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Bacterial sulphur and iron cycling and deterioration of historic ships

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Little is known about biogeochemical processes operating in marine archeological timbers from the time of their burial to their subsequent conservation. An understanding of these processes is essential to ensure successful conservation of historic ships. Of particular relevance is elucidating the impact of bacterial biofilms and biomineralization reactions on wood acidification associated with the so-called "*sulphur problem*" (SP). Such acidification poses a serious threat to structural integrity of restored historic ships such as 16^{th} century flagship of King Henry VIII "*Mary Rose*", 17^{th} century Swedish warship the "*Vasa*" and the 19^{th} century tea clipper the *Cutty Sark*.

Although it is recognized that abiotic and biological sulphur and iron cycling in timbers of these ships results in SP, the role of biofilms is controversial and poorly understood.

This presentation details studies of timbers from *Vasa*, *Mary Rose* and *Cutty Sark* under different states of preservation using techniques of confocal microscopy, microbial molecular ecology based on 16S rRNA sequence analysis, microbiology and surface science, e.g. synchrotron radiation methods. Our investigations revealed the rRNA diversity in acidified wood and demonstrated the presence of bacterial species associated with sulphur and iron redox pathways. Sulphate-reducing, sulphur oxidising and iron reducing/oxidizing bacteria were successfully cultured from wood samples, confirming molecular data. The chemistry and spatial distribution of minerals deposited within the wood matrix indicated that bacterial biofilms contribute to their formation. In view of these results the SP model depicting relationship between abiotic and biofilm-driven S and Fe redox reactions is presented and discussed.