Biosphere mapping - the next phase

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Reasons and rationale

The current strontium (Sr) isotope biosphere variation map of Britain (Fig. 1) has been well used (114 citations in 5 years). It allows the user to identify which out of seven spatial domains a sample most strongly resembles with respect to strontium isotopes. It has enabled archaeologists to look at movement and migration on people and fauna across Britain, and to highlight individuals who may have originated outside Britain.

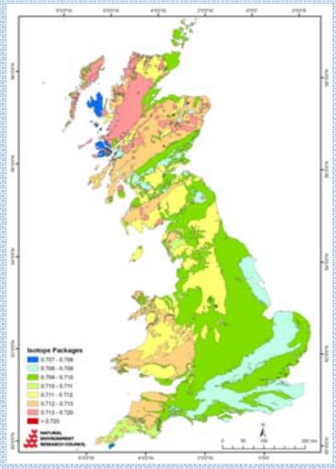

Fig 1. 87Sr/86Sr isotope biosphere map of Britain from Evans et al 2010.

However, the "measure and match" approach gives no indication of the uncertainty of these allocations (i.e. in some cases the allocation may be very confident, in others it may be more marginal between two or more domains) limiting its use. It also suffers from patchy sample coverage, and an absence of consideration of surface deposits.

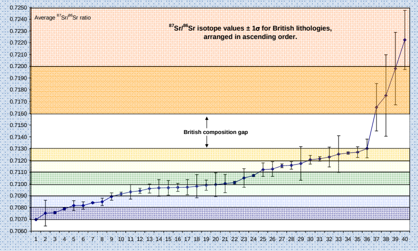

Fig 2. Diagram showing how the mean values of the isotope ranges were combine to colour in the biosphere map.

Progress so far

It would be prohibitively expensive to provide enough analyses to contour Sr isotope variation to an appropriate level. With this in mind we are developing a **predictive model of Sr isotope biosphere variation** based on the interaction of geological, climate, and geographic contributions.

The new approach is to construct a mosaic of 1 km hexagon cells in GIS space. These are linked to the underlying geology and are classified according to the type of deposit that comprise more than 50% of their area. Data from designated rock types will be assigned a value and probability to each appropriate hexagon. These values are retained within the hexagons which can be interrogated.

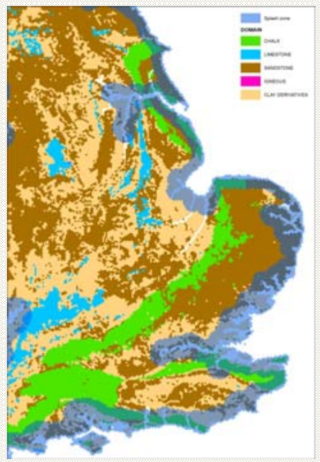

Fig 3. Britain subdivided in the 1 km hexagon domains and allocated a particular rock type with marine splash zone superimposed.

Instead of simply assessing whether or not there is a match between the value of a sample and a particular isotope domain, this system will allow the user to identify the least probable areas of Britain a Sr sample would have originated.

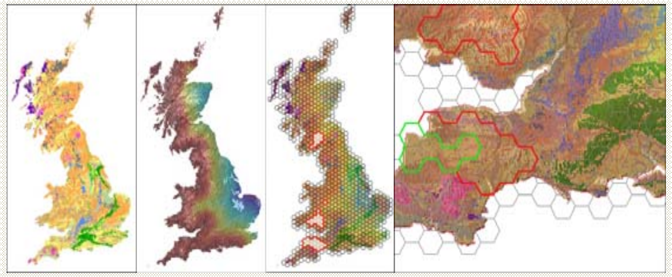

Fig 4. A mock up of the way in which the map layers will work.

Future aims

We aim to produce the first digital, interrogable, statistically constrained, isotope domain map for Britain. As part of our development plan we will link the Sr biosphere map with the published British oxygen isotope map (Darling et al 2003), and other isotope data, to create a multi-layer, multi-purpose resource for environmental, food security, and ecological studies. Once the model is established it can be tested so that it can be developed, refined, and added to as new data became available.

We hope that anyone planning to work in a particular area will factor in environmental sampling within their study. We could then provide a more detailed, higher precision map for their area of study.

This map can be linked to other datasets such as arable land quality, geochemical data sets, and geographical information such as topography so that domain data, specific to studies, can be extracted (e.g. isotope characterizing of sheep grazed above a certain altitude). In moving Sr biosphere mapping methodology from "measure and match" to a statistically robust, model-based system, we will provide a developable resource for food security, forensic, and environmental research.

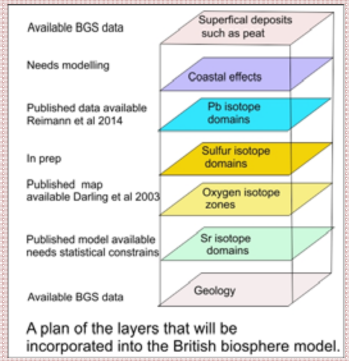

Fig 5. Possible layers that could be incorporated in the new biosphere model.

Darling, W. G., A. H. Bath and J. C. Talbot (2003). "The O & H stable isotopic composition of fresh waters in the British Isles. 2. Surface waters and groundwater." Hydrology and Earth System Sciences **7**(2): 183-195.
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