

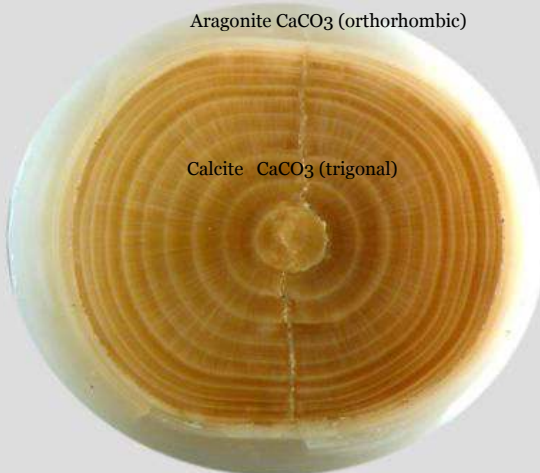
## Radiocarbon dating of pearls:

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*21<sup>st</sup> International Radiocarbon Conference  
Paris, 9-13 July 2012*

## Pearl: Product of biomineralization

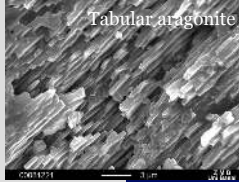


Aragonite  $\text{CaCO}_3$  (orthorhombic)


Calcite  $\text{CaCO}_3$  (trigonal)




Columnar calcite



Tabular aragonite



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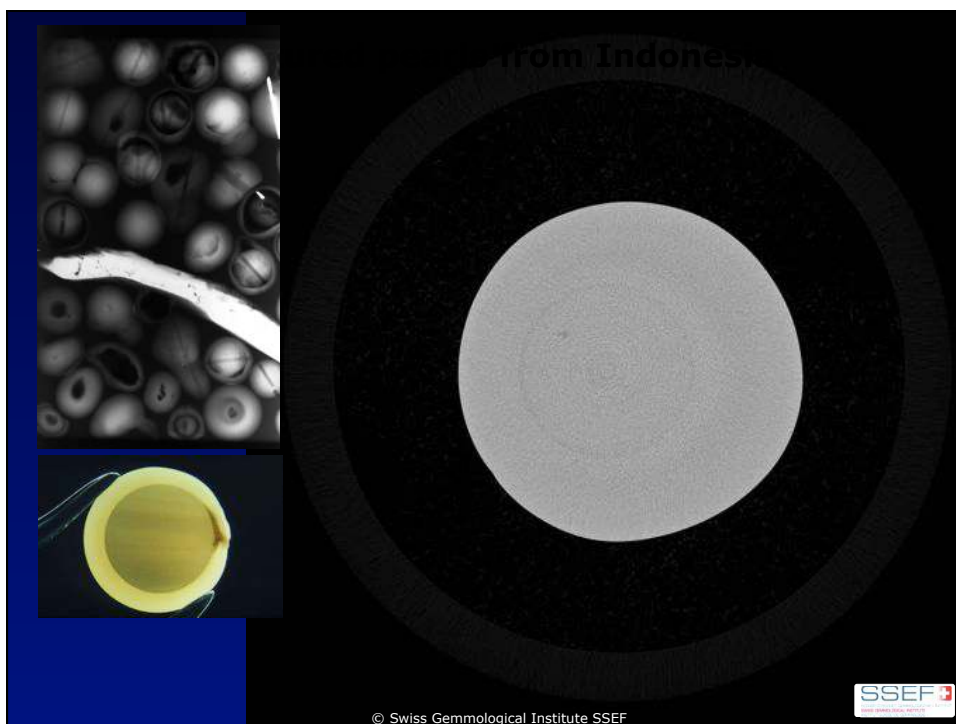


## Natural pearls versus cultured pearls



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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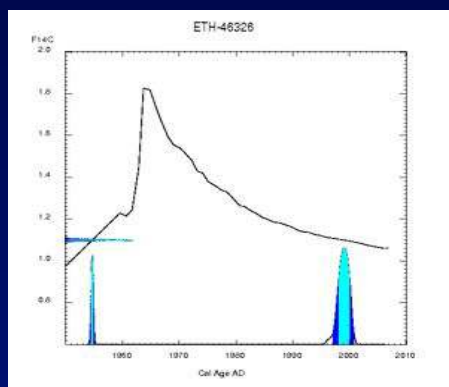


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## Recent shells:



Calibration of  $1.099000 \pm 0.003000$  with Levin  $^{14}\text{C}$  dataset  
Smoothing: 1.000000

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

I. Levin, S. Hammer, et al. (2008) Radiocarbon observations in atmospheric  $\text{CO}_2$ : Determining fossil fuel  $\text{CO}_2$  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

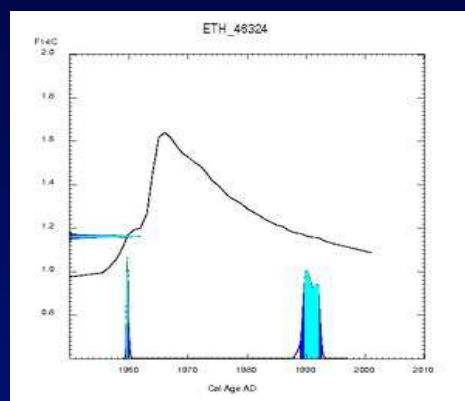
TwoSigma

[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  $1.162000 \pm 0.004000$  with SH1.14c dataset  
Smoothing: 1.000000

Q Hua and M Barbetti (2004) Review of Tropospheric Bomb  $^{14}\text{C}$  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

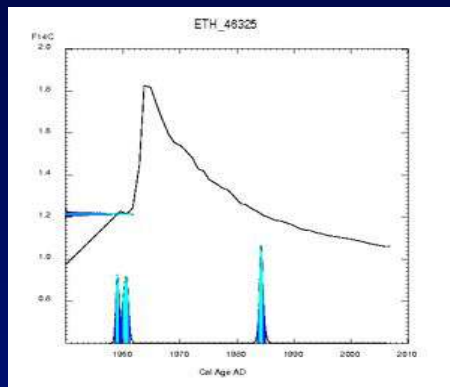
TwoSigma

[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±0.0040000 with Levin <sup>14</sup>C dataset  
 Smoothing: 1.000000

I. Levin and B. Kromer (2004) The tropospheric <sup>14</sup>CO<sub>2</sub> level in mid latitudes of the Northern Hemisphere. Radiocarbon 46(3):1261-1272.

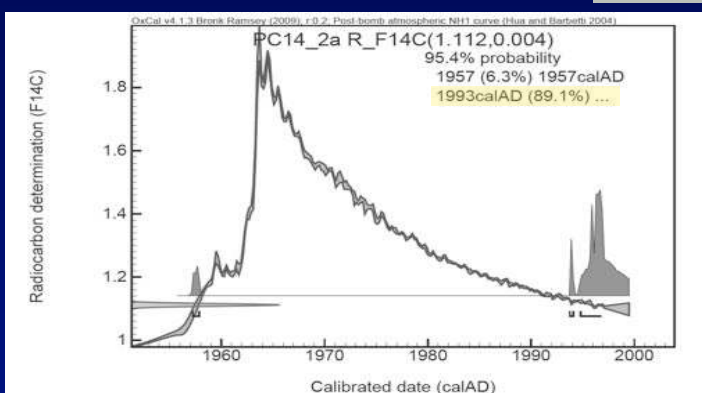
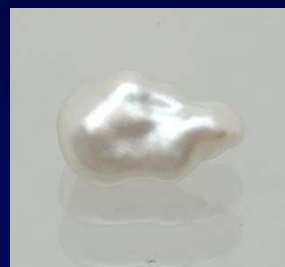
I. Levin, S. Hammer, et al. (2008) Radiocarbon observations in atmospheric CO<sub>2</sub>: Determining fossil fuel CO<sub>2</sub> over Europe using Jungfraujoch observations as background. Science of the Total Environment 391:211-216.

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## Recent pearl

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

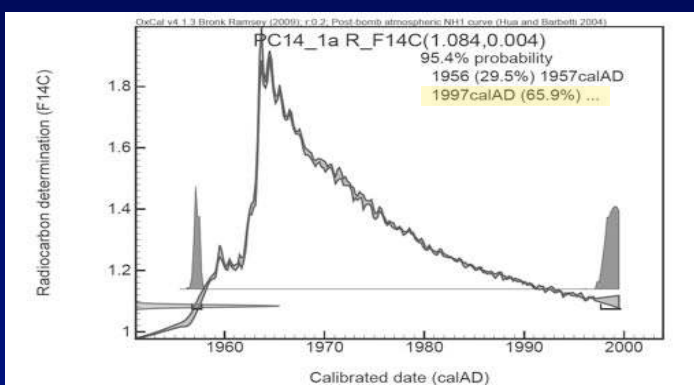


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## Recent pearl

Beadless freshwater cultured pearl  
*Unio*, China  
 ~ 2000 AD

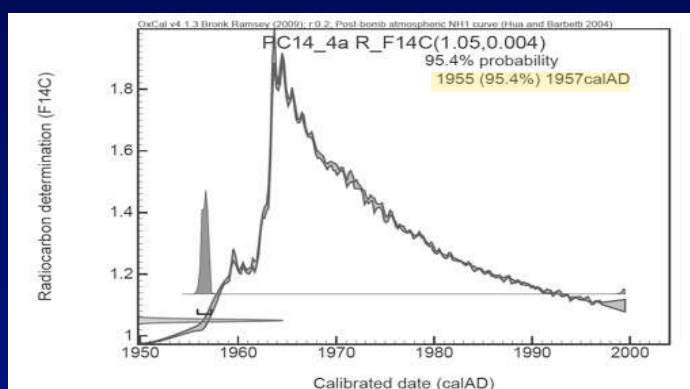


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## Pearl before bomb peak

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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# La Peregrina Pearl



sold for 11 mio US\$ at Christie's auction in New York, Dec. 2011

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**SEEF**

**TEST REPORT No. 5834**

**Object:** Pear-shaped, Cult Pearl

**Net weight:** approximately 13.9 grams

**Measurements:** approximately 17.8 x 12.8 x 10.2 mm

**Color:** approximately P-1, 20% pinkish white with some greenish overtones

**Origin:** NATURAL PEARL

**Comments:** The pear-shaped pendant with the matching diamond-encrusted pendant.

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 Geneva 1999  
 19.05.2012  
 Dr. phil. Dr. phil. h.c. Dr. phil. h.c. Dr. phil. h.c. Dr. phil. h.c.

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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

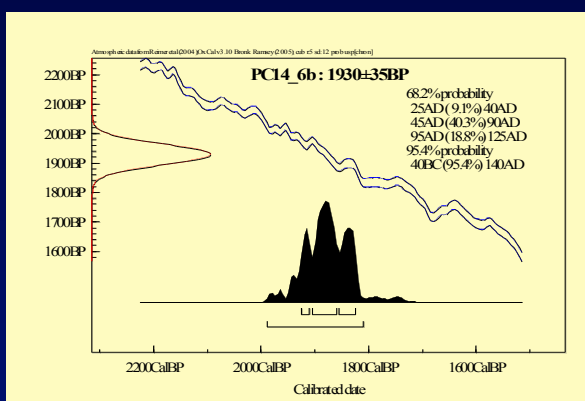
### Calibrated C14 ages (Calendar time intervals) using OxCalv3.10

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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