Scientific techniques are transforming the study of the past, and the analysis of isotopes is shedding new light on the origins of archaeological finds and human migration in prehistoric Britain. What are isotopes, and how do they help us understand long-vanished cultures? Sara Coelho explains.

Finding the wisdom in teeth

Dave Norcott, Wessex Archaeology

The grave of the bowmen during excavation. Unlike most contemporary graves in southern England, this one contained the remains of seven individuals: three adult males, a teenage male and three children.

Indiana Jones might be the world's most famous archaeologist, but finding the secrets of the past rarely involves hunting treasure in glamorous locations. Archaeology is more about understanding how and where ancient people lived, and how they related to their environment. To do that, archaeologists study artefacts, burial sites and other remains of ancient cultures. But some questions are difficult to answer with traditional techniques, and the field is drawing more and more on scientific methods.

One of the tricky problems is pinpointing the origin of archaeological artefacts like glass, clothing or weapons, because you can't tell where objects are from just by looking at them. Roman coins, for example, were minted across the Empire and a denarius found in Britain could easily have been issued far away. But knowing where things are from is essential to understand ancient trading routes and networks.

The same is true of people. The discovery of the so-called Boscombe Bowmen near an airfield in Wiltshire raised more questions than answers. 'The site's features were very unusual for Bronze Age Britain,' says Dr Jane Evans, science-based archaeology theme leader at the NERC Isotope Geosciences Laboratory (NIGL) in Keyworth, Nottingham. It was a mass grave with seven bodies buried with plaited cord beaker pots, bone toggles and the flint arrowheads that inspired archaeologists to call the adults the Boscombe Bowmen.

Where were these people from? Were they born in Wiltshire or in Eastern Europe like the Amesbury Archer found nearby buried in a similar way?

'It's very hard to find a definite answer about provenance from grave features,' says Evans. Burial rites depend on cultural traditions that may change throughout life; migrants can adopt local customs and locals can be influenced by foreign partners, neighbours or their own experiences abroad. But there's something else in ancient graves that may record the origin of their occupants – teeth.

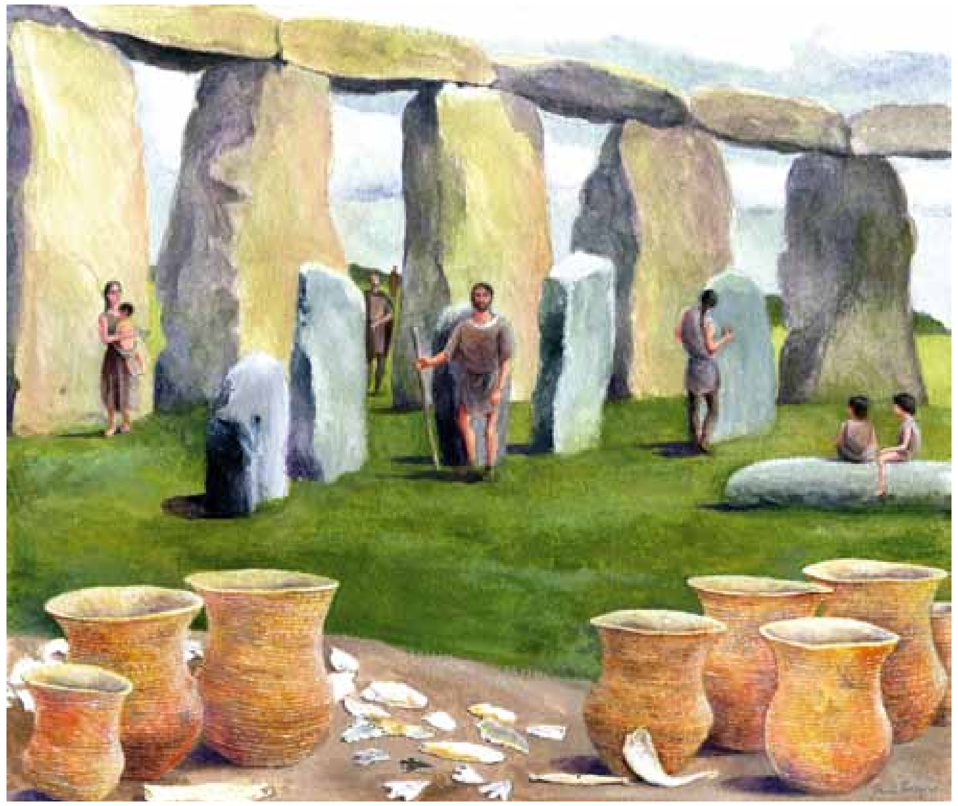
'Teeth grow during early life and as they do, they take up oxygen, strontium and other elements from food and drinking water,' Evans explains.

A matter of neutrons

Not all atoms of the same chemical element are equal and the different types are called isotopes. 'The number of protons in the nucleus is equal in all isotopes – that is why they remain the same element – but the number of neutrons changes,' explains Professor Randy Parrish, head of NIGL.

'Take oxygen, for example,' says Parrish. '99.8 per cent of oxygen atoms on Earth are oxygen-16, with eight neutrons but about two atoms in 1000 are the heavier oxygen-18, which has two extra neutrons.'

Isotopes are a goldmine of information for archaeologists, who started to tap into this resource in the 1990s. Since then, 'the whole field has mushroomed,' says Evans, who started in the British Geological Survey as a geochemist and has since specialised in isotope science. 'Isotopes are a huge plus for archaeology because you can look at origin from what you are, not from burial rite.'



Jane Brayne 2004

So were the Boscombe Bowmen among the builders of Stonehenge?

Stable vs radioactive isotopes

Oxygen and nitrogen isotopes are stable and keep the same number of neutrons. But isotopes of radioactive elements like uranium or thorium have too many neutrons to be stable, and tend to shed the extra load over time. In doing so, they transform into other elements in a process called radioactive decay. As time goes by, the initial amount of radioactive isotopes decreases as they decay into stable 'daughter' isotopes.

The proportion between radioactive and daughter isotopes can be used to keep track of time. carbon-14, for example, decays into nitrogen relatively fast and is used to date recent organic materials such as wood or bones. To do this, scientists measure how much carbon-14 remains in a sample. They know the speed at which it decays, so they can estimate how long ago the plant or animal that provided the material died.

Radioactive uranium isotopes, on the other hand, have long and complicated decay sequences and lose about 30 neutrons before turning into lead atoms after many millions of years. The decay series of uranium isotopes is well known and is used to calculate the age of very old rocks. This process has shown that some crystals of the mineral zircon, which is naturally rich in uranium isotopes, and its daughters are more than four billion years old.

Isotopes provide a wealth of information but to reveal their secrets 'you need very accurate equipment and qualified personnel', says Parrish. Just five or six extra strontium-87 isotopes for every 1000 strontium-86 can make all the difference for archaeological problems like the Boscombe Bowmen.

Evans collected two teeth from each of the three Boscombe Bowmen and analysed their strontium content at NIGL. 'The isotope ratio of the teeth is derived from the isotope composition of their diet, which is determined by the properties of the soil and underlying rocks,' she says.

The mix of heavy strontium-87 and light strontium-86 isotopes depends on how old rocks are: older rocks are richer in the heavier isotope than younger ones. So by comparing the strontium isotopes in someone's teeth with a map showing where different isotope proportions are found, researchers can work out where they grew up.

Isotopes cannot be used to pinpoint precise locations, 'but they're very useful to exclude places,' says Evans. For example, if someone's teeth have a very low strontium isotope ratio, this person couldn't have grown up in an area with very old rocks.

'The analysis provided the best evidence for childhood migration yet seen,' Evans says. In all three cases there was a significant drop in the strontium ratio, between the second and third molar tooth. This means that the men left their homeland when they were between 9 and 13 years old, before they developed their third molars.

'We don't know if they travelled together, but the findings suggest a cultural pattern where people spent their childhood somewhere and then moved elsewhere in their early adolescence,' Evans explains.

But where did the bowmen come from? 'They were obviously not from Wiltshire,' she says. Wales is the nearest possible area, which means that they travelled at least 150 to 200km during childhood. This is a tantalising possibility since the Preseli Hills, where Stonehenge's famous bluestones come from, fall within the range of possible birthplaces for the men.

Isotopes can be applied to a variety of finds, not just human remains. Evans' group at NIGL has used isotopes to look at everything from the migration routes of British cattle during the Bronze Age to prehistoric pottery from the Shetlands and Viking fishing weights. 'It's also possible to use lead isotopes to find out where Roman coins were minted,' she adds.

So were the Boscombe Bowmen among the builders of Stonehenge? We may never know for sure, but without isotope analysis we wouldn't even be aware of the possibility.

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