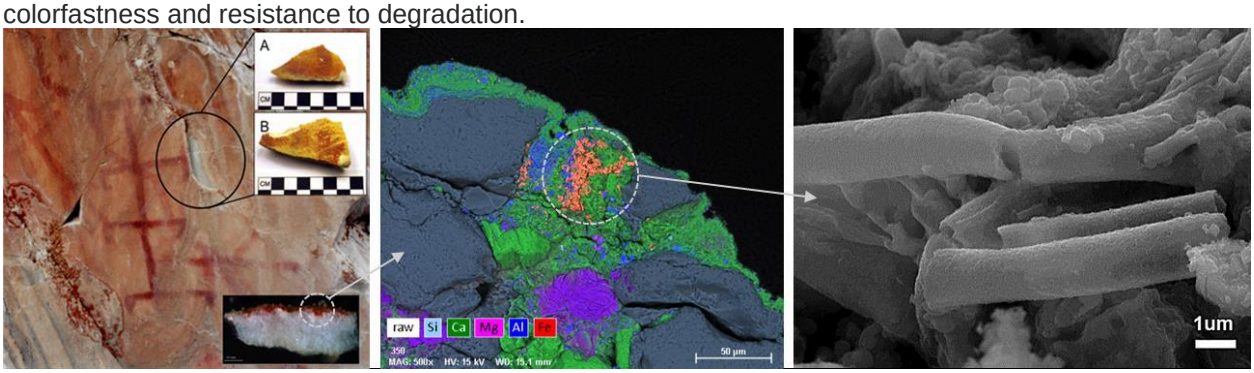
“Reconstructing Pigment Technologies: Evidence for Harvesting and Thermal Alteration of Iron Oxide Producing Bacteria to Produce Pigment for Rock Art”

David Stalla[1], Brandi L. MacDonald[2], Xiaoqing He[1,3], Tommi White[1,4]

[1]Electron Microscopy Core, University of Missouri, Columbia, MO 65211
[2]Archaeometry Laboratory, University of Missouri Research Reactor, Columbia, MO 65211
[3]Department of Mechanical & Aerospace Engineering, University of Missouri, Columbia, MO 65211
[4]Department of Biochemistry, University of Missouri, Columbia, MO 65211

Iron-enriched mineral deposits have been collected and prepared as pigment for use in rock art, personal adornment, and mortuary practices for millennia, yet little is known about early developments in mineral processing techniques in North America. Microanalysis of rock art pigments from the North American Pacific Northwest reveals a sophisticated use of iron oxide produced by the biomineralizing bacterium Leptothrix ochracea, a keystone species of chemolithotroph recognized in recent advances in the development of thermostable, colorfast biomaterial pigments.

Here we show evidence for deliberate human engagement with this bacterium indicating that controlled pyrotechnology was a key feature of how biogenic iron oxides were prepared into paint. Through employing an array of characterization techniques, including SEM-EDS with in-situ heating, HR-TEM, XRD, FTIR, Raman spectroscopy, and SQUID magnetometry, our results demonstrate that hunter-gatherers prepared pigments by harvesting aquatic microbial mats dominated by iron-oxidizing bacteria, which were subsequently heated in large open hearths at 750 °C to 850 °C. Such thermal treatment, representing a marked technological innovation, would have been implemented to enhance color properties, and increase colorfastness and resistance to degradation.



Dr. David Stalla - Sr. Research Technician, University of Missouri Electron Microscopy Core

David Stalla is a staff scientist at the University of Missouri’s Electron Microscopy Core, specializing in SEM and microanalysis. He received his PhD in Physics from MU in 2020 (during one of his department’s inaugural “Zoom defenses”), with his research primarily focused on developing and characterizing functionalized nanoporous carbons for adsorptive hydrogen storage. In addition to supporting the Missouri research community and having the opportunity to collaborate across a wide range of disciplines, David is especially excited to participate in preparing the next generation of scientists through both formal EM instruction and training as well as community outreach.