Monitoring Environmental Changes through the Lens of Oyster Shells from the 1600’s through Today

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Background

- John (2016) compared the Crassostrea madrasensis to a study in 1962 by Smith & Wright, which led to the conclusion that environmental factors cause different concentrations of minerals.
- Calcium was found to have the highest concentration followed closely by Carbon, with other elements, like Sodium, Magnesium, Sulfur, Strontium, Hydrogen, Silicon, Iron, Copper, and Zinc detected (John, 2016).
- The effects of changes in seawater carbon dioxide concentration varies among marine calcifiers (Ries, 2011).
- Calcite and Aragonite are minerals of CaCO3, that could be contained in oyster shells (Tai & Chen, 1998).
- During the American Industrial revolution, sulfur and nitrogen compounds were released, and affected the marine ecosystem (Onion et al., 2009).
- A study published in 1998 about the Hudson River stated that Ag, Cd, Cu, Pb, and Zn were found in the water from the contaminants being released at the mouth of the estuary (Feng et al., 1998).
- Phosphate rock and phosphorite are names used for sedimentary rocks that contain deposits, and therefore the rate of P reserves are depleting (Samreen & Kausar, 2019).
- Research Aim: Determine if development around New York over the past few centuries has changed the elemental composition and abundance in oyster shells.

Methods

Sample Collection

Oyster shells (Crassostrea virginica) from the 1600’s and 1800’s were donated from the archaeological collections of NY City Landmarks Preservation Commission. Modern oysters were collected from NY Harbor.

Sample Preparation

XPD - oyster shell pieces broken off and ground to powder with a mortar and pestle, then loaded into kapton tubes. TES - oyster shells were sectioned 30um at Spectrum Petrographics, and mounted with superglue on Suprasil 2A quartz glass.

Data Analysis

Beamline Specifications

<table>
<thead>
<tr>
<th>XPD</th>
<th>28-ID-2, XPD (X-ray Powder Diffraction)</th>
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<tbody>
<tr>
<td></td>
<td>Perkin Detector</td>
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<tr>
<td></td>
<td>Wavelength: 0.19316 Angstroms</td>
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<td></td>
<td>Distance: 1479 mm</td>
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<tr>
<td>TES</td>
<td>8-9M, TES (Tender Energy X-Ray Spectroscopy)</td>
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<tr>
<td></td>
<td>Energy: 2700eV</td>
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<td></td>
<td>Distance: 40 mm</td>
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</tbody>
</table>

Data

Figure 2: RGB images of each oyster shell reveal the presence of Sulfur (green) and Strontium (blue) in each shell, while Phosphate (red) is only present in the older oyster shells and not the modern shell. The 1600’s and 1800’s images are 5um pixels while the modern image is 25um pixels and also depicts pink and purple grains of sand filler in the epoxy mounting material.

Discussion

- Minerals identified by XRD were: Aragonite, Calcite, Calcium Carbonate, Calcium Phosphate, Apatite.
- Light elements identified by XRF were: S, Sr, Ca, P.
- Conclusions
  - XRF imaging at TES revealed Phosphorus in 1600’s and 1800’s shell that was not present in modern shell. XANES determined speciation is phosphate.
  - XRD at XRF revealed shells contain calcium phosphate.
- Future Research
  - Continue TES data analysis
  - Additional beam time at XPD using whole shell
  - Proposal for SRX or XFM beam time to identify heavy metals
  - Requesting additional oyster shells for analysis

References


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