

A Large Naturally Colored Natural Blister Pearl

by

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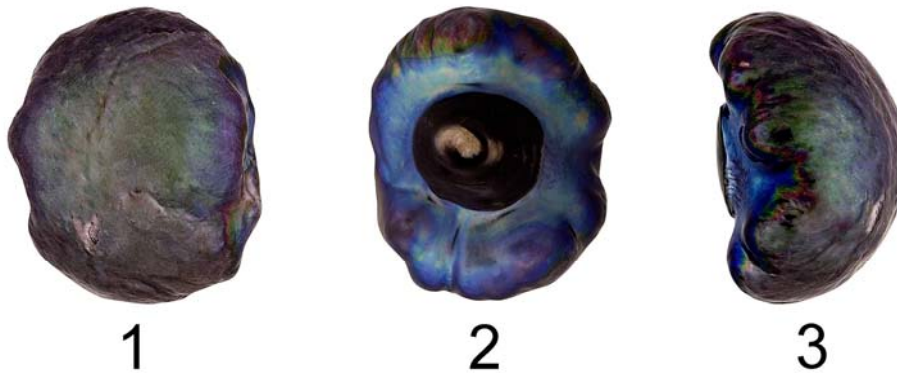


Figure 1: Three views of a 391.20 grain naturally colored, natural blister pearl. Front (1), back (2) and side-on (3).

Introduction

Most of the nacreous pearls encountered in the trade tend to be white, cream or various tones and saturations of yellow. Other natural colors are therefore rarer and some are extremely rare. These are subsequently often more in demand and usually command high values in the market. This report details the examination of a large naturally colored pearl that the firm W. Truman in London wanted the GIA to examine and issue a report upon (Figure 1). In addition to the loose pearl, Truman's were also fortunate enough to have one half of the mollusk's shell available and this was also submitted, out of interest, for examination and comparison purposes (Figure 2).



Figure 2: The 391.20 grain naturally colored, natural blister pearl (bottom) | together with the shell it reported formed within.

The Pearl

Weighing in at 97.80 carats (391.20 grains) and measuring 29.95 x 23.16 x 19.34 mm, the baroque, dark violetish gray pearl certainly had a striking visual appeal and while the front displayed some nice orient, the reverse exhibited a very pronounced and impressive orient, with blue and green being the most prominent colors (Figure 1). Apart from the size, color and orient, one other noticeable feature visible on the back of the pearl was clearly evident, and this was a dark central structural attribute with an irregular white core (Figure 3). This area exhibited very pronounced concentric growth rings with the naked-eye and was clearly heavily worked and polished. This did not hinder the overall appearance though and even provided an extra visual characteristic by which the pearl could be identified.

Unlike a previously examined pearl (Sturman. 2009) this pearl did not feel or look odd when it was handled, so no suspicions arose with regards to any fillings or unusual treatments. Yet the color and identity of the pearl still had to be determined and so the pearl was first examined with the GIA's Faxitron CS-100AC Real-Time X-ray Unit prior to other analytical procedures.

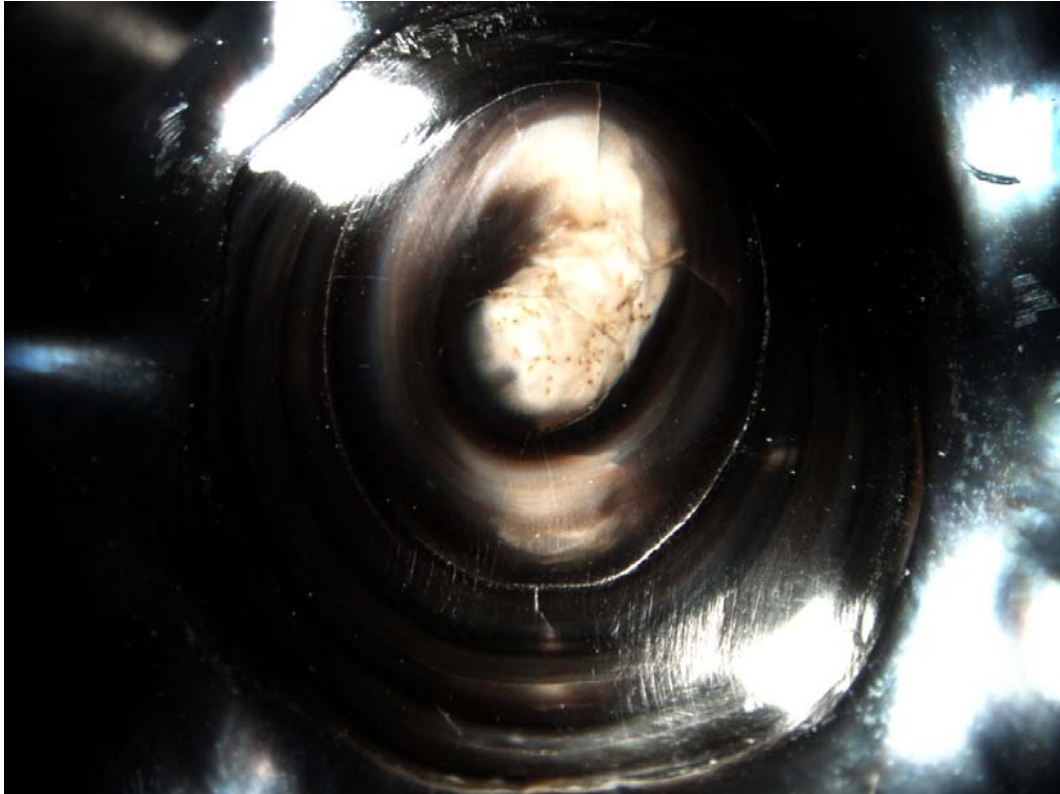


Figure 3: A heavily worked and polished area on the base (of the 391.20 grain naturally colored, natural blister pearl) showing a white central core. Magnified 7.5x. Photo ©GIA.

Microradiographs

Like all pearls, the only safe and non-destructive way to visually inspect the interior is to expose them to X-rays and see what the resulting images reveal. Whilst the internal form can in some cases be anticipated with experience, nobody honestly knows exactly what will result until the film or other forms of image are obtained and examined. Therefore, it is always an exciting time for pearl testers when unusual or large pearls are examined.

The structure of the pearl detailed herein revealed a solid body with some dark arcs, proving its natural formation, at various points within it (Figure 4). These were especially prominent at the bottom of the pearl near the 'edges' as can be seen in the magnified image in Figure 5.

These structural arcs can be seen following the baroque shape of the pearl and are what would be expected in a natural pearl. Sometimes natural pearls will also reveal a nice often concentric nucleus which all pearl testers like to see, but in this particular example no such nucleus revealed itself, although study of the overall structure suggested that it would quite likely be positioned towards the center or center basal area. However, the pearl was slightly unusual in that it showed some fairly distinct to very distinct dark lines traversing it in all three microradiographic

orientations. As is normal policy in GIA's pearl testing protocol, at least two micrographic directions are required for each loose pearl, and in this example three were chosen. Of these the clearest orientation depicting these features was the flat or base to dome orientation (Figure 6). The radio-translucency of these lines is not really expected for structural lines associated with conchiolin deposition as is normally seen in natural and cultured pearls, but is more characteristic of cracks/fractures. It therefore appeared that a few sub-surface or possibly surface reaching cracks might be present, and the only way to confirm this would be with the assistance of external examination using a loupe or microscope together with suitable lighting. Also of note in this orientation was a central near-round area that appeared to be whiter (more radio-opaque) than the surrounding pearl. This was however explained by the fact that it related directly to the darker worked and polished core feature on the base of the pearl and that the pearl's thickest point lay in the same orientation and position as this core.

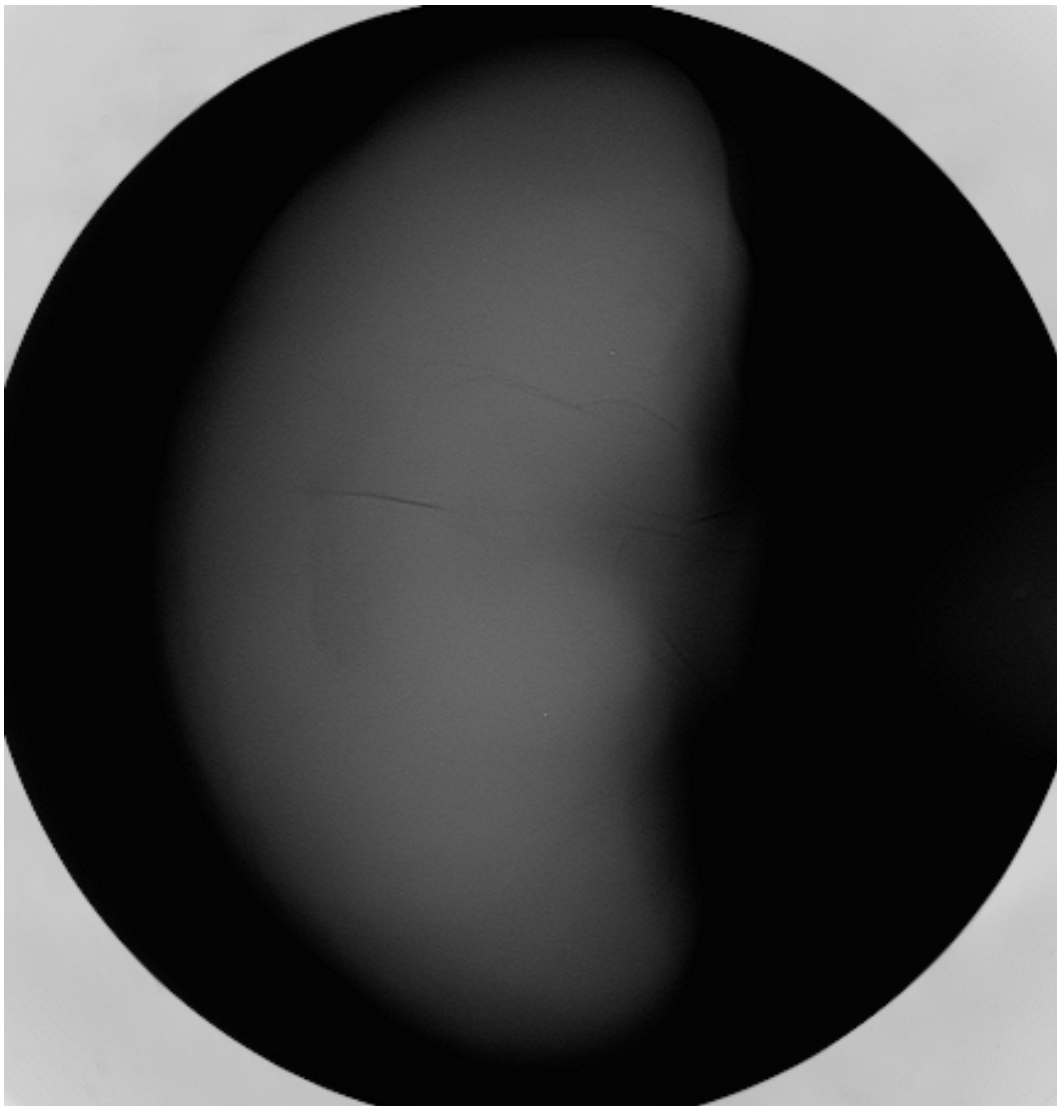


Figure 4: The structure visible in the 391.20 grain naturally colored, natural blister pearl in the side-on orientation

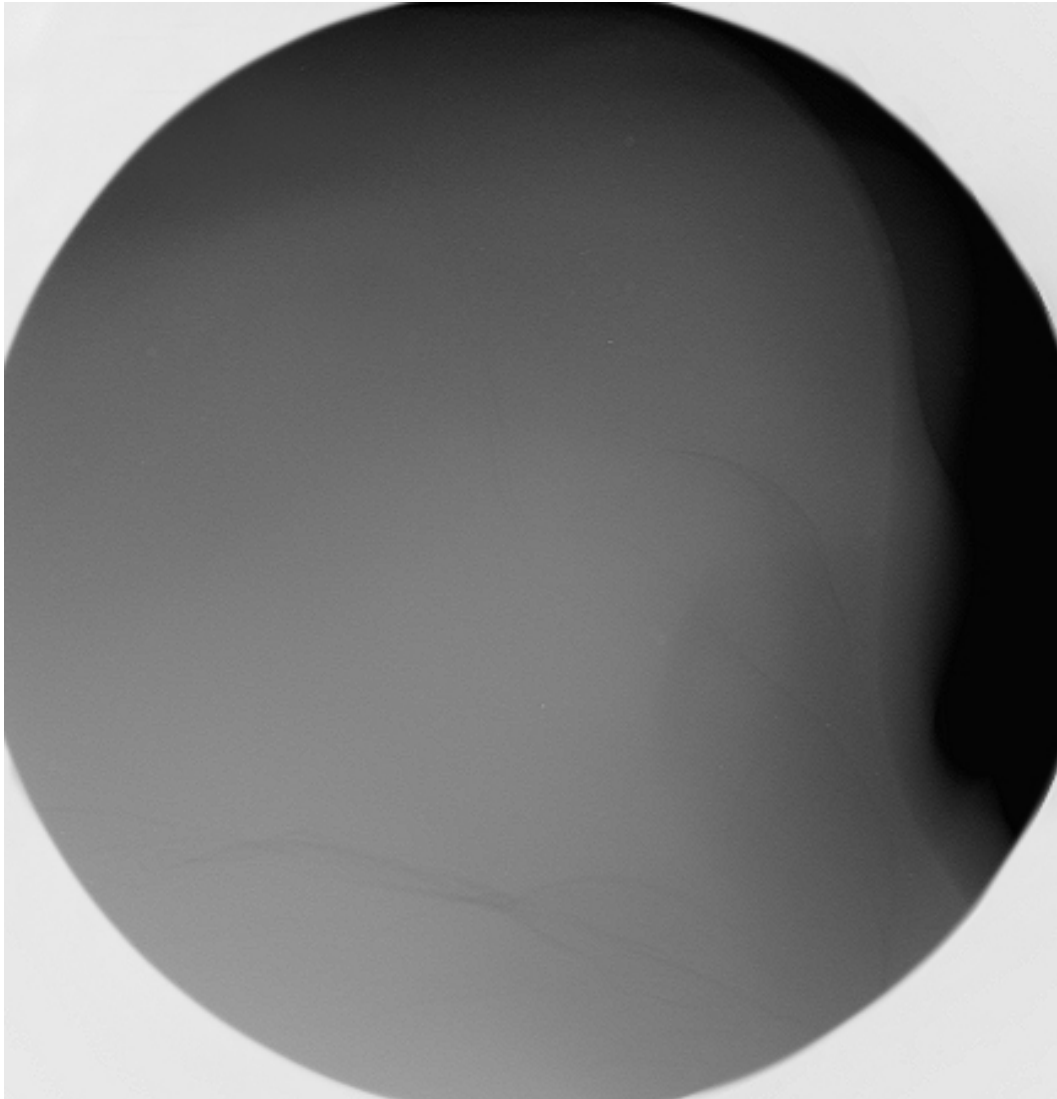


Figure 5: Some of the structural growth lines visible near the base of the 391.20 grain naturally colored, natural blister pearl.

Color and External Appearance

All colored pearls, no matter what their color, need to undergo further analytical procedures to determine if the color is of natural origin or has undergone some form of treatment. The detection of such treatments may be relatively straightforward or require a good deal of time and thought, depending in part on the color being tested and on exactly which form of treatment has been applied. Yellow pearls for instance are more challenging to identify as the spectral and chemical features observed in the natural and treated samples are less defined than in many of the brown, black, gray, pink and purple hued pearls (Elen. 2001). However proving that some of the irradiated gray to black pearls are treated is always a challenge.

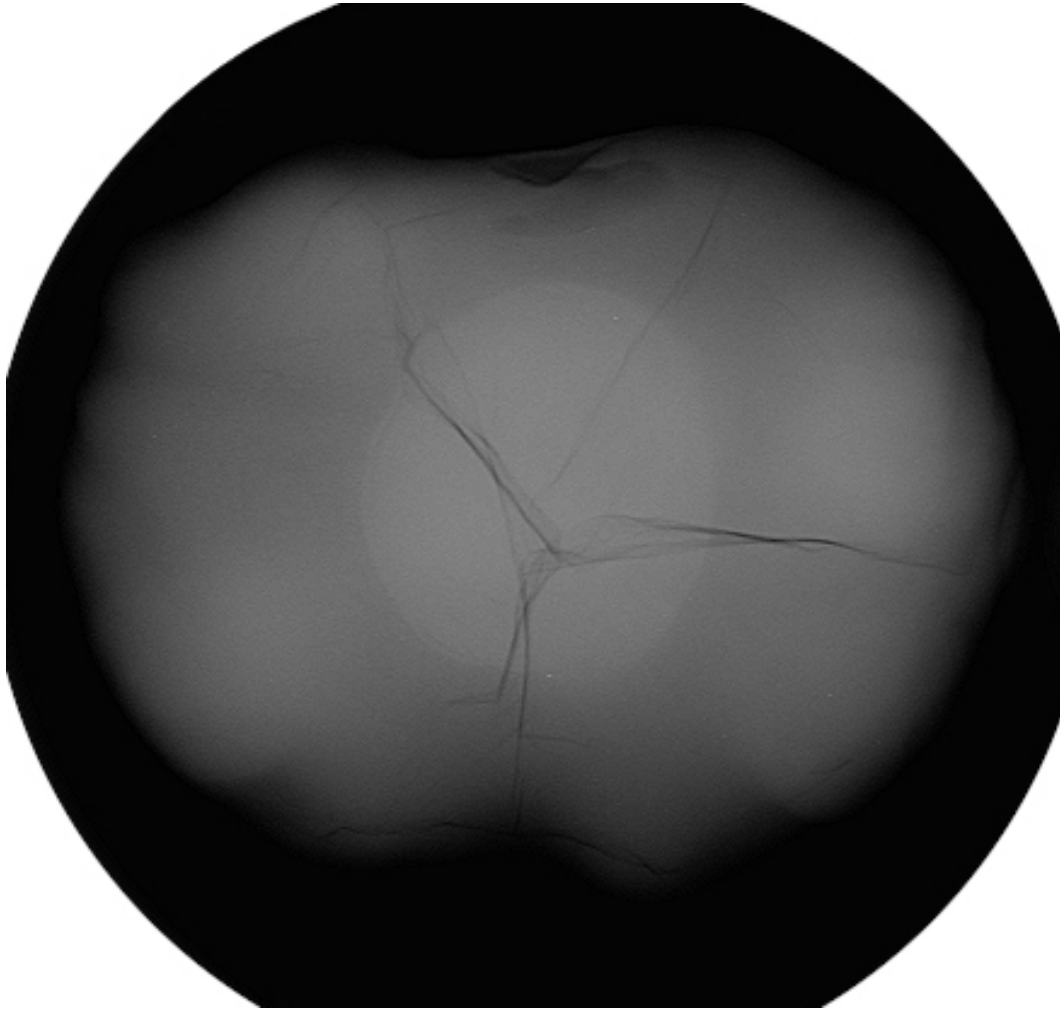


Figure 6: Microradiographic view of the base to top orientation of the 391.20 grain naturally colored, natural blister pearl showing the obvious sub-surface cracks

External visual examination is always an important procedure and in some cases can be the ultimate answer to color origin determination. This is due to the very likely concentration of the dye used in treating the pearl in surface reaching imperfections such as pits, spots, wrinkles, cracks or chips. Hence careful examination of any dyed pearl often reveals some indication of the treatment process, no matter how small, even if the search requires some time! Drill-holes and surface reaching cracks are especially useful in this respect, since artificial color can 'bleed' into the pearl, however the pearl described in this report was not drilled, and so all the other features had to be inspected for any signs of artificial coloration. As the pearl was known, during microradiography, to have some cracks within it, these were an obvious area of interest to us and so they were concentrated on for the first part of the visual inspection. Examination with fiber-optic lighting showed that none of the quite prominent cracks appeared to reach the surface (Figure 7 and Figure 8), and a fruitless search for signs of any color concentration in them and other surface related features via the microscope indicated that the color was natural.

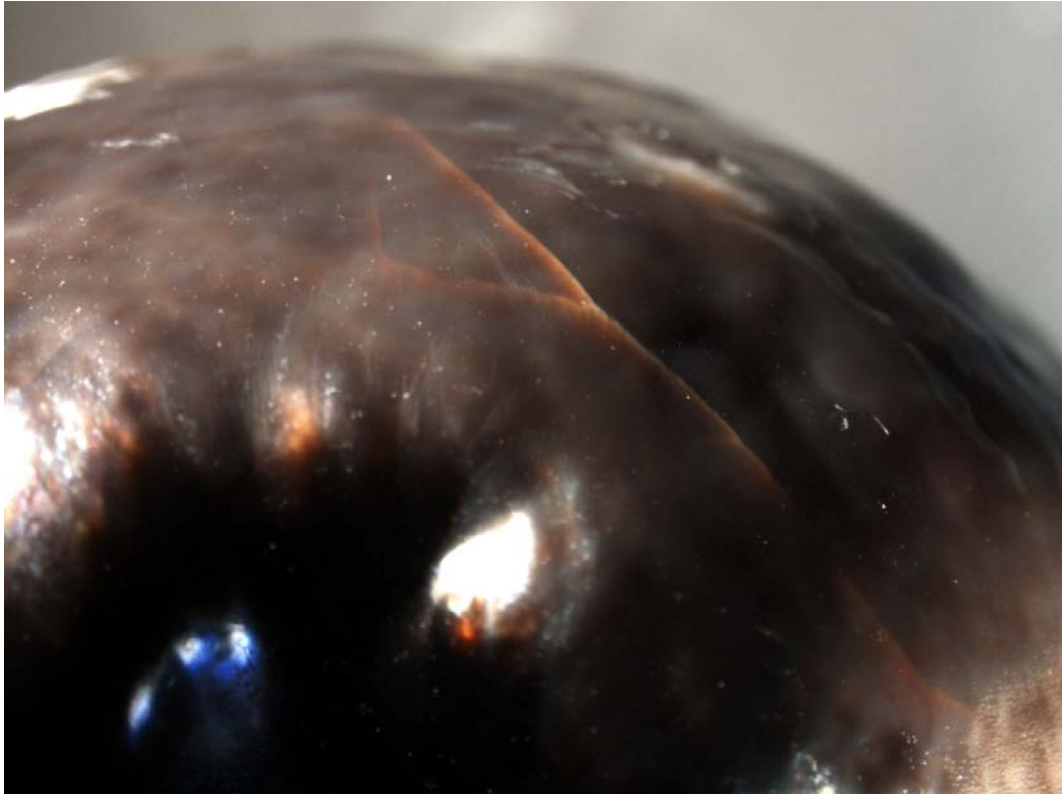


Figure 7: One sub-surface crack in the 391.20 grain naturally colored, natural blister pearl clearly visible with magnification (magnified 7.5x) Photo ©GIA.



Figure 8: Magnified view of the crack in figure 7 within the 391.20 grain naturally colored, natural blister pearl. (magnified 16x.) Photo ©GIA

Unfortunately color origin determination in pearls is never quite so straightforward and visual results need to be endorsed with as much proof as possible from the scientific side. This means that all colored pearls, according to GIA's protocols, must be examined with a range of advanced equipment to verify initial impressions as much as possible.

The Other Tests

Whilst not considered an advanced analytical test, the use of Ultra-Violet light (UV) in gemology is widely known and can certainly have its uses when applied to pearl testing. Some pearls, especially brown and gray to black pearls from certain mollusks, are known to exhibit a weak to strong orange to red fluorescence that strongly indicates that the color is more likely to be natural owing to the concentrations of porphyrin pigment within their composition (Comfort. 1949). *Pteria sterna* pearls and shells of this natural color range in particular provide good examples of the range of orange to red fluorescent colors produced when they are exposed to long-wave (LW) UV light. *Pinctada margaritifera* pearls and shells on the other had produce much weaker reddish reactions under LW UV light (Kiefert, Moreno, Arizmendi, Hanni and Elen. 2004). With this in mind and clearly having a pearl with a dark gray orientated body color, we decided to see how it and the similarly colored shell would react to LW UV light. The result was spectacular to say the least (Figure 9). The resulting red fluorescence provided very strong evidence that the colors of both items were natural and also just as importantly provided a very good connection between the two items. If the fluorescence of the shell had been different in any way to the pearl's, it would have created doubt as to the association between the two but as can be seen the reaction was a very good match in all ways and provided real evidence that the pearl may well have originated from this specimen, or at least from this species.

The back of the pearl also exhibited a nice matching fluorescence with the concentric rings on the worked and polished area showing clearly and the white core to this feature reacting in a different way and producing a whitish fluorescence (Figure 10).

Unlike all white, cream and light yellow pearls which require less advanced analysis, yellow pearls of medium tone or stronger and all other pearls require additional tests to assist in reaching a conclusive result on their color origin. Thus all relevant colored pearls must be examined using UV-Vis-NIR spectroscopy and Raman Microscopy in addition to a chemical analysis (using an Energy Dispersive X-ray Fluorescence (EDXRF) spectrometer) which is applied to all pearls. These were the next steps in the identification procedures used on this particular pearl.

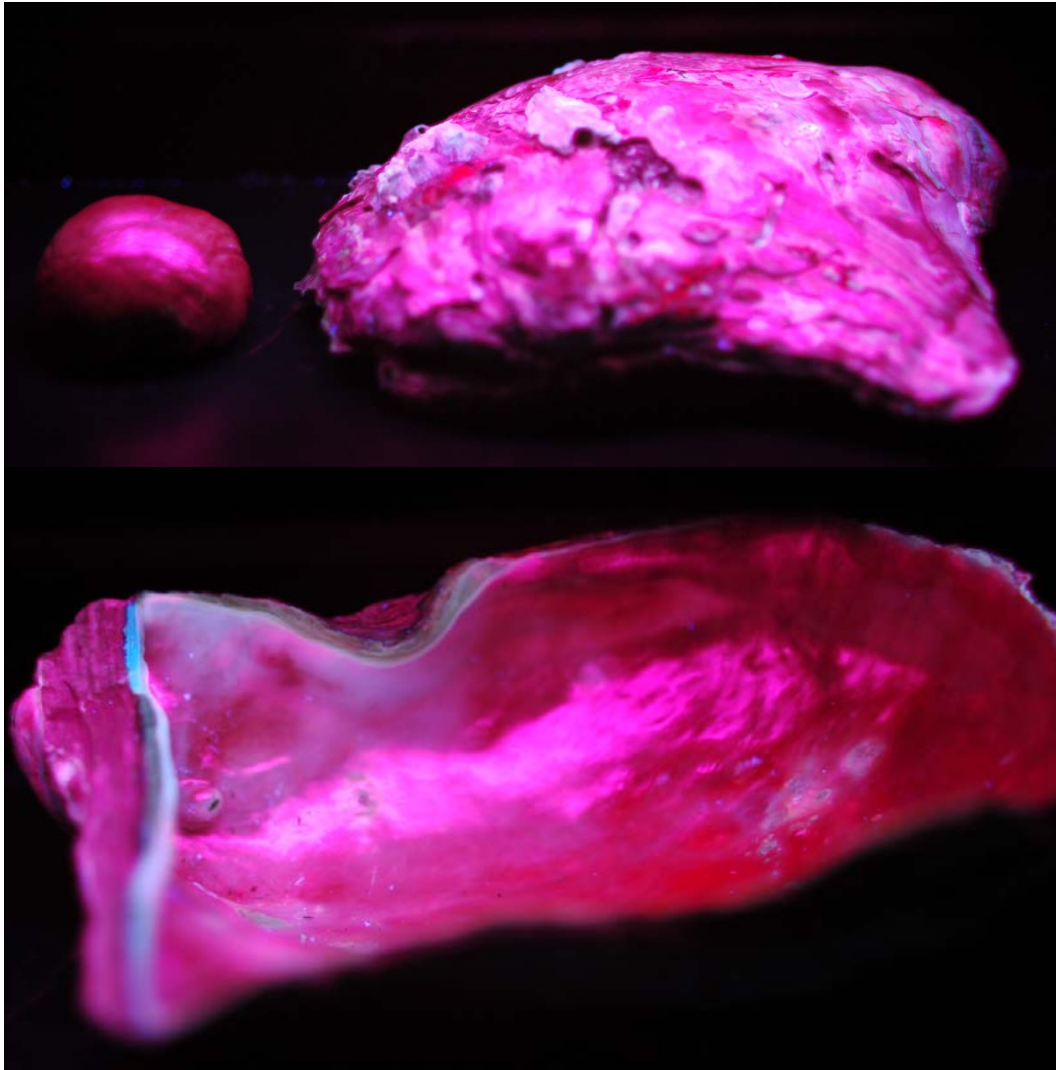


Figure 9 Reactions of the 391.20 grain naturally colored, natural blister pearl (top left) and outer surface of the shell (top right), as well as the shell's inner surface (bottom) to LW UV light.

Chemistry

All pearls examined by the GIA are examined with a Thermo Fisher Scientific ARL QUANT'X spectrometer to semi-quantitatively measure the manganese (Mn) and strontium (St) content. The levels of each element subsequently permit the gemologists to determine which water environment the pearls formed within and ultimately allow the GIA to state 'freshwater' or 'saltwater' on the final report. The levels of both elements in this particular pearl clearly proved that this pearl formed within a saltwater environment. This data matched the visual clues obtained from inspecting the shell too, since the mollusk form is typical of those that form within a saltwater environment. In some cases analysis of brown or gray to black pearls has to be taken a step further with the EDXRF and a search for specific elements has to be undertaken. In such cases the full spectrum and not just specific areas of a spectrum have to be analyzed, however in this particular case, given the color of the

pearl, the lack of any dye with magnification and the strong red fluorescence, it was decided that this extra analysis was not required in respect of this pearl.

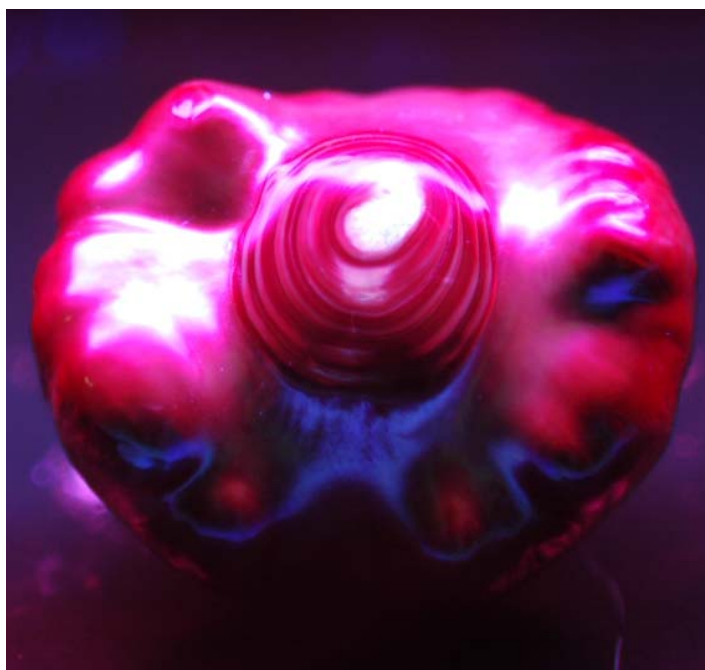


Figure 10: Reaction to LW UV light of the 391.20 grain naturally colored, natural blister pearl's base

Ultra-Violet -Visible and Near Infra-red Spectrometry

Another important test applied to colored pearls is examination with an Ultra-Violet-Visible Near Infra-red spectrometer in order to see the full range of the pearl's visible spectrum and either side of this in the Ultra-Violet and the Near Infra-red regions of the electro-magnetic spectrum. Whilst all the data is recorded for the full range, it is in most cases the visible portion that is the most important with regards to colored pearl testing and so this data was duly obtained for this pearl too. Whilst some brown to gray and black pearls that form within specific mollusks can produce a characteristic spectrum, i.e. *Pinctada margaritifera* with a diagnostic peak at around 700 nm, not all pearls of this color range do, so it was interesting to see whether this pearl would produce anything that would indicate from which mollusk it came. The resulting spectrum (Figure 11), obtained using the GIA's Perkin Elmer Lambda 950 UV/Vis Spectrometer, showed that the pearl was not likely to be from *Pinctada margaritifera* as the 700 nm absorption feature was absent, however there was a slight shift in the 700 nm area and a subtle absorption was present. Once again, as per the LW UV reaction, our focus moved more towards *Pteria sterna* as the producing mollusk as the resulting spectrum had features in common with other spectra we have in the GIA database for pearls produced by this mollusk.

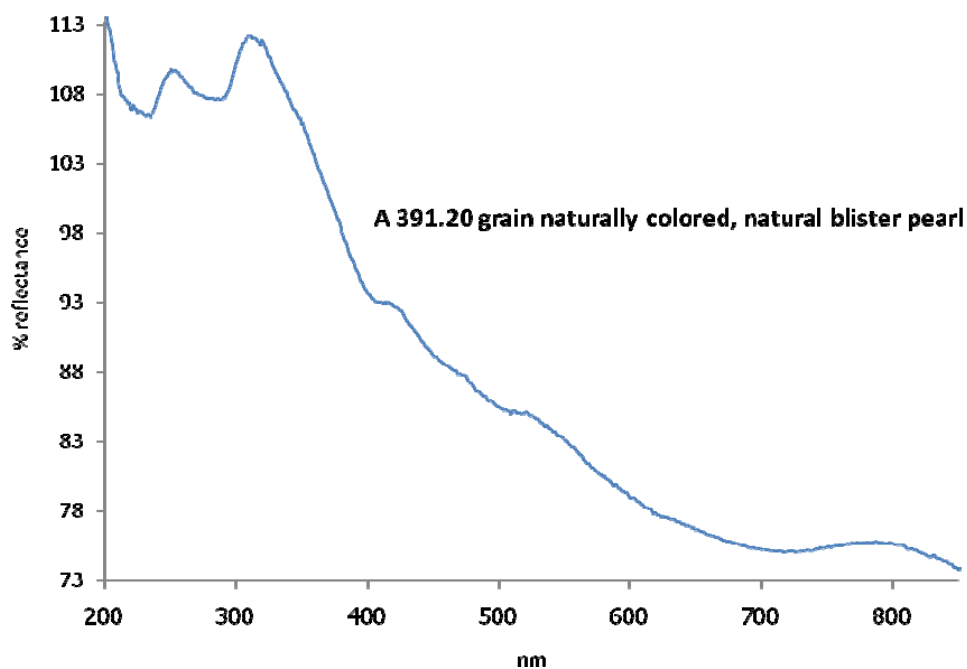


Figure 11: UV-Visible spectrum of the 391.20 grain naturally colored, natural blister pearl described herein.

Raman Microscopy

The final advanced analytical technique that was applied to the pearl was examination with a Renishaw inVia Raman Microscope fitted with a 514 nm argon ion laser. Rather than providing any specific data on this particular colored pearl, Raman is more valuable in ascertaining the color origin of pink, orange and purple pearls. However, it is a very useful tool for identifying the mineral species within/of a sample and so with regards to pearls it will therefore differentiate between the polymorphs aragonite and calcite and prove which form constitutes the main building blocks of any particular pearl. In the pearl under examination in this report, the characteristic aragonite peaks at 1084 cm^{-1} and 702 cm^{-1} were clearly observed in various positions. Analysis of the shell in various positions also showed that aragonite was the polymorph form of calcium carbonate that formed the shell. Once again this linked with the saltwater origin determined via the various methods and observation carried out beforehand, since aragonite is a more likely constituent of saltwater formed pearls and mollusks, whereas calcite is associated more with freshwater. Although this is not a definite rule, it often turns out to be the case that when calcite is detected the pearl is of freshwater origin.

In conclusion

After spending a good deal of time running a number of analytical procedures on the pearl and examining it carefully via the microscope, as reported above, it just remained for us to decide on all of the final conclusions to mention on the report. The natural origin of the pearl based on its microradiographic structure was not in doubt, so this was the first and most important detail. However, since pearls form as both cyst (within the mollusk's tissue) pearls and blister (attached in any way to the mollusk's shell) pearls, we still had to answer this question. Evidence in the form of the heavily worked and polished basal area and the structure within this formation, specifically some features in the whiter core area, and the overall shape and appearance of the pearl indicated that it was more likely to have been attached to the mollusk's shell and subsequently have been removed. Therefore we decided that it was more likely to have been a blister pearl and hence the report detailed the result as a 'natural blister pearl'. The next most important decision to agree on was the color origin and this was proved to be natural on the basis of the striking red fluorescence, lack of any silver related evidence in the microradiographs, UV-Vis-NIR spectrum data and lack of any dye features through the microscope. Another straightforward decision, based on the chemistry and pearl's appearance, to conclude was that of the environment it formed within. This was definitely a saltwater pearl. The final decision to make was whether the pearl did indeed come from the same mollusk provided at the time of submission. Whilst it would have been very nice to have seen the other half of the mollusk and see if there were any signs of an attachment point, it was obviously not the case and so we only had half the evidence to go by. There was certainly no obvious attachment point on the shell we did have, and speculation can be made for the reasons why the other half was missing. One obvious theory that comes to mind is that the shell was destroyed in an effort to remove the pearl, but we have no proof of this in reality; however it could well be the case. On the basis of the matching color, fluorescence and appearance/formation of the platy structure (Figure 12) on the surfaces of each however, a very strong case can be made for a direct link between the two. It is our belief that this pearl did come from what looks to be an example of *Pteria sterna*.

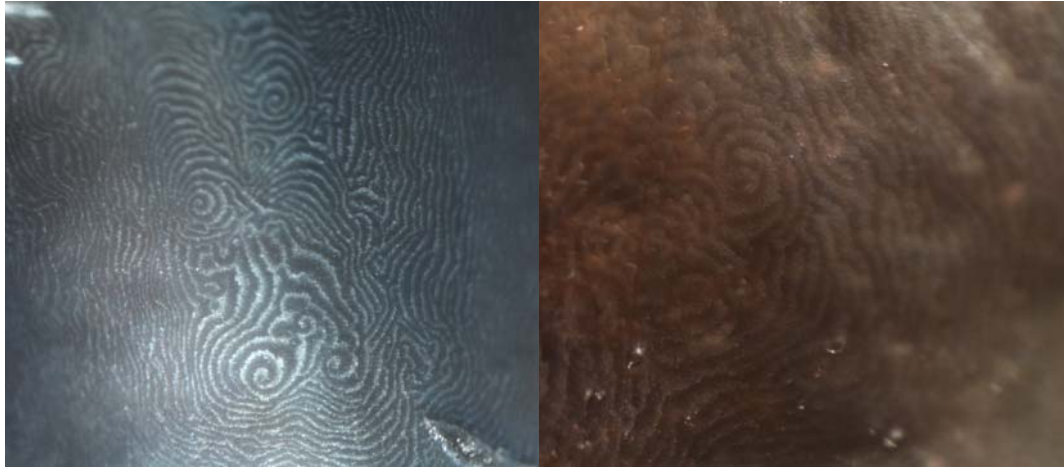


Figure 12: Platy surface structure seen on part of the pearl (left, magnified 70x) and part of the shell (right, magnified 100x) showing similar appearances. Photos ©GIA.

Acknowledgments

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