3.7. European Origins

Analysis of bone & tissue material of European late Holocene man

Oetzi, the iceman
3300 BC

The archer of Stonehenge
2300 BC

Genetic map from the Neolithic to Bronze age

The finding of the iceman
Oetzi Discovery
Isotope analysis of $^{18}$O/$^{16}$O ratio in teeth shows much higher ratio than expected for high altitude origin. This indicates that Oetzi originates from the local lower altitude country. The comparison with the typical isotope distribution in northern and southern alpine valleys in that region clearly indicates that he originated from one of the valleys, of what is now South-Tyrol in Italy. Ratios in bones indicate at least 20 years of high altitude habitat.

The iceman tooth 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 and basalts regions as childhood location. He grew up in phyllites gneiss dominated regions and moved towards a permian volcanics environment.

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

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

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

\[
\left( \frac{^{18}O}{^{16}O} \right)_{SMOW} = (2005.2 \pm 0.45) \cdot 10^{-6}
\]

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

The \(^{18}O\) fraction decreases with altitude and distance from coast since heavy \(^{18}O\) water condenses and freezes out faster than \(^{16}O\) based water.
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!
Stonehenge Archaeology
Recent (2002) discovery of human remains (2300 BC) near Stonehenge

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

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

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

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

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."
Origin of Equipment

Element analysis through isotope analysis:

- Archer from Alpine Region
- Copper from Spain
- Gold from central Europe
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.