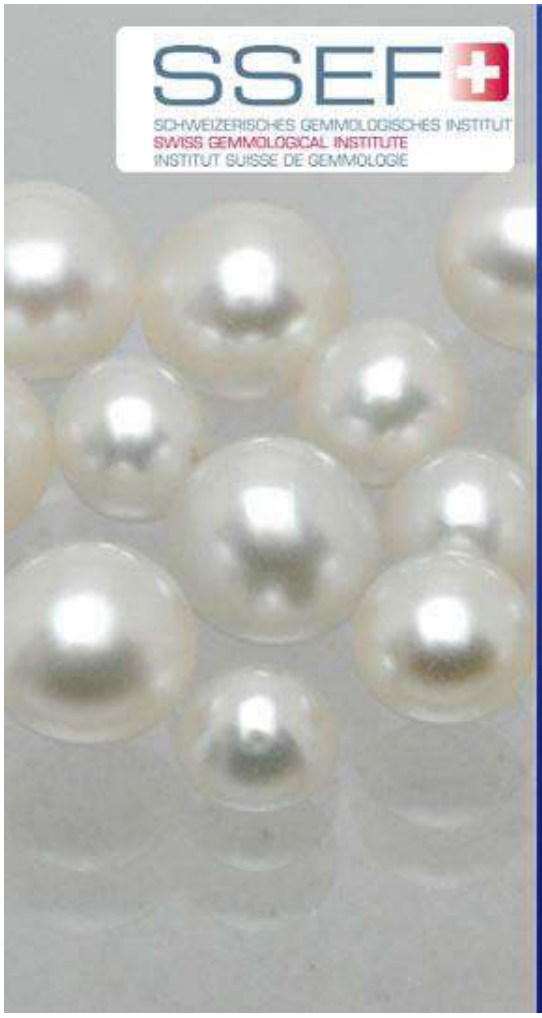

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SCHWEIZERISCHES GEMMOLOGISCHES INSTITUT
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New Developments in Pearl Analysis : X-ray micro Tomography and Radiocarbon ^{14}C Age Dating

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Pearls, pearls, pearls...

Radiocarbon ^{14}C age dating of pearls: Historic or recent ?

Samples for our study:

Radiocarbon ^{14}C

Cosmic rays produce free neutrons in the atmosphere.These neutrons react with ^{14}N (7 neutrons and 7 protons) and form ^{14}C, a radioactive isotope (8 / 6). Normal carbon ^{12}C (6 / 6) is lighter than radiocarbon ^{14}C.

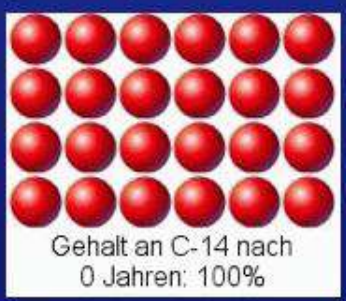
$$^{14}N + n \longrightarrow {}^{14}C + p$$

In the atmosphere, carbon is mostly found as CO_2, with a steady-state between these two isotopes.

The ^{14}C / ^{12}C ratio is approx. $1{,}2 \times 10^{-12}$ (nearly constant in human history)
For comparison: With a population that is 250x higher than today, just one person would be different from all the rest.

^{14}C decays into nitrogen by releasing an electron
(a neutron is transformed into a proton).
The ^{14}C half-decay time is 5730 years.

$$^{14}C \longrightarrow {}^{14}N + e^-$$



Radiocarbon ^{14}C in organisms

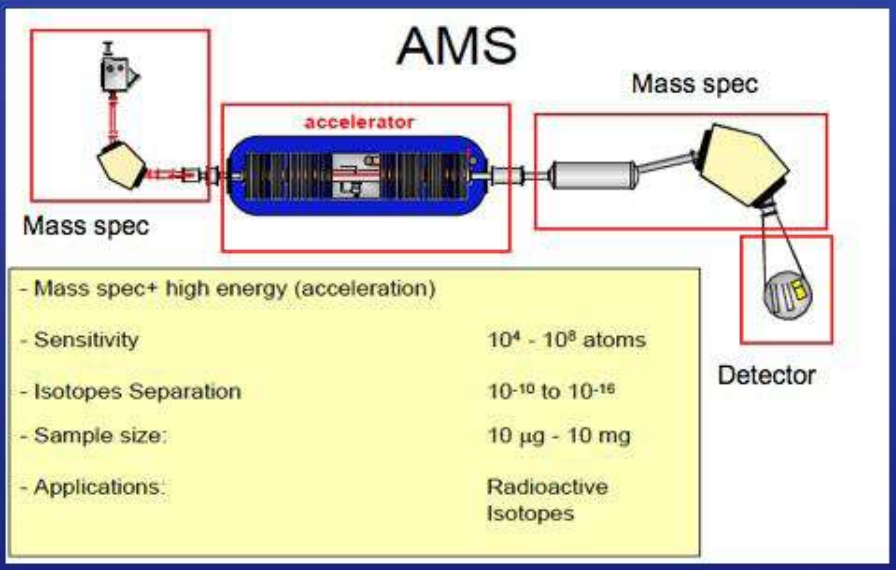
Organisms usually uptake carbon (radiocarbon ^{14}C and stable ^{12}C) as CO_2.

During the lifetime of any organism, there is a contineous steady-state in uptake and release of carbon. But after death, no further carbon exchange is possible. The ^{14}C concentration will decrease due to radioactive decay.

By measuring the ^{14}C / ^{12}C ratio, we get access to the age of organisms.

Prehistoric mummified „Oetzi"

^{14}C analysis - AMS accelerator mass spectrometer



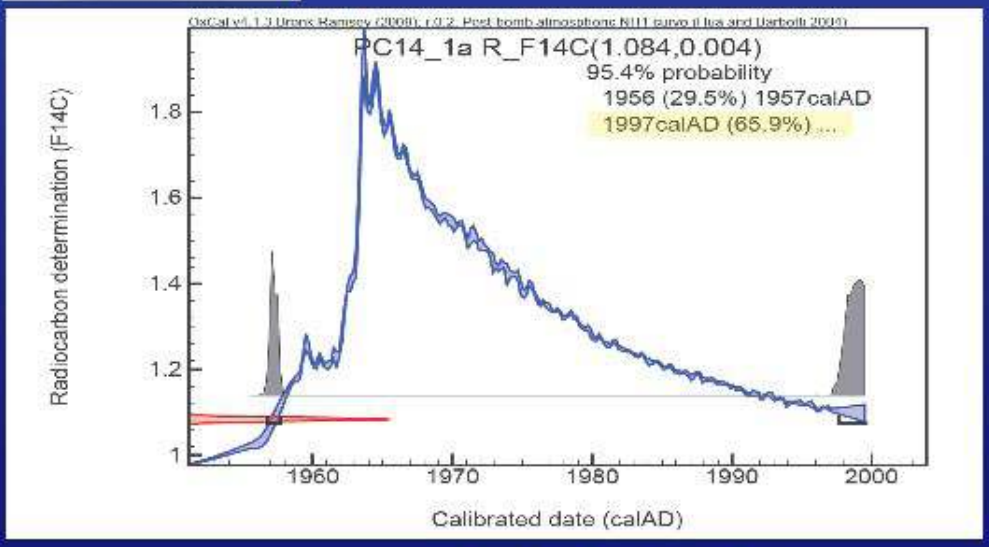
- Graphite 'sputtered' by caesium ions
- Mass separation
- Counting ^{14}C atoms
- $^{14}C/^{12}C$ ratio sample (A_t) and known sample (A_0) → t

$$t = -8033 \cdot \ln \frac{A_t}{A_0}$$

Radiocarbon ^{14}C age dating: Preliminary results

PC-14_1

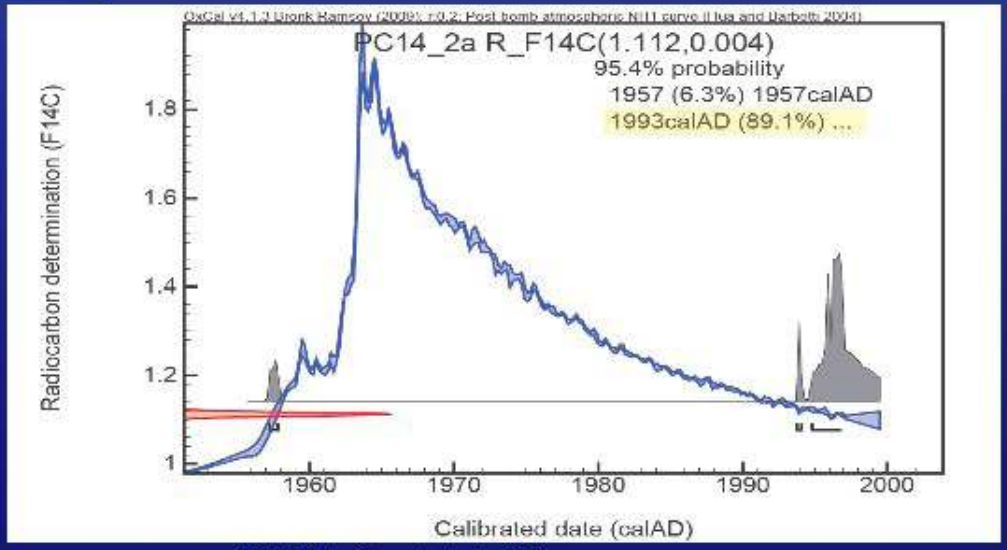
Freshwater cultured pearl
China
~ 2000 AD



Radiocarbon ^{14}C age dating: Preliminary results

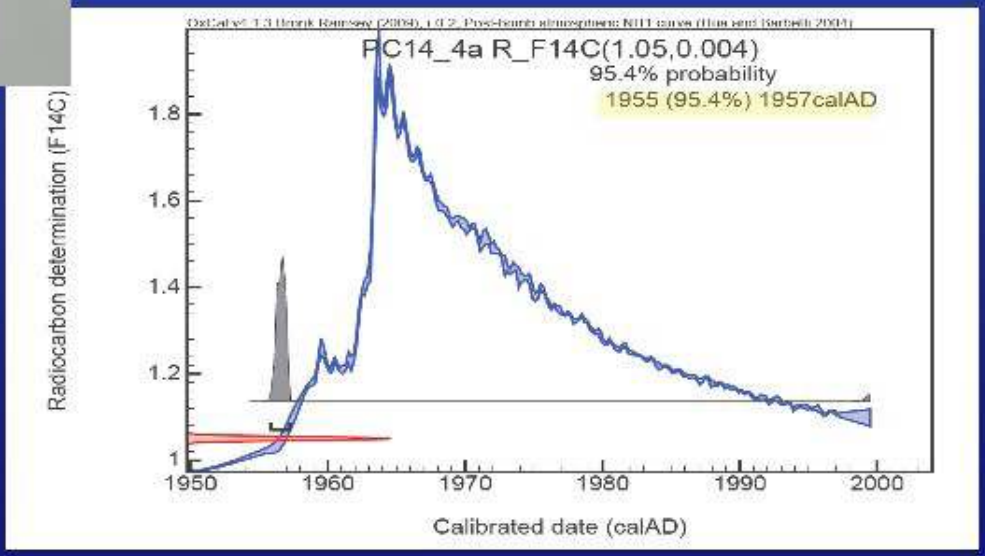
PC-14_2

Saltwater cultured pearl
Keshi-type
~ 2000

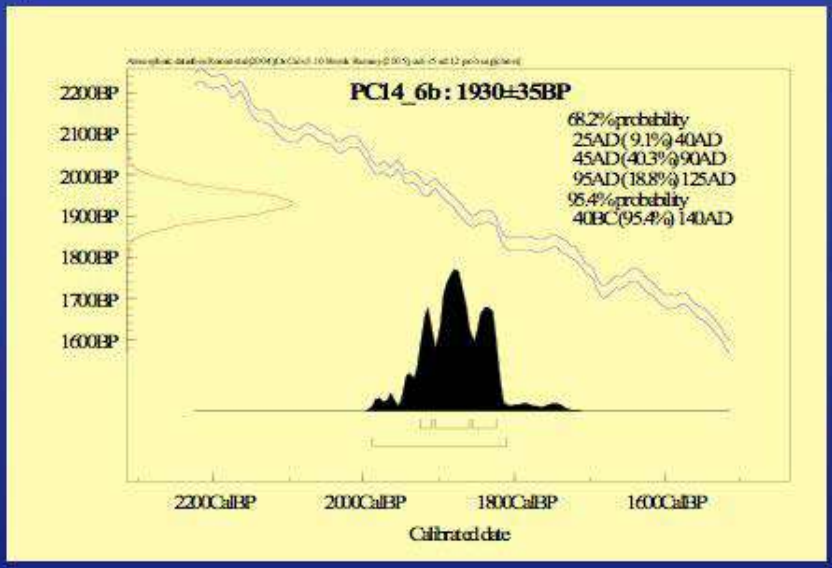


Radiocarbon ^{14}C age dating: Preliminary results

PC-14_4
Saltwater natural pearl
Nova Scotia, Canada
~ 1950 ??



Radiocarbon ^{14}C age dating: Preliminary results



PC-14_6

Freshwater natural shell
Switzerland
~ 1910

Problem of „old" ages due to mixing of carbon reservoirs (atmosphere and sediments).

Conclusions Part I: Radiocarbon age dating

Aim of this study:
Get a better understanding of the formation age of a pearl

- Slightly destructive method (about 0.05 ct required)
- Highly sophisticated and expensive method, not for common pearl testing
- Analysis and age calculation needs much time!
- Problems of carbon reservoir mixing and carbon containing additives by glues/impregnations have to be further studied.

The data so far present is only preliminary and we will have to further investigate if this method is helpful for distinction of historic pearls from newly formed pearls!