2.13. European Origins

Analysis of bone & tissue material of European late Holocene man

Oetzi, the iceman
3300 BC

Genetic map from the Neolithic to Bronze age

The archer of Stonehenge
2300 BC

Oetzi Discovery
Recent Discoveries, the Iceman Oetzi

Isotope analysis of $^{18}\text{O}/^{16}\text{O}$ ratio in teeth shows much higher ratio than expected for high altitude origin. This indicates that Oetzi originates from low altitude country. Comparison with characteristic isotope distribution in northern and southern alpine valleys clearly indicates that he originated from the valleys, of now South-Tyrol in Italy. Ratios in bones indicate at least 20 years of high altitude habitat.

Origin of Oetzi

The large variety of geological rock compositions (Mesozoic limestone, Permian volcanics, Eocene basalts, and heterogeneous gneiss) in the alpine rock environment helps to locate the origin of the iceman Oetzi.

The present Pb and Sr isotope ratios are determine of the initial content of Rb and U-Th with long decay times.
Oetzi’s home

Iceman enamel analysis shows $^{87}\text{Sr}/^{86}\text{Sr}$ ratios of 0.7203 to 0.7206 (childhood). Bone values, which reflect later age indicate lower values of ~0.718. Comparison with Pb isotope ratios exclude limestone basalts, and Permian Volcanics environment as childhood location.

Most likely location, Eisack valley in South Tyrol
Oxygen Isotope Fractionation

\[ \delta^{18}O = \left( \frac{O^{18}}{O^{16}} \right)_{\text{sample}} \cdot \left( \frac{O^{18}}{O^{16}} \right)_{VSMOW} - 1 \cdot 1000\% \]

For oxygen isotopic measurements of water the standard is standard mean ocean water, VSMOW

\[ (^{18}O/^{16}O)_{VSMOW} = (2005.2 \pm 0.45) \cdot 10^{-6} \]

For higher \(^{18}O\) values compared to standard, \(\delta^{18}O > 0\)

For lower \(^{18}O\) values compared to standard, \(\delta^{18}O < 0\)
Oxygen isotope composition

Northern content of alpine watershed is defined by the precipitation of North Atlantic H$_2^{18}$O rain water contact which is depleted in $^{18}$O by distance to coast. Northern rivers show lower $\delta^{18}$O value than southern rivers. The ice man $\delta^{18}$O (-10.6 to -11 as child, -11.7 to -11.4 as adult) value matches southern river water. The reduction of $\delta^{18}$O with altitude points to an initial valley habitat as child with the subsequent move to higher altitudes as adult. The location of his death has $\delta^{18}$O values of -13.4 to -16.4!
Recent (2002) discovery of human remains (2300 BC) near Stonehenge

The Stonehenge Archer, King of Stonehenge
$^{18}$O/$^{16}$O distribution on the British Isles

Rain in coastal regions contains higher $^{18}$O abundance than rain in continental regions ($^{18}$O weight)

$\delta^{18}$O $\approx$ -9 to -10

$^{18}$O enriched at the rainy west coast!

Oxygen ratios in tooth enamel

Analysis of tooth enamel indicates low $^{18}\text{O}/^{16}\text{O}$ ratio: $\delta^{18}\text{O} \approx -9$ to -10; much lower than typical for British Isles!

Ratio decreases with altitude and with distance from coastal area. The teeth show low ratio indicating high altitude and continental origin. Comparison with other characteristic isotopes such as Sr points towards alpine origin - northern Alp range.
The king of Stonehenge, an immigrant from Central Europe???

The Daily Express expressed the opinion. "This is as shocking as the discovery that the first cricket players wore leather pants and ate Bratwurst with their tea."
Summary Isotope Analysis

The analysis of isotopic ratios is a rapidly emerging tool for provenance studies. It has a broad range of applications in history, archaeology, and anthropology. Isotope analysis studies can be performed with neutron activation techniques if the neutron capture products are radioactive and will emit a characteristic decay signal which can be easily identified and detected. In most cases, application of neutron activation techniques is insufficient for a thorough determination of all isotopic abundance ratios for an element. In these cases, isotope separators with high mass resolution and low sample mass requirements are the main tool for isotope analysis today.