A tale of two quarries: biologic and taphonomic signatures in the oxygen isotope composition of tooth enamel phosphate from modern and Miocene equids. *PALAOIS*:397-408.

D'ANGELA, D. & LONGINELLI, A. 1990. Oxygen isotopes in living mammal's bone phosphate: Further results. *Chemical Geology* 86:75-82.

DELGADO HUERTAS, A., IACUMIN, P., STENNI, B., SÁNCHEZ CHILLÓN, B.S. & LONGINELLI, A. 1995. Oxygen isotope variations of phosphate in mammalian bone and tooth enamel. *Geochimica et Cosmochimica Acta* 59:4299-4305.

- DOMINGO, L., PÉREZ-DIOS, P., HERNÁNDEZ FERNÁNDEZ, M., MARTÍN-CHIVELET, J., ORTIZ, J.E. & TORRES, T. 2015. Late Quaternary climatic and environmental conditions of northern Spain: An isotopic approach based on the mammalian record from La Paloma cave. *Palaeogeography, Palaeoclimatology, Palaeoecology* 440:417-430.
- FABRE, M., LECUYER, C., BRUGAL, J.P., AMIOT, R., FOUREL, F. & MARTINEAU, F. 2011. Late Pleistocene climatic change in the French Jura (Gigny) recorded in the delta O-18 of phosphate from ungulate tooth enamel. *Quaternary Research* 75:605-613.
- FRICKE, H.C. & O'NEIL, J.R. 1996. Inter- and intra-tooth variation in the oxygen phosphate composition of mammalian tooth enamel phosphate: implications for palaeoclimatological and palaeobiological research. *Palaeogeography, Palaeoclimatology, Palaeoecology* 126:91-99.
- FRICKE, H.C., CLYDE, W.C. & O'NEIL, J.R. 1998. Intra-tooth variations in  $\delta^{18}\text{O}$  ( $\text{PO}_4$ ) of mammalian tooth enamel as a record of seasonal variations in continental climate variables. *Geochimica et Cosmochimica Acta* 62:1839-1850.
- GENONI, L., IACUMIN, P., NIKOLAEV, V., GRIBCHENKO, Y. & LONGINELLI, A. 1998. Oxygen isotope measurements of mammoth and reindeer skeletal remains: an archive of Late Pleistocene environmental conditions in Eurasian Arctic. *Earth and Planetary Science Letters* 160:587-592.
- HALLIN, K.A., SCHOENINGER, M.J. & SCHWARCZ, H.P. 2012. Paleoclimate during Neandertal and anatomically modern human occupation at Amud and Qafzeh, Israel: the stable isotope data. *Journal of Human Evolution* 62:59-73.
- HOPPE, K. A., AMUNDSON, R., VAVRA, M., MCCLARAN, M. P. & ANDERSON, D. L. 2004. Isotopic analysis of tooth enamel carbonate from modern North American feral horses: implications for palaeoenvironmental reconstructions. *Palaeogeography, Palaeoclimatology, Palaeoecology* 203: 299-311.
- KIRSANOW, K., MAKAREWICZ, C. & TUROSS, N. 2008. Stable Oxygen ( $\delta^{18}\text{O}$ ) and Hydrogen ( $\delta\text{D}$ ) Isotopes in Ovicaprid Dentinal Collagen Record Seasonal Variation. *Journal of Archaeological Science* 35:3159-3167.
- KOVACS, J., MORAVCOVA, M., UJVARI, G. & PINTER, A.G. 2012. Reconstructing the paleoenvironment of East Central Europe in the Late Pleistocene using the oxygen and carbon isotopic signal of tooth in large mammal remains. *Quaternary International* 276:145-154.
- LONGINELLI, A. 1984. Oxygen isotopes in mammal bone phosphate: a new tool for paleohydrological and paleoclimatological research? *Geochimica et Cosmochimica Acta* 48: 385-390.
- LUZ, B., KOLODNY, Y. & HOROWITZ, M. 1984. Fractionation of oxygen isotopes between mammalian bone-phosphate and environmental drinking water. *Geochimica et Cosmochimica Acta* 48: 1689-1693.
- NELSON, S.V. 2005. Paleoseasonality inferred from equid teeth and intra-tooth isotopic variability. *Palaeogeography, Palaeoclimatology, Palaeoecology* 222:122-144.
- PRYOR, A.J.E., STEVENS, R.E., O'CONNELL, T.C. & LISTER, J.R. 2014. Quantification and propagation of errors when converting vertebrate biomineral oxygen isotope data to

temperature for palaeoclimate reconstruction. *Palaeogeography, Palaeoclimatology, Palaeoecology* 412:99-107.

SHARP, Z.D. & CERLING, T.E. 1998. Fossil isotope records of seasonal climate and ecology: straight from the horse's mouth. *Geology* 26:219-222.

VELIVETSKAYA, T.A., SMIRNOV, N.G., KIYASHKO, S.I., IGNATIEV, A.V. & ULITKO, A.I. 2016. Resolution-enhanced stable isotope profiles within the complete tooth rows of Late Pleistocene bison (Middle Urals, Russia) as a record of their individual development and environmental changes. *Quaternary International* 400:212-226.