Outlook on pearl treatments and pearl testing

Dr. Michael S. Krzemnicki
Swiss Gemmological Institute SSEF
www.ssef.ch

Photos © M.S. Krzemnicki and SSEF, except where indicated otherwise
Necklace with exceptional South Sea cultured pearls (SSEF 59459) (diameter approx. 15 - 18 mm) from Pinctada maxima (silver-lipped pearl oyster)

World record at auction for necklace of exceptional saltwater natural pearls

With pearls measuring from 10.4 to 13.7 millimeters (SSEF 66235), Sold for $8.5 million at Christie's Geneva in May 2013
The SSEF is testing and certifying pearls for the trade to maintain the confidence of the consumers in the product.

Main questions are:
- Is the pearl natural or cultured?
- Is it from freshwater or saltwater molluscs?
- Is the pearl treated, and how?
- Eventually what is the species?
- Eventually what is it’s age?

To solve these questions, SSEF is since many years strongly focussing it’s research activities on pearls.

Natural or Cultured ??

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.

All saltwater natural pearls, except centre pearl which is a beadless cultured pearl („Keshi”) from Pinctada maxima.
Internal structure of a natural pearl

- Is reflecting the structure of the shell in which it has grown

Photos © H.A. Hänni, SSF & M. Duggelin, Centre for Microscopy, University Basel

---

X-ray shadow images: radiography

For many decades, radiography is the method commonly used for pearl identification

Photos: H. A. Hänni
MICRO-TOMOGRAPHY AT SSEF

X-ray micro-tomography (CT scan)

Natural pearl (P. radiata)

Scanco µCT 40 Scanner at SSEF

to visualize internal structures of pearls in 3 dimensions.

New SSEF research project:
Extended possibilities in pearl-radiography

Example:
Beadless cultured pearls (dyed) from China

Absorption  Refraction  Scattering
Cultured Pearls with „new beads”
the next challenge...

SSEF Trade alert in May 2010

Beaded cultured pearl from P. maxima with a natural pearl used as „bead”

Saltwater oyster or freshwater shell?
X-ray luminescence of pearls
analysed at SSEF
with the PearlView system

X-ray luminescence of natural and beaded cultured pearls
(bead = freshwater shell bead)

Trace element analysis of pearls
Using X-ray fluorescence spectrometry

Thermo Scientific
Quant'X EDXRF
at SSEF
Trace element analysis of pearls using LA ICP mass spectrometry

Saltwater pearls

freshwater pearls

Which species?
Pinctada radiata (Orient pearls) from Bahrain

The Cowdray necklace containing pearls from Mexico (*Pteria Sterna*) which sold at Christie’s for a world record prize.

Harvesting a natural pearl from *Pinctada maxima*...
Simple testing may do...

Pearls (and shell) of Pteria Sterna show a characteristic and distinct red fluorescence reaction under a longwave UV-lamp.

But often sophisticated methods are required

Raman spectra of Conch pearls (Strombus gigas) of different colour and saturation.
SSEF - ETH Zurich collaboration achieves major breakthrough in pearl research: DNA fingerprinting and age dating of pearls

Basel, Switzerland -- October 16, 2013:

Researchers at the Swiss Gemmological Institute SSEF and the Swiss Federal Institute of Technology Zurich ETHZ have successfully extracted oyster DNA from pearls, allowing them to trace and fingerprint pearls from different origins. This is the first report of oyster DNA extraction from a pearl. The researchers' results have just been published in the international open-access journal PLoS ONE, and the technology is currently being patented.

The team of Swiss researchers was able to recover minute amounts of DNA from a wide range of pearls. The amount of recovered DNA was sufficient to identify the mother oyster species of studied pearls. The sampled pearls came from Pinctada maxima, Pinctada margaritifera and Akoya oysters, which are the most important species in the trade of natural and cultured marine pearls. Samples also included Pinctada radiata pearls from the Arabian/Persian Gulf, Pinctada maxima from both Australia and Indonesia and Pinctada margaritifera from Fiji and French Polynesia.

By collaborating with the Institute of Integrative Biology (IBZ) of ETH Zurich, the research team had access to extensive DNA extraction expertise and technology. The project was led by Dr. Joana Meyer of ETH Zurich and Laurent Cartier of SSEF. This two-year research project funded by the Swiss Gemmological Institute SSEF was carried out to advance knowledge about pearls and to investigate the possibility of using DNA to carry out geographic origin determination of pearls.

An important part of this project was the development of a practically non-destructive technique to extract DNA so as to preserve the commercial value of tested historic and modern pearls. In one sample, 10 mg of drilled sample powder (see figure below) was sufficient to successfully identify the pearl-oyster species based on extracted DNA material.

Dr. Michael S. Krzemnicki, director of SSEF, commented: "This is a breakthrough in pearl science and opens up new and interesting opportunities for future pearl research and testing. We are constantly exploring new scientific methods to test pearls and are excited about this new method we have developed in collaboration with scientists at ETH Zurich, one of the world's leading universities."

He went on to say: "These new methods give us a considerable advantage in distinguishing DNA fingerprinting of pearls TCAGCGAECTGC... = P. radiata

DNA fingerprinting of pearls

TCAGCGAECTGC...

= P. radiata

P. maxima P. radiata P. margaritifera

500 200

raw pearl drilled pearl

PR PMX PMR

Dr. Joana Meyer, head of project

Outlook:

Determination of shell population by DNA analysis

= geographical "origin of formation"
Testing colour authenticity of pearls

UV-Vis reflectance spectra of pearls of natural colour (*Pinctada margaritifera*)

- FGH_15
- FGH_17
- FGH_16

Increased and bulging general luminescence

Slowly increasing general luminescence

Treated / worked / fake pearls?

A Before

A After
Microscopic observations

A visual examination with the loupe and the microscope can already reveal important information.

Worked surface of pearls

Very common „treatment” for natural pearls
Polished surface of pearls

Not considered a „treatment”. Nearly all pearls

Worked beads from shells (fake pearls)
...to support the documented historical provenance of a pearl

Radiocarbon dating of pearls:

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

Bomb peak

Kim Jong Boom ??
Radiocarbon Dating of Pearls:

Figure 4. Calibrated ages of two historic pearls ETH-46322 and ETH-46323 that were formed before the bomb peak. Both pearls originate from the Arabian Gulf, and were calibrated using marine calibration curve INTCAL09 (Reimer et al. 2009) and \( \Delta R = 190 \pm 180 \) yrs.

Sample ETH-46319, a large pearl from Pinctada maxima (Fig. 3) - although declared being pre-1950 - reveals a historic age of 1623-1781AD (2 sigma probability). From the information of the collector, the measured \(^{14}C\) age is possible, but unfortunately not well documented. However, despite the unknown accuracy of the historic age, the age provided by the radiocarbon age determination allowed us in this specific case, to unambiguously identify the sample as a natural pearl, although previous testing with radiography and X-ray computed \( \mu \)-tomography was not conclusive. The fact, that cultured pearls from Pinctada maxima of such large size were only produced commercially after the "bomb peak" and the pre-bomb radiocarbon age helped to resolve the problem. For the seven more recent pearls and shell samples, which formed distinctly after the bomb-peak, the calculated and corrected radiocarbon ages are in four cases are quite well matching with the "declared" ages (ETH-46324, ETH-46325, ETH-38493, ETH-46326), whereas the cultured pearl from Japan (ETH-46327) with a declared age of 1982 and the two cultured pearls from Indonesia (ETH-46320, ETH-46321) from 2009 reveal older ages. This again might indicate some variability in reservoir ages of this region that affects our results. Nevertheless, the pearls detect \(^{14}C\), which shows the potential of \(^{14}C\) for detection of this time marker.

Conclusions

This study has shown that radiocarbon age determination can provide additional and valuable information when testing pearls. We can distinguish two very different scopes. In the case of antique jewellery and treasures, age determination may support evidence for their historic provenance (e.g. sample ETH-46322). This can be of high importance, especially in the case of pearls of iconic significance in cultural history. A pearl set in a historic jewellery...
Thank you for your attention

Get more pearl news at www.ssef.ch