Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 465

Investigation of Manganese in Salt- and Fresh-water Pearls

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In the past the origin of a pearl was a matter of speculation. Even to day we do not know the exact reason of formation of each and every individual pearl. However modern techniques enable us today to answer various questions regarding the formation of a pearl, an unique product of biomineralization. The concentration of certain chemical elements in pearls from fresh-water molluscs are higher than those from salt-water. Particularly the manganese content varies from species to species even fresh-water and salt-water pearls. It is found that the manganese concentration is generally higher in fresh-water pearls compared to salt-water pearls. The content of manganese in shells and in soft parts, e.g. in the mantle of molluscs is influenced by environmental factors like temperature and salinity of water. We present results from analyzing pearls from fresh- and salt-water environments with proton induced x-ray emission (PIXE), cathodoluminescence (CL)-spectroscopy/-microscopy and electron spin resonance (ESR)-spectroscopy. We found that the concentric structure of fresh-water pearls is often a mixture of different carbonates containing calcite, Mg-calcite and aragonite phases depending on environmental and lifetime characteristics. Aragonite dominated zoning in fresh-water pearl often contains sub-microscopic calcite and Mg-calcite phases. Using the combination of PIXE and CL-spectroscopy/microscopy we evaluate the Mn^{2+} concentration and relative Mn^{2+}- distribution coefficient in these mineral phases. The ESR-analyses were performed to investigate paramagnetic defects caused by radiation experiments and by the charge transformation of Mn^{2+} to Mn^{4+} in the calcite, Mg-calcite and aragonite phases.