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Mapping biosphere $^{87}Sr/^{86}Sr$ variation for archaeological and environmental purposes.

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Strontium isotopes provide a powerful tool for studying the movement of humans and animals across isotopically different terrains because strontium is absorbed by the body and deposited, with calcium, in teeth and bones. Tooth enamel forms during the early years of life and its composition is not altered subsequently; hence, it constitutes a recoverable archive of childhood diet. In archaeological skeletal remains, enamel is also the tissue most resistant to post-mortem contamination, thus retaining its isotopic integrity over thousands of years. The composition of strontium in the food chain is controlled ultimately by the isotope composition of the leachable component of the soil on which plants grow. Once incorporated into plants, it passes up the food chain unfractionated. The isotope composition of strontium in the food chain varies depending upon a combination of factors which include the age of the underlying rocks, the rubidium content, weathering conditions and how susceptible different components of a heterogeneous rock are to weathering processes. Sr-isotope analysis of tooth enamel provides a tool to differentiate between people or animals based on the place they obtained their food and water at the time of tooth mineralisation. Data obtained to date from human and animal, archaeological tooth enamel testify to the easily measurable variations that exist within and between teeth, and between populations; a highly significant $^{87}Sr/^{86}Sr$ range from 0.7066 ....(Montgomery et al., 2003) to 0.7200 (Montgomery unpublished) has been found within Britain.

This tool has, however, a very major drawback, which is stopping it being fully utilized: there is virtually no data available from the biosphere against which to compare tooth enamel values. Apart from a few sporadic published samples of soil leaches, plants and water and archaeological studies (which are dominated by soil and rock types such as marine carbonates where buried bone is preserved), the isotope composition of the UK biosphere currently has to be extrapolated from a basic understanding of the geology. This is severely hampering the progress and development of Sr based migration studies.

The aim of this presentation is to outline the problems involved in $^{87}Sr/^{86}Sr$ biosphere mapping and discuss the approach that we are taking.

The main issue to resolve is the approach to the problem. How do we determine the Sr isotope variation in an area? One possibility is to undertake a systematic sampling project based on a grid system and develop a database for reference. However this is costly, labour intensive and wasteful of resources, as it does not tailor the approach to the problem. One may, for example, argue the value of sampling across tracts of land (such as upland heath and peat covered regions) where no archaeological evidence for food production exists. The aim, therefore, is to combine archaeological understanding of population distribution with targeted sampling on the scale of human land use to understand the extent of Sr-isotope variability available to the ancient populations in question. In this study we will focus on two sites that have recently produced evidence of human and animal migration of significance to the understanding of society at these times. The first is a major Iron Age event at the onset of Roman occupation of UK; this site is based in NE England. The second is an Early Bronze Age group of men who are buried close to Stonehenge and contemporary with the later phases of its construction and who could, on the basis of our current understanding of Sr isotopes, have come from SW Wales, which is where the bluestones of the inner Stonehenge circle originate.

We use several lines of analysis in order to document biosphere variation.

a) Plants; these provide a certain provenance and are always available in some form.

b) Snails: these are in many ways an ideal sample source. Snails have a carbonate shell containing 500-700 ppm Sr, they are territorial, and generally live 3-5 years. Thus, they provide a time-averaged accumulation of Sr from a specific area. The shell is simple to prepare, dissolve and analyse.

c) Skeletal material. The remains of sheep, rabbits and hedgehogs, etc can provide useful data for animals higher up the food chain. However their rarity, and the uncertainty of their geographic origins (especially for sheep) mean this is an occasional/low priority source of samples.

d) Water. River water provides an average value that is close to the mean of human populations living in the river catchment area (Evans and Tatham 2004).

All samples are ranked and weighted in terms of reliability as a local province indicator. Soils are not used, as they do not provide a direct biosphere measurement.

References

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