





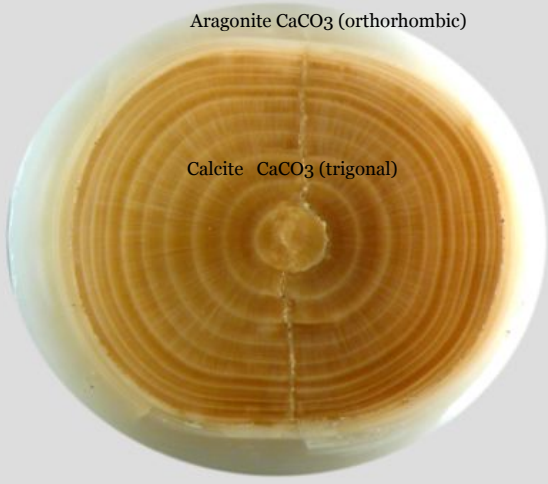
Radiocarbon dating of pearls:

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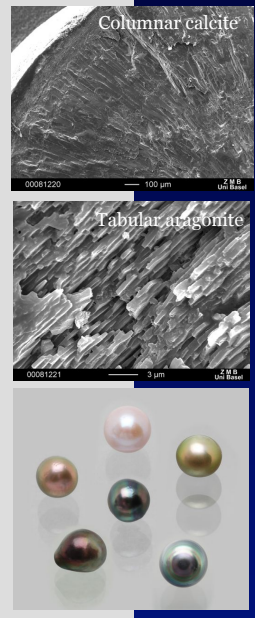
*21st International Radiocarbon Conference
Paris, 9-13 July 2012*

Pearl: Product of biomineralization




Aragonite CaCO_3 (orthorhombic)

Calcite CaCO_3 (trigonal)




Columnar calcite

Tabular aragonite



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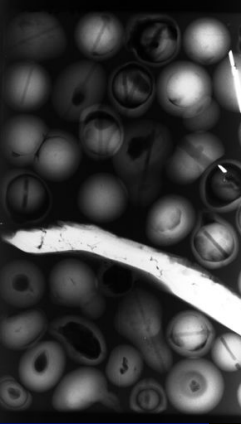
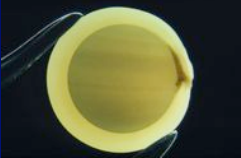
Natural pearls versus cultured pearls



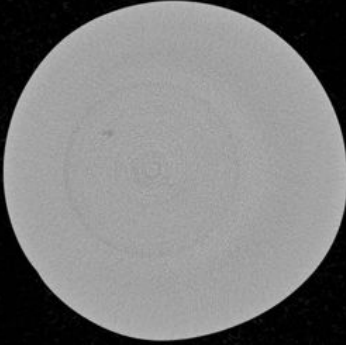

Natural pearls are forming accidentally and without any human intervention in a wild shell, living in its natural habitat. Cultured pearls are produced in molluscs in a pearl farm, either with a shell bead in the centre or without bead.

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from Indonesia



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Test Report No. SPECIMEN

on the authenticity of the following pearls, strung on a necklace

Shape: round to roundish and button-shaped, drilled

Total weight: approximately 35.2 grams (including thread and clasp)

Diameters: approximately 5.45 - 6.60 - 10.20 - 6.70 - 5.55 mm

Total length: approximately 48 cm

Colour: slightly cream to light cream, partly with rose and green overtones

Identification: regularly graduated necklace of **64 NATURAL PEARLS**

Comments: The analysed properties confirm the authenticity of these saltwater natural pearls.

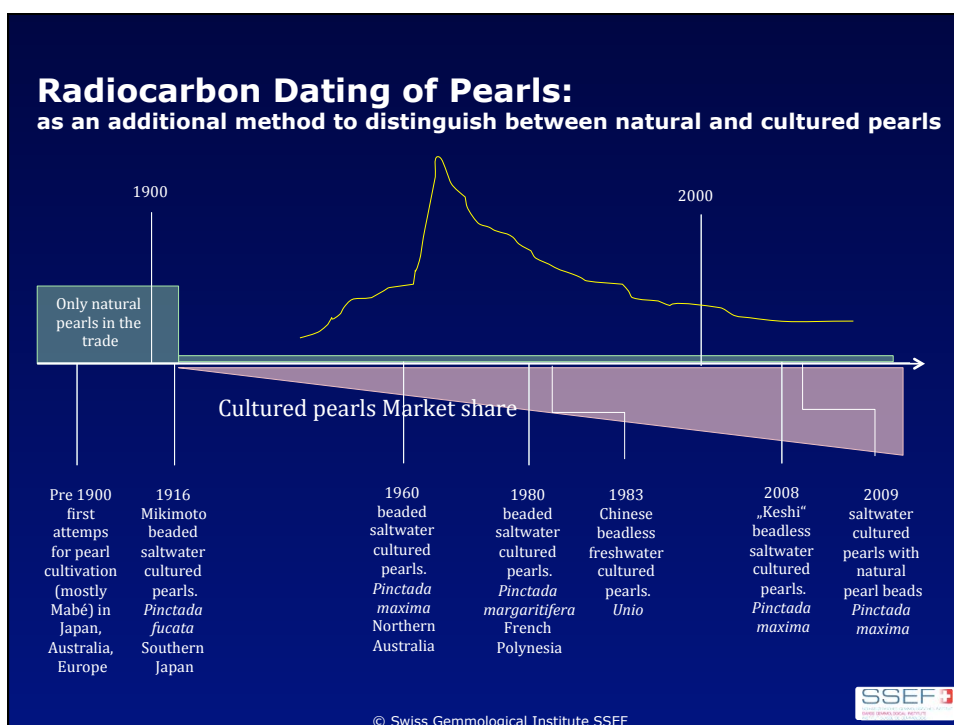
Importance: The conclusion on this Test Report reflects our findings at the time it is issued. Mounting may have completely changed a gemstone or pearl. Thus all conclusions are based on the state of the gemstones. The gemstones and mounting are not responsible for the state of the gemstones and mounting. A gemstone or pearl can be modified and/or removed at any time. Therefore, the 2021 can be issued at any time what the gemstones of pearl is in accordance with this Test Report. Only the Test Report with the valid major inscription, authentication and/or "Test" for the purpose of the gemstones' Test Report is valid document. Two items and conditions are necessary for the Test Report to be valid document.

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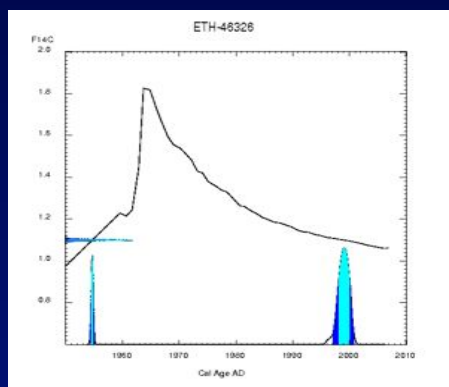
Basel, 19 October 2011. cy

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Recent shells:



Calibration of 1.099000 ± 0.003000 with Levin ^{14}C dataset
Smoothing: 1.000000

I. Levin and B. Kromer (2004) The tropospheric $^{14}\text{CO}_2$ level in mid latitudes of the Northern Hemisphere. Radiocarbon 46(3):1261-1272.

I. Levin, S. Hammer, et al. (2008) Radiocarbon observations in atmospheric CO_2 : Determining fossil fuel CO_2 over Europe using Jungfraujoch observations as background. Science of the Total Environment 391:211-216.

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Shell from *Pinctada radiata* (Orient pearl oyster) from the Arabian Gulf, personally collected in 2009.

OneSigma

[1954.50(Jul) - 1954.81(Oct)] 0.127141

[1998.10(Feb) - 2000.06(Jan)] 0.872859

TwoSigma

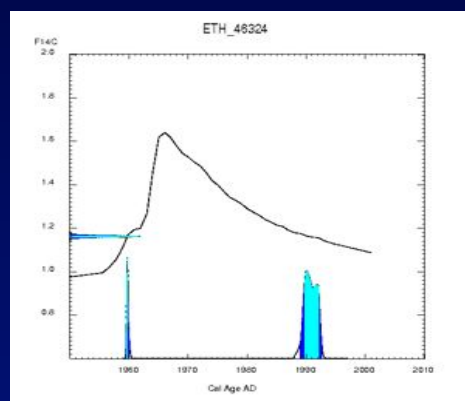
[1954.28(Apr) - 1955.05(Jan)] 0.150058

[1997.12(Feb) - 2000.80(Oct)] 0.849942

Note: 300 years of INTCAL04 data have been prepended to this data set



Recent shells:



Calibration of 1.162000 ± 0.004000 with SH1.14c dataset
Smoothing: 1.000000

Q Hua and M Barbetti (2004) Review of Tropospheric Bomb ^{14}C Data for Carbon Cycle Modeling and Age Calibration Purposes, Radiocarbon 46: 1273-1298

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Shell from *Pinctada maxima* (Silverlip pearl oyster) from the Philippines, collected 1990 (pers. comm. H.A. Hänni)

OneSigma

[1959.61(Aug) - 1959.81(Oct)] 0.092576

[1989.67(Sep) - 1992.10(Feb)] 0.907424

TwoSigma

[1959.47(Jun) - 1960.07(Jan)] 0.118790

[1988.98(Dec) - 1992.65(Aug)] 0.881210

Note: 300 years of INTCAL04 data have been prepended to this data set



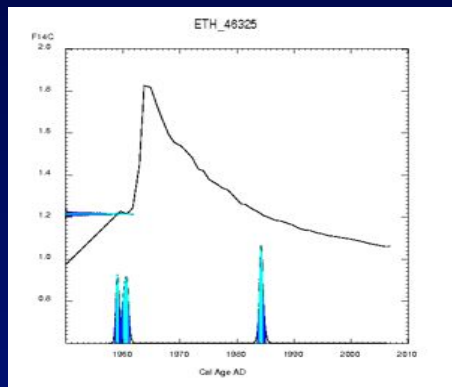
Recent shells:



Shell from *Pinctada radiata* (Orient pearl oyster) from the Arabian Gulf, collected in 1990 (pers. comm H.A.Hänni).

OneSigma
 [1958.76(Oct) - 1959.31(Apr)] 0.228138
 [1960.03(Jan) - 1960.91(Nov)] 0.365475
 [1983.87(Nov) - 1984.62(Aug)] 0.406388

TwoSigma
 [1958.50(Jul) - 1961.26(Apr)] 0.617661
 [1983.61(Aug) - 1985.05(Jan)] 0.382339
 Note: 300 years of INTCAL04 data have been prepended to this data set



Calibration of 1.215000 ± 0.004000 with Levin ^{14}C dataset
 Smoothing: 1.000000

I. Levin and B. Kromer (2004) The tropospheric $^{14}\text{CO}_2$ level in mid latitudes of the Northern Hemisphere. Radiocarbon 46(3):1261-1272.

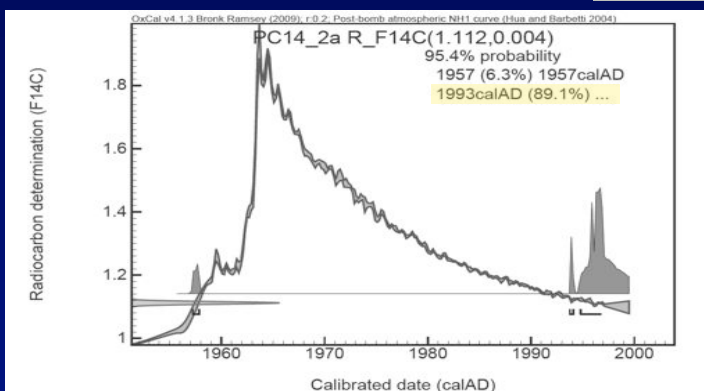
I. Levin, S. Hammer, et al. (2008) Radiocarbon observations in atmospheric CO_2 : Determining fossil fuel CO_2 over Europe using Jungfraujoch observations as background. Science of the Total Environment 391:211-216.

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Recent pearl

Beadless saltwater cultured pearl, Keshi-type
Pinctada maxima, Indonesia
 ~ 2000 AD

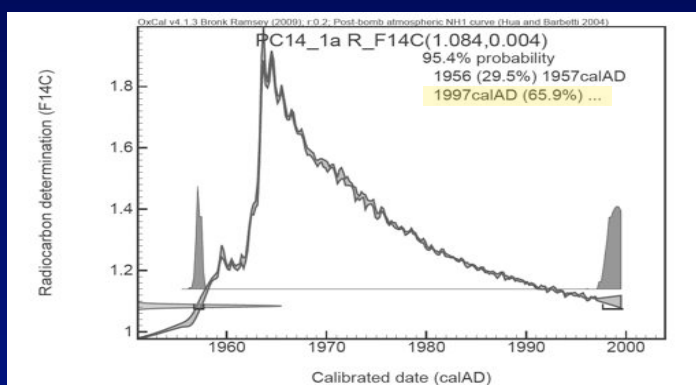


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Recent pearl

Beadless freshwater cultured pearl
Unio, China
 ~ 2000 AD

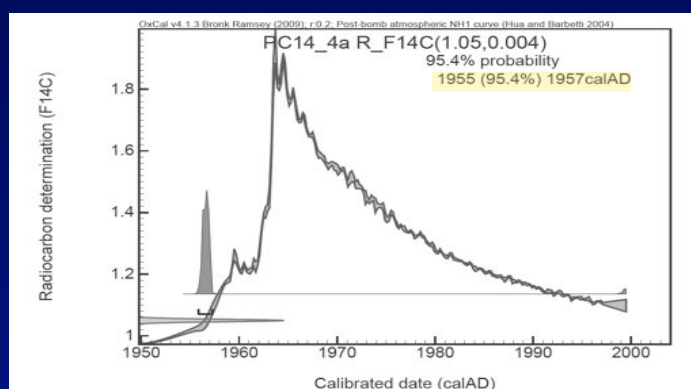


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Pearl before bomb peak

Saltwater natural pearl
 Nova Scotia, Canada
 ~ 1950 ??



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**Case study from a client:
Natural or cultured pearl ?**

Since about 2009: cultured pearls
with natural pearl as bead



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Conclusion:

Natural pearl, as cultivation
methods for *Pinctada maxima*
pearls with natural pearls were
not developed before 2009.

ETH-46319 :
365±30 BP
68.2% probability
1450 AD (45.9%) 1530 AD
1570 AD (22.3%) 1620 AD


95.4% probability
1440 AD (51.5%) 1530 AD
1540 AD (43.9%) 1640 AD

Calibrated C14 ages (Calendar time intervals) using OxCalv3.10
INFORM : References - Atmospheric data from Reimer et al (2009);
OxCal v3.10 Bronk Ramsey (2005)




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Radiocarbon Dating of Pearls:

To support the documented historical provenance of a pearl.



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Renaissance necklace with pearls



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Historic pearls:



Pearls from *Pinctada radiata* from the Arabian Gulf, probably from 1860 (pers. Comm. T. Faerber, Geneva)

ETH-46322 :

130±30BP 68.2% probability
 1680 AD (20.9%) 1740 AD
 1750 AD (1.1%) 1770 AD
 1800 AD (7.8%) 1820 AD
1830 AD (27.0%) 1890 AD
 1910 AD (11.4%) 1940 AD

95.4% probability
 1670 AD (37.9%) 1780 AD
 1790 AD (57.5%) 1950 AD

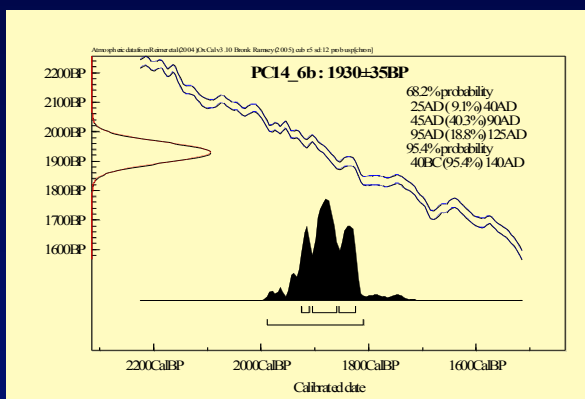
Calibrated C14 ages (Calendar time intervals) using OxCalv3.10

INFORM : References - Atmospheric data from Reimer et al (2009);
 OxCal v3.10 Bronk Ramsey (2005)

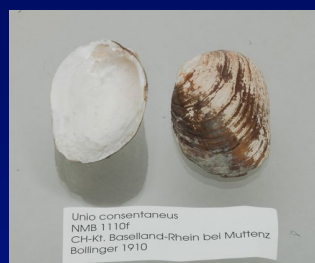
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Historic freshwater shell



Freshwater shell
 Switzerland
 ~ 1910



Problem of „old“ ages due to unknown correction for carbon reservoir.

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Conclusions

- First results on a limited number of samples show that radiocarbon age dating of pearls is possible.
- Radiocarbon dating may result in additional data (using the bomb-peak) which enables a unambiguous distinction between cultured and natural pearls.
- Radiocarbon dating of historic pearls must be further investigated with well-documented samples.
- Extraction methods to avoid destruction of pearls have to be further developed by minimising the sample weight.
- For most pearls, the geographic locality where they formed is not known or only vaguely. This results in problems when corrections for the carbon reservoir ages are required.
- In general, freshwater shells and pearls give “fancy” ages (carbon reservoir).

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**Thank you for
your attention**

Acknowledgements:
Thomas Faerber, Geneva,
José Casares (Shanghai
Gems), Geneva,
Henry A. Hänni (GemExpert),
Basel; Imura Daiji (RAK
Pearls), Ras-Al-Kaihmah;
Andy Muller (Hinata
Trading), Kobe, Japan,
A.R. Mahmood, Bahrain.

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