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The mineralogical microstructure of shells: PART 2.[1] The iridescence colors of abalone shells

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Abstract

The iridescence colors of abalone shell arise from Bragg diffraction of light from the layers of the nacre. The thickness of the aragonite nacre tiles is locally regular but varies during the growth cycles of the shell and this can give rise to complex color play. In Paua shell (*Haliotis iris)* and in *H. fulgens* (particularly the muscle scar shell) the thickness of the nacre tiles varies from 0.25(3) to 0.39(3) μm, but locally the thickness is constant within domains of hundreds of tiles. Other species such as *H. laevigata* and *H. rufescens* are similar, but their tile thicknesses range from 0.35(4) to 0.52(4) μm. In all species, the color displayed changes with observation angle and is due to layer diffraction. In *H. iris* and *H. fulgens*, the colors displayed encompass the complete visible spectrum; color hues are pure and are well-defined first-order diffraction colors. Shells of the other species display red and green, but not blue colors. The colors are rendered most vividly where dark organic growth layers are formed. These absorb or scatter light and enhance the iridescence colors. The origin and nature of the diffraction colors are compared with those observed in labradorite and opal. The degree of regularity in tile thickness needed to allow diffraction colors to be generated is modeled using pearl (sheet nacre) and abalone shell (columnar nacre) as examples. The wavelength dispersion is proportional to the product of the squares of the refractive indices of the material, the normalized standard deviation of the thickness, and the order of the diffraction color. For this reason, only first-order diffraction color is seen from shells.