

ANCIENT SCIENCE AND TECHNOLOGY
OF COLOUR: AN INTRODUCTION

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THIS double special issue is based on the papers delivered at the conference “Ancient science and technology of colour: pigments, dyes, drugs and their perception in Antiquity”, that took place in Pisa on 28-29 April 2022.¹ The conference was jointly organised by the authors of this introduction in the framework of two research projects: the ERC project “Alchemy in the Making: From Ancient Babylonia via Graeco-Roman Egypt into the Byzantine, Syriac and Arabic Traditions (acronym *AlchemEast*), based at the University of Bologna, and the University of Pisa research unit of the PRIN project “Material and Visual Culture of Science: A *Longue-Durée* Perspective”. On that occasion, historians of ancient science and technology, archaeologists, and historians of ancient art met in a joint, wide-ranging exploration of the production methods, uses, and conceptualisations of colour substances in the Graeco-Roman world as well as in the ancient Near East. Our project, strongly multi-disciplinary and the first of its kind, requested the investigation of a variety of sources, from ancient scientific and technical literature to archaeological data and results of chemical analysis. We are happy to say that all the participants did their best in shaping this challenging issue over two days of lively and friendly discussion that are to be fondly remembered, and their contributions to this volume have even exceeded our expectations. We are grateful to each of them for their part in what turned out to be a common, rewarding achievement.

One general assumption of our project was that in Antiquity the term ‘art’ encompassed a wide spectrum of practices, encapsulated by the malleable category of *techne*. Various defined and much debated by both natural philosophers and experts in different fields, *techne* could refer to a variety of activities that manipulated natural substances in order to produce a great number of artefacts. These *technai* did not develop in splendid isolation but belonged to a rich corpus of practical knowledge

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¹ In comparison with the conference, we slightly reformulated the title of this double special issue to underline how the experience of colour is a theme touched upon across most papers collected in these volumes.

that emerged across various ancient civilisations, from Mesopotamia to Egypt. Both textual and archaeological records testify to the array of techniques and procedures devised by generations of Babylonian, Egyptian, Greek and Roman metalworkers, dyers, glassmakers, painters – just to name but a few examples – who were all called *technitai* (namely, ‘artisans’) in the Graeco-Roman world. They all knew how to produce and exploit *pharmaka*, whether these were medicines, paints, dyes, or transmuting agents. In such a context, technologies often arose that were at the crossroad of different arts, and this is precisely the case of the making of pigments and dyeing substances, which had a tremendous impact on ancient painting as well as on pharmacology, alchemy, and so on.

With this input, the relations, if not the contiguity, between the dyes production workshops and those of painters, alchemists, or pharmacists have been extensively explored spanning time and space from the ancient Near East, through the Greek world, to the Roman age. In this volume, just like she did at the conference, Shiyanthi Thavapalan kicks off the discussion by pointing out the relationship between practical and codified knowledge that emerges from a set of cuneiform texts attesting the colouring procedures practised in Mesopotamian glass industry. Akkadian tablets also testify to a certain preoccupation for the durability of the dyed artefacts. Once produced, colours were to be maintained as discussed by Eduardo Escobar with special attention to wool dyeing technologies. Through a fresh analysis of a unique Akkadian tablet that records instructions for dyeing and re-dyeing wool, Escobar highlights both the technological and cultural values of these procedures.

The case studies collected in the special issue also help to address critical questions of broadest cultural significance about the connection between colouring practices and the sensible experience (or rather, experiences) of colour in ancient cultures. For example, it is noteworthy that the modes of production and distribution of a certain dye may end up charging the aesthetic effect of the corresponding colour with connotations of preciousness and luxury. This is the case with purple: that the latter was the most sought-after hue of antiquity finds rich confirmation in the research conducted by Gil Gambash, Beatrice Pestarino and David Friesem on the dense network of centres of production, dyeing, and commerce throughout the Mediterranean area.

The production of colourful gemstones and purple textiles are integral to the early development of alchemy in Graeco-Roman Egypt. Dye baths were used across different technologies for [dyeing](#) various materials, from quartz and wool to pearls and metals. Matteo Martelli’s paper focuses on the technology of colouring ‘waters’ that ancient alchemists used to dye metals gold and silver. These workshop practices, indeed,

underpinned early conceptions of metallic transmutation. Moreover, along with gold and silver, the black colour played a pivotal role in the development of transmutational theories, as discussed by Cristina Viano. This colour did not only mark a key step in the alchemical transformation of metals, but it also informed the term *chemeia*, that is, the name by which alchemy was referred to in Antiquity. At the conference in Pisa, Agnese Benzonelli further explored the value of black colour in ancient metallurgy by focusing on the so-called “black bronzes”, specific black alloys that were produced across different ancient civilisations. Various circumstances prevented the author from submitting a written version of her paper. She kindly agreed to provide us with a summary of her research, which has been included at the end of this introduction.

The material dimension of colours, crucial to ancient chromatic experience, comes to the fore in the following essays, embedded in what is one of the most fascinating strands in archaeology and ancient art history nowadays: namely, the study of polychromy in Greek and Roman art. One can find here, among other things, a plethora of indications that perceptual saliency and symbolic associations are determining factors for the choice of certain colours in visual arts, which boosts in its turn the search for sophisticated techniques for manufacturing pigments as well as applying them to works of art. In one of their papers, Ulrike Koch-Brinkmann and Vinzenz Brinkmann demonstrate the aesthetic effect of colouring bronze statues adding new insights to their previous research on the techniques of coloration of bronzes and even including the first report ever on a new bronze group; in the other, they reconstruct the millenary production and use of blue, favoured owing to its peculiar shininess, in the form of faience, glass, and pigment. On the other hand, Giovanni Verri and Hariclia Breccoulaki carefully analyse two specific cases of colouration (the whites of the eyes and the skin tones) and conclude with a welcome general invitation to take into account the transformations of meaning that ancient painting techniques undergo through diverse cultural contexts.

Still insisting on aspects of materiality, Agnès Rouveret investigates the definition and history of painting by Pliny the Elder in Books 34 and 35 of the *Naturalis Historia*, with a focus on the technique of *chiaroscuro* and the contrast between line and colour as considered, on the one hand, in the Greek treaties that are Pliny’s sources, on the other hand in the remains of Greek and Roman paintings. Pliny’s work (more precisely, Book 37) is also the key-text for the study of gemstones in early Imperial Rome, from which Chiara Ballestrazzi eloquently brings out a ‘semantic system’ rooted in the material and chromatic features of Roman culture.

Finally, it is noteworthy that colours were often deemed to be endowed with active power, as it seems to be the case in pharmacology, alchemy or magic, either in connection with a certain colour's perceptual salience or its symbolic and cultural associations, or both. This is the case with the *red earth* (*miltos*), whose pharmacological use is investigated by Effie Photos-Jones both through chemical analyses and a brilliant reading of a report by Galen on a religious ceremony in Lemnos.

Strengthened by the wealth of insights gained during this undertaking, Michela Sassi addresses the general issue of the chromatic experience of colours in the Greek world, introducing theoretical problems such as the Greek sense for grades of brightness rather than for hues; the scholarly discussion on relativism vs. universalism of colour taxonomies; the odd fact that Greek philosophers, in developing their theories about the nature and diversity of colours, could have resorted to numberless observations of manufactures and practices of pigments and dyes, but mostly did not.

Last but not least, each author in this volume exemplarily combines their specific expertise (be that history of philosophy and science, textual philology, archaeology or chemistry) with recourse to written sources, archaeological remains, or results of scientific analysis. Therefore, while we do not claim to have been able to completely map the network of innumerable relations that we had set out to outline, we firmly believe that the inquiries collected in this volume can offer the first lines of an innovative and fertile picture encouraging new transdisciplinary explorations.

APPENDIX: SUMMARY OF AGNESE BENZONELLI'S RESEARCH ON BLACK BRONZE ALLOYS ¹

Dr. Benzonelli's talk focused on the combined archaeometric and archaeological study of "Black bronzes alloys", a class of artificially patinated materials used for high-status objects from ancient Egypt to modern China. Precious metals are added to copper and submitted to various treatment techniques to develop a fine, durable black patina. Current knowledge on black bronze production technologies mainly derives from translations of ancient texts, with no proper assessment of their feasibility or efficacy. Moreover, the assignation of certain materials vaguely described in ancient texts to the class of black bronzes alloys is dubious. One example is the Corinthian bronze, a highly valued material in classical antiquity but not clearly defined, that is currently included in

¹ We warmly thank Agnese Benzonelli for providing us with this summary of her current research.

this class of alloys, while, in fact, various theories have been submitted about the material composition and manufacturing ingenuity.

In Benzonelli's study, a series of black bronze alloys with controlled compositions of tin, gold and silver was produced and treated using four different techniques: chemical patination with solutions mimicking those in traditional methods; Chinese patination with perspiration; thermal patination; and simulated natural corrosion. The resulting patinas were examined with a wide range of analytical techniques (including OM, SEM-EDS, XRF, XRD Raman spectroscopy, colorimetry), and provide important information about the characteristic features of each process and the composition, microstructure, colour, appearance, and durability of different patinas.

An analysis of Eastern and Western archaeological artefacts from various museums was compared with the experimental dataset to provide insight into manufacturing procedures and materials employed by different cultures to create black bronzes. This procedure allowed the author to elucidate the technical choices behind alloy preparation and composition, solution ingredients and patination processes. Examination of Chinese and Japanese artefacts, together with information from written sources, confirmed the presence of a well-defined, sophisticated tradition and time-honoured recipes for black bronze alloys consistent with the existence of a knowledge transmission chain between ancient China and Japan.

Conversely, the designation of Egyptian, Roman and Anglo-Saxon artefacts to the class of intentional patinated artefacts is questionable and points to research gaps. Even if we accept these artefacts as intentional black bronzes, their variability suggests the lack of a standardised tradition with established recipes, making the previous proposition that these artefacts derived from a single technology highly unlikely and calling for a major reconsideration of the accepted knowledge that black bronzes were a time-honoured, well-defined class of alloys.

The 'sacrifice' of precious metals and the use of complex patination processes to turn bronze surfaces black suggest the symbolic importance of this colour and implore an understanding of underlying metalwork technologies and the consequent transmission of traditions in antiquity. Benzonelli's study provides a robust experimental framework within which to interpret an enigmatic group of metals and is the first to relate alloy composition, production technology, and physical-chemical patina features to the materials and production choices of ancient cultures. The systematic scientific knowledge in her research can provide an impetus for more substantive translations of historiographic sources. The methods and analytical protocols developed herein are of interest not only

to archaeologists and archaeometallurgists but also to museum curators and conservators who work with artefacts from a range of cultures and can lead to a more well-informed display of artefacts, thus engaging wider audiences at the intersection between science and the humanities.

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