

The Luster of Pearls

Pearls occur in Wisconsin and Minnesota, in the shells of fresh water mollusks along the Mississippi River and in other rivers and lakes in our region. Their harvest and crafting into fine jewelry forms a small but vigorous cottage industry. The mysterious luster of pearl has delighted humans since the dawn of history. It is alluded to in Hindu literature and the Bible. Without this luster, pearls would be a biological curiosity rather than a sought-after gemstone. To what physical effect do pearls owe this distinctive luster?

Pearls form as growths which many species of mollusks secrete around impurities. The outer part of an oyster shell consists of a layer of calcite or, more rarely, aragonite. The calcite crystals line up perpendicular to the shell's surface, giving it a coarsely fibrous appearance. Inside is the nacreous layer. The nacreous layer is made of thin plates of aragonite in a network of a horny protein called conchiolin (C₃₂H₄₈O₁₁). The nacreous inner lining of the mollusk is called mother-of-pearl and has the same luster (for the same reasons) as isolated pearls. When a bit of grit gets between the mollusk's tissues and nacreous layer, the mollusk secretes a coating of nacre around it, isolating it from the rest of the shell. Blister pearls, growths still attached partly to the shell, show an intermediary stage of this process.

What is it about nacre that gives rise to luster? The answer is linked to the common test used to distinguish true from artificial pearls. True pearls feel rough against the teeth. This is because the surface of the nacre consists of thousands of tiny overlapping plates of aragonite, whose edges give the rough sensation. These edges also interact with the light that falls on the pearl's surface.

The light striking the pearl experiences a phenomenon called diffraction in which light is split up into a spectrum of color by passing through a tiny opening. The different colors of light bend differently, separating them into their color. The edges of the aragonite flakes act as tiny diffraction gratings, and the colors we see are tiny spectra, playing out as we turn the pearl to different angles. The light striking the pearl's surface also experiences an interference effect at the grain boundaries. This occurs as different rays of light partly emphasize or cancel out different colors as they are bent differently at the platelets' edges. The thinner and more numerous the plates, the more pronounced is this effect.

Knowing that, we will have one less question to ask St. Peter when we get to heaven and are standing by those gates.

- Dr. Bill Cordua, University of Wisconsin-River Falls

References:

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