

## **“Isotopes in Archaeology: From Dating Rock Art to Prehistoric Diet”**

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**Joint annual lecture with the Cirencester Archaeological and Historical Society**

Dr Pike's subject was ideal in that it showed how the application of science could help archaeologists with dating and understanding how ancient people lived.

He briefly explained that many elements could contain differing numbers of neutrons in their nuclei and although chemically the same, these isotopes had different atomic masses. Some isotopes such as uranium<sup>235</sup> or C<sup>14</sup> were unstable whereas others such as C<sup>12</sup>, N<sup>14</sup> and O<sup>16</sup> are completely stable. Unstable isotopes may decay by emitting energy and either revert to a more stable form or become a different element. Since the rates of decay can be accurately determined, it is possible to use such isotopes for archaeological purposes provided they have a suitable half-life.

Dr Pike described an application of uranium<sup>235</sup> /thorium<sup>230</sup> to the dating of prehistoric rock art. The unstable uranium isotope decays to thorium<sup>230</sup> and unlike uranium compounds that are soluble in water, thorium salts are less so. This means that they are selectively precipitated from solutions such as those that lead to stalactites. Rock paintings are often at least partially covered with similar calciferous layers. By carefully scraping off small amounts from the surface and measuring the ratio of uranium to thorium it is possible to estimate a date before which the painting must have been made. The paintings in the Cresswell caves in Derbyshire have been shown to be at least 10,000 years old. Dr Pike is currently working on cave paintings in Spain.

Carbon, nitrogen and oxygen each have at least one stable isotope that is always present in fixed amounts. However in many natural processes one isotope reacts preferentially to the other. Thus photosynthesis and nitrogen fixation can lead to differing isotope ratios in plants and these differences can pass up the food chain. The isotopic ratio of N<sup>14</sup> to N<sup>15</sup> can be related to diet: a vegan diet has a low ratio, vegetarian somewhat higher and omnivores the highest. This makes it possible to determine diet from samples of hair and bone collagen. This confirmed that Neanderthals were essentially meat-eaters, the Mesolithic inhabitants of Orsay ate mainly fish and Neolithic peoples were omnivores.

Strontium also has a stable isotope and this has been used to look at diet by measuring the isotope ratio in teeth. This approach showed that the Amesbury Archer must have originally come from Scandinavia.

A gravesite at Eular in Germany was C<sup>14</sup> dated to about 2500BC. The graves showed evidence of very careful burial, in some case of apparently family groups. Mitochondrial DNA analysis confirmed that in some graves several members of the same family were buried together. Strontium isotopic ratio analysis of the teeth showed that all the children and adult males had essentially the same diet. However the diet for all the adult females was different indicating that the males sought mates from another settlement about 200 kilometres away.

Advances in this technology using lasers and modern mass spectrometry means that 300 or more different ratios can now be measured on a single tooth and thus changes to diet/environment with time can be estimated.

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