Scientific analysis of historical paint and the implications for art history and art conservation. The case studies of naples yellow and discoloured smalt.
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INTRODUCTION

Over the past decades a new branch of art historical research, known as technical art history, has evolved. In technical art historical research the subject of study is the production process of works of art. Knowledge on the manufacturing of art is becoming increasingly important. Various factors have given rise to this new, interdisciplinary field of research. First of all, proper conservation and restoration treatment of art is ever more dependent on knowledge of the materials and techniques used in the making of an artwork. Secondly, authenticity research relies more and more on the material and technical analysis of an art object. In addition, material characteristics of an artwork have proven to be a rich source of information about the piece of art itself, giving insight into aspects of the artistic concept, function, context and other, immaterial aspects of the object concerned.

It should be noted that conventional art historical research has long been dominated by theoretical, literary, iconographical and stylistic examination of art. While traditionally little attention has been given to the technical examination of works of art, in recent years technical art historical research seems to have become gradually integrated in mainstream art historical research. Nowadays, catalogues raisonnées, monographs on artists, as well as exhibition catalogues usually contain a chapter on the technical characteristics of the works of art involved.

Subjects of this study are the production history of Naples Yellow and the discolouration of smalt. Naples Yellow, or lead antimonate yellow, is the most important synthetic yellow pigment in the history of the visual arts. The usage of lead antimonate covers a period of more than 3500 years, the first application of the pigment dating back to the 18th Egyptian dynasty (ca. 1500 BC). The production history of the pigment, notably over the past few centuries, is rather diverse and not well understood. This research project focuses on the European history of the pigment from the 16th to 19th century. The aim of this study is to describe different manufacturing methods and, subsequently, different forms of lead antimonate used over time, thus opening the basic possibility to date lead antimonate paint samples of unknown origin.

Unraveling the history of the manufacture of Naples Yellow requires a comparative research studying textual sources as well as scientific analysis of authentic pigment material. After interpretation of historical production literature reconstructions of the pigments are made according to the descriptions in these sources. In addition, paint samples were taken from historical paintings of known origin. Subsequently, painting and reconstruction samples are studied using various analytical techniques. Both paths of research, scholarly interpretation of sources and scientific analysis of art objects, as well as some peculiarities of such interdisciplinary research are discussed in chapter 1.

During the Middle Ages the application of lead antimonate yellow seems to have been
limited to the Eastern Mediterranean. The use of the pigment is then suddenly taken over by Italian ceramic artists during the early 16th century. The circumstances under which lead antimonate suddenly popped up in Italian Renaissance are investigated in chapter 2. Two contemporary manuscripts are discussed in which the synthesis of lead antimonate yellow is described. Reconstructions according to these pigment recipes show that at least three, possibly four different types of lead antimonate can be produced. Furthermore, textual examination of the recipes provides evidence on the origin of the manufacturing know-how.

Chapter 3 deals with the introduction of lead antimonate yellow in Northern European painter studio's after 1700. Until the early 18th century lead-tin-yellow remained the most common yellow pigment, but was completely replaced by lead antimonate yellow at the middle of the 18th century. This development is discussed from technical, economical and art historical points of view. In addition, a contemporary Northern European manual is examined and pigments are reconstructed according to the descriptions given by that manual. The results show interesting characteristics of 18th century lead antimonates that clearly differ from earlier Italian types.

Various original samples of 19th century lead antimonate yellow have been preserved in several historical pigment collections. In chapter 4 pigment samples are subjected to extensive analysis, including synchrotron- as well as laboratory-based X-ray powder diffraction. Again, chemical characteristics of these samples are discussed in the context of 19th century textual sources on lead antimonate yellow.

While the earlier chapters deal with chronological characteristics of lead antimonate production, chapter 5 is aimed at locating the geographical origin of the pigment. Lead isotope analysis (LIA) is used to determine the exact isotopic ratio of naturally occurring lead in lead-bearing material. LIA was performed on a few 18th and early 19th century samples of lead antimonate yellow. Samples were taken from historical pigment collections as well as a painting of known date and origin.

Chapter 6 discusses the digital colour reconstruction of a 17th century Dutch painting containing discoloured smalt. Smalt is one of the most common 17th century blue painting pigments. Being at the time a relatively cheap pigment, smalt was used as a substitute for other, more costly pigments roughly between the 15th and 17th centuries. As main disadvantage, however, smalt has shown to discolour over the years. Employing a variety of analytical techniques, this chapter presents the digital reconstruction of the approximate original appearance of a painting suffering from severe smalt discolouration. This chapter also discusses the pictorial and art historical implications of paint discolouration.