Library Undergraduate Research Award Essay

Richard D. Weimar III

The sculptures of classical antiquity, familiar to most as pristine marble-white, were originally vibrant and colorful creations. This so-called *polychromy* has been known for quite some time, and scientific analyses are the only way to accurately characterize the constituent pigments of a sculpture. These important analyses date as far back as the mid 18th Century! Despite this long history the field remains underdeveloped. Not only have old analyses been essentially nullified as scientific theory and technology have progressed, but very few modern studies provide sufficiently rigorous documentation of the scientific procedures or data in support of conclusions. Although such documentation may seem tangential to many readers, the use of scientific methodology warrants appropriate scientific rigor; to neglect this affords no opportunity to subject the findings to the scrutiny of peer review, and is irresponsible scholarship. This problem is recognized by leaders in the field who are working to better understand classical antiquity.

I know this not only from the literature, but also from my direct participation in cutting-edge research. My training in chemistry has equipped me well to analyze ancient pigments, and I have conducted Raman spectroscopy experiments for two state-of-the-art sculptural polychromy investigations: the Oplontis Project (in collaboration with the University of Texas at Austin) and the Orpheus Relief Project (in collaboration with the Georgia Museum of Art).

These interesting projects deal with polychrome sculpture of Pompeii, and are aimed directly at setting a new standard for disclosure and documentation. In doing so, they seek to firmly establish a comprehensive and fruitful intersection between the Humanities and the Sciences. Such an opportunity - to actively participate in establishing something new - is exciting and rare, particularly for an undergraduate scientist. However, the lack of high-quality literature makes reading for these projects difficult. To add to that difficulty, the profoundly multidisciplinary nature of these projects is, in a word, humbling. Case in point: to answer the question “What did this sculpted man clad in red communicate in Pompeii?” may only be completely answered with input from many specialists: historians, anthropologists, art historians, geologists, economists, classicists, physicists, linguists, artists, geographers, psychologists and, apparently, <u>analytical chemists</u>!

Clearly, to make the most meaningful contribution I could, I needed considerable background information covering a broad array of topics. Most immediately, I needed to hone my theoretical understanding of the analytical techniques I planned to use, especially those also used in the literature for similar analysis. These techniques included my *modus operandi*, micro-Raman spectroscopy (μ-Raman), and others, namely, polarized light microscopy (PLM), scanning electron microscopy (SEM), and energy-dispersive x-ray spectroscopy (EDS). The purpose behind this reading was twofold: first, a theoretical footing would allow me to understand my experimental results and identify the relevant instrumental and chemical phenomena to consider when interpreting data. Second, a theoretical understanding would enable me to adjust experimental methods and instrument parameters to best suit the needs of the sample and the needs of the project as a whole.

The Libraries' print media served as a great resource in learning these foundational concepts and also allowed me to learn about the different contexts in which each technique may be used. To aid in finding the right books, I utilized GIL in conjunction with Google Books' search abilities. Specifically, using Google Books to review the actual contents of a volume enabled me to quickly and efficiently identify the most relevant resources. Using this method, I was able to find a book on the μ-Raman of ancient artifacts, which proved an indispensable resource. It was especially nice when my research advisor had it delivered from the library!

Once my theoretical foundation was firm, I consulted the online literature databases, first to inform the actual experiments and second to investigate the latest advances in related fields. Of the most help were Web of Science and Google Scholar, whose "cited references," "related articles," and "times cited" functions proved enormous time-savers and very helpful at locating the information I needed. It is no exaggeration to say that without these online resources, I could not have interpreted any data or identified any pigments. Helpful, indeed!

To make the jump from confirming a pigment's *identity* to assigning its *significance* required taking the plunge into the liberal arts literature in a way I had never before experienced. To begin establishing this very other theoretical background, I mined print media and journal databases once more. I started with topics immediately relevant to pigment significance: the technological capabilities for synthetic pigment production, ancient concepts of color and the roles of visual media in Pompeian society, etc. However, an artist's choice of pigment(s) is not isolable from the whole sculpture, neither is the whole sculpture from its historical context; I quickly found the web of connections rapidly increasing in complexity with each layer of inquiry. For example, the significance of cinnabar, a bright red pigment, on the clothing of a sculpture is closely related to role of Roman visual media, which, in turn, is closely related to the literacy of the Roman populace. The Library's resources were absolutely essential, and enabled me to form some framework of understanding to make the connections from pigment to purpose. The thorough assortment of literature allowed me to synthesize my scientific understanding with the experimental results and to continue to synthesize the conclusions thereof with the historical sciences and liberal arts.

Such has been the nature of these projects: making the connections between the sciences and the humanities has been the intentional task of the scholars involved, and where the literature is silent - often because it does not yet exist - connections have been made anew. These projects have certainly stretched me as a scientist and researcher; their inherent demand for a full body of resources has profoundly influenced my view of research. The opportunity to use chemistry to answer non-chemical questions has been a welcome challenge and has significantly developed my understanding of chemistry's articulation with other fields.

Abstract

The white marble of ancient Greek and Roman sculpture and architecture was originally vividly colored. This polychromy was first demonstrated with the 'Treu Head' in 1889; since then, archaeologists' and historians' view of the ancient West has become much more colorful. However, until the development of modern scientific technologies, the analysis of these masterpieces was limited largely to stylistic and historical approaches. Despite the huge wealth of information and insight that becomes available with state-of-the-art analytical chemistry techniques, their application to archaeological artifacts has not be refined or widely applied. The highly multidisciplinary studies described in this work – The Oplontis Project and The Orpheus Relief Project – seek to establish scientific analyses as integral to further advances in the fields of archaeology and art history. To do this, we intend to completely disclose all scientific data and experimental procedures for peer revision and critique. In doing so, we seek to set a new, high standard for future contributions and to robustly establish a fruitful intersection between the physical sciences and the humanities. This particular work encompasses our technical findings on the first-ever scientific analysis of polychrome statues in the Gulf of Naples, along with findings on an ancient polychrome Roman relief currently on loan at the Georgia Museum of Art. The techniques used include micro-Raman spectroscopy, X-ray fluorescence spectroscopy, and near infrared luminescence spectroscopy.

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